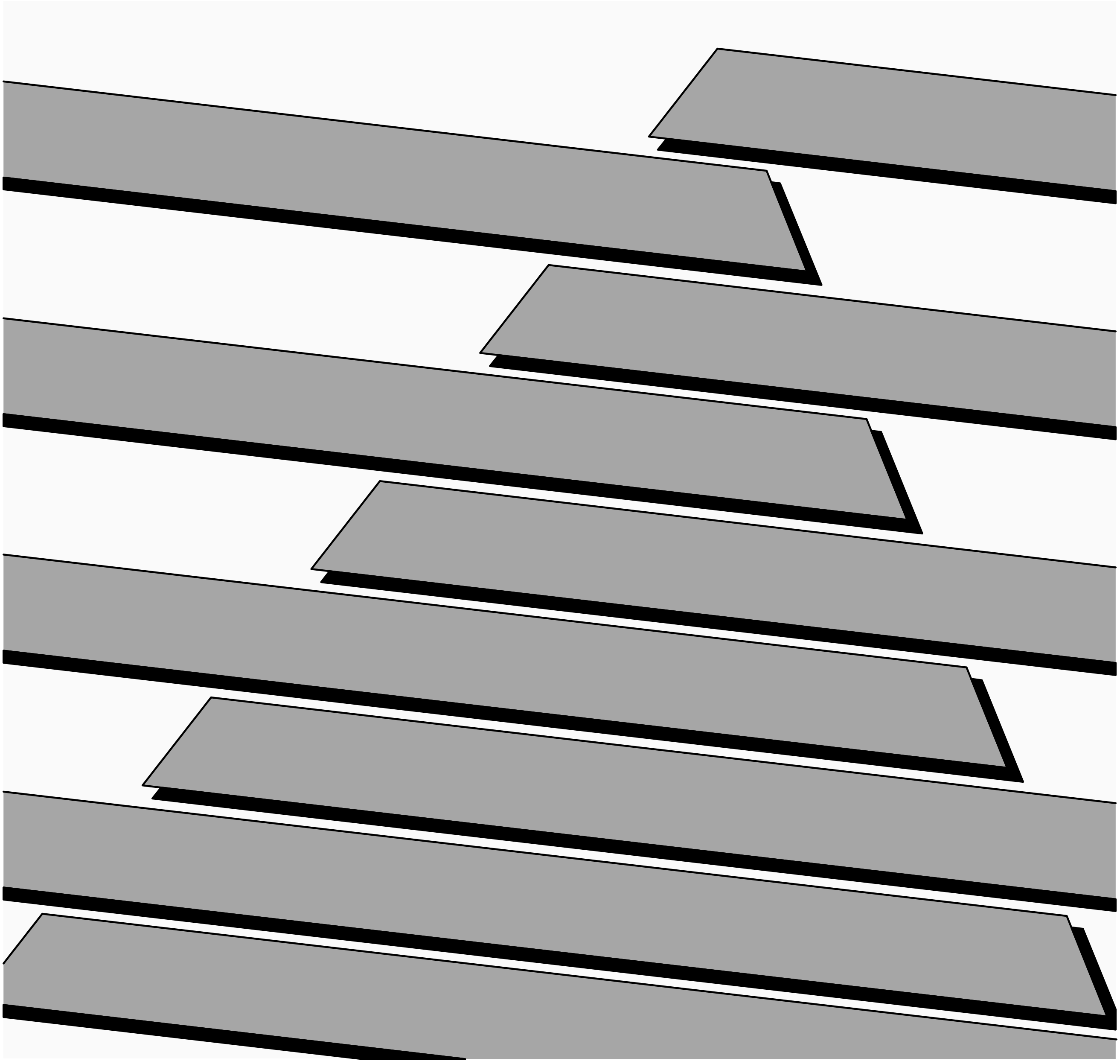
ALLEN-BRADLEY

Attended Workstations

(Catalog Nos. 2708-DH5B2L & -DH5B4L)
(Series B)

User Manual



Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. “Application Considerations for Solid State Controls” (Publication SGI-1.1) describes some important differences between solid state equipment and hard–wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Table of Contents
Attended Workstations
User Manual

Introduction

Installing a Network

Barcode Connection

Status Displays

Configuration Menus

Operating Procedures

Network Design

Host Communications

What is BASIC

Developing and Running An A-B BASIC Program

The A-B VBASIC Cross-Compiler

Special Devices in A-B VBASIC

A-B VBASIC Application Library

A-B VBASIC and Visual BASIC Tips

Differences Between A-B VBASIC and Visual BASIC

Application Library Subroutines

A-B VBASIC Limits

Chapter 1

Introduction

Chapter Objectives

Allen-Bradley workstations are designed to be rugged and very reliable when installed using the correct voltage and network cabling. An inexpensive network connector (Catalog No. 2708-NNC) has been designed in order to simplify the network installation. Although the workstations may be securely installed without this connector, it is highly recommended that this connector be used. The time saved and the ease of installation will be significant.

Chapters 2 through 4 describe network installation, host communication, and the connection of barcode scanners.

Installation of a network includes cabling (both power and network) and configuration of the workstations. In some instances, it may be necessary to consult Chapters 5 through 8 for detailed information on the proper ways to configure the workstations.

Catalog Numbers

The catalog numbers covered by this manual include Attended Workstations 2708-DH5B2L and 2708-DH5B4L.

Accessory Items

Accessory items for the 2708-DH5B2L and -DH5B4L workstations are listed below:

Item	Catalog No.	Description
DH5 Power Supply, U.S.	2708-NP1	Accepts 120V AC input power.
DH5 Power Supply, Europe	2708-NP2	Accepts 240V AC input power.
DH5 Network Connector	2708-NNC	Communications port connector that may be wired for point-to-point or multidrop applications.
Application Generator Software	2708-NAG	Menu-driven development software package for custom application programming. Includes Catalog Nos. 2708–NNM and –NBD.
Network Manager Software	2708-NNM	Terminal emulator software utilities package that allows the workstation to be configured for a variety of network configurations.
Basic Language Development Kit Software	2708-NBD	Contains a set of source files that can be used to reduce program development time.
Hand-Held Scanner	2755-G3, -G6	Visible laser diode, moving beam, hand-held scanner for bar codes.
Bar Code Wand	2755-W1	Visible red light source (high density bar codes).
Bar Code Wand	2755-W2	Visible red light source (low density bar codes).
Bar Code Wand	2755-W5	Infrared light source (high density bar codes).
Slot Scanner	2755-B1, -B2	Slot scanner for bar codes.

Related Publications

The following table lists the publications that are available:

Publication No.	Title	Purpose of Publication
2708-801	Application Generator User's Manual	Describes how to use Application Generator Software to create custom application programs.
2708-802	Network Manager User's Manual	Describes how to use the Network Manager Software to configure the workstation for a variety of network configurations.
2708-803	Basic Language Kit User's Manual	Describes how to use the Basic Language Kit source files to reduce program development time.
2708-2.3	A-B VBASIC vs. Visual BASICt	Describes the differences between standard Visual BASICt and the Allen-Bradley VBASIC modified for use with the 2708-DH5B_L workstation.

Safety Information

Throughout this manual we use notes to make you aware of safety considerations.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is especially important for successful application and understanding of the product.

Chapter 2

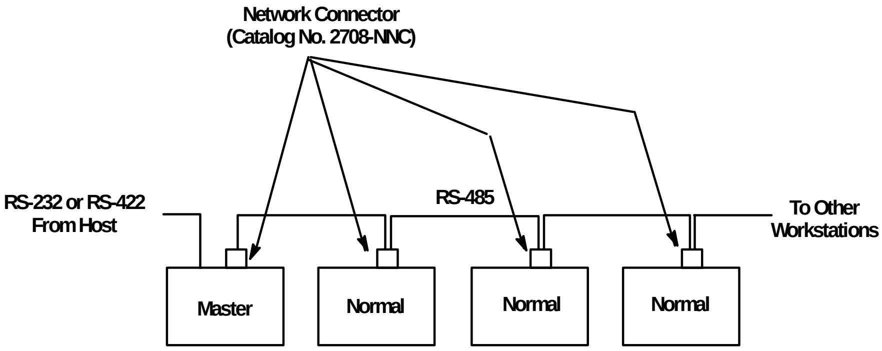
Installing a Network

Chapter Objectives

The physical network is based on a twisted pair cabling technique that follows the Electronic Industrial Association (EIA) RS-485 standard. This standard specifies the electrical characteristics of the balanced voltage digital interface circuit. This electrical standard is similar to the more familiar RS-422 standard. The RS-485 communication drivers are capable of withstanding greater voltage surges and tolerating more installation errors than standard RS-422 communications.

The RS-485 network cabling system used by the workstations is a daisy-chain (or multidrop) architecture. Each workstation is directly connected to its neighbor. An example of this multidrop architecture is shown in Figure 2.1.

Figure 2.1
RS-485 Multidrop Architecture



Although the workstations in the network may be physically identical, the network role of an individual workstation may be different from its neighbor. The seven possible network configurations are:

Normal	Standard Workstation
Master	Communicates with host computer via COM1
Alternate	Backup for the Master
Concentrator	Connects Submaster to backbone network
Submaster	Connects tributary to Concentrator
Alt Submaster	Backup for Submaster
Gateway	Master/Concentrator

These configurations are described in Chapters 5 through 8 along with workstation set-up instructions. It is necessary to understand the configuration set-up to be able to wire the network properly.

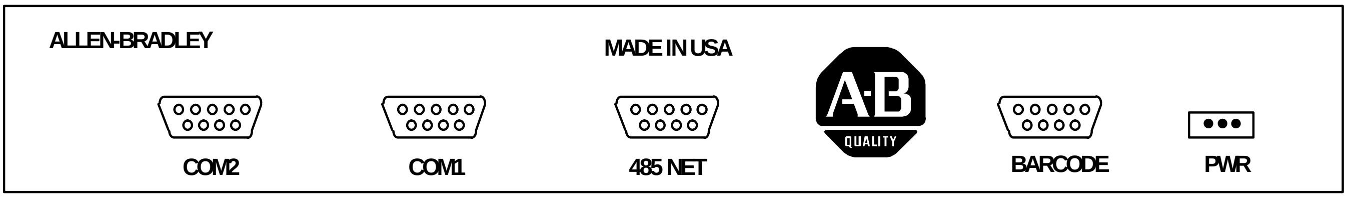
The network check out may be entirely accomplished by using the diagnostic tests resident in the workstations.

Simple Network

Power Requirements

Each workstation must be powered with 28V of AC power. This power is supplied by the power supply (Catalog No. 2708-NP1, -NP2) which is a sealed AC adaptor that is plugged into a wall outlet. The power output cable is plugged into the power connector as shown in Figure 2. A full diagram of all the connectors is shown in Figure 2.2.

Figure 2.2
Back Plate of the Workstation

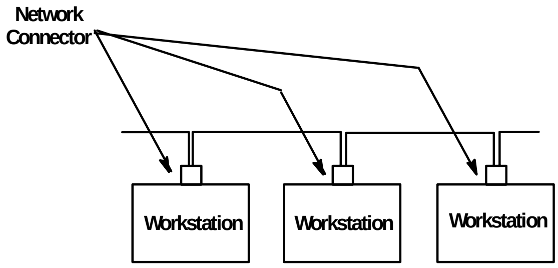


In a normal installation, each individual workstation is powered by its own power supply.

The RS-485 Network Bus

It is highly important to recognize that the network should be wired to appear as a continuous cable or bus and should not be spliced in a manner that allows the cable to make a 3-way junction. Figure 2.3 shows the right way to wire a network.

Figure 2.3
Correct Network Connection



Simple Network (cont'd)

Figure 2.3 shows the correct method of wiring a network. This figure shows the cable coming into the Network Connector (Catalog No. 2708-NNC) and making connection with the cable coming out of the connector. If the workstations are removed from their respective network connectors, it is easy to determine that a continuous cable or bus has been created.

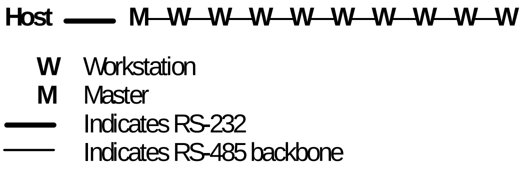
The network is a signal transmission line and cannot be treated the same as a power voltage line. The transmission line operates at considerably higher frequencies and therefore must be properly wired and terminated (resistance loaded). If this network transmission line is not installed properly, as shown in Figure 2.3, then voltage standing wave reflections (VSWR) and various other propagation phenomenon may occur.

This could cause workstations to not come on-line, drop off and on-line, or have multiple communication retrys in order to make a signal connection.

⚠ **ATTENTION:** It must be emphasized that the network cable be installed as a transmission line and not as a power voltage line.

As discussed in this section, a simple network consists of a single cable to connect up to 32 workstations. This is called a "backbone" network and is diagramed on Figure 2.4.

Figure 2.4
Simple Network Configuration



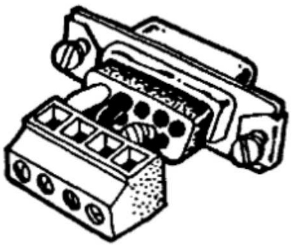
No more than 32 workstations can be connected to the same network cable. If more than 32 workstations are required, refer to the Complex Networks section.

The Network Connector (Catalog No. 2708-NNC)

The Network Connector is made up of three elements. These are (1) the plastic shroud or hood, (2) the DB-9 connector, and (3) the four screw terminal block. The terminal block is wired to the back of the DB-9 connector. The black terminal wire is connected to pin 5 of the DB-9 connector and is the network (–) side of the RS-485 network. The red terminal wire is connected to pin 4 of the DB-9 connector and is the network (+) side of the RS-485 network. The blue terminal wire is the workstation's terminal's chassis ground, and is connected to pin 8. The last terminal slot is open and is not connected to the DB-9 connector.

Simple Network (cont'd)

Figure 2.5
Network Connector (Catalog No. 2708-NNC)



Cabling a Network Using the Network Connector

Tools Needed — You will need a 3/32" flatblade screwdriver, and a pair of wire strippers/cutter.

Cable Wire

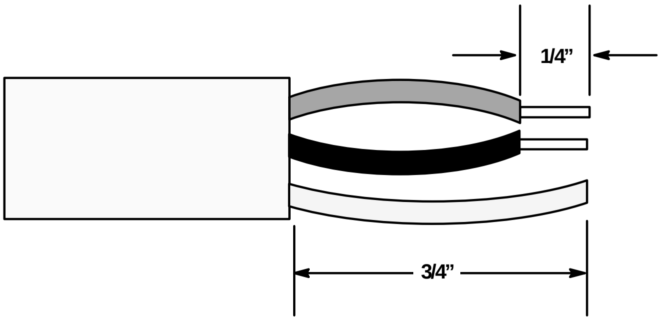
The recommended cable is a Belden 8723. This cable has 2 pair of conductors (4 wires) and a common drain wire. Although only one pair of conductors is necessary for the network, it is desirable to have a back-up or secondary pair in the event the primary pair has an open wire or some unforseen malfunction occurs in the primary pair.

The primary cable pair consists of a Red and Black conductor which match the color of the Network Connector leads. This primary pair will be used in describing the cable connection.

Preparing the Wire

Check that the cable is cut off evenly. (There should be no wire hanging beyond the cable insulation.) Remove about 3/4" of the insulation from the end of the cable. Strip about 1/4" of insulation from the end of each wire.

Figure 2.6
Cable Connecting Length



Simple Network (cont'd)

Installing the Connector

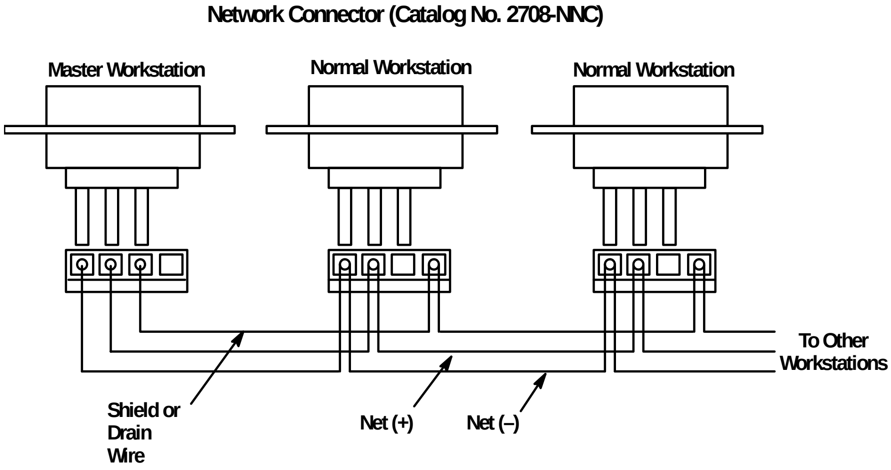
There are two types of connections using the Network Connector. These are a Master connection and a Non-Master connection. These connections are shown on Figure 2.7. The physical network connector is shown on Figure 2.4. An examination of both figures shows that there are four open sockets in which to place three wires; the network plus (+), the network (–), and the shield wires. In the Network Connector, the three wires connecting the terminal block to the pins in the DB-9 connector are color coded. This is consistent with all Network Connectors. It is advised the cable be color-coded to match the Network Connector to avoid confusion.

Master Connection

The network (–) wire is placed in the connector socket for pin 5 of the network connector. The network (+) wire is placed in the connector socket for pin 4 of the network connector. The shield or drain wire is placed in the connector socket for pin 8 and is the ground connection.

The shield wire is placed in the blue connector socket **ONLY** in a MASTER or SUB-MASTER connection. This will effectively ground the network cable at the MASTER only, and eliminate ground loop current problems.

Figure 2.7
Schematic of the RS-485 Network Using the Network Connector



Simple Network (cont'd)

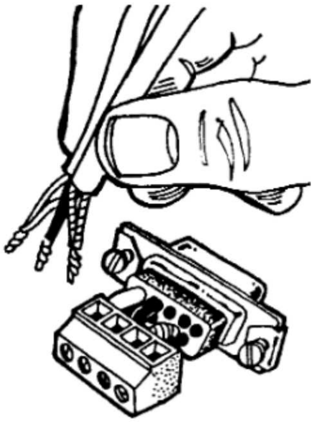
NON-MASTER Connection

The following connections are NON-MASTER connections:

Normal
Concentrator
Alternate
Alternate Master
Alternate Sub-Master

All Non-Master workstations, with the exception of the last workstation in the network, will have a cable going into and a cable coming out of the network connector. This will cause two wires to be installed in each connector socket. This is shown on Figure 2.8.

Figure 2.8
Two Wires in a Connector Socket



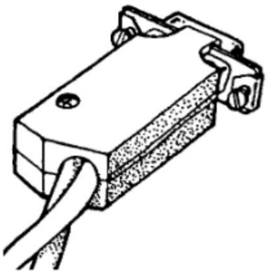
Twist the network (–) wires (black) together and place them in the black connector socket and tighten the screw. Next, twist the network (+) wires (red) together and place them in the red connector socket and tighten the screw. The only cable leads left should be the drain or shield wires. Twist these together and place them in the empty socket that has NO wire going to the DB-9 connector. Tighten the screw and then examine all connections to make sure they are secure and that no wires are touching any adjacent connections to cause short circuits.

If the cable was cut and stripped according to instructions, it should be straightforward to put the shroud on the network connector and complete the assembly. When possible, it is advantageous to use the cable restraint device in the connector to avoid pulling connections loose or breaking the wire. Remember, cabling problems are the number one cause of problems in a network.

Step By Step Installation

It is recommended that at least a simple volt/ohm meter along with assorted screwdrivers be acquired for installation.

Figure 2.9
The Completed Network Connector



Making a good cable installation is one of the keys to having a properly working network. Cable installation must always alternate between installation and inspection. The inspector’s job is to play devil’s advocate at each phase. By inspecting in phases, you avoid having to do the entire job over again when problems are found too late.

We recommend the following sequence:

1. Obtain tools, select connectors and cable type. Get a sample of the cable so you can identify the colors.
2. Draw a MAP of where each workstation is to be placed in the building or area. Trace a general path that the cable will follow in the physical building. Make multiple copies of this diagram. One good way to do the map is to get blueprints of the building and draw in the cables and workstations. Make sure that you note the WORKSTATION NUMBER which will be in each location, as well as the location of the Host computer.
3. Make color keyed cable drawings showing which color wires go to the pins of the connectors. We recommend you make multiple copies of this drawing, and store one copy with the installation map.

4. Run the cable through the building. Always leave a few extra feet at each workstation location so that there is room with which to work.

Step By Step Installation (cont'd)

5. Inspect the locations where the cable has been run, using a different person than the installer. **Make sure that the cable:**

   a. Is not run parallel to AC cables (BUILDING POWER) for more than a few feet at any time. This will avoid induction of AC onto your low voltage data network. Whenever the network cable must cross AC power lines, they should cross perpendicular to each other.

   b. Is not allowed to rest on top of fluorescent lamps in the ceiling. The ballasts from these lamps are worse than AC power lines.

   c. Is never spliced in a manner that allows the cable to make a 3-way junction. Network cables must be a bus. Only the Master workstation and the last workstation can have a single network cable going to them; all others will have two cables.

   d. Is not located next to or run over large motors, building transformers, or very large current areas, such as radiology labs.

   e. Is not located where it is easily broken or shifted around.

   Note: Make sure that the workstations are not next to building transformers, or large electric motors. Induced voltage spikes can affect the operation of the network.

6. Inspect visually every connector. It is recommended that a person, other than the one who connected the wires, inspects the following:

   a. Correct COLORS of wire have been connected.

   b. Be sure that ALL of the strands of the conductor are properly inserted into the connector. It is very easy to nick the wire when stripping it. This results in the strands breaking.

   c. Flex the wire at the connector a few times (this is not the time to prove your strength, THEY CAN BE BROKEN) to see if the wire has been badly nicked. It will break if this has occurred.

7. Inspect the pins for proper color in the proper hole.

8. Check continuity of the network cable by:

   a. Temporarily short pins 4 and 5 of the MASTER workstation's network connector together. You can do this with a clip lead, or use a female 9 pin solder type connector with pins 4 and 5 soldered together. (You can get solder type connectors at local electrical retailers.)

   b. Set the voltmeter to the 100 OHM scale (or the nearest available value).

Step By Step Installation (cont'd)

c. At the next workstation location, place the meter on pins 4 and 5. You should have almost no resistance. A good rule of thumb is 1 ohm for every 25 feet of network cable. If there is 400 feet of cable to the Master, then there should be no more than 16 ohms of resistance.

d. Try each workstation in turn, checking to see that the resistance does not change drastically. If the resistance is high, you may have a poorly crimped pin, or a partial break in the cable itself. If the resistance is infinite (completely open), then there is a break, or a broken conductor.

e. By going from one station to the next, you can isolate what segment of the cable has a problem.

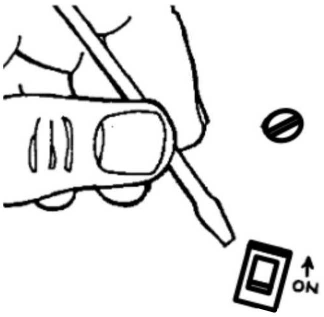
f. When the entire cable has been checked, remove the jumper from the Master's connector.

9. Install the hoods on the connectors. Attach the connectors to the workstations.

The Terminator Switch

After the network is installed, it is usually necessary to cancel out signal reflections inherent in any cable layout. To do this, flip on the terminator switch underneath the MASTER and SUBMASTER WORKSTATIONS ONLY. The terminator switch is on the bottom of the workstation. The ON position is toward the top of the workstation.

Figure 2.10
Terminator Switch



Note: The terminator switch should be OFF on all workstations except the MASTER and SUBMASTER. If other terminator switches are on, indeterminate network conditions will occur.

Communication Cables

The cables used to communicate from the Host computer to the Master or from a Concentrator to a Sub-Master workstation use either RS-232 or RS-422 signal standards. The connector pin-out diagrams for all of the possible workstation configurations are shown in Appendix D.

Testing the Network for Data Transmission

1. At the LAST workstation in the network, place the workstations into the menu setup mode (see Appendix B).
   a. Press the left arrow key (<) until the **Diagnostic** menu statement appears in the display.
   b. Press the **ENTER** key and then depress the left arrow key (<) until RS-485 – BLK-Rx is shown on the display.
   c. Press the ENTER key and the following should appear:

```
Rx = 00000      ERRS = 00
000
```

   If the counters are not zero, press EXIT, then press ENTER, and they should be set to zero.

   d. Repeat steps a, b, and c for all workstations, except the Master workstation.

2. At the Master workstation enter the **Diagnostic** menu and press the left arrow key (<) until RS-485 – BLK-Tx is shown on the display.
   a. Press ENTER and the display should show the following, momentarily:

```
Tx = 00000      ERRS = 00
000
```

   After the counters appear, the **Tx** counter will begin incrementing to represent the number of blocks being transmitted over the network to all workstations.

   b. An observation of the display of the workstations placed in receive will show the **Rx** counter changing accordingly as the transmitted network blocks are received.
   c. After a reasonable testing interval, press the **EXIT** key on the Master workstation, thus suspending the network block test.
   d. Examine each workstation to see that the Rx block count is the same. It should be the same at all workstations (It is possible to be off by one or two counts.) Also, inspect to see that ERRS count is zero or less than three. Either a missing block count or high error count indicates a bad network connection or a faulty workstation. Exchanging the workstation will determine which is the case.
   e. For additional confidence, perform step 1 at the Master workstation location and step 2 at the last location. Step 1 may be repeated at all other workstations. The changing of block transmission locations verifies communications in the opposite direction.
   f. Press **EXIT** three times on each workstation.

3. Always use retaining screws for all DB-9 connectors. Connect the RS-232 (or RS-422) cable to the host computer.

Communication to the Host Computer

Connect the WORKSTATION COM1 Port to the Host computer using a cable wired according to the pin-out diagrams shown in Appendix D. To communicate to the Host computer, it is necessary to be able to make your computer send and receive ASCII characters in an asynchronous communication manner. If a personal computer is used, programs such as PROCOMM^{R}, and KERMIT are ideal for this purpose. Most ASYNCHRONOUS TERMINAL EMULATION PROGRAMS will work. The communication set-up parameters must be the same for both the computer and the workstation terminal. Please see Appendix B, Menu Trigger Keys, for the procedure to enter the workstation menu mode.

If the program is resident in the workstation, press the menu trigger keys (Enter and Right Arrow simultaneously), disconnect power, then reconnect power while holding down the Enter and Right Arrow keys simultanenously to enter the workstation menu mode.

1. In the menu mode

   ```
   1—Network
      Menu
   ```

   will appear.

   Press ENTER; “Terminal Number” will appear.
   Press 1, then ENTER; “Terminal Type” will appear.
   Press < – until the terminal type changes to “Master”,
   then press ENTER, then press EXIT.

2. Press the < –, until “2-Comm Port Menu” appears. Press ENTER; “Comm Port Mode” will appear.

   Press < – until the mode changes to “XON/XOFF”.[1]
   Press ENTER; and “Comm Baud Rate” will appear.

3. Press < – until the baud rate is the SAME AS THE BAUD RATE SELECTED ON THE HOST COMPUTER. 9600 and 1200 are the most common baud rates.[2] In some cases NO character will show up if the baud rate is improperly set.

   Press ENTER; “Comm Data Bits” will appear.

4. Press < – until the Data Bits are the same as the Host computer. This is normally 7.

   Press ENTER “Comm Parity” will appear.

[1] For testing the cable connections, use XON/XOFF. If you are using a data collection program such as Network Manager Software (Catalog No. 2708-NNM), you may have to change this to “POLLED” before using such programs.

[2] If the baud rate is incorrectly set, when your computer sends characters to the workstation, unpredictable characters will show up on the display when you are in “COMM RECEIVE TEST” mode. In some cases NO character will show up if the baud rate is improperly set.

5. Press < – until the parity is the SAME AS THE PARITY SETTING ON THE HOST COMPUTER. A selection of "EVEN" is commonly used.[3]
   Press ENTER; "Comm Stop Bits" will appear.
6. Press < – until "One" appears.[4]
   Press ENTER; "Comm CRLF" will appear.
7. Press < – until "ENABLED" appears.[5]
   Press ENTER; "Comm Echo" will appear.
8. Press < – until "ENABLED" appears.[6]
   Press EXIT; "1-Network Menu" will appear.
9. Press OUT; "Diagnostics" will appear.
   Press ENTER; Press < – until "Comm Rx Test" appears.
   Press ENTER;
10. The following should appear on the two line display:

```

DTR: ON          CD: ON
```

Pressing the number 1 and 2 will turn DTR ON and OFF.[7]

11. Start the communication program on the Host computer. If the program is an asynchronous terminal emulator program, then characters that are typed on the computer are sent directly over the communication line. These characters should appear on the top line of the workstation display.[8]

12. Press EXIT; "Comm Rx Test" will appear.
    Press OUT; "Comm Tx Test" will appear.
    Press ENTER; The top line will be blank and the second line will show:

```

DTR: ON          CD: ON
```

The Host computer should be receiving a continuous transmission of

[3] If the parity is set incorrectly, the workstation will still RECEIVE characters properly. Your Host computer may not receive correctly, if at all.

[4] If the baud rate is incorrectly set, when your computer sends characters to the workstation, unpredictable characters will show up on the display when you are in "COMM RECEIVE TEST" mode. In some cases NO character will show up if the baud rate is improperly set.

[5] If you find that your computer is receiving double spaced lines from the workstation, then set CRLF to DISABLED. Also disable when using Network Manager Software (Catalog No. 2708-NNM) or similar software.

[6] If you find that when you are using your workstation program, you see two characters for each one you type (such as DDIISSPPLLAAYY//HHEELLOO//) then set Com Echo to DISABLED. Note that when using a data collection program (such as Network Manager Software (Catalog No. 2708-NNM) you will also DISABLE this option.

[7] Your computer may be unwilling to transmit characters unless these RS-232 lines are in the proper state. If you are having trouble communicating, check your cable diagram against the specifications for your computer's RS-232 port. Additionally, the workstation **requires** CD to be high (or on) for communications.

[8] Random characters on your computer or the workstation display indicate the baud rate is wrong. If about half of the characters are wrong or missing, the parity is set incorrectly. If nothing at all happens, the cable is wrong or something is broken.

"The quick brown fox jumped over the lazy dog"[9]type of messages. Communications can receive at rates that are faster than any terminal emulation program due to the use of POLLED mode as the COMM PORT MODE.

13. Press EXIT, three times
14. The AUX port (labeled COM2 on the back of the workstation) can be set up and checked out in the same manner as the primary COM1 port. The AUX port, however, is strictly a data transfer port operating with XON/XOFF flow control. It has transmit, receive, and signal ground lines. There are no modem control lines on this port.

The installation of the workstation in a simple network is now complete.

Complex Network

Description of Large or Complex Network

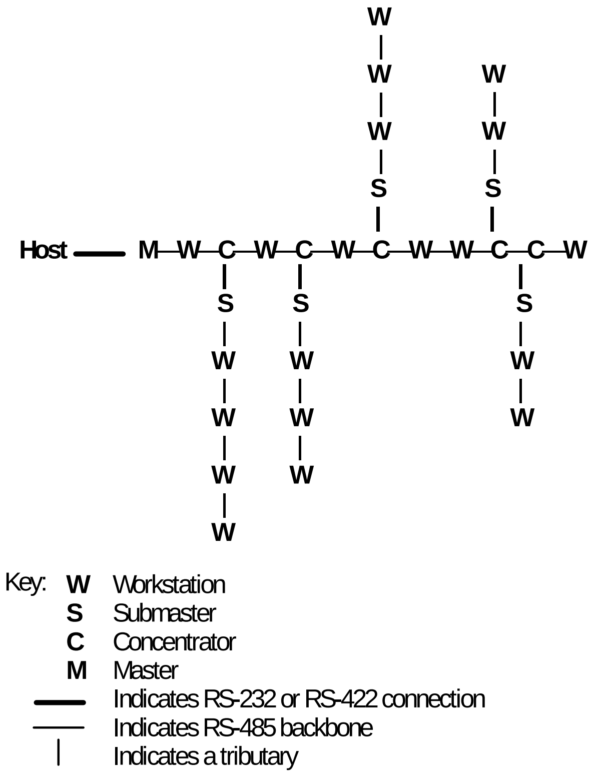
Installing a large or complex network of workstations involves connecting together several smaller networks.

The network which connects all of the smaller or sub-networks together is called the **"backbone"** network. Each sub-network is referred to as a **"tributary"** network. Up to 31 tributary networks may be attached to the backbone to form a very large network. Each tributary, in turn, may contain up to 32 workstations. A maximum of 1024 workstations may be connected in this fashion. Once the layout of such a network has been determined, cabling proceeds in the same manner as cabling for a single or backbone network. Both tributary and backbone networks are wired as previously described.

The workstation which is attached to the Host is configured as the **"Master"**. Each workstation on the backbone network that connects to a tributary network is configured as **"Concentrator"**. The workstation on the tributary which attaches to the Concentrator is configured as the **"Sub-Master"**.

[9] After a few seconds or minutes of receiving these messages, your computer starts displaying wrong characters or only parts of messages, then your computer (or the communications program) is unable to accept records at the rate they are being sent by the workstation. Try a lower baud rate on your Host and the workstation until you can receive successfully as quickly as the data is sent. Note that some programs such as Network Manager Software (Catalog No. 2708-NNM) can receive at rates that are faster than any terminal emulation program due to the use of POLLED mode as the COMM PORT MODE.

Figure 2.11
Large Network Configuration



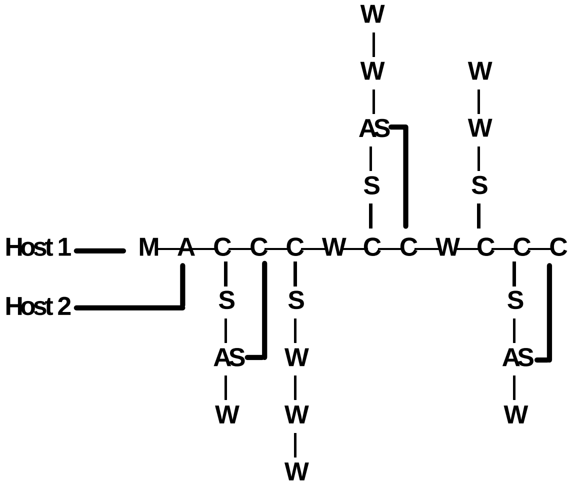
All of the workstations, including Masters, Concentrators and Submasters, are standard workstations which have been configured for their individual roles in the network. A configuration parameter is changed to allow any workstation to adopt a new role in the network. Each workstation is capable of operating in both a data collection and a data communications mode.

A workstation which is being used as a Master, Concentrator, or Submaster can perform data collection functions even while serving in the communication network.

Alternate Communication Links

When installing large networks, you may consider redundant communication links in order to protect against Host or Master workstation failures. This involves establishing certain workstations as **"Alternate Sub-Masters"**. Configuring a large network with Alternate Masters will allow the alternate workstation to take over communication operations if the designated Master becomes inoperable or is removed from the network. An Alternate Host provides full redundancy for collection in the event of a Host failure.

Figure 2.12
Large Network Configuration with Alternate Masters



Key:		
	W	Workstation
	S	Submaster
	M	Master
	C	Concentrator
	A	Alternate Master
	AS	Alternate Submaster
	━━	Indicates RS-232 or RS-422 connection
	——	Indicates RS-485 backbone
	│	Indicates a tributary

An Alternate Submaster will allow the communication operations to continue through a secondary Concentrator if the primary Concentrator becomes inoperable or is removed from the network.

Networks Over Telecommunications Lines

It is possible to configure a workstation network which spans multiple buildings, outposts, or sub-stations located at remote sites. Switched or leased telephone lines can be used with asynchronous modems to provide communication links for such a network.

Asynchronous short-haul modems may be used to extend the normal RS-232 communication distance from 100 feet to as much as several miles. To use modems for communications between a Concentrator and Submaster the workstations *MUST* have an RS-232 communication port (Workstation Catalog No. 2708-DH5B2L). A modem cable must be correctly connected to TXD, RXD, RTS, CTS, DSR, DTR, and GROUND signals (see Appendix D). The COMM BAUD RATE parameter must be changed to the same baud rate as the modem.

As soon as the modems establish communication between themselves, the remote system will be ready for use.

Extension of a network across telephone lines consists of placing a modem on one side of the line to connect with the Concentrator, and placing another modem on the other side to connect with the Submaster.

Figure 2.13
Extending Network Across Common Carrier

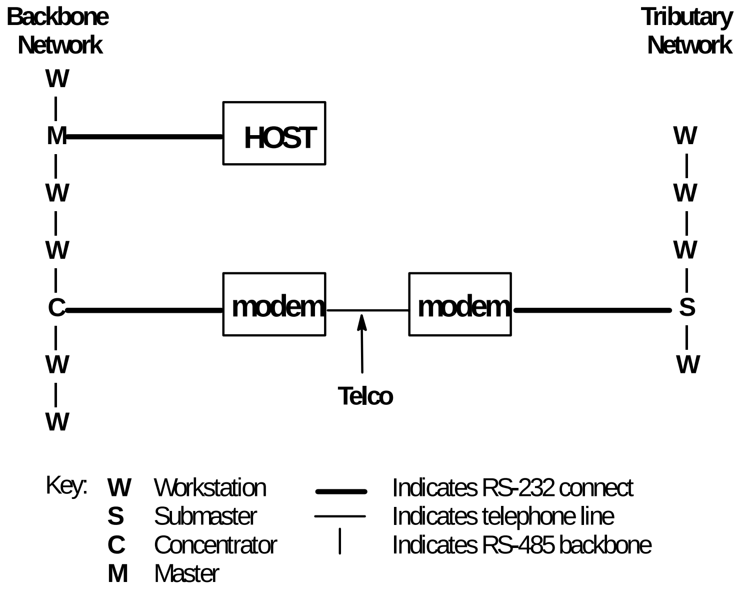
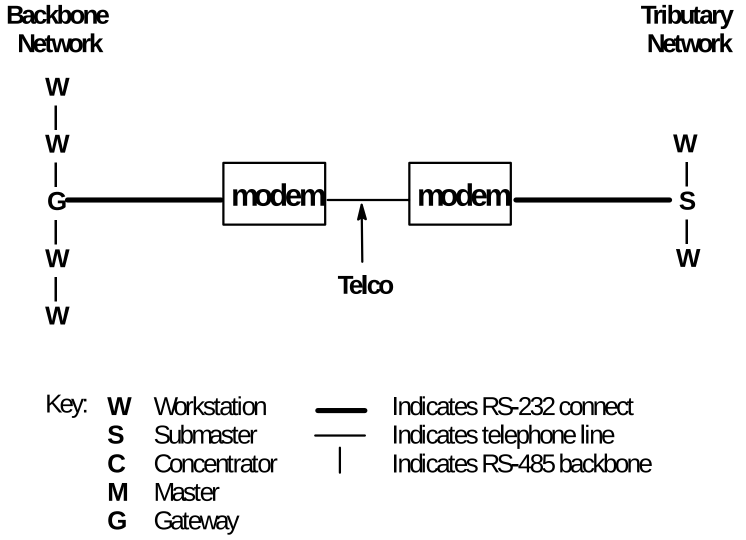


Figure 2.14
Use of the Gateway Option



Chapter 3

Barcode Connection

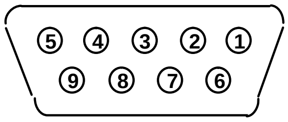
Chapter Objectives

The barcode connector on the back of the workstation is a 9 pin DB-9 connector for the bar code scanner.

Connection

The pin-out for the BARCODE connector on the back of the workstation is shown on Figure 3.1.

Figure 3.1
BARCODE Connector



Pin Number	Function
1	Start of Scan
2	Data
3	LED light
4	NOT CONNECTED
5	Trigger
6	Laser synchronization
7	GROUND
8	GROUND
9	Power (+5V)

Allen-Bradley offers the following barcode scanners for use with the workstation:

— Catalog Number 2755-G3 or -G6 Hand-Held Scanner

— Catalog Number 2755-W1, -W2, or -W5 Wand

— Catalog Number 2755-B1 or -B2 Slot Scanner

Chapter 4

Status Displays

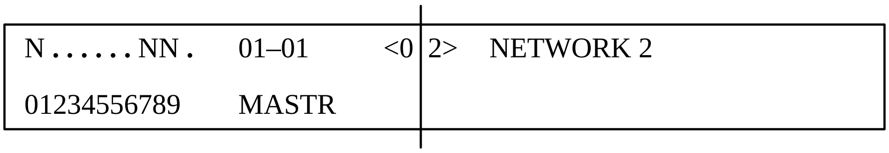
Introduction

The status display provides visible and easily available information concerning the state of the 2708-DH5B2L or -DH5B4L Attended Workstation. The workstation reports its operational status through ten informational displays on the front panel LCD Display. The status displays are automatically shown when the workstation is powered up unless a BASIC program is running. Each of the status displays is assigned a number from 0 to 9. To see status display 1, press the “1” key. When any number is entered, the workstation will present the status display associated with that number. The ten displays are:

1. **Network Status.**
2. **Reserved Status.**
3. **Time Status.**
4. **System Reset Status.**
5. **Network Que Status.**
6. **Workstation Memory Status.**
7. **Program Load Status.**
8. **Program Run Status.**
9. **Application Status.**
0. **Summary Status.**

On the workstation’s 2 x 40 display, two separate status displays will be shown.

Figure 4.1
Example Status Display



```
N . . . . . . NN .    01–01      <0 | 2>    NETWORK 2
01234556789           MASTR         |
```

Introduction (cont'd)

With the display, the workstation can show two status displays at the same time. In Figure 4.1, the summary status display is on the left hand side along with the reserved status on the right hand side. The '< 0'(in Figure 4.1) is associated with the summary status (left hand side), and signifies that the summary status is status display number zero. The '2>' tells us that the right hand display is status display number 2.

On the display, as the user selects a new status display, the new status screen will be displayed on the left hand side, and the display on the right hand side will be replaced by the one from the left hand side.

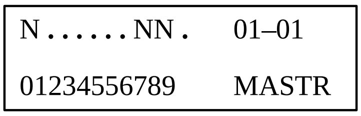
Invoking Status Display – Status displays are visible under these circumstances:

1. After power-up for 15 seconds.
2. When the workstation has a non-zero terminal number, but is without an A-B VBASIC program.
3. When the A-B VBASIC program terminates.
4. When manually invoked during a power up. This method will present the status display for 15 seconds after the last keystroke. The A-B VBASIC program, if loaded, will resume execution after this 15 second status display.

Summary Status Display (Status Display 0)

The Status Display 0 summarizes the status of the other nine status displays. The numbers 0-9 on the lower line represent the ten status displays. The information above each number refers to the number under it, i.e. the '.' over the 3 refers to the status display 3 – the time display.

Figure 4.2
Summary Status Display



```
N......NN.    01–01
01234556789   MASTR
```

Summary Status Display (Status Display 0) (cont'd)

Display No. / Name		Code	Description
1	Network Status.	 O S	Online Offline Standalone
2 3	Reserved Status. Time Status.	• T	Always a period Time is set Time is not set
4	System Reset.	• R	No serious errors Serious error occurred
5	Network Queue.	• O	Online Offline
6	Workstation Memory.	• F	Memory remains Out of memory
7	Program Load.	• N L	Program loaded Never loaded Loading error
8	Program Run.	• E N	No errors Run error Never ran
9	Application.	•	Always a period
0	Summary		

To view one of the other nine status displays, simply enter the number key associated with the status display desired while viewing status.

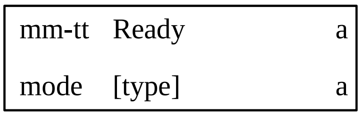
The '01-01' is the workstation number. The first number is the Master number (01), the second number is the individual workstation number (01). In this example the Master number and the workstation number are the same. In the case of Master number 06 and workstation number 24 the total workstation I.D. number would be '06-24'.

Network Status (Status Display 1)

The Network Status display shows information about the network. The information is updated many times a second, to reflect the status as it changes.

The information displayed appears in the following form:

Figure 4.3
Network Status, Display 1



```
mm-tt   Ready            a

mode    [type]           a
```

where, moving from left to right on the top line:

mm is the Master ID or Submaster attached to the workstation. If the workstation is not attached to a network string, no Master ID will be present.

tt is the workstation or station ID number.

Ready indicates that the application program is capable of performing a SEND operation. Alternately,

Full Indicates that there is no memory remaining in which to save data.

a represents the current polling address. The character which represents the polling address will be a space, while the unit has the factory configuration and is offline. If the workstation is online and waiting for a poll, a question mark will appear in this position.

Moving from left to right, the bottom line meanings are:

mode	ONLINE	The workstation will send records to its Master.
	OFFLINE	The workstation will not send records.
	TERMINAL	The workstation is in standalone mode, and sends each keystroke.

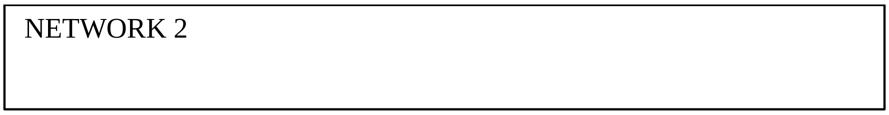
type The role the workstation plays in the network:

[N]	Normal
[M[	Master
[A]	Alternate Master
[C]	Concentrator
[SM]	Submaster
[AM]	Alternate Submaster
[G]	Gateway

Reserved Status (Status Display 2)

This display (Figure 4.4) currently has no function. Allen-Bradley has reserved this menu for future enhancements.

Figure 4.4
Reserved Status, Display 2

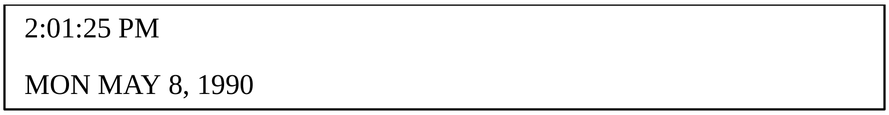


```
NETWORK 2
```

Time Status (Status Display 3)

This display shows the time and date.

Figure 4.5
Time Status, Display 3



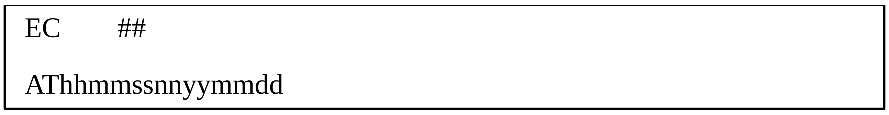
```
2:01:25 PM

MON MAY 8, 1990
```

To change the format of the time and data, simply choose the option CLOCK MODE on the system menu (menu 3). Refer to Appendix I for a description of the CLOCK MODE options.

System Reset Status (Status Display 4)

Serious errors encountered by a workstation are known as “system resets”. To try and correct a problem the workstation will reset itself and in the process will attempt to identify the error. The error is then logged, and the number of system resets is incremented.

Figure 4.6
System Reset Status, Display 4



```
EC      ##

AThhmmssnnyymmdd
```

The EC in Figure 4.6 represents the Error Code. The ## represents the number of serious errors. The lower lines gives you “at time and date”.

System Reset Status (Status Display 4) (cont'd)

A – Error Codes

1 Undetermined reason for failure

8, 10 These error codes could be the result of excessive power fluctuations or a sign that the workstation is not functioning properly because of a hardware problem. Technically, the error is a result of the micro-processor vectoring to the restart vectors. If the problem continues, contact your A-B representative.

82 Stack overflow

83 Bad transaction memory structure

84 Illegal interrupt

85 8048-64180 mismatch

86 Bad byte count from extended RAM

87 String from network not properly terminated

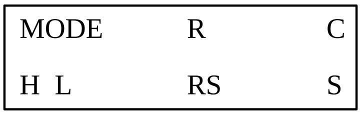
88 Invalid block address

89 Out of memory for files

Network Queue Status (Status Display 5)

This display presents the status of the data queues which link the A-B VBASIC program to the network.

Figure 4.7
Network Queue Status, Display 5



```
MODE        R        C
H  L        RS       S
```

The top line contains:

Mode [OFF] Offline, the workstation is unable to communicate with the Host.

[ON] Online, the workstation has established communications with the Host.

R Records From Host – Records from Host applies to the number of data records which have arrived from the Host. This number does not include network commands, only data destined for the A-B VBASIC program.

Network Que Status (Status Display 5) (cont'd)

C Count Of Records Lost From Host – This count is incremented whenever a data record arrives from the network, before the previous one was read by the A-B VBASIC program.

The lower line contains:

H Host Output Blocked Flag.

Data collected by the application is not being forwarded to the network, because the Host device is not currently OPEN by an A-B VBASIC program. Unless some action is taken to OPEN "Host", this data will be stranded. The condition can be cleared by an:

OPEN "Host"
KILL "Host"
KILL "QUE"

L Lost Data Flag

Data has been lost. This could be because the Host sent a record and the workstation was not ready to receive it, or the Host is sending faster than the workstation can process the data.

RC Record Count From Network – This is a count of the records which have been transmitted to the Host from the A-B VBASIC program.

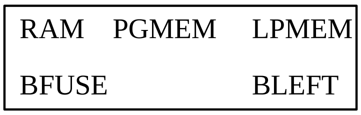
S Size Of Host Queue – This is the number of bytes currently in the que for transmission to the Host. Data in this queue can be prevented from going to the Host by:

1. A Host computer which has stopped polling (when the Master is in polled mode).
2. A Host computer which has issued a XOFF, (any mode).
3. The device Host being closed. This condition is associated with the Host Output Blocked Flag.
4. The workstation being offline.

Workstation Memory Status (Status Display 6)

This display presents information that describes the utilization of the workstation’s RAM.

Figure 4.8
Workstation Memory Status, Display 6



```
RAM   PGMEM    LPMEM

BFUSE          BLEFT
```

The top line contains:

RAM Total RAM Memory – Displays the total number of K bytes of RAM installed.

PGMEM Bytes Remaining For Program Use – This value shows the amount of RAM available for an A-B VBASIC program. The value is decreased from its factory default setting by the use of memory for:

1. Program pseudo-code (i.e. “logic”)
2. Program variables
3. Program pseudo-stack (for procedure returns, etc.)

This value is reset to its factory default when the first record of an A-B VBASIC program is received (the “>, AA record”). It is decremented as the program arrives and as it runs. Thus, this value reflects the difference between the factory default and the maximum used by the current application (A-B VBASIC program).

LPMEM Least Used Program Memory – This value represents the program’s peak memory utilization. A value of zero means that at some point, the program memory was full.

The lower line contains:

BFUSE Bytes For File Usage – This value shows the amount of RAM available for use in A-B VBASIC files.

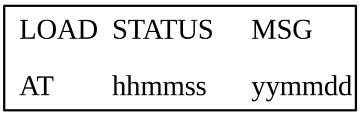
If this value ever reaches zero, the effect will be quite serious, unless the A-B VBASIC program detects this condition.

BLEFT Bytes Remaining For File Use – The amount of RAM available for file use that has never been used by the current application.

Program Load Status (Status Display 7)

This display shows the progress of the loading operation of the A-B VBASIC program on the top line and the date/time of the loading operation on the lower line.

Figure 4.9
Program Load Status, Display 7



```
LOAD  STATUS     MSG

AT       hhmmss     yymmdd
```

Program Load Messages that could appear on the top line are:

Never loaded This message appears from the time the workstation is set to factory defaults until the arrival of a program record.

Loading Line: xx This message is shown as each program record is received. It should take only a few moments at most to load a program. If this line is not being updated every few seconds, the download operation has been interrupted, possibly by a communications protocol error from the Host computer.

Loaded <filename> This message indicates that the A-B VBASIC program was loaded without error and started. The PC program name is shown. **Note:** This does not imply that the program loaded is currently running. For workstation run status, check status display eight.

Load Sequence xx – This message indicates that at least one of the records of the program was received in the wrong order. The ‘xx’ indicates the expected record.

Length Counters! – This message indicates that the counters holding the size of the program’s pseudo-code and array descriptions do not equal the total program length counter.

Load Length! – This message says the amount of pseudo-code received does not equal the number supplied in the total length count.

Program Checksum – This message says the checksum of the pseudo-code does not equal the value expected.

Program Load Status (Status Display 7) (cont'd)

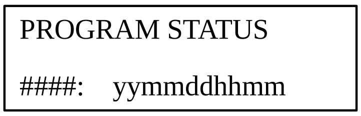
Interpreter Vers – Unlike the previous errors, this error is probably due to an incompatibility between the interpreter firmware in the workstation and the version of the LXB cross-compiler that made the program file. Consult technical documentation or Allen-Bradley representative to determine whether the compiler employed is correct for the workstation which is being downloaded.

The lower line tells you at what time and date the error occurred.

Program Run Status (Status Display 8)

This display shows the running status of the A-B VBASIC program.

Figure 4.10
Program Run Status, Display 8



```
PROGRAM STATUS

####:    yymmddhhmm
```

Program run status messages that could appear on the top line are:

Argument count
Argument count mismatch
Big file number
Copy record leng
Divide by zero
Double overflow
End of SYSTEM
File memory
File name overflow
File not open
File number busy
Formal Parameter
Format type mismatch
Get needs RANDOM
New Progrm Load
No field format
Not Data item
Not a NORMAL terminal type
Not string item*
ON jump out-of-range
Operator Abort
Open file limit

POP-LOAD wrong tag*
Pseudo-PC*
Pseudo-stack underflow
RETURN no GOSUB
Seek < 1
Seek past EOF
Stack tag*
STORE stack tag mismatch*
String overflow
String/Network type mismatch
Subscript range
Swap length
SWAP_STR IV item*
Tag required popping stack*
Type count mismatch*
Type for PRINT&WRITE*
Type mis: whole
Type mismatch

The offset in the pseudo code causing the message appears as ####: on the lower line with the date and time.

* Indicates a Bad Error Message (problem in the application program).

Application Status (Status Display 9)

This display is available for workstation application use. It is under the control of the A-B VBASIC program currently running. It's contents are set via the STAT device (see I/O supplement for details). Unless changed, the display reads as follows.

Figure 4.11
Application Status, Display 9

```
Application

Status
```

Chapter 5

Configuration Menus

Introduction

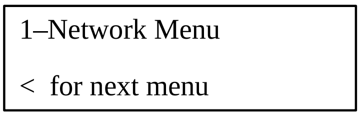
The workstation uses menus to make configuration parameters accessible and easy to change. They were designed to be entered, changed and exited by pushing various keys on the keypad. It is also possible to access the menus through the communications port using host commands. See section “Menu 2: Comm Port Menu Parameters”.

Using Menus via Workstation Keypad

In order to access the menus, press the menu trigger keys (Enter and Right Arrow simultaneously). If a program is loaded, the trigger keys must be held down while power is removed and then reapplied.

The first menu is the Network Menu and it looks like the display in Figure 5.1.

Figure 5.1
Network Menu



1–Network Menu

< for next menu

When the IN key is pressed, it will allow you to scan the six major menus, one at a time. They are:

1. **Network Menu**
2. **Comm Port Menu**
3. **System Menu**
4. **Bar Code Menu**
5. **Read Only Menu**
6. **Diagnostics Menu**

From the Diagnostics Menu, pressing <IN> one more time will cause the Network Menu to reappear. By pressing <OUT> you can scan backwards or you can select the desired menu by pressing the appropriate menu number. For example, if the Comm Port Menu is showing on the display, you can get to the Diagnostics Menu simply by pressing the <6> key. The Diagnostics Menu will now appear on the display.

Using Menus via Workstation Keypad (cont'd)

Sub-Menus

After you have selected the appropriate menu item, you can now examine the sub-menu by pressing <ENTER>.

With the exception of the Diagnostic Menu (which is discussed later), you can scan through the list of parameters by pressing <ENTER>, and scan backwards by pressing <CLEAR>. The parameter which appears on the display is the one which is selected.

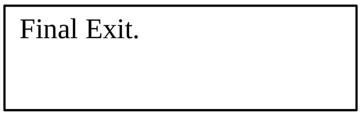
Once a parameter is selected, it may be changed. The settings or options suitable for that parameter can be examined/changed by pressing <LEFT ARROW>. For some parameters, this is a numeric item which requires that you enter a value in order to modify it. **Once the parameter has been changed, you must press <ENTER> for the parameter to be accepted.** If you press <EXIT> or <CLEAR> without having pressed <ENTER>, you selection will be ignored.

Note: Once you have entered the diagnostics menu (by pressing <ENTER> from the 6-Diagnostics menu) use <LEFT ARROW> to move through and select the diagnostic you want to execute. Press <ENTER> to start the diagnostic. Most diagnostics can be stopped by pressing <EXIT>. Pressing <EXIT> from any of the parameters will return the unit to the Network Menu (Figure 5.1).

Exiting Network Menu

Pressing <EXIT> from the Network Menu will exit the menus completely. First, “Final Exit” (Figure 5.2) will briefly appear on the display, to be replaced either by the status display, or in the case where a program has been already placed into the workstation, program run will begin.

Figure 5.2
Final Exit Menu



Final Exit.

Using Menus from the Comm Port

After you have attached the cable from the COM1 or COM2 port on a Master workstation to the appropriate port on your PC or Host, you must transmit a control character sequence from the communication port menu (see section titled “Menu 2: Comm Port Menu Parameters”). This is typically done by holding down the Control (Ctrl) key and pressing the appropriate letter key (T, C, O, or N) at the same time.

Note: The factory default configuration of the COM1 and COM2 ports is 9600 baud, 7 data bits, EVEN parity and 1 stop bit. The workstation will also ECHO each character it receives.

The following should appear on your PC:

Figure 5.3
Menu Mode

```
 ——Menu  Mode——
Use Backspace to select
Use Return for next item
Use Control-Z to exit
1–Network Menu
```

If the workstation does not show the text in Figure 5.3, then you should check to make sure:

1. The cabling is correct.
2. Your workstation baud rate matches that of the host.
3. The workstation has not been configured as a Concentrator, Submaster or Alternate Submaster.
4. A control character, such as Control-T, is selected to enter the menus from the comm port. Check the Comm Menu Character in the comm port menu.

The <BACKSPACE> and the <SPACE> key will allow you to select one of the following menus:

1–Network Menu	**2–Comm Port Menu**
3–System Menu	**4–Bar Code Menu**
5–Read Only Menu	**6–Diagnostics**

When you have selected the menu you want, press the <ENTER> key on your workstation. Each time you press <ENTER>, the display will skip down to another parameter in the menu. Holding down the <CTRL> and pressing <Z> (referred to as < ^Z>) will exit from the menu back to the 1–Network menu. Exiting from the Network menu with the < ^Z> will display:

```
Final Exit.
```

The workstation will then continue its normal operation.

Using Menus from the Comm Port (cont'd)

Notice that the selection of a parameter can be managed by scanning through the parameters using <backspace> or <space>. Also, the number or letter of the parameter you wish to invoke can be entered directly. In the case of the Diagnostics, this can be particularly helpful due to the large number of Diagnostics available.

Pressing <LEFT ARROW> will back through the parameters.

Note: To enable a parameter, you must press <ENTER> in order for your selection to actually take place. Pressing < ^Z> or <DELETE> will cause your selection to be ignored.

Menu 1: Network Menu Paramters

The following is a description of those parameters accessed by pressing <ENTER> when 1–Network Menu is showing on the display.

Workstation

Setting terminal to zero (0) turns the workstation into a dumb terminal ("standalone mode"). Normally a workstation will be configured as number 1-99. The terminal number (I.D. number) is 0 only when the workstation is used in standalone mode. A value between 1 and 99 must be used for the workstation to operate on a network.

Note: The selected workstation number must be different from the other terminals on the network. Two workstations cannot have the same terminal number.

Workstation Type

The six possible workstation types are:

Normal	Standard Workstation
Master	Communicates with Host via the Com1 port
Alternate	Backup for the Master
Concentrator	Connects Submaster to backbone network
Submaster	Connects tributary to Concentrator
Alternate Submaster	Backup for Submaster
Gateway	Master/Concentrator

Lower Poll Addr (1 - 99) – This value is set on each Concentrator/-Master workstation and specifies the lowest unit number that the Concentrator or Master should attempt to locate. It is used to expedite bringing units online in small network environments.

Host Port (COM or AUX) Select which port will communicate with the host device.

Menu 1: Network Menu Paramters (cont'd)

Upper Poll Addr (1 - 99) – This value is set on each Concentrator/-Master unit and specifies the highest unit number plus 1, that the Master or Concentrator should attempt to locate when bringing units online. It is used to expedite accommodation of workstations coming online in a small network environment.

Offline Cycle (normally 40) – This value is set on each Concentrator/-Master workstation and gives the number of online unit polls which will be performed before an attempt is made to find an offline workstation. Larger values will initiate fewer polls for offline workstations.

Max Net Retries (1 - 999) – This value is set on each Concentrator/-Master workstation and is the number of times that the Concentrator/Master will retry a failed poll before designating the workstation offline.

Comm Mode – The following communication protocols are selectable:

XON/XOFF
DSR
Polled
Request

Menu 2: Comm Port Menu Parameters

The following is a description of those parameters accessed by pressing <ENTER> when 2–Comm Port Menu is showing on the display.

Comm Port Mode

The four parameters available are:

The data collection software you use on your Host will determine which comm port mode to use. (If you are using the Network Manager Software package (Catalog No. 2708-NNM), set the comm port mode to POLLED.)

XON/XOFF Use Control-Q (XON) and Control-S (XOFF). In this mode, the Master sends the data records to the Host as they are collected. Records are sent from the workstation even if there is a problem with the Host, or no Host exists.

Note: If the host is not ready to receive the data, the data will be lost.

DSR Lower DSR to stop transmissions.

Polled The workstation transmits only when polled. However, if DSR or Polled mode are selected, XON/XOFF will also be honored by the workstation.

Request This mode does error checking and retransmission of all data blocks. It is intended for electrically noisy environments.

Comm Baud Rate

The following baud rates are available:

19200	**1200**
9600	**600**
4800	**300**
2400	**150**
	75

Comm Data Bits

The parameters are 7 to 8.

Comm Parity

Your choice of parities for 7 data bits are:

Even
Odd
None
Zero
Mark

Your choice of parities for **8** data bits are:

Even
Odd
None

Comm Stop Bits – Parameters available are:

One
Two
One and a half

Comm CRLF Parameters are Enabled or Disabled. When enabled, the workstation will send a line-feed after each carriage return that it transmits.

Comm Echo The choices are Enabled or Disabled. When enabled, the workstation will echo each character it receives from the comm line back to the communications line. **This must be disabled when communicating with most Host computers.**

Sync Count When 0, asynchronous communication is enabled on the COM1 port. **This should always be left at 0 (zero).**

Aux Baud Rate for COM2 – The following baud rates are available:

38400
19200
9600
4800
2400
1200
600
300
150
75

Aux Parity For COM2 – Parity choices are:

Even
Odd
None
Zero
Mark

Aux CRLF For COM2 – Parameter choices are:

Enable
Disable

Aux Echo For COM2 – Parameter choices are:

Enable
Disable

Comm Menu char – Parameter choices for enabling menu configuration from a host computer are:

^T
^C
^O
^N
NONE [Default]

This parameter specifies the character that is used from the comm ports to enter the menu mode. NONE is the default. If the selected character conflicts with the data transmission between the Host and the Master workstation, then it may be necessary to select another character to be used to signal the workstation to enter the menus.

When the NONE option is selected, it is not possible to enter the menus from the comm ports, nor is it possible to reboot the workstation with the ^R character.

Menu 3: System Menu Parameters

Time (hhmmss) Current time – This is one method of setting time in the workstation. Notice that the time shown is the time the menu was entered.

Date (yymmddw) Current date – This is one method of setting the date and day of week in the workstation. The date must be entered in year, month, and date order. The "w" represents the day of the week. (Sunday = 1 through Saturday = 7).

Menu Password 0-9999 – When this is non-zero, the workstation user will be required to enter this value before access to the menus is allowed.
Note: For added security, the user will be shown prompts for a 5–digit password, even though only four digits configured are entered.

Clock Mode 1 - 35 (normally 7) – This is a value which contrtols the format of the time on status displays. This does not affect the BASIC "Time$" variable. See Appendix I for the full list of formats, and examples of each.

File Block Size – This value controls the size of the blocks which are allocated for file usage[1]. Choices are:

256
512
1K
2K
4K

Menu 4: Bar Code Menu Parameters

The following is a description of those parameters accessed by pressing <ENTER> when the 4–Bar Code Menu is on the display.

Code 3 of 9 . . . . Enabled/Disabled
The workstation will auto-discriminate between codes that are enabled. In order for the workstation to even attempt to read a code, it must first be enabled. By default, only Code 3 of 9 is enabled.

Code 3 of 9 Check Digits Disabled/Enabled
Enables check digit verification of all codes read using Code 3 of 9.

[1] See the chapter on RAM files in the A-B VBASIC Program Development Manual.

Menu 4: Bar Code Menu Parameters (cont'd)

Code 3 of 9 Mode
ASCII . . . . Full ASCII character set.

Normal Only . . . . Does not allow +$ to switch mode.
ASCII Only . . . . Does not allow -$ to switch mode.

Code I 2-of -5 . . . . Disabled/Enabled
Used to enable Interleaved 2 of 5.

I 2-of-5 Check Dgts . . Enabled/Disabled

I 2-of-5 Length
This command enables and disables the I 2-of-5 label length checking. There are three types of label length checking:

n = 0
I 2-of-5 symbols can be of any (even) length between 4 and 32 digits, inclusive.

n > = 3 and n < = 32
Only symbols of length n will be read. If an odd value of 'n' is specified, it will be incremented to the next even integer since I 2-of-5 symbols must have an even number of digits.

n = 33
Then the symbols can be either 6 or 14 digits long.

Codabar . . . . Disabled/Enabled
Used to enable Codabar.

Code 128 . . . . Disabled/Enabled
Used to enable Code 128.

UPC . . . . UPC/EAN/JAN, UPC only, or Disabled
Used to enable UPC, European and Japanese Codes.

UPC Supplement . . . None, 2-digit only, 5-digit only, or 2 and 5
Enables reading of the 2 or 5 digit supplement to the standard UPC code.

Bar Header . . . . None or STX
This selects a header to be sent in front of bar codes which are SENT IN STANDALONE MODE ONLY. By default, no header is sent.

Bar Trailer . . . . CR, NONE, ETX, or TAB
This selects a trailer to be placed on the end of barcodes which are sent in STANDALONE MODE ONLY. By default a carriage return is sent.

Bar Echo . . . . Enabled/Disabled
This enables the echo of bar codes to the display in STANDALONE MODE ONLY.

Menu 5: Read Only Menu

The Read Only Menu displays the following information:

1–ROM configuration, version and date
2–RAM side
3–Serial Number
4–Program Load Status – i.e. never loaded or never started

Menu 6: Diagnostics Menu Parameters

The diagnostics provided in the firmware of the workstation allow testing of the internal hardware, as well as many devices which may be attached to the workstation.

The following are specific diagnostic tests with the identifier for each:

1–Kbd/Laser Test
2–Display Test
3–Dest. RAM Test
4–Cont. RAM Test
5–Comm Tx Test
6–Comm Rx Test
7–Comm Loop Test
8–Aux TX Test
9–Aux Rx Test
A–Aux Loop Test
B–RS485 Blk Rx (Block Receive)
C–RS485 Blk Tx (Block Transmit)
D–RS232 Blk Rx (Block Receive)
E–RS232 Blk Tx (Block Transmit)
F–Lamp Test
G–Reset Powerup
H–Reset Unit to Factory Defaults
* –Internal Use Only

Use the <IN>: key to scan forward and the <OUT> key to scan backwards, or use the number/letter of the test to select it directly. Press <ENTER> to start the test. <EXIT> stops most tests.

Menu 6: Diagnostics Menu Parameters (cont'd)

1–Keypad/Laser Test

This diagnostic test is used to check the keypad and bar code inputs of the workstation.

Keypad Test – To test the keypad press each key, which should echo to the display. The keys cause the following display echoes:

Q	echos q	W	echos w	E	echos e	R	echos r
T	echos t	Y	echos y	U	echos u	I	echos i
O	echos o	P	echos p	A	echos a	S	echos s
D	echos d	F	echos f	G	echos g	H	echos h
J	echos j	K	echos k	L	echos l	:	echos :
Z	echos z	X	echos x	C	echos c	V	echos v
B	echos b	N	echos n	M	echos m	?	echos ?
1	echos 1	2	echos 2	3	echos 3	4	echos 4
5	echos 5	6	echos 6	7	echos 7	8	echos 8
9	echos 9	0	echos 0	IN	echos +	OUT	echos -

Each alpha key described above will echo a Capitalized version of the letter pressed when the key is pressed concurrent with pressing the SHIFT key.

Some keys echo different characters when pressed concurrent with either the SHIFT or Alt keys. These are described below:

Key	:	,	.	?	!	1	2	3	4	5	6	7	8	9	0
SHIFT	”	*	/	(	)	1	2	3	4	5	6	7	8	9	0
Alt	’	;		<	>	[	@	]	{	^	}	&		|	_

Key	IN	OUT	ENTER
SHIFT	+	–	=
Alt	$	%	#

Alpha keys pressed with the Alt key produce Control-letter codes.

The following six keys do not echo but produce the following effects:

CLEAR . . . . clears the display and starts placing input characters at the home position.

LEFT ARROW . . . . . backs up the cursor by one position.

RIGHT ARROW . . . advances the cursor by one position.

SPACE . . . . inserts a space character and advances the cursor one position.

ENTER . . . . places the cursor at the left most position of the display line it is currently on.

EXIT . . . . will terminate the test.

Menu 6: Diagnostics Menu Parameters (cont'd)

Laser Test – All bar codes scanned will be echoed to the display (if this test was selected from the keypad) or to the comm line (if this test was selected from the comm line). When a bar code is scanned, the decoded data appears on the top line of the display. The bottom line of the display will indicate the type of code read (ie – Code 3 of 9) and the type of scanner used (laser or wand). If an error occurs, any one or all of the three following errors may appear on the second line of the display:

```
LRC error!
N Parity errors!
Timeout!
```

Press <EXIT> to terminate the test.

2–Display Test

If <ENTER> is pressed while 2–Display Test is on the display, the display test will be activated. All characters that can possibly be displayed will be displayed.

This test repeats indefinitely until the <EXIT> key is pressed.

Press <EXIT> to terminate the display test.

3–Destructive RAM Test

Note: This RAM test is identical to the test which is run when the workstation is reset to factory defaults.

The third diagnostic is a destructive test of all RAM. Since selecting this test will reset the workstation, the following message is displayed before the test is started:

```
Unit will reboot
after test
```

```
Enter to start
Clear to quit
```

If you do not want to run this test, press <CLEAR>, which will cause 3–Destructive RAM Test to be displayed. Pressing <EXIT> will then return to the Network Menu selection point.

Menu 6: Diagnostics Menu Parameters (cont'd)

If you press <ENTER> the 3–Destructive RAM Test will be started. The test is an exhaustive test of all RAM. It measures and testsd all RAM using memory to memory transfers, testing 48 at a time. Sub-tests include 00, FF, 55, AA, and AD.

The display will show the progress of the test. The top line of the display shows FULL RAM Test. The lower line shows the progress of the test.

It is followed by the ALIGNMENT which verifies that a byte stored at a 4K boundary address can be fetched using the same address. This test also checks for high address line failures by checking the unique contents of each 4K block.

The sub-tests are:

00 and FF . . . . Check the ability to store Zero and one bits.

55 and AA . . . . Ensure that adjacent bits are not “pairing”.

AD . . . . Stores and checks a pattern from 0 to 254. This skews the data in memory (from the 256 byte alignment) and checks for low address line failures.

Failure of the low RAM test halts the workstation unconditionally. The failure of the other two tests at powerup is not fatal, i.e., the workstation will run with whatever memory is available.

4–Continuous RAM Test

This is the same as the previous RAM test, except that it will run continuously. This continues until an error occurs or the workstation is powered off, and then on. This test will erase the contents of all RAM. Since this test also destroys the contents of all RAM, these messages are displayed:

```
Unit will run
test forever
```

```
Enter to start
Clear to quit
```

If you do not want to run this test, press <CLEAR>, which will cause 4–Continuous RAM Test to be displayed.

Pressing <EXIT> will then return to the Network Menu selection point. Press <ENTER> to start the test.

Menu 6: Diagnostics Menu Parameters (cont'd)

As the test runs, the display will show the progress of the test. The top line of the display shows FULL RAM Test. The lower line shows the progress of the test.

Note: The ONLY way to stop this test is to disconnect the power from the workstation; then reapply power.

5–Comm Transmit Test

When Enter is pressed while 5–Comm Transmit Test is showing on the display, the following prompt appears on the display:

```

DTR:    ON      CD:     ON
```

Pressing <IN> will turn on DTR.
Pressing < **-** (LEFT ARROW) will turn off DTR.

For any communications to occur, Data Carrier Detect (DCD) must be high. Any data transmitted to the workstation through the COMM port will be echoed to the display. For example, if another workstation is placed in “COMM Transmit test” and is connected via null modem to the device in “COMM receive test”, the following test pattern will be received:

> 0123456789 —<The quick brown fox jumped over the
> lazy dog.— 9876543210 <carriage return> [<line feed>]

The line feed is optional and is sent only if the Comm CRLF parameter has been enabled (in the Comm Port Menu). The bottom line of the display will show:

```

DTR:    ON      CD:     ON
```

The pattern is sent continuously until the <EXIT> key is pressed.

Pressing <EXIT> will terminate the test and display 5–Comm Transmit Test.

Note: This test will not operate on a workstation which is currently set up as a Submaster, Alternate Submaster or Concentrator.

Menu 6: Diagnostics Menu Parameters (cont'd)

6–Comm Receive Test

When Enter is pressed while 6–Comm Receive Test is showing on the display, the following prompt appears on the display:

```

DTR:   ON    CD:    ON
```

Pressing <IN> will turn on DTR.
Pressing < - (LEFT ARROW) will turn off DTR.

For any communications to occur, Data Carrier Detect (DCD) must be high. If DCD is high, and another workstation has been set to run Diagnostic 5–Comm Transmit Test, the following test pattern will be received through the communications port (single 80 column line):

```
0123456789   —<The quick brown fox jumped over the
lazy dog.—   9876543210 <carriage return> [<line feed>]
```

While operating this test, characters received will be echoed to the top line of the display. The bottom line displays:

```

DTR:   ON    CD:    ON
```

Pressing <EXIT> will terminate the test and display 6–Comm Receive Test.

Note: This test will not operate on a workstation which is currently set up as a Submaster, Alternate Submaster or Concentrator.

7–Comm Loop Test

When Enter is pressed while 7–Comm Loop Test is showing on the display, the following prompt appears on the display:

```

DTR:   ON    CD:    ON
```

Pressing <IN> will turn on DTR.
Pressing < - (LEFT ARROW) will turn off DTR.

The Comm Loopback test is used to verify proper operation of the communications line. The same pattern used by the transmit test is sent, and the test expects to receive this pattern from the comm line. To use this test, a LOOPBACK PLUG must be made or acquired.

Menu 6: Diagnostics Menu Parameters (cont'd)

To make an RS-232 loopback plug, use a 9-pin female D connector.

Jumper pin 2 to 3 (TxD to RxD)
Jumper pin 7 to 8 (RTS to CTS)
Jumper pin 6 to 4 (DSR to DTR)

In addition, Data Carrier Detect (DCD) must be high.

To make an RS-422 loopback plug, use a 9-pin female D connector.

Jumper pin 3 to 2 (TxD + to RxD +) through a 1K ohm resistor
Jumper pin 1 to 4 (RxD– to TxD–) through a 1K ohm resistor

The 1,000 ohm resistor is placed in-line between each Receive and Transmit pin to simulate a 1,000 ft. length of cable.

Install the loopback connector into the communications port of the workstation BEFORE starting this test.

Once this test is started, the upper line of the display should show the transmit pattern flashing past. If a character is lost, then the display will freeze. This indicates a test failure. If a character is substituted, a beep will sound and the display will pause for 3 seconds. Losing characters is indicative of a hardware error occurring in the unit.

The keys 1 through 9, <ENTER>, <CLEAR>, <RIGHT ARROW>, <IN> and <OUT> will be transmitted to the comm line.

Pressing <EXIT> will terminate the test and display 8–Comm Loopback Test.

Note: This test will not operate on a workstation which is currently set up as a Submaster, Alternate Submaster or Concentrator. This test CANNOT be selected from the comm line.

This test can also be used for remote loopback through a modem for checking the integrity of a modem line. In this case, character substitution errors may occur occasionally.

8–Aux Comm Transmit Test

When Enter is pressed while 8–Aux Comm Transmit Test is showing on the display, the following prompt appears on the display:

```

DTR:   ON    CD:   ON
```

DTR cannot be toggled OFF.

Menu 6: Diagnostics Menu Parameters (cont'd)

Pressing <ENTER> will transmit the following test pattern through the communications port to the Host computer (single 80 column line):

0123456789 —<The quick brown fox jumped over the
lazy dog.— 9876543210 <carriage return> [<line feed>]

The line feed is optional and is sent only if the Aux Comm CRLF parameter has been enabled (in the Comm Port Menu). The bottom line of the display continues to show:

```

DTR:   ON    CD:   ON
```

The pattern is sent continuously until the <EXIT> key is pressed.

Pressing <EXIT> will terminate the test and display 8–Comm Transmit Test.

9–Aux Comm Receive Test

When Enter is pressed while 9–Aux Comm Receive Test (Aux Rx Test) is showing on the display, the following prompt appears on the display:

```

DTR:   ON    CD:   ON
```

DTR cannot be toggled OFF.

If another workstation has been set to run Diagnostic 7–Comm Transmit Test, the following test pattern will be received through the communications port (single 80 column line);

0123456789 —<The quick brown fox jumped over the
lazy dog.— 9876543210 <carriage return> [<line feed>]

While operating this test, characters received will be echoed to the top line of the display. The bottom line continues to display:

```

DTR:   ON    CD:   ON
```

Pressing <EXIT> will terminate the test and re-display 9–Aux Rx Test.

Menu 6: Diagnostics Menu Parameters (cont'd)

A–Aux Comm Loopback Test

When Enter is pressed while A–AUX Loop Test is showing on the display, the following prompt appears on the display:

```

DTR:    ON     CD:    ON
```

DTR cannot be toggled OFF.

The Aux Comm Loopback Test is used to verify proper operation of the communications line. The same pattern used by the transmit test is sent, and the test expects to receive this pattern from the comm line. In order to use this test, a LOOPBACK PLUG must be made or acquired.

To make an RS-232 loopback plug, use a 9-pin female D connector:

Jumper pin 2 to 3 (TxD to RxD)

To make an RS-422 loopback plug, use a 9-pin female D connector:

Jumper pin 3 to 2 (TxD + to RxD +) through a 1K ohm resistor
Jumper pin 1 to 4 (RxD– to TxD–) through a 1K ohm resistor

The 1,000 ohm resistor is placed in-line between each Receive and Transmit pin to simulate a 1,000 ft. length of cable.

Install the loopback connector into the communications port of the workstation BEFORE starting this test.

Once this test is started, the upper line of the display should show the transmit pattern flashing past. If a character is lost, then the display will freeze. This indicates a test failure. If a character is substituted, a beep will sound and the display will pause for 3 seconds. Losing characters is indicative of a hardware error occurring in the workstation.

The keys 1 through 9, <ENTER>, <CLEAR>, <RIGHT ARROW>, <IN> and <OUT> will be transmitted to the comm line.

Pressing <EXIT> will terminate the test and display A–Aux Comm Loopback Test.

Menu 6: Diagnostics Menu Parameters (cont'd)

B–RS485 Block Receive

This RS485 Block Receive Test is used in conjunction with diagnostic test C–RS485 Block Transmit to test the cabling integrity of the network.

When this test is enabled, the following appears on the display:

```
Rx=nnnnn    ERRS=nnnnn      ——contents of a block———
```

The Rx indicates the number of blocks received by this workstation, the ERRS indicates the number of errors encountered.

If the Rx count does not change on the display, then the cable is probably not connected, is shorted or has a break.

If the Rx Error count is more than 1% of the received blocks (Rx count), then there are cabling problems present which must be corrected for proper operation of the network. See Chapter 2. This test is terminated by pressing <EXIT>.

C–RS485 Block Transmit

This RS485 Block Transmit Test is used in conjunction with diagnostic test B–RS485 Block Receive to test the cabling integrity of the network. It causes a continuous stream of test records to be transmitted out the RS-485 port of the workstation on which it is running.

Other workstations may be placed in RS485 Block Receive mode in order to verify that the cabling between the workstations in test are properly wired, connected and are functioning. When this test is enabled, the following appears on the display:

```
Tx=nnnnn    ERRS=nnnnn   ——contents of transmitted block———
```

The Tx indicates the number of blocks transmitted by this workstation, the ERRS indicates the number of ERRS encountered.

Menu 6: Diagnostics Menu Parameters (cont'd)

The following is a cable verification procedure:
Place the workstation at the Master's location into RS485 Block Transmit test mode (Diagnostic Test C).

As you install each workstation, place it into RS485 Block Receive mode (diagnostic test B). If the receiving workstation does not show the test block, it is indicative of a cable fault. Correct any cable faults before proceeding.

Always work your way out from the Master workstation, installing workstations further and further away as you progress.

After all workstations on the network are in place, verify that every one is receiving the test message.

Place the Master workstation into RS485 Block Receive test mode (diagnostic test B), and place the workstation at the most remote position in the network into RS485 Block Transmit mode (diagnostic test C). Once again, verify that all workstations are receiving the test block. Remember that only one workstation on the network can ever be in Block Transmit mode.

Pressing <EXIT> will exit the Block Transmit mode.

Note: This test must never be performed on a network operating in an actual application. All other network activity must cease while this test is being run.

D–RS232 Block Receive

This test, and its counterpart, the RS232 Block Transmit must be used only with asynchronous modem lines. It is used for testing the Concentrator to Submaster connection ONLY.

When this test is enabled, the following appears on the display:

```
Rx=nnnnn   ERRS=nnnnn    ——contents of a block———
```

The Rx indicates the number of blocks received by this workstation, the ERRS indicates the number of errors encountered.

If the Rx count does not change on the display, then the cable is probably not connected, is shorted, wired incorrectly or has a break. If the Rx Error count is more than 1% of the received blocks (Rx count), then there are cabling problems present which must be corrected for proper operation of the Concentrator to Submaster link. See Chapter 2.

This test is terminated by pressing <EXIT>.

Menu 6: Diagnostics Menu Parameters (cont'd)

E–RS232 Block Transmit

This test and its counterpart, the RS232 Block Receive must be used only with asynchronous modem lines. It is used for testing the Concentrator Submaster connection ONLY.

This test causes a continuous stream of test records to be transmitted out the RS-232 port of the workstation on which it is running.

The workstation at the other end of the Concentrator/Submaster connection must be placed in RS232 Block Receive mode in order to verify that the cabling between the workstations in this test is properly wired, connected and is functioning.

When this test is enabled, the following appears on the display:

```
Tx=nnnnn    ERRS=nnnnn    ——contents of transmitted block———
```

The Tx indicates the number of blocks transmitted by this workstation, ERRS indicates the number of errors encountered.

What follows is a cable verification procedure:

Place the workstation at the Concentrator’s location into RS232 Block Transmit test mode (Diagnostic Test E).

Place the Submaster workstation attached to the Concentrator into RS232 Block Receive mode (Diagnostic Test D). The Submaster should show the test block being received. If the block does not display the count of received blocks, it is indicative of a cable fault. Correct any cable faults before proceeding.

Place the Submaster workstation into RS232 Block Transmit mode. Now place the Concentrator into RS232 Block Receive test mode. The Concentrator workstation should show the test block being received. If the count of received blocks is not displayed, it is indicative of a cable fault. Correct any cable faults.

Pressing <EXIT> will exit the Block Transmit mode.

Note: This test must never be performed on a network operating in an actual application. All other network activity must cease while this test is being run.

Menu 6: Diagnostics Menu Parameters (cont'd)

F–Lamp Test

If this test is selected, it will turn on, one by one, each of the keypad LEDs.

After all the lights are on, the workstation will return to the G–Lamp Test Menu and the LEDs will return to off.

G–Reset Powerup

When the Reset Powerup Test is entered, it reboots the workstation, causing the workstation to go through the entire power-up sequence exactly as if power had been removed, then re-applied.

H–Reset Unit to Factory Defaults

When <ENTER> is pressed while Reset Unit to Factory Defaults is on the display, it causes all of the workstation parameters, those described in the Network, Comm and Bar Code menus, to be reset to the way they were set when the workstation left the factory. This is particularly helpful when attempting to track other problems, as the factory defaults are a known starting place from which to work. Refer to Chapter 6 for default values.

Operating Procedures

Chapter Objectives

This chapter describes most of the operations normally used in the set-up and maintenance of a network. It also includes descriptions of some methods used in discerning correct operation. Some of these are:

- verifying proper operation
- removal of a Master or Submaster from the network
- changing a workstation into a Master
- removal of a Normal workstation from the network
- adding a Normal workstation to the network

Default Configuration – The major factory default settings are:

Parameter	Value	Configuration Menu
Terminal Number:	0	Network
Host Port:	COM	Network
Terminal Type:	Normal	Network
Lower Poll Address	1	Network
Upper Poll Address	99	Network
Offline Cycle	40	Network
Max Net Retries	10	Network
Comm Port Mode:	Polled	Network
Comm Baud Rate:	9600	Comm Port
Comm Data Bits:	7	Comm Port
Comm Parity:	Even	Comm Port
Comm Stop Bits:	One	Comm Port
Comm CRLF:	Disabled	Comm Port
Comm Echo:	Disabled	Comm Port
Sync Count:	0 (Remains 0 always)	Comm Port
Aux Baud Rate:	9600	Comm Port
Aux Parity:	Even	Comm Port
Aux CRLF:	Disabled	Comm Port
Aux Echo:	Disabled	Comm Port
Comm Menu Char.:	None	Comm Port
Menu Password	0	System
Clock Mode	7	System
File Block Size	256	System
Bar Code Symbology	Code 3 of 9 Enabled all others Disabled	Bar Code

The workstation will be reset to these settings when Option H – Reset to Factory Defaults is selected from the Diagnostics Menu (Menu 6)

Verifying Proper Network Operation

Each workstation is capable of displaying information which can be used to ascertain if it is operating correctly. The Network Status display for workstations that are online are:

```
cc–nn        READY
ONLINE
```

Normal workstation

normal operating display

```
cc–nn        READY
ONLINE            [M]
```

Master workstation

normal operating display

```
cc–nn        READY
ONLINE            [SM]
```

Submaster workstation

normal operating display

```
cc–nn        READY
ONLINE            [A]
```

Alternate Master

normal operating display

```
cc–nn        READY
ONLINE            [AM]
```

Alternate Submaster

normal operating display

```
cc–nn        READY
ONLINE            [C]
```

Concentrator

normal operating display

```
00           READY
TERMINAL
```

Workstation standalone mode

normal operating display

```
cc–nn        READY
ONLINE            [G]
```

Gateway

normal operating display

Note: Since the program has complete control of the display, the status message will only be present when no program is active or if ENTER/OUT has been invoked.

Note: On the displays shown in this manual:

cc = Master or Submaster I.D. number
nn = Workstation I.D. number

Removing a Master

If the Master is physically removed from the network, fails to function, or the Host stops communicating, then a Master is considered removed from the network. No data can be received by the Host until the problem is remedied.

If the problem is that the Host has stopped communication, there is a possibility that the problem lies with the Host. If that is indeed the case, the solution of the problem is also with the Host, and should be addressed there.

In some cases, the Host will stop communicating due to a problem with the Master, even though to outward appearances, the Master is fine. Substitution of another workstation to act as Master will usually show whether the problem is with the Master Workstation or the Host. See the section on Instituting a New Workstation as Master.

Alternate Master in Place – If an Alternate Master has already been selected and established as an Alternate Master on the network, then it will begin operation at any time from 90 to 120 seconds after the original designated Master became inoperable.

When the alternate Master begins operating as the new Master, it will briefly display:

```
cc–nn        READY
ONLINE            [M]
```

where cc is the Master number if this workstation is a Submaster, and nn is the workstation ID.

Notice that all of the workstations attached to this Master (or Submaster) will change their Concentrator or Master number to correspond to the new configuration.

Host/Alternate Master – The Host computer must be ready to accept data from the Alternate Master or else the workstations on the network will continue to accept transactions only until their memory is filled. They will then stop functioning.

No Alternate Available – If no alternate Master is available to take over the role of Master, then the group of workstations attached to the offline Master will also go offline after about a minute. When that occurs, each of the workstations will display:

```
nn       READY
OFFLINE
```

Instituting a New Workstation as Master

If the network is not operating, then adding a new Master to the system involves the following steps:

1. Disconnect the cables from the ‘old’ Master
2. Remove the ‘old’ Master
3. Attach cables to the new workstation
4. Configure the new workstation as a Master (see Configuration Menu)
5. Set the communications parameters from the list in your site parameter list for a Master (see Communications Menu)

Before becoming active, the new Master will wait for a moment to make sure that no other workstation is currently acting as Master. During this time, when 1–Network Status is entered, the Master will display:

```
nn       READY
OFFLINE         [M]
```

As soon as the new Master comes online, it’s display will change to:

```
cc–nn       READY
ONLINE          [M]
```

where cc is the Concentrator or Master number, and nn is this workstation’s number.

Note: Under polled mode the Master Workstation will not actually go online until it receives a poll from the Host.

Removing a Workstation from the Network

When a workstation is removed from the network, or it becomes inoperable for whatever reason, there may be approximately a 2 second pause in network operations. This occurs because the Master makes multiple attempts to get data from the (now) absent workstation before it stops trying.

When several workstations are removed from the network at the same time, the pause will be 2 seconds x number of workstations removed.

Adding a Workstation to the Network

When a workstation is first added to the network, it may not immediately be recognized by the Master. This recognition may take up to a minute. During this period, when 1–Network Status is entered, a workstation not yet recognized by the network will display:

```
nn        READY
OFFLINE
```

As soon as communications are established, the display changes to:

```
cc–nn        READY
ONLINE
```

If the workstation does not come online in approximately 1 minute, the cables should be checked. This can be done quickly by substituting a known working workstation at the questionable position. If the cabling is fine, then check the site parameter list for this workstation. Verify that the parameters are set correctly.

Any attempts to load application programs into individual workstations should not be attempted until the ONLINE message has been received from that workstation. Premature attempts at downloading a program can result in nothing being loaded into the workstation.

Visual examinatioin of the 7–Program Load Status display should show whether a program has been loaded properly.

Network Problems

Network problems usually fall into one of the following categories:

Configuration error . . . . This is usually a duplicate station number, but can be caused by configuring two Masters and starting them at the same time.

Cabling error . . . . The most common error is caused by switching polarity of the network wires. Other errors include: cold solder joints, improper grounding, excessive induced noise and failure to set the Terminator switch on one AND ONLY ONE of a string of workstations.

Workstation malfunction The most likely workstation malfunction which can effect network operation is a workstation which contains an improperly operating RS-485 line driver. Such a workstation can render the entire network inoperable until it is located and removed.

Network Problems (cont'd)

Once the application programs have been loaded into the network workstations, it may not be possible to see the status display, making it even more difficult to recognize and solve network problems. When tracking network problems, liberal use of the ENTER/OUT key combination to cause brief display of the workstation status can be helpful.

Workstation Status

The following is a collection of displays which may be helpful in identifying (and solving) some network problems.

```
cc–nn       WAIT
```

This workstation is waiting ONLINE to be polled.

When this appears on the display, the data memory of the workstation is full and it is trying to send a transaction to the Host, but has not been polled. This should only occur for very short periods of time (less than a second).

If waiting occurs for as long as a minute, the workstation will go into offline operation.

If waiting occurs on a sporadic basis, then cabling may be the problem. Some intermittent cable problems have been discovered to be the cause of sporadic waiting. Verify that the Terminator has been set on either end of the string in question; check individual cable connectioins to workstations and verify that all workstations are operating.

If WAIT appears for more than a few seconds only during your peak usage time, then too many workstations may be trying to send too much data to a single Master. If this problem continues or worsens, consider laying out a network with more than a single backbone (see chapter on Network Design).

```
nn       READY
OFFLINE
```

The Master has stopped polling this workstation

This indicates that the station is only able to store information in its local memory, instead of sending data on to the Master. It will do so until either the Master begins communicating again or the memory becomes full.

```
nn       FULL
OFFLINE
```

The memory of this workstation is full and offline

Workstation Status (cont'd)

Wait for the Master to come back ONLINE. If it is ONLINE, and all the other workstations are ONLINE, a then check the cables for this workstation. Replace the workstation if no cabling problem can be located. If all other workstations are ONLINE, and the one unit remains OFFLINE, and the cables do not seem to be at fault, the problem could be with the network port.

To avoid losing data which may be in the unit, perform the following steps: 1) remove the workstation from the network, 2) connect it to an individual power source and configure it as a Master, 3) establish communications with it through its communications port, and 4) dump its contents via the Host communications. Run the network diagnostics (test D and E) on the workstation to verify that the problem is the network port.

```
nn–nn        READY
OFFLINE          [M]
```

The Master has not been able to communicate with the Host

The Host has turned off this Master workstation by sending it an XOFF. The workstation will not resume transmitting until it receives an XON. There will be no DSR or poll for at least 10 seconds. If this condition persists, and the Master is ready to receive data, one way to clear this condition is to enter then exit the menu mode (ENTER/IN, the EXIT). If the condition persists, check the cabling. After that, check the Host's communication (both hardware and software).

```
mm–nn      READY
OFFLINE          [C]
```

The Concentrator cannot contact its Submaster

Check the cabling to the Submaster. If the cabling is correct, then verify that both the Concentrator and the Submaster are set to the same baud rate. If the problem persists, replace first the Concentrator then the Submaster to identify the failed workstation.

```
nn       READY
OFFLINE          [SM]
```

The submaster cannot contact its Concentrator

Use the same solution as described above.

```
00       READY
TERMINAL
```

This workstation has been reset to factory defaults

If this was not specifically caused by changing the workstation's station number, then there may be something wrong with this workstation. Reconfigure the workstation and let it continue to operate in service. If the workstation resets again, remove it from use and send it back for service.

Chapter 7

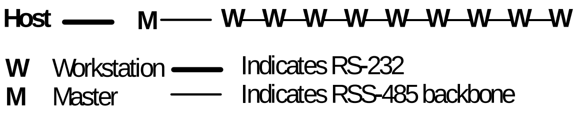
Network Design

Networks of 32 Workstations or Less

Designing a network to connect fewer than 32 workstations is fairly straight forward: select the best place for the Master Workstation to be, and then run one single multi-dropped twisted pair cable through each workstation location. The “Master” workstation is the workstation which communicates to the host.

A simple network Configuration follows:

Figure 7.1
Simple Network Configuration



No more than 32 workstations can be connected to the same network cable. If more than 32 workstations are required, see the next section.

The last step of this network is to compare the actual cable distances between each workstation with the distances described in Chapter 2.

Note: All references to RS-232 should be understood to mean RS-422 if the workstation’s COM1 port was ordered as RS-422.

Network Installation of More than 32 Workstations

Installing a large network of workstations involves connecting together smaller networks. Up to 31 smaller sub-networks may be attached to form a large network. Each sub-network, in turn, may contain up to 32 workstations. The network which connects all of the sub-networks is called the ‘backbone’ network. Each sub-network is referred to as a ‘tributary’ network. A maximum of 1024 workstations may be connected in this fashion. There are instances where a tributary network can improve performance even when fewer than 32 workstations are on the network.

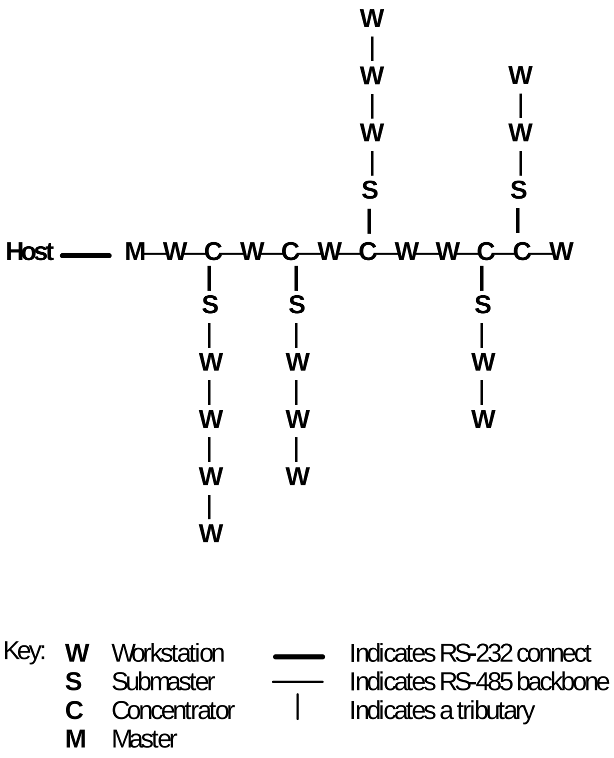
The workstation which is attached to the host is configured to as the “Master”. Each workstation on the backbone network that connects to a tributary network is configured as “Concentrator”. The workstation on the tributary which attaches to the Concentrator is configured as a “Submaster”.

Network Installation of More than 32 Workstations (cont'd)

All of the workstations, including Masters, Concentrators and Submasters, are standard workstations which have been configured for their individual roles in the network. A configuration parameter is changed to allow any workstation to adopt a new role in the network. Each workstation is capable of operating in both a data collection and data communications mode.

An example of a large network configuration follows:

Figure 7.2
Large Network Configuration



A workstation which is being used as a Master, Concentrator or Submaster can perform data collection functions even while serving in the communications network.

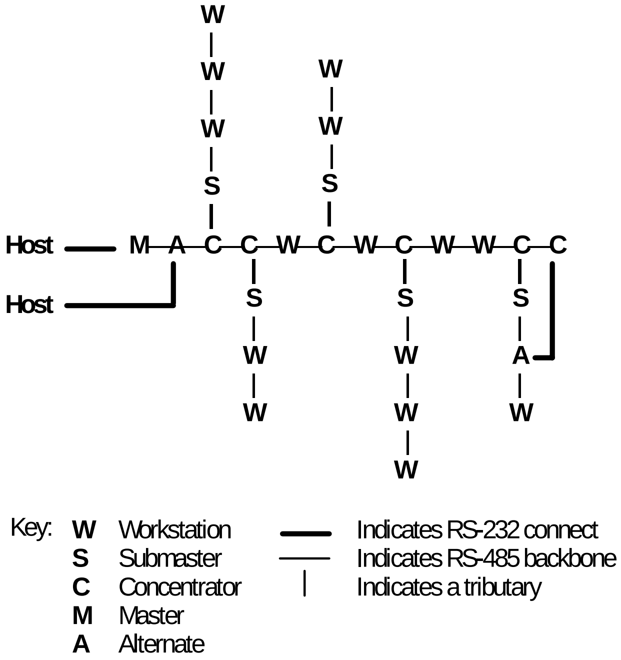
Note: All references to RS-232 should be understood to mean RS-422 if the workstation's COM1 port was ordered as RS-422.

Fault-Tolerant Networks

When installing large networks, you should consider redundant communication links in order to protect against workstation failures. This involves establishing certain workstations as “Alternate Masters” and certain workstations as “Alternate Submasters”. Configuring a large network with Alternate Masters will allow the Alternate workstation to take over communication operations if the designated Master becomes inoperable or is removed from the network. An Alternate Host provides full redundancy for collection in the event of a host failure.

A large network configuration with Alternate Masters could look like the following:

Figure 7.3
Large Network Configuration with Alternate Masters



Note: All references to RS-232 should be understood to mean RS-422 if the workstation’s COM1 port was ordered as RS-422.

Extending Networks Over Phone Lines

It is possible to configure a network which spans multiple buildings, outposts or sub-stations located at remote sites. Switched (dial-up) or leased telephone lines (also referred to as ‘Common Carrier’) can be used with asynchronous modems to provide communications for such a network.

Asynchronous short-haul modems may be used to extend the normal RS-232 communication distance from 100 feet to as much as several miles. The only modem recommended for networks over dial-up telephone lines is a 212-A compatible modem.[1]

To use modems for communications between a Concentrator and Submaster, the workstations must have the RS-232 communications port and a modem cable connected for TXD, RXD, RTS, CTS, DSR, DTR and GROUND (see Chapter 2). The COMM BAUD RATE parameter must be changed from 9600 baud to whatever baud rate is correct for your modem. As soon as the modems establish communications between themselves the remote system will be ready for use.

A Concentrator which has not yet been connected via modem to the Submaster will display:

```
mm–nn    READY/ONLINE  [C]  ?
```

When the Submaster does respond, the ? is removed to display:

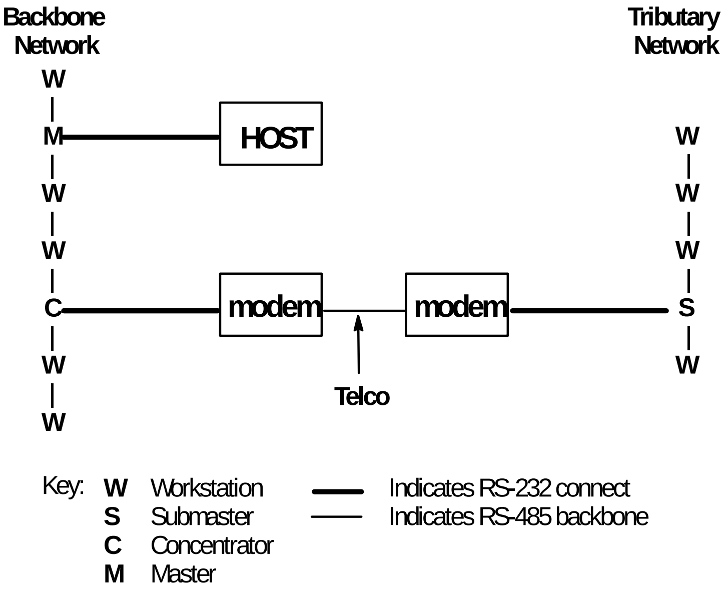
```
mm–nn    READY/ONLINE  [C]
```

[1] A “Hayes-compatible” modem is a good choice.

Extending Networks Over Phone Lines (cont'd)

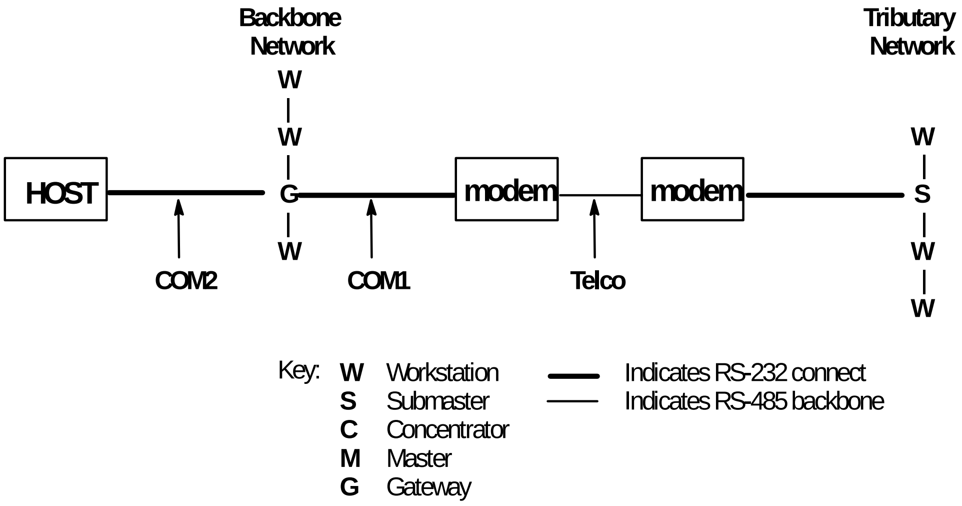
The following is an example of a network extending across a Common Carrier.

Figure 7.4
Extending Network Across Common Ca;rrier



The extension of a network across telephone lines consists of placing a modem on one side of the line to connect with the Concentrator, and placing the other modem on the other side to connect with the Submaster.

Figure 7.5
Extending Network Across Common Ca;rrier



Chapter 8

Host Communications

Network Status Records

The Master workstation sends notification to the Host of any change of status in the network. Usually these status records indicate that a workstation which used to be communicating with the Master has been disconnected.

Status records consist of a 10-character prefix described below. However, all status records carry 00 as the transaction number.

The ten character transaction prefix is explained in the following:

ccssrrqqtt	Station number of the Concentrator or Master
cc**ss**rrqqtt	Station (workstation) number
ccss**rr**qqtt	Number of retries required to transfer the record
ccssrr**qq**tt	Sequence number used internally by the network
ccssrrqq**tt**	Transaction number containing the SEND

In addition, a two-letter code follows the prefix. These codes are referred to as Network Diagnostics. The codes are:

ON WORKSTATION ONLINE: the workstation indicated by the Concentrator/ID and workstation number has just been attached to the network. The Host may need to set up a new transaction configuration for this workstation.

OF WORKSTATION OFFLINE: the workstation indicated by Concentrator/ID and workstation number has ceased to respond to polling. The Master or Submaster reports this problem.

MO ON-LINE: the workstation indicated has come on line as a Master.

CO Concentrator ON-LINE: the workstation indicated has come on line as a Concentrator.

SO Submaster ON-LINE: the workstation indicated has come on line as a Submaster.

DU DUPLICATE: the Master has detected a station with a duplicate station number attempting to act as a Master. This *MUST* be corrected before network operation.

AO Alternate OVERRIDE: this Master has detected another workstation that is operating on the same network that has a smaller station number than this one. This message indicates that this workstation is giving up control and turning itself into an Alternate.

Network Status Records (cont'd)

NF NO FORWARD: the addressed station cannot forward the requested information to a sub-network. It is *NOT* a Concentrator.

ER ERROR: the transaction command contains some form of error or the workstation has detected an error. The remainder of the record contains text which indicates the contents of the error.

A sampling of network status messages the Host could expect to see as this network comes up would be:

Message	Description
0101001100MO	actual Master indicating it is ready
0102000000ON	backbone workstation 2 online
0103000000ON	backbone workstation 3 online
0104000000ON	backbone workstation 4 online
0104000000CO	workstation 01-04 indicating it is a Concentrator
0105000100ON	tributary workstation 5 online
0105000000SO	tributary workstation 5 becomes Submaster
0509000000ON	tributary workstation 05-09 online

As the number of Concentrators and Submasters in a network increases, more time is required for each of the workstations on the sub-strings to come ONLINE. When installing very large networks with many sub-networks, it is advisable to set up the network with all the workstations in one room, and observe just how long it takes for the last workstations on the sub-networks to come online.

When installing very small networks, set the upper and lower polling addresses (in the Main Menu), such that they narrowly window the Concentrators in the network. This will reduce time in bringing workstations online, as the Master will not spend time polling for non-existent workstations. For example, if a Master is connected to only 2 Concentrators, (Concentrators #4 and #5), then set the lower poll address to 3 and the upper poll address to 6.

Using Retry Counts for Network Diagnosis

The middle pair of numbers in the status records, the retry count, may be used to diagnose improper cabling, or to identify workstations which may be malfunctioning. Normally all retry counts should be 00.

If the retry count has a non-zero value, then the record following that prefix had to be sent more than once in order for it to reach the Master. If certain workstations require retries on a frequent basis, then it is recommended that the cabling be checked for these workstations. If one workstation only is registering consistent retries, consider swapping it with another workstation to show if it is cabling or the workstation which is the cause of the problem.

If the number of retries shown in prefix becomes much greater as the workstations creating those records are farther from the Master along the network cable, then a faulty or poorly grounded cable is suspect. See the Chapter 2 for information pertaining to cabling, termination and network layouts.

Responses to Network Directives

The network directives are a set of commands which can be sent from the Host to any workstation on the network. All responses are directed to the Host, and take the form:

<10-byte prefix> ND <command letter> data

where:

10-byte prefix is the prefix attached to all records (as described above)

ND appears in positions 11 and 12, and indicates a Network Diagnostic

<command letter> is a single UPPER case character which identifies the data which follows

data the useful portion of the response.

For example, the response to the <T directive (a request for time) might be:

```
0808001400ND    T    1743077788020506
```

Network Directives

Requests may be sent through the network to perform various command functions on the workstation.

These requests constitute a valid “poll”. For workstations which are currently using polled mode, any available record will be forwarded to the Host after receipt of one of these network directives. Your Host software must be able to handle any data records which are transmitted during the course of network directives transmissions.

The following is a list of the network directives, with a one-line description of what each does. Details on each individual network directive follow the list.

These commands are of two principle types:

1. Requests for information
2. Commands

The way you can distinguish between these two types is by observing which way the arrow (bracket) points in the command.

<	is a request for information
>	is a command

The directives which start with a left angle bracket request information from the workstation.

< D	shows contents of front panel display
< E	shows last language error message
< R	shows last RESET error message
< S	shows serial number and other status
< T	shows date and time as set on workstation
< V	shows firmware version and description

```
10-3:<V
```

This request is made to workstation 3 attached to master 10. The directive <V asks to return the firmware version and description. Directives preface with a left arrow (<) identifies a request for information. Right arrow directives (>) indicate a command that requires an action. If the colon (:) is replaced by an equal sign (=) then all subsequent transfers will take place on the specified workstation. For example, if *10-3* = is entered, all directives will only act on this workstation until another workstation number is specified.

Network Directives (cont’d)

The directives which begin with a right angle bracket > direct the workstation to perform a specific action. Note that any data which is sent along with the command must be preceded by a space.

> > A	abort the currently running BASIC program
> > G	restart an aborted program
> A	abort the test invoked by B directive
> C	output text to communications port
> c	output text to aux communications port
> D	output test to unit display
> E	erase the current menu password
> F	reset the unit to factory defaults
> N	Initialize the network
> R	reboot the unit
> S	save the configuration
> T	set date and time
> Z	zero the reset error and powerfail counters

Several of the network directives are intended for internal use only, as indicated in the detailed descriptions which follow. They have been included here for completeness.

< D – Show Unit Display

Is used to request what is currently on the display of the workstation addressed. In the example below, it is the status line.

Directive: < D
Response: 0808001600ND D 8-8 Ready —Online [M] ? 45

< E – Show Last Error Message

Requests the text of the last error message issued from the language interpreter at the workstation addressed.

Directive: < E
Response: 0808001600ND E ERROR 03 UNKNOWN AT 255.00.00
TIME OF ERROR ... 1742478802056

< R – Show Last Reset Message

Request the text of the last ‘reset’ error message. If a recoverable “reset” condition occurs, this message is automatically generated. The < R directive can then be used to see it again.

Network Directives (cont’d)

Directive: < R
Response:

```
0808001600ND   R   Reset  30  #1  00005017000000  [1234]  PF = 0
0808001600ND   @  T1  PC = 32DA  SP = 87D4  Regs = 0000 0000 0000
0808001600ND   .   338F  BC8B  0003  0013  0868  0C9E  6AA5  650F
0808001600ND   .   83AF 646C  0380  0000  0000  0000  0000  0000
0808001600ND   .   0000  0000  0000  0000  0000  0000  FFFF  FF00
0808001600ND   .   FFFF  FFF   FFFF  FFFF  FFFF  FFFF  FFFF  FFFF
```

If a recoverable “reset” condition occurs, this message is automatically generated. The < R command can be used to view it again. In the R line, Reset 30 is the error number, #1 counts the number of resets, the date/time string follows. [1234] is the unit serial number and PF is the power fail count.

In the @ line, is the task number, PC is the program counter, or top of stack; SP is the stack counter and the values following represent registers BC, DE and HL.

< S – Show Unit Serial Number

Requests the workstation to return its current status and serial number. The number appearing between [ ] is the workstation’s serial number. The size of the workstation’s memory is next, followed by the number of reset errors and the number of power failures.

Directive: < S
Response:

```
0808001600ND  S  [1234]  4K  RS = 1  PF = 0
```

< T – Show Workstation Date & Time

Requests the workstation to show its date and time. The string format for the message response is the same as that used in the Set Time network directive (> T).

Directive: < T
Response:

```
0808001600ND  T  174423518802056
```

< V – Show Firmware Version

Asks for the firmware version and description.

Directive: < V
Response:

```
0808001600ND  V  A-B VBASIC ABC
```

Network Directives (cont'd)

> > A – Abort Currently Running A-B VBASIC Program

Terminates the program which is currently running on the workstation. This will also generate an error message back to the Host which says: "BASIC Error: Operator Abort xxxx: yymmddhhmmss", where xxxx is the address at which the program was aborted.

> > G – Restart an Aborted BASIC Program

A program which has been aborted using the > > A network directive can be restarted with this command. The program is restarted at the beginning, and all variables can be assumed to be re-initialized.

> A – Abort Test

Allows the Host program to terminate the network performance test initiated by the B command (described next).

> C – Send Text Out Comm Port

Causes the text which follows the command to be sent out the communications port of the destination workstation. If the symbol "&" appears first in the text, no carriage return will be output.

Note: Control codes cannot be directly sent, only printable characters. However, a backslash (\ ) is converted to a carriage return, a grave accent (') is converted into an escape, and an up arrow (^) is converted into a linefeed.

Directive: > C text
Action: text specified is sent out comm port of destination workstation.

> c – Send Text Out Aux Comm Port

Same as > C except it uses the aux comm port.

> D – Display Text on Front Panel

Causes the specified text to appear on the front panel displayof the indicated workstation. If the symbol "&" is the first character of the text, the display is not cleared prior to displaying the text.

Directive: > D text
Action: text specified is displayed on front panel of workstation.

Note: Control codes cannot be directly sent, only printable characters; however a grave accent (') is converted into an ESC.

Network Directives (cont'd)

> E – Erase the Menu Password

Causes the menu password to be erased on the specified workstation.

Directive: > E
Action: erases menu password.

> F – Reset to Factory Defaults

Causes the unit to be reset to the factory defaults.

Directive: > F
Action: resets specified workstation to factory default settings. Note that the factory default for Terminal Number is 0, which will immediately abort the Host communications protocol currently in use, and will put the terminal into Standalone mode. (You may not be able to continue commanding the workstation.)

> N – Initialize Network

Gives the Host program the ability to tailor the network for throughput. It contains three required numeric parameters in the range 0 to 255. They affect the network activity only in workstations which are currently serving a network role, i.e., Master, Concentrator or Submaster. The network is initialized after any (or none) of the parameters are reset. These parameters are:

111	the lower polling address
uuu	the upper polling address + 1
sss	the sync count (leave at 0 for Asynchronous communications)

The parameters are the same ones which are set by entering the Main Menu at the Keypad of a workstation. When the > N directive is issued, the network polling will perform in the manner specified by setting these parameters.

Directive: > N 111 uuu sss
Action: initializes network

> R – Reboot Unit

Causes the specified workstation to be rebooted.

Directive: > R
Action: reboots the specified workstation

Network Directives (cont’d)

> T – Set Time

Causes the time and date in the destination workstation to be set to the value provided as a parameter.

Directive: > T hhmmssnnyymmddw

Where:	hh	= hours
	mm	= minutes
	ss	= seconds
	nn	= 1/100 second
	yy	= year
	mm	= month
	dd	= day #
	w	= dayof week

Action: resets time and date in the destination workstation. The entire string is mandatory. You cannot, for example, set only the time and leave the date portion off, or the workstation’s date will be set to zeros. The “w” (day of the week: Sunday – 1) parameter is, however, optional: if ommited or specified in error, the workstation will calculate and set its own day of the week.

> Z – Zero Reset Error

Used to zero the reset error and powerfail counters on the designated workstation. Intended for internal use only.

Directive: > Z
Action: resets the error and powerfail counters

What is BASIC?

Introduction

The acronym “BASIC” stands for “Beginner’s All-purpose Symbolic Instruction Code”. It was designed as a programming language for novice programmers in the early 60’s. In the 90’s, BASIC still ranks as one of the most popular programming languages.

BASIC is used as a workstation programming language for several reasons:

1. its ease of use
2. its wide-spread popularity
3. its structure and versatility

What is Visual BASIC ?

Almost no one is using the original ANSI standard BASIC any more. The language only allowed 26 variables, had no string capability, and was very simplistic. Visual BASIC is a product of Microsoft Corporation which expands greatly on the original language, and provides an integrated development environment containing a BASIC program editor, a BASIC compiler with a vast array of statements, and a debugging platform.

The Visual BASIC program editor checks each line of the program for syntactical errors as they are entered. It has all the functions normally found in program editors and is designed to interact with the compiler and debugger. It facilitates the separation of functions and subroutines into easy-to-read pages, and has full search and replace facilities.

The Visual BASIC program compiler can be invoked from inside the editor, or from the DOS command line. Once an error is found, the compiler returns control to the editor on the line with the mistake so that changes can be made to correct the problem. When the program is compiled successfully, it can be run either from inside the debugger, or from the DOS command line. If a run-time error is encountered, the screen returns to the editor at the line containing the error.

In the event the program fails to do what was planned, the program debugger can be used to track down any logical problems.

These tools are essential for programmers at any level. We highly recommend that you make use of Microsoft’s Visual BASIC to develop application programs for the workstations.

What is A-B VBASIC?

A-B VBASIC is a subset of Microsoft's Visual BASIC, consisting of those commands which are relevant in the workstation environment. A-B VBASIC includes a set of Special Devices which allows access to things like bar code scanners. Many commands which would be appropriate in a PC environment, but are not applicable on a workstation, such as color, graphics, and disk commands have been left out.

A-B VBASIC provides the user with a near-industry-standard programming language which is powerful enough to handle any application, yet easy to learn.

Additional reference resources for learning about Visual BASIC and A-B VBASIC are:

Learning to Use Microsoft Visual BASIC – by Microsoft
Programming in BASIC – by Microsoft
Basic Language Reference – by Microsoft

Note: These publications are provided with the Application Generator Software (Catalog No. 2708-NAG) and the BASIC Language Development Kit (Catalog No. 2708-NBD).

Together, they provide all the information needed by a programmer with some BASIC experience. However, none of the books can be considered a *tutorial* on the BASIC language. Check your local library, the computer section of your local bookstore or a computer dealer near you for beginner BASIC books. Most programmers have programmed in BASIC or a similar language and will have little trouble converting to A-B VBASIC.

Chapter 10

Developing and Running an A-B VBASIC Program

The A-B VBASIC Development Procedure

Step #1 – Planning

The 2708-DH5B2L and -DH5B4L workstations have approximately 79K bytes dedicated for program memory. Programs that are larger than about 20-30 pages of BASIC source code need to be broken up into several smaller CHAINed programs. It is much easier to plan for this in the design stage than to be forced into it in the coding stage.

For smaller applications (applications that can be coded in 20-30 pages of source or less) there is no need to worry about the CHAIN statement. By far the majority of applications fall into this category.

Step #2 – Coding with the Workstation Application Generator Software

For many data collection programs, a software development tool called the Application Generator Software (Catalog No. 2708-NAG) may be all you need to implement your application. Application Generator Software is extremely useful in the development of applications, prototyping applications with an end-user, and creating demonstration programs quickly. Application Generator Software requires very little learning curve. It allows the program to be simulated on the PC, which helps in the testing and debugging of the program, and outputs a syntactically correct A-B VBASIC source program as a ".BAS" file, which can then be compiled as described later.

Step #3 (Alternate) – Coding with Visual BASIC Editor

If you do not use Application Generator Software, we recommend that you enter your A-B VBASIC programs using the Visual BASIC editor. This provides syntax checking, subroutine and function menus, and liberal help screens. Since A-B VBASIC is a subset of Visual BASIC, you can enter any A-B VBASIC commands with the editor.

Note: When using the Visual BASIC programming environment, be sure to save your A-B VBASIC program file in ASCII text format rather than the compact format. (Use the SAVE AS option in the Visual BASIC editor.)

Step #4 – Simulation Using Application Library

A design goal for A-B VBASIC was to have the workstation behave like a PC when running the same code. Since the PC and workstation act the same, the ideal place to test the subroutines of your application is right on the PC itself in the Visual BASIC environment.

The A-B VBASIC Development Procedure (cont'd)

In order to emulate programs on a PC the A-B Application Library was developed (see Chapter 13). Many basic I/O routines for the various devices found on a workstation are available through this library. These include inputs from barcode scanners, timeouts, formatted and edited keypad read routines, data conversion routine, etc. One of the clear benefits of using the library is that you don't have to "re-invent the wheel".

There are two main files in the Application Library: ENV.BAS and ENVPC.BAS. When testing your program on a PC, just include ENVPC.BAS into your program, and all your I/O will be directed at standard PC devices which will emulate the workstation. When it's time to run the program on the real workstation, simply substitute ENV.BAS at compile time.

Step #5 – Compiling the A-B VBASIC Program

After the program has been written and tested on the PC using ENVPC or Application Generator Software, the program must be converted into a form that a workstation can understand. This is done with the A-B VBASIC cross compiler (LXB). LXB will flag any lines that do not fit the subset of allowed commands. It will also flag syntactical errors, but those will normally already have been taken care of by the Visual BASIC editor. The output of the LXB compiler is a ".LXE" file, suitable for downloading to a workstation.

Step #6 – Downloading

You can download the program with another software product called Network Manager Software (Catalog No. 2708-NNM). Network Manager Software is a data collection and network management program which can collect data, download programs and files, and perform network management functions. It is the preferred tool for commmunicating between a PC and a workstation network. It interprets network status records and provides repetitive command transmissions to multiple workstations. However, in the absence of Network Manager Software, any asynchronous terminal emulator that has a file transfer feature and honors XON/XOFF protocol should work.

As soon as the download is complete, the program automatically starts running. At this point the program can be tested for proper functioning on the workstation itself.

To summarize, the steps in developing an application for a workstation are as follows:

1. Lay out a structured design for application
2. Decide if application is small or large (is CHAINing necessary?)
3. Use developed tools wherever possible
   (BASIC Language Development Kit)
4. Code the application using the Visual BASIC editor or Application Generator Software
5. Test the program under simulation (include ENVPC.BAS)
6. Compile with LXB (include ENV.BAS)
7. Download the program
8. Test the program on the target workstation

Loading and Auto-Starting an A-B VBASIC Program

The .LXE “download” file produced the the A-B VBASIC cross-compiler must be transmitted, through the Master Workstation, to the target workstation. This transmission must honor whatever protocol has been chosen for Host-Master communication in the Setup menus on the workstation: XON/XOFF, Polled Mode, Request Response, or whatever other method is enabled. In particular, the following **will NOT WORK**:

```
COPY PGM.LXE COM1
```

This WON’T WORK, since the standard DOS communication drivers do not implement XON/XOFF.

Downloading a BASIC program in .LXE format will terminate any program in progress at the start of the downloading process. Successful completion of a download results in the initiation of the new program. However, a program that is in .PGM format (described in Chapter 11) can be downloaded into RAM without interrupting the currently running program. The .PGM format program can later be executed by calling it with a CHAIN statement.

Start-up Condition of an A-B VBASIC Program

This section summarizes the status of the workstation when a program starts.

LCD:

The front panel display may be thought of as being blank. The first character output will appear in the upper left corner of the display. The cursor is on.

The words “BASIC START” are placed on the display by the operating system before the BASIC program is initiated. If this text is visible long enough to be noticed, the probable cause is a BASIC program which has not yet reached a PRINT statement.

Random numbers:

The random number seed is set to 1.

RAM files:

All files are closed but their contents, if any, remain unchanged.

Variables:

Are 0 or null string per Visual BASIC defaults.

Host device:

The Host device is closed and therefore any data collected by the workstation and queued is held until an OPEN “Host” command is encountered.

Loading and Auto-Starting an A-B VBASIC Program (cont'd)

Prefix digits 9 and 10 of the network record: are 01. (See Chapter 8 on responses to Network Directives.) Manual Intervention in an A-B VBASIC program:

> In a normal production use of a workstation, the application program remains running continuously. Consequently, only limited facilities are supported for manual intervention.
>
> Sending an > > A command to the terminal will abort any A-B VBASIC program in progress and generate the "operator abort" BASIC ERROR message. For more information on commands, refer to Chapter 8.
>
> The > > G command will restart a terminated A-B VBASIC program. It is ignored if the program is already running.

Note: The program will restart at the beginning not at the point of termination.

Termination of an A-B VBASIC Program

The following are reasons for the absence of a running A-B VBASIC program:

1. The download of a .LXE file was never started, never completed, or resulted in an error. The load status display (number 7) should be consulted (refer to Chapter 4).
2. The program was started but terminated voluntarily by executing an EXIT, STOP, or SYSTEM statement, or by "reaching the bottom". We suggest that if you allow a program to terminate itself, you leave a descriptive message on the application status display (number 9) before termination. (See the STAT device later in this manual.)
3. A running program is automatically terminated when any record of a download (.LXE) file is received. This results in the BASIC ERROR "New Program Load", which means "Program aborted due to a new download".
4. The program was aborted by the operator using > > A.
5. Power failure.
6. A runtime error occurred.

A-B VBASIC Run-Time Errors

All errors encountered by the A-B VBASIC pseudo-code interpreter are serious enough to result in the termination of the application program. Program termination results in the following:

1. A return to the display of workstation status information (10 operator-selectable status displays discussed in Chapter 4.
2. An error message is sent through the network to the Host which begins with the words “BASIC ERROR”.
3. The error message is also available on the BASIC run-time status display (number 8), and through the read-only menu.
4. The diagnostic command < E will return the error message on demand (refer to Chapter 8).
5. The error flag E is posted over the 8 on the summary status display (number 0).

Format of a BASIC Error Message

The format of a BASIC run-time error message is:

text offset date time

where **“text”** is an explanation of the error,

and **“offset”** is the displacement from the start of the program’s pseudo code of the pseudo-instruction which was unable to complete. The corresponding BASIC statement can be found by correlating this value with the offset information provided in the program listing (.LST File) from LXB. The following chapter discusses how to get a listing file from LXB.

“date time” is the date and time the error occurred in the same form returned by the DATE$ and TIME$ functions. Example:

```
0101000600BASIC  ERROR:  New Program Load 054B:  9102281345
```

Runtime error messages presented to the Host computer are preceded with the customary 10 digit prefix, digits 9 and 10 of which are 00, followed by BASIC ERROR (refer to Chapter 8).

Power Failure

Circuitry within a workstation is capable of detecting and reporting to the processor an imminent loss of power. When this occurs, all tasks are brought to a logical conclusion and the following message:

```
POWERFAIL SHUTDOWN!
```

is sent to the LCD. Normally, this message will never be seen because a true power failure will blank the display. Its viability for any perceptible length of time is evidence of a power failure which was not quite long enough to completely turn off the workstation, or a workstation overly sensitive to power fluctuations.

The restoration of power results in this environment for the A-B VBASIC program:

1. The program is restarted FROM THE BEGINNING.
2. All files (RAM FILES) in existence at power failure are intact, although closed. Any write operation (a single PUT, etc.) to a file of a length under 4K bytes which was in progress when the power failure occurred, either did or did not complete AS A UNIT. Stated differently, record fragments are not present, only whole records.
3. All others program parameters are reset as for any other program initiation: variables 0, etc.

Programs wishing to distinguish between initial (cold) start-up and powerfail restart (warm), should open a file named, say, POWER. If the LOF function on POWER returns 0, assume a cold start and PUT something into the file. A non-zero file length implies a warm start.

Chapter 11

The A-B VBASIC CROSS-COMPILER (LXB)

Overview

The Visual BASIC Development Environment alone will not generate a program for a workstation. Visual BASIC allows the developer to create a program which can execute on a PC, but it is unable to create programs that a 2708-DH5 workstation can understand. To do that, we have developed a cross compiler that accepts an ASCII text file containing valid BASIC statements and creates a file that will execute only on a 2708-DH5 workstation. The extension .LXE is an adaptation of the .EXE name commonly used for executables under MS-DOS.

Typically a program is created and tested on a PC compatible computer with Visual BASIC and the application library. Once the program is refined through editing and testing, it can be compiled into an LXE file. The LXE file is also an ASCII text file. However, because it contains pseudo-code it doesn't look like anything familiar. Even character strings will not be visible in the file. The LXE can therefore be considered an encrypted file.

Because it is pure ASCII displayable text, it can be uploaded to other computers without worrying about control codes or binary objects becoming garbled. There should be no problem, for example, uploading an LXE file to an IBM mainframe, which can later download the program to a 2708-DH5 network using its native EBCDIC/ASCII translation tables.

Each line of an LXE file begins with a two-character sequence called a Network Directive. These are discussed in detail in Chapter 8. For downloadable files, the two characters are a greater than (>) and a comma (,). When the operating system sees an incoming record prefaced with these two characters, it knows that this is a line from a compiled program and not a line of data. If the file is in PGM format (see next section), it will have an additional network directive appended to the front of each record, and a 2-record header on the file.

The next two characters will begin with AA and increment sequentially through ZZ.

Any further discussion of the contents of the LXE records is beyond the scope of this document. Since the LXB compiler puts out an entire file, no further information is needed.

Following a successful download, the workstation will begin immediately executing the program.

Invoking the Compiler

The LXB compiler is executed on a PC by entering the following command. You must be in the right directory, or have the directory containing the LXB.EXE file set in your PATH. Optional parameters are in parentheses:

LXB param 1 (,param2) (,param3) (,param4)

The parameters are:

param1	Source filename (Default extension: .BAS)
param2	Download filename (Default extension: .LXE)
param3	Listing filename (Default extension: .LST)
param4	Secondary download filename (Automatic extension .PGM)

Entering the LXB command without any parameters will cause the compiler to prompt for the source, download, and list file names, offering defaults as appropriate. The default file extensions are in most cases the only allowable ones, and should not be specified or overwritten:

A.BAS source file extension is assumed. The source filename must always be specified.

The .LXE file is always generated. If the .LXE filename is omitted, it assumes the same name as the source file, and has the extension LXE.

If the .LST filename is omitted, the compiler will not generate a listing. Use a comma to hold its place if you want to specify a 4th parameter but don't want to enter the filename for the .LST file.

If the .PGM filename is omitted, the compiler will not generate a secondary download file. If it is specified, LXB will output (in addition to the regular .LXE file) a download file which contains the necessary network directives to cause the program to be stored in RAM and not immediately executed upon download. This feature is used for programs which will be CHAINed to later on. The RAM filename for the CHAIN statement will be the one specified in this parameter. In order for the fourth file to be generated, the .LXE file's default extension of ".LXE" *MUST NOT* be overridden.

Invoking the Compiler (cont'd)

Examples:

LXB

In the case above, the operator is prompted for 3 file names.

LXB Prog1

In this case, the file Prog1.BAS is read, and Prog1.LXE is the product. (This is the fastest compile option.)

LXB Prog1,Prog1,Prog1

File Prog1.BAS is the source, Prog1.LXE and Prog1.LST are generated.

LXB Prog1,Download,PRN

Generate Download.LXE, and send listing directly to the printer (PRN).

LXB Prog1,Startnow,Prog1,Wait

Generate Startnow.LXE and Wait.PGM output files, and Prog1.LST as the listing file.

A – Source File Specification

The A-B VBASIC compiler requires a plain ASCII text file. By default, the Visual BASIC editor saves the source text in a compacted format. Be sure to use the SAVE AS option in Microsoft's Visual BASIC to save the source as an ASCII file. LXB cannot recognize the compacted representation.

For a tutorial on BASIC programming, please refer to Microsoft's "Learning and Using Microsoft Visual BASIC", and "Programming in BASIC", both of which are supplied with the Application Generator Software (Catalog No. 2708-NAG) and BASIC Language Development Kit Software (Catalog No. 2708-NBD). A list of the STATEMENTS & FUNCTIONS supported by A-B VBASIC can be found in Appendix M of this manual.

Invoking the Compiler (cont'd)

B – Downloaded Executable File

The usual extension of a file that is produced by most other compilers is “.OBJ”. Those files usually go through a separate LINK step before an executable “.EXE” file is generated. However, the extension of the A-B VBASIC cross compiler output is “.LXE”. The extension “.LXE” is used for two reasons:

1. The file cannot be link edited like a usual PC object file.
2. There is only one useful operation that can be performed on this file: Download it to a workstation.

The code portion of the file is checksummed. Except for carriage returns, the entire file is within the printable ASCII character set. Transmission of a download file using modems should be safe since a corrupted file will result in a checksum error instead of program initiation.

C – Listing File

If specified, LXB places a listing into a file with the same base name as the source file, with an “.LST” extension. The OFFSET column of the listing shows the location of the pseudo-code corresponding to the BASIC statement. Error messages at run-time provide this offset as an aid in locating errors.

Program pseudo-code size is given in the listing file which can be used to gauge how much of the maximum 13,700 bytes of available program space (32K memory workstation) were used. Other statistics provide insight into the free variable space and other elements of memory use.

D – Secondary Download File

If the secondary download file parameter is specified, then a .PGM file will be output in addition to the .LXE file. The .PGM file is a special type of download file which will not begin executing immediately, but rather stores itself into RAM for future execution via a CHAIN statement from another program. It does this by appending some additional network directives onto the front of the file, and onto each record.

Chapter 12

Special Devices in A-B VBASIC

Introduction

Most I/O in A-B VBASIC is performed by accessing special device names which are unique to the workstation. In A-B VBASIC, as in Visual BASIC, devices are accessed with the same statements as files. For example, access to the workstation's barcode reader is obtained by an OPEN of the device named "BAR", followed by GETs or LINE INPUTs.

We highly recommend use of the BASIC Language Development Kit (Catalog No. 2708-NBD) of subroutines for faster, easier development of larger programs. Subroutines in that library automatically open the required devices and perform the appropriate timeouts and formatting operations. In addition, debugging can be done on the PC without the need for downloading each time a program change is made. Refer to Appendix M.

Most of the following information assumes that you are not using the BASIC Language Development Kit, but are writing a program which directly addresses I/O devices.

Here is a list of all reserved filenames which address the special devices. Note that they are different from DOS device names, and that they do not contain colons:

Real Devices	**Name**
Front panel LCD	LCD
Keypad	KEYS
Comm line - primary	COM
Comm line - auxiliary	AUX
Barcode	BAR
Lights on keypad	LITE
Timer	EGG
Host computer	HOST and NET

Pseudo Devices	**Name**
Queue to host computer	QUE
User status display	STAT

RAM files (any non-reserved name, 12 characters per file name max.)

Introduction (cont'd)

Some statements and intrinsic functions implicitly refer to a specific device. These are:

Front panel LCD	CLS, CSRLIN, LOCATE, POS, PRINT and WRITE (without file numbers)
Keypad	INKEY$, INPUT$ (without filenumber), LINE INPUT (without filenumber)
Beeper	BEEP, SOUND
Timer	DATE$, SLEEP, TIME$, TIMER
Files	KILL

Device: LCD Display

Reserved device name: LCD
These statements always access the LCD display:

PRINT and PRINT USING (without a file number)
WRITE (without a file number)
CLS
CSRLIN
LOCATE
POS
Prompts for LINE INPUT (without a file number)

As an alternative, OPEN "LCD" may be used to associate the device with a file number and PRINT # or WRITE # used.

Note: Once OPENed, the "LCD" file CANNOT be closed.

At program start, the LCD displays the words "BASIC START". The cursor is at the home position and is on. The LCD is set to clear when the program's first character is output to it. Thus, the programmer can act as if the LCD were actually already blank.

PRINTs to the LCD, ending without a comma or semicolon (, or ;) leave the cursor at the start of the next line. Thus, the next PRINT causes that line to be cleared before data is written.

PRINT statements terminated by a comma or semicolon leave the cursor where it was at statement's end, as shown in the following example.

Device: LCD Display (cont’d)

Note: See the description of PRINT USING and WRITE for details on other formatting options supported.

See also the READ.BAS collection of BASIC Language Development Kit subroutines for useful LCD output subroutines, including automatic formatting of display lines, automatic clearing of the display, and cursor positioning.

```
CLS
Name$ = “Fred”
PRINT “Please Enter Now!”
PRINT “Thank You”; Name$;   ‘ Keep cursor on second line.

CONST ScreenDev = 1
OPEN “LCD” FOR OUTPUT AS #ScreenDev  ‘ Cannot be CLOSEd
LineWidth% = LOF (ScreenDev) \ 2     ‘ Width of display.
PRINT #ScreenDev, “Please Enter Code:”;  ‘ Cursor remains on line.
LINE INPUT, Code$
```

Device: Keypad

Reserved device name: KEYS
These statements always access the Keypad:

INPUT$ (without a file number)
LINE INPUT (without a file number)
INKEY$

When a Keypad line is being entered with LINE INPUT, only the enter and backspace keys perform the expected termination and correction functions.

As an alternative, INPUT$ and LINE INPUT can be used to access this device using OPEN “KEYS”.

The BASIC Language Development Kit (Catalog No. 2708-NBD) modules READ.BAS and MENU.BAS contain several helpful subroutines for obtaining input through the Keypad.

```
CONST KeyDev = 1                        ‘ Assign device a file number
OPEN “KEYS” FOR INPUT AS #KeyDev        ‘ Open device.
DO WHILE a$ = ” ”:  a$ = INKEY$:  LOOP  ‘ Wait for a key stroke.
LINE INPUT “Enter your name:  ”; Name$  ‘ Must press enter.
b$ – INPUT$ (1)                         ‘ Another way to get a key stroke.
```

Device: Barcode Scanners

Reserved device name:	BAR
Open Modes:	INPUT
Statements:	LINE INPUT
Functions:	EOF returns TRUE when a complete record has arrived. Once TRUE, a LINE INPUT statement can be used and will immediately return the data when LINE INPUT completes. EOF returns to FALSE. LOF remains 0 until a barcode is read. Then it contains the length of the data record. It must be called before LINE INPUT. Once LINE INPUT has been used, LOF returns 0 until the next barcode is read.

IOCTL$ may be called after LINE INPUT to obtain more information about the type and origin of the data. In general, the string which is returned is of the form:

Type/Source

When reading barcodes:

Type can be: Code 3 of 9, I25, UPC, CBAR, or C128
Source can be WAND or LASER

There are two intrinsic functions which may be used before LINE INPUT to determine whether a barcode has been read: EOF, and LOF.

For barcodes, “read” means that the operator correctly used a wand, laser, or slot reader to scan one of the barcode types enabled through the barcode menu. For example, an A-B VBASIC program will not be aware that a UPC barcode has been scanned if UPC is not enabled or if another condition such as a check digit has not been satisfied. It also means that the operating system was able to decode the pattern of the barcode because the reader was operated at the correct speed and angle. Unsuccessful attempts to read a barcode are not reported to the BASIC program.

Once a read has occurred, the TRUE returned by EOF, the barcode length from LOF, and the data from LINE INPUT, are “latched” until a LINE INPUT is used.

Note: Allen-Bradley slot scanners (Catalog No. 2755-B1, -B2) can be used in place of a wand or hand-held scanner.

Device: Barcode Scanners (cont'd)

This means that:

1. EOF and LOF may be called any number of times before LINE INPUT, and they will return the information for the current barcode. Program structure might make it convenient for one procedure to detect the presence of a barcode with EOF, and another to get its length with LOF, and yet another to place its contents into a string with LINE INPUT.
2. All barcodes must be accepted by LINE INPUT before subsequent barcodes can be read! It is not possible to use LOF to read a barcode, then to ignore it because its length is wrong.
3. Once LINE INPUT is used, EOF and LOF are reset to false and 0 until another barcode arrives.

The status returned by IOCTL$ is valid from one transition from EOF TRUE to another.

To summarize, if you do not use the BASIC Language Development Kit subroutines (which are a faster and easier way to develop larger programs), the proper programming sequence to read barcodes is:

```
Optional test for EOF and/or LOF
Optional IOCTL$
LINE INPUT
Optional IOCTL$
CONST BarDev = 2
DO WHILE NOT EOF(BarDev): LOOP  'Wait for data.
SOUND 1200, 1 'Give a nice beep.
LINE INPUT #BarDev, InputData$
DataLength = LEN(InputData$)
```

Device: Host Computer

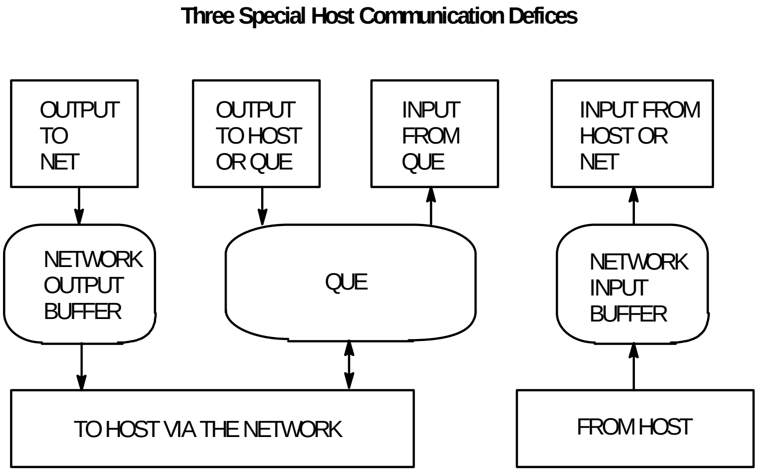
Reserved device names: HOST, NET, and QUE

It is very easy to forward the data collected by a workstation to the host computer attached to the Master Workstation. We recommend the BASIC Language Development Kit subroutines SendQue and Send. However, if you are not using these, the simplest method is to OPEN the "file" named HOST and WRITE # or PRINT # to it.

Two important features are that:

1. The data is forwarded to the host computer regardless of the network role played by the unit. Stated differently, output to HOST works the same for a workstation which is a Master, Concentrator, or any other workstation type.
2. Once a record has been written to HOST, no further action by the A-B VBASIC program is required to get the information to the host. If the workstation is offline, the data is stored temporarily in a FIFO queue and forwarded when network conditions permit. This occurs transparently to the application.

Figure 12.1
Data I/O through a Network



This diagram shows the various methods which can be used to move data into and out of a workstation through its network.

All output operations to HOST enqueue data in a FIFO (first-in-first-out) queue, which is a special form of RAM file. The network task removes records one at a time as it is able to transport them to the host computer.

Output operations to the NET device bypass this queue. The record is placed in an output buffer which is checked before the queue. Use this method sparingly for high priority alarms which must bypass queued records.

Device: Host Computer (cont'd)

Note: There is no queue for data FROM the host, only a single buffer. Input operations from HOST and NET access this buffer.

As just mentioned, the FIFO queue is a special file. As such, it can be manipulated as a file, through the reserved file name QUE.

IMPORTANT NOTE: Outputs to the QUE device will remain in the queue and will not be sent to the host until the QUE device is closed and the HOST device is opened. Nothing further needs to be done with the HOST device; it only needs to be left open until the entire queue is emptied.

If, on the other hand, data should be routed to the host as quickly as possible, do not use the QUE device at all, but rather send everything directly to the HOST device. It will still use the queue, but will not wait to transmit.

General restrictions and warnings:

1. Only printable ASCII characters may be moved through the network. Output only characters within this range:

   Lowest valid: Space, CHR$(32), Hex 20
   Highest valid: }(right curly bracket), CHR$(125), Hex 7D

   Programs which access QUE as a binary file will also encounter carriage return/line feed sequences. These have been inserted by the interpreter. Do not remove them or try to insert them explicitly using CHR$( ).
2. Like any other RAM file, the size of QUE and HOST is limited by physical RAM. Use the FRE function often to prevent out-of-memory conditions which could have disastrous effects on operations.
3. All output operations must contain a complete record in ONE statement. All outputs place a trailing carriage return/line feed sequence after the data provided. It is not possible, for example, to use multiple PRINT statements, terminated by a comma to assembly a HOST or QUE record piecemeal. THIS RESTRICTION IS ENFORCED, see PRINT.
4. Do not allow HOST and QUE to be OPEN at the same time.
5. Input FROM the host computer may not begin with < or > or a numeric digit (0 to 9). Chapter 8 describes the effect which these characters have on the firmware.
6. All output to NET has the potential disadvantage that its data might be classified as a network status or other error message and not application related data. This can happen because, when using the NET device, the "Transaction Code" digits 9 and 10 of the 10 character record header are set to zeroes, and cannot be changed by an IOCTL statement (see IOCTL description later in this chapter). Two zeroes are typically an indication of a status or diagnostic message, BASIC ERROR, or other system generated response.

Device: Host Computer (cont'd)

For example:

```
PRINT #NETDEV, "BAD INVENTORY NUMBER"
```

may be trapped by the host computer as a BASIC ERROR because the complete record sent to the host will look something like this:

```
0101000100BAD INVENTORY NUMBER
```

If the host program is testing for zeroes in digits 9 and 10, and is then looking for "BA" to indicate a BASIC ERROR, it will become confused by this error message, and potentially abort the programs.

We suggest that, if you must use NET instead of HOST, make your first two bytes something odd like **.

7. A maximum length is imposed on all records moving through the network. Consult Appendix N in this manual.
8. AnyA-B VBASIC program reading from HOST or NET must do so at a rate fast enough to "Keep up" with the host. If a new record arrives before the previous one is input, the "lost" count is incremented on the #5 status display.

Details of Specific Statements and Functions

We highly recommend that you utilize the subroutines contained in the BASIC Language Development Kit (Catalog No. 2708-NBD) to do all I/O in the workstation. These library routines allow you to simulate the workstation on a PC during development, saving you hours of time and headaches. When using the BASIC Language Development Kit, you will only need to call OpenLINX, then execute a ReadEvent and wait for a return. Any data received from the devices (slot reader, COM ports, etc.) will be returned in appropriate variables, and flags will be set to let you know where the data came from. Refer to Appendix M for details. If you must use the devices directly, the following programming examples will show you how:

OPEN "HOST"

Host should be opened only as a sequential or random access file, in keeping with the record oriented nature of network I/O. QUE may be OPENed for binary access so long as the general restrictions are observed.

An OPEN "HOST" has a very important side effect: it allows the network task to deque records from the QUE and forward them to the host.

Program initiation CLOSEs HOST. Program termination leaves HOST unchanged.

Details of Specific Statements and Functions (cont'd)

CLOSE "HOST"

Note: When HOST is CLOSEd, the A-B VBASIC interpreter always tells the network task that no data is available from the QUE, even if data is really present. There may be records remaining in the QUE. If so, they will not be available to the network until HOST is once again made OPEN. If necessary, use the LOF function to determine when the QUE is empty, before CLOSEing HOST.

WRITE

If the presence of commas and quotation marks is acceptable to your host, this is the simplest way to send a record. Don't forget to precede the WRITE with a call to FRE to make sure memory is available. As with all output to the network, the interpreter adds the required record delimiters.

PUT to HOST

PUT is an excellent way to output a variable which has been defined in a TYPE statement. Just remember that all the elements in the TYPE must be fixed length strings. Numerics are not allowed (as binary quantities) since adherence to the "printable character" restriction is not assured.

The data is put into the queue for automatic transmission to the host computer, in order, when possible.

PUT to NET

If the (network) output buffer is empty (see LOF), the record provided will be the next one taken by the network for transmission to the host.

Note: If the output buffer is in use, execution of this statement suspends the A-B VBASIC program until the previous record is taken. So, unless your program is prepared to wait, do not use this statement without first checking LOF on the NET device. Better yet, PUT to HOST.

PUT to QUE

This statement acts like PUT to HOST. Generally, it is used to create a "batch" of records for the host which will be released at some future time by an OPEN "HOST". Important distinction: PRINT, and WRITE to the QUE add a record delimiter in the same way as output to HOST. Outputs to regular RAM files do not perform this insertion.

PRINT

All PRINT #s to HOST, NET, and QUE are restricted. After every PRINT, the interpreter inserts the carriage return, line feed record delimiter. It is not possible to use multiple PRINTs to make one record.

Details of Specific Statements and Functions (cont'd)

LINE INPUT # for HOST and NET
GET # for HOST and NET (OPEN with RANDOM)

These statements will read one record which the host computer has sent to this. If there is no record available, the program waits for its arrival. Use the EOF or LOC functions first if waiting is not acceptable.

LINE INPUT # for QUE
GET # for QUE (OPEN with RANDOM enforced)

These statements act as if a file is being accessed because QUE is a file.

EOF for HOST and NET

EOF returns TRUE when a record is available for reading. When FALSE, nothing is present.

LOC for HOST and NET

LOC returns the number of characters which can be read from the network input buffer.

Example:

```
IF LOC(#1)  0 THEN
      LINE INPUT #1,  INLINE$
ELSE
      ‘ Do something else
END IF
```

LOF for HOST

LOF returns the size of the queue, that is, the number of bytes awaiting transmission to the host.

LOF for NET

LOF returns the number of bytes free in the network output buffer. When non-zero, a single record of that size may be output without waiting. When 0, output is permitted but the A-B VBASIC program will wait until the previous record is accepted by the network. Note that only one record may be output even though the record is shorter than the buffer. For example, say the function returned 200. It is not possible to output 3 records of 20 bytes without waiting.

Details of Specific Statements and Functions (cont'd)

IOCTL$ (intrinsic function) for HOST and NET

This function returns a string formatted as follows:

Byte 0: '0' when the workstation is offline to the network.
'1' when the workstation is online.

Bytes 1-4: is the workstation's number (without a minus).

Bytes 5-9: is the workstation type (its network role) as

NORML	CONCN
MASTR	SUBM
ALTM	ALTSM

IOCTL (statement) for HOST

Characters 9 and 10 of all records arriving at the host contain a 2 digit number ("Transaction Code"). Numbers 00, 98, and 99 are reserved. A-B VBASIC programs can change these two digits for records from HOST, from the default of 01.

For example, if the statement IOCTL #5, "29" is used where #5 is associated with HOST, digits 9 and 10 of records containing data from this workstation, will be 29.

Note: Only numeric digits are valid. IOCTL is not valid in its statement form for the NET device.

Devices: Communication Ports, Primary and Auxiliary

Reserved device names: COM and AUX
Opening a com port:

Access to the communications ports begins with the statement OPEN "COM" and OPEN "AUX". On a PC, Visual BASIC allows you to specify baud rate and other parameters in the OPEN "COM" statement. In A-B VBASIC these are NOT valid! Comm parameters are set using the Setup Menus (see Chapter 5 for details). If you are using the ENV/ENVPC collections of subroutines in the BASIC Language Development Kit (Catalog No. 2708-NBD), a call to OpenLINX will automatically open all required comm ports.

The primary communication port is dedicated to networking functions in all terminal types except NORMAL. Any attempt to OPEN 'COM" on any workstation which has not been set to a workstation type of NORMAL (using the Setup Menus) will result in a runtime error.

Units with a second ("AUX") port may use that port via OPEN "AUX" regardless of the workstation's network role.

OPENing a communications port has no effect on the state of the modem control lines DTR and RTS. These are always under the control of the BASIC program using IOCTL, or one of the BASIC Language Development Kit subroutines discussed later.

Devices: Communication Ports, Primary and Auxiliary (cont’d)

A – Output to a Communication Port

The BASIC Language Development Kit (Catalog No. 2708-NBD) contains subroutines SendCom, ReadEvent and Test Event for accessing the COM port when the terminal is configured as a NORMAL workstation type. If you need more immediate control of the port, use the following programming instructions:

The PRINT and WRITE statements are available for output to the communications ports. Unless a semicolon is placed at the end of the PRINT statement, a carriage return will be output. When enabled through the menu, a line feed is also output.

Each of the communications lines has an output buffer. The LOF function returns the number of bytes free in this buffer. When less than the size of the message, output to the corresponding port will result in a wait until all characters can be enqueued. This wait will be short in a workstation which is able to transmit. However, for a workstation which has received an XOFF, the wait can be long (or even infinite)!

B – Input from a Communication Port

All COM and AUX input is performed with the INPUT$ function. If more characters are requested than have been accepted by INPUT$, the program waits until the count is satisfied.

LINE INPUT is not valid with the COM or AUX device.

The LOC function returns the number of bytes currently in the port’s communication input buffer bytes. A program will never wait if LOC is used to get the byte count, and that count is used in INPUT$.

For example:

```
CONST AuxDev = 1
OPEN “AUX” FOR INPUT AS #AuxDev    ‘ Cound also be “COM’
J$ – INPUT$ (LOC(5), #5
```

NOTE
Receipt of Control-C (or whatever control code was specified in the Setup Menu) will cause the workstation to enter the menu mode. Receipt of Control-R will reboot the workstation.

Devices: Communication Ports, Primary and Auxiliary (cont’d)

C – Modem Control Lines

The primary communication port is equipped with DTR and RTS. These can be set through the IOCTL statements. The character string passed must contain two bytes. There are two valid options for each byte:

“0” to turn the line off
“1” to turn the line on

The first byte controls DTR, the second controls RTS. Thus:

`IOCTL #5, “01”` turns off DTR and turns on RTS.

These modem lines can also be controlled using the BASIC Language Development Kit routines SetDTR and SetRTS.

AUX has only one line, DTR. It is controlled in the same way as COM. For future compatibility, always add a second (character) zero, to imply RTS off.

Device: RAM Files

Name: Any name which is not reserved and is within the rules for file names.

Description:
Data files on a PC are resident on disk. They are RAM resident in the workstation. A-B VBASIC supports the three types of file access provided with Visual BASIC, sequential, binary, and random. File I/O is thoroughly discussed in Microsoft’s “Programming in BASIC”, Chapter 3.

Statements and Functions supported:[1]

CLOSE
EOF
GET
INPUT$
KILL
LINE INPUT
LOC
LOF
OPEN
PRINT
PUT
SEEK Statement
SEEK function
WRITE

```
CONST DataFile = 1
OPEN “EMPLOYEE” FOR OUTPUT AS #DataFile
PRINT #DataFile, “Employee  ”;EmpName$ ;“ – ”;TIME$
CLOSE #DateFile
```

ATTENTION: Both Visual BASIC and A-B VBASIC allow a PUT to a record number which is greater than the last record in existence before the PUT. Both BASICs extend the file to the length required to accommodate the request.

[1] Refer to Appendix M for any restrictions on Syntax.

Device: RAM Files (cont'd)

For example, in a new file:

```
PUT #X, 1, something
PUT #X, 1000, something
```

will result in space being allocated for 1000 records, not 2!

Moral: *Keep record numbers under control.*

File Memory Management

Files are allocated in blocks of RAM. Every file has at least one free byte. In essence this means that a file with a length of zero is allocated one block. Each block contains 2 bytes of overhead. The remainder contains the file's contents. The block size is set via the configuration menu, to 256, 512, 1K, 2K, or 4K bytes. In an application with several small files, a block size of 256 is recommended. In an application with one large file, a block size of 4K allows for a slightly larger file and slightly better performance. The maximum file size is limited by a workstation's memory, not A-B VBASIC.

Visual BASIC does not allow you to PUT a variable length string to a RANDOM file. In A-B VBASIC this is also not recommended. However, it can be done. Remember to allow at least 2 bytes of overhead for the carriage return/line feed sequence that accompanies each variable PUT to a record. Integrity of data stored and retrieved in this fashion cannot be maintained or updated with any relative degree of confidence.

Device: Beeper

This device is accessed through the BEEP and the SOUND statements. SOUND requires both a frequency and a tone duration. The correspondence between the frequency and a "true" pitch of that value will be approximate.

The duration of the tone is given in units of 1/20 second.

Unlike Visual BASIC which pauses until a SOUND is finished, A-B VBASIC initiates a SOUND and continues. A second SOUND or BEEP which is encountered before the first completes, resultls in the truncation of the initial tone.

Device: Front Panel LED's

Device: Front Panel LED's
Reserved device name: LITE

The LEDs on the keyboard are numbered from 1 up. The maximum LED number depends on the keyboard style. PUTting a "0" to record number X, turns off LED number X. PUTting a "1" to record number X, turns it on.

Device: Front Panel LED's (cont'd)

The LED in the lower left corner of alphanumeric keyboards is used as a shift lock indicator by the operating system. A-B VBASIC programs should not change it.

The BASIC Language Development Kit contains a subroutine SetLED which can be called to turn LEDs on and off. Or use this code example:

```
CONST LiteDev = 1
On$ = "1": off$ = "0"              ' Cannot be a CONSTant
OPEN "LITE" FOR RANDOM AS #LiteDev
FOR X = 1 TO 10                    ' Do 10 LEDs
     PUT #LiteDev, X, On$          ' Turn LED on.
     SLEEP .25
     PUT #LiteDev, X, Off$         ' Turn LED off
     SLEEP .25
NEXT X
CLOSE LiteDev
```

Device: The #9 User Status Display

Reserved device name: STAT

Description:

The front panel status displays shows information about the condition of a workstation. The number 9 status display is dedicated to showing status information from the application.

Two lines are available with 40 characters each. A summary status character which appears over the 9 on the zero summary status display, is also available.

The PUT statement is used to place information in the buffer which is shown when the #9 display is selected.

PUT to record number 1 places the string on the top line of the display. Put to record number 2 places the string on the second line of the display. PUT to record 3 places the first character of the string over the 9 on the summary display.

```
OPEN "STAT" FOR RANDOM AS #3
LTOP$ = "Data Corp Inventory"
LBOTTOMS$ = "Duncan Street Warehouse"
SC$ – " . "
PUT #3, 1, LTOP$
PUT #3, 2, LBOTTOM$
PUT #3, 3, SC$
```

If your application must shut down or cannot start up, for example due to a missing file that the host was supposed to download, put an error on the status display before program termination.

Remember that these statements do not cause the status display to appear, they only define the display's contents when invoked by the operator.

Device: The Egg Timer

Reserved device name: EGG

Description:

The egg timer is a word of memory which, when non-zero, is decremented by one every 1/100 second.

These statements, when used with the file number associated with an OPEN “EGG”, control this timing device:

SEEK statement: sets the timer to an integer or long

For example:

```
OPEN “EGG” FOR INPUT AS #4
SEEK #4,  1000
```

sets the timer to reach 0 in ten seconds.

SEEK function: returns the current value of the timer as a LONG value. (LONG is used to avoid sign confusion for values over 32767 with an INTEGER).

LOF and LOC also return the timer’s current value.

EOF returns TRUE (-1) when the timer “goes off” by reaching zero. This device is an easy way to implement delays and timeouts without the midnight rollover problem associated with TIME$ and TIMER.

Chapter 13

A-B VBASIC Application Library

Introduction

The BASIC Language Development Kit (Catalog No. 2708-NBD) consists of a set of BASIC source files which you may use to decrease your development time and enhance the quality of your A-B VBASIC applications.

Note: Subroutines for the A-B VBASIC Application Library can be found in Appendix M of this manual.

The core of the library is the module ENV.BAS.

ENV.BAS provides a set of I/O routines for access to the workstation devices such as the bar code port, comm ports, network, and so on. Since virtually all workstation applications are driven by external events from multiple devices, ENV provides a simple mechanism for reading from more than one I/O device at once with timeouts.

In order to speed developoment on IBM PC compatible computers, we have provided a second library of subroutines (ENVPC.BAS) with names identical to those in ENV.BAS, but which use standard PC devices to emulate 2708-DH5B2L or -DH5B4L workstations. This allows testing of A-B VBASIC applications under MicroSoft's Visual BASIC. ENVPC allows you to simulate input from slot readers, comm ports, and the network all on your development PC without needing an actual workstation.

READ.BAS provides a library of field oriented I/O subroutines. You may read string fields, autoexit fields, numeric fields, secured (password) fields, and fields with default values using the routines. The FORMEX.BAS example program demonstrates forms style entry using READ.BAS.

MENU.BAS subroutines allow you to create visually oriented selection menus for easy-to-use application programs. This is also demonstrated by the example program FORMEX.BAS.

The IOTEST directory contains examples for A-B VBASIC Low Level I/O. Scientific math support for process control applications is provided with MATH.BAS, TRIG.BAS, and HYP.BAS.

Using the Library

Installation consists of installing the diskette in drive A: and typing:

```
A:
INSTALIB d:
```

Where d is the destination drive.

You must first set up Visual BASIC, see Microsoft manual “Learning to Use Microsoft Visual BASIC” for installation procedures (manual is provided with the software). Also, make sure that the commands VB and LXBC are available from the installed directory “ \ LIB”.

The A-B VBASIC compiler requires that all of your program reside in a single file. (It does not support a LINK step which would combine multiple independent object files into a single run file.) Since the BASIC Language Development Kit is made up of multiple files, the normal way to use it is to append all of the desired modules together and then load the resultant file under Visual BASIC or compile it with the A-B VBASIC Compiler.

The only required module of the library when testing on the PC is ENVPC.BAS.

Suppose you have the following program:

```
DEFINT A–Z    ’ Recommend default variable type
OpenLINX      ’ REQUIRED library initialization
TIMEOUT% = 1000                      ’ Set a 10 second timeout
DO
    CLD
    PRINT “Library Test”
    PRINT “Do something” ;           ’ 2nd line MUST have;  or scrolls
    e = ReadEvent% (2)               ’ The mask (the 2) means read
    SELECT CASE e                    ’ from keyboard/bdg with timeout.
        CASE TimeoutEvent            ’ The 10 seconds expired so make
            CLS: PRINT “ *Timeout* ” ’ this obvious.
            BEEP : SLEEP 2
        CASE BadgeEvent : CLS        ’ The event that occurred was a
            PRINT “Badge read”       ’ Bar code badge.
            PRINT InBuf$;            ’ The badge contents is in InBuf$
            BEEP : SLEEP 2           ’ Make some noise, and show badge.
        CASE ELSE : CLS              ’ Case Else required in LinxBASIC!!
            PRINT “Key = ” ;e;       ’ Display ASCII code for the key
            SLEEP 2                  ’ or negative code if its special.
    END SELECT
LOOP                                 ’ Do this test forever
```

Using the Library (cont'd)

If you don't want to type this in, you will find this sample program under ENVEX1.BAS. Now, assuming that the VB command (Visual BASIC) is in your directory or is set up in your DOS PATH for you to access it, you could enter the following DOS commands:

```
TYPE ENVPC.BAS > MAIN.BAS
TYPE ENVEX1.BAS > > MAIN.BAS
VB/RUN MAIN.BAS
```

The first TYPE command copies the ENVPC library source file into MAIN.BAS. The second type command appends your test program to MAIN.BAS. Finally, the command VB/RUN MAIN.BAS tells Visual BASIC to run and start executing MAIN.BAS.

A batch file is provided which you can use to do the DOS commands which were shown above. This batch file is supplied on the distribution diskette. To use it, type:

```
LVB ENVEX1
```

You will note that LVB.BAT also includes READ.BAS and MENU.BAS into the MAIN.BAS which it creates. If you do not need these modules, remove the TYPE lines for them from the batch file.

When you type the VB command, the Visual BASIC screen should be displayed and the bottom line will display "Loading and parsing" for a few seconds. Then it will say "Binding", and then the I/O environment emulator will be running, with your program executing.

Type ALT X or TAB then X to stop the Emulation.

Writing Programs

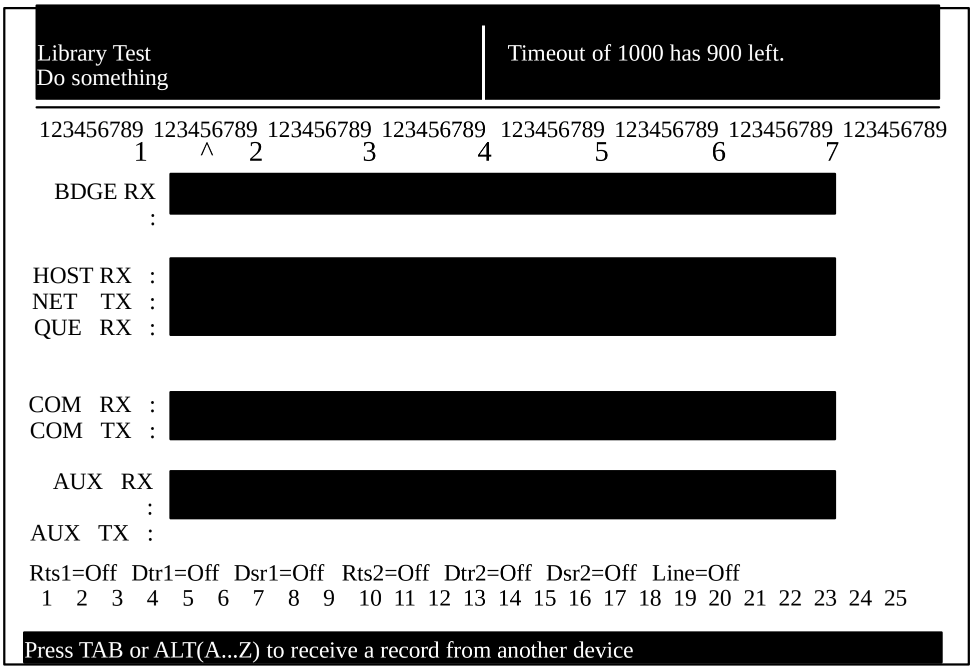
After examining the example BASIC programs and running them under the emulator, you should be ready to write your own. The subroutines are listed in Appendix M, along with the required arguments and returned values. Start with a small application and refer to the source code of the following files: FORMEX.BAS, ENV.BAS, READ.BAS and MENU.BAS for info about how to use each routine. Also print copies; of any BASIC files which interest you, as these will provide insight into various ways to use A-B VBASIC.

When you are ready to test your program on the workstation, you should first compile it using the A-B VBASIC Cross-compiler LXB. The LLXB.BAT batch file has the same syntax as LVB, except it starts with ENV.BAS instead of ENVPC.BAS.

When having subtle syntax problems, try examining MAIN.BAS or using LXBC to create a listing of MAIN.BAS.

Using the ENVPC Simulator

Figure 13.1
ENVPC Main Screen (Running ENVEX1)



```
Library Test                                   Timeout of 1000 has 900 left.
Do something

123456789 123456789 123456789 123456789 123456789 123456789 123456789 123456789
        1     ^   2         3         4         5         6         7
  BDGE RX
         :
HOST RX  :
NET   TX :
QUE   RX :

COM   RX :
COM   TX :

  AUX  RX
         :
AUX   TX :
Rts1=Off  Dtr1=Off  Dsr1=Off  Rts2=Off  Dtr2=Off  Dsr2=Off  Line=Off
 1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25

Press TAB or ALT(A...Z) to receive a record from another device
```

TAB X or ALT X: TERMINATES emulation.

CTRL-BREAK: Pauses program and enters Visual BASIC environment.

TAB S or ALT S: Slot reader manual input. You key in a record which will be read as slot reader input.

TAB B or ALT B: Same as above (B is for Badge reader input).

TAB H or ALT H: Host manual input. You key in a record which simulates a record from the host computer. Leave the station number off of the record.

If your actual host would send:

“1-23:REJECT/Bad lot number”

To workstation 23 attached to Master 1, you should just enter:

“REJECT/Bad lot number”

Using the ENVPC Simulator (cont'd)

Since that is all that your BASIC program would input.

TAB C or ALT C: Com port manual input. You key in a record which simulates an input record from your RS-232 or RS-422 com port. Note that Master, Submaster, and Concentrator workstations cannot use the com port since it is in use by the network.

TAB A or ALT A: Aux port manual input. A manual input record from RS-232 or AUX port.

TAB D or ALT D: Puts the display in 40 column mode (FOR COLOR MONITORS ONLY!). The next TAB or ALT command will switch back to 80 column mode.

TAB L or ALT L: Starts or stops logging. When logging is enabled, all output to all devices (except the display and front panel LEDs), and all input (except from the keyboard) is recorded in a file (usually named LINXIO.LOG). The log file contains a timestamp and device name for each I/O record.

TAB F or ALT F: Opens a device input file. The Barcode, Host, Com, and Aux devices may each have an open device input file. Each time you press ALT N, the next record can be input from that file instead of keying in the records by hand. This can be a big time saver when simulating a complex application. You will be asked for the device that you want to input for (BC, H, C, or A) and you select the letter. You are then asked for a file name to input from. Make sure you enter the correct name or the emulator will terminate.

TAB N or ALT N: If only a single device input file is open, then this will perform a device read from that file. If more than one device input file is open, then you will be prompted for the device which you want to input for (BC, H, C, or A).

A – Predefined Constants

Predefined constants are available in Env.BAS and EnvPC.BAS.

TRUE and FALSE may be assigned to integer variables which are used as boolean variables.

Using the ENVPC Simulator (cont'd)

The lower ASCII characters from 0 to 31 and 127 are named. These are:

NUL = 0
SOH = 1
STX = 2
ETX = 3
EOT = 4
ENQ = 5
ACK = 6
BEL = 7
DEL = 27

BS = 8
HT = 9
LF = 10
VT = 11
FF = 12
CR = 13
SO = 14
SI = 15

DLE = 16
DC1 = 17
XON = 18
XON = 19
XOFF = 20
NAK = 21
SYN = 22
ETB = 23

CAN = 24
EM = 25
SB = 26
ESC = 27
FS = 28
GS = 39
RS = 30
VS = 31

The function keys are named F1..F10. The SHIFTED and ALT function keys are available as ShiftF1..ShiftF10 and AltF1..AltF10.

Alt letters are available as AltA..AltZ. Note that ENVPC uses the Alt keys for control.

Special key equates are:

ClearKey, ExitKey, EnterKey, Up, Left, InKey, OutKey, Right, and Down

Note: Left is identical to BS (backspace) on the workstation.

B – Global Variables

InBuf$: . . . . Filled when SlotEvent WandEvent occurs

InCom$: . . . . Filled when ComEvent or AuxEvent occurs

InNet$: . . . . Filled when NetEvent occurs

DSPWIDTH%: . . . . . . Width of the display in characters (40/16) (set in OpenLINX)

ONLINE%: . . . . Set to TRUE when Master is polling (set by TestEvent%)

MEMFULL%: . . . . . . Set to TRUE when File or QUE memory is almost gone

PENDING%: . . . . Set to TRUE when a Send will pause

COMOPEN%: . . . . . . TRUE if this is a normal workstation
(set in OpenLINX)

TERMNUM%: . . . . . . Number of this workstation (set in OpenLINX)

TERMTYPE$: . . . . . . Type of workstation (set in OpenLINX)

EXITEVENT%: . . . . . Event code of the last event from a Read%

EXITOFFSET%: . . . . Offset in a menu or string from ReadStrField% and Menu%

Using the ENVPC Simulator (cont'd)

MODIFIED%: . . . . . . True when a read changes the default value
TIMEOUT%: . . . . YOU set to 100th seconds before a timeout for reads
BLOBALMASK%: . . YOU set mask used for ReadStr%, ReadStrField%, ReadInt% etc.
GLOBALATTR%: . . . YOU set attributes use for ReadStr%, ReadInt%, etc.
INSERTMODE%: . . . YOU set FALSE to disable insert mode on Read...

C – BASIC Language Development Kit Limitations

The BASIC Language Development Kit (Catalog No. 2708-NBD) subroutines provide access to all of the devices supported by the workstation. The following are some of the I/O methods that they do not support.

If ENV is unable to provide exactly the kind of support you require, MODIFY BOTH ENV.BAS AND ENVPC.BAS to add the special support you need. This way you can continue to debug your program under the Visual BASIC Environment before you download it to the workstation.

You *don't have* to use ENV or any part of it. We recommend it because it greatly speeds development and provides a common base for many workstation applications.

D – PC Simulation Constants and Variables

Note: Device numbers #20 and up are reserved for use by ENV.BAS.

PcMode . . . . is TRUE when running under the emulator (ENVPC.BAS)
DSPWIDTH% . . . . . . is set to 40

EmAltAccess is TRUE. Set it to FALSE to allow your program to access ALT keys. These are normally trapped by the emulator for device I/O access.

Bar code data is collected with the subroutine TestEvent%. The subroutine will return a BadgeEvent when the data has been read into InBuf$. Examine BadgeType for barcode inputs to get the bar code type ("Code 3 of 9", "I25", "UPC", "CBAR", or "C128").

Using the ENVPC Simulator (cont'd)

Display and Keyboard

You may use the full range of PRINT, LOCATE, etc. functions to write to the display. Do not use the cursor size arguments to LOCATE, but you can turn the cursor on and off using the third argument.

Reading from the keyboard should only be done using TestEvent% or one of the functions which use it such as ReadEvent%, ReadStr%, ReadInt%, Menu%, etc. The keys are returned as the ASCII value of the key. Special keys such as function keys and cursor keys, will return a negative event code. All special keys have named constants in ENV.BAS which MUST be used to test for a key value.

Network I/O

Only LINE INPUT and LINE OUTPUT are supported via TestEvent% as a NetEvent. The data is left in InNet$. Output to NET is supported with the Send subroutine. (Note that, as with any output to NET, you must first test to make sure the previous output to NET has completed, or you will get an error. This means the host must be online. If you need to send data while the workstation might be offline from the host, use SendQue instead.) Output to the network through the queue is supported via SendQue. No support is provided for opening the QUE device and accessing it as a file. No support is provided for PRINT # USING to the network.

COM and AUX

Only LINE INPUT is supported for input via TestEvent%. The events are ComEvent and AuxEvent, and the data is left in InCom$.

For OUTPUT you build a string which is output in exactly the form you provided it (Line-Feeds are added to Carriage Returns when that option is enabled). No support is provided for PRINT # USING to the COM or AUX ports.

Support for the control lines is provided with SetDTR and SetRTS.

Support for the status line is via GetDSR%. No event support is provided for DSR state changes.

Note: While the BASIC Language Development Kit subroutines will accept the AUX port as a target for DTR, RTS, and DSR commands, the WORKSTATION DOES NOT HAVE THESE LINES on the AUX port, and the results are unpredictable!

Using the ENVPC Simulator (cont'd)

Status Display

The application status display (one of the special status displays described in Chapter 4) is not accessible through any subroutines in ENV, and is not emulated in ENVPC. Use a section of code which is conditional on the value of PcMode to set the status display.

Printing Reports and Forms

Since PRINT # USING.. is not supported, we recommend that you format reports by first printing the report to a scratch file, then copying the file to the device. Example:

```
listfile$ = "SCRATCH"
OPEN listfile$ FOR OUTPUT AS #1
PRINT #1, USING " . . . . . . .
. . .
build your report, form, or complex response here
. . .
PRINT #1, USING " . . . . . . .
CLOSE #1
OPEN listfile$ FOR INPUT AS #1
DO WHILE NOT EOF(1)
LINE INPUT #1,  s$
SendQue  s$          ' This could be SendQue, Send, or SendCom
LOOP
CLOSE #1
KILL listfile$
```

Appendix **A**

2708-DH5B2L and -DH5B4L Workstation Specifications

Electrical – 2708-NP1

Input Line Voltage:	90 to 130 V, 60 Hz
Current Requirements:	175 mA to 425mA at AC input for standard DH5 workstation. (Dependent on which scanner chosen)
Power Output:	At full load 24V; 40VA – U.L. Listed

Electrical – 2708-NP2

Input Line Voltage:	198 to 264V, 50 Hz
Current Requirements:	90mA to 220mA at AC input for standard DH5 workstation. (Dependent on which scanner chosen.)
Power Output:	At full load 24V; 40VA – U.L. Listed

Mechanical – 2708-DH5B2L and -DH5B4L

Enclosure:	NEMA Type 1
Weight:	4.73 lbs. (2.25 kilograms)
Height:	2.25 inches (57.2 millimeters)
Width:	9.125 inches (231.8 millimeters)
Depth:	7.75 inches (196.7 millimeters)
Environment:	Ambient temperature range of 4° C to 50° C (40° F to 120° F)
Relative Humidity	5% to 95% (non-condensing)
FCC:	This product compiles with the requirements of FCC Part 15 Rules for Class A Computing Devices.

Communication Ports

Host Port:	Labeled COM1, 9 pin DIN male connector
Auxiliary Port:	Labeled COM2, 9 pin DIN male connector
Network Port:	Labeled 485 NET, 9 pin DIN female connector
Barcode Port:	Labeled BARCODE, compatible with Allen-Bradley hand-held scanning devices.

Menu Trigger Keys

The Menu Trigger Keys are two keys that when pressed simultaneously, allow the user to access menu items. Normally, all you have to do is press these two keys to access menu items. However, if an A-B VBASIC program is running, the workstation will have to be powered-off and then powered back on while the Menu Trigger Keys are being held down.

Knowledge of the Menu Trigger Keys is customarily kept secret to circumvent unauthorized access to vital workstation functions. In addition, when workstations are installed for use, a menu protection mode using a password should be implemented to avoid unintentional or deliberate menu access.

> The Menu Trigger Keys are the ENTER/RIGHT ARROW key combination.

Once you are in the workstation Menus, each press of the EXIT key will allow you to back-out one menu at a time until you are in the workstation status menu of (if a program is running) the program status menu.

Appendix C

Technical Description

The 2708-DH5B2L and -DH5B4L workstations have been designed for use in both factory and office environments. They are protected against the hardships presented by many factory environments and offices including sunlight, spills, dust, and most corrosive substances (NEMA Type 1 enclosure). The case is made of rugged steel and aluminum.

1. Software Features

- Programmable in Microsoft Visual BASIC.
- Simple, error free data entry with edit checking performed at the terminal.
- Operations can be interactive, transaction oriented, or fully offline.
- The host can be connected via RS-232 or RS-422 and collect data from all workstations in either input only mode or in an interactive polled model.
- A password protected menu mode which allows parameters to be changed without requiring either communications from the Host or opening the workstation.
- Up to 1024 workstations can transfer data to a single RS-232 or RS-422 port on the Host computer using simple asynchronous communicatioins.
- No controller is required, since all communication between workstations is handled transparently via the network cable.
- Large networks can be laid out conveniently using a backbone network collecting data from tributary networks.
- Portions of the network can be attached using modems and switched lines allowing remote tributary networks.
- Complete fault tolerance is provided through the use of alternate routing and off-line operation.
- Full error detecting and retransmission network protocol operates transparently to the Host. All Host I/O is via simple asynchronous records.
- Terminal mode allows operation as a “dumb terminal” for applications requiring total Host control.

2. Hardware Features

Installation
Separate power and network connectors make installation and replacement both fast and simple. No switches are used, since all configuration data can be entered from the workstation menu. All configuration information is stored permanently.

Display
40 character x 2 line dot matrix LCD. The character is a 5x7 dot matrix with a character size of 0.165” x 0.115”.

Keyboard
63 key sealed keypad with tactile and audible response. 10 programmable function keys.

Power
Each workstation is powered via an external 3 wire AC power supply.

Barcode Scanners
Barcode scanners can be used for data input.

Bar Codes
Code 3 of 9, Interleaved 2 of 5, UPC, Codabar, UPC/EAN/JAN, and Code 128. Auto discrimination or single code recognition.

Tone Generator
Produces bar code acceptance tones, keypad audible response, and acceptance or rejection tones.

Real Time Clock
The Real Time Clock can be used to timestamp transactions. During loss of AC power, the clock is battery powered.

Memory
96K battery backup RAM for storage of workstation configuration, application programs and data.

3. Barcode Specifications

General

Minimum narrow bar width:	0.0075 inches (0.019 cm)
Maximum narrow bar width:	0.0800 inches (0.203 cm)
Minimum quiet zone:	0.1000 inches (0.254 cm)
Recommended quiet zone:	0.2500 inches (0.635 cm)
Scanning velocity:	3 inches/sec. to 30 inches/sec.
Bar ratios from:	2.0/1 to 3.0/1

Code 3 of 9

Record length may be up to 80 characters.
Full ASCII mode can be configured.
Check digit verification is configurable.

AIAG Support

Full support of Code 3 of 9 and Interleaved 2 of 5 is provided in accordance with the AIAG (Automotive Industry Action Group) specifications.

Interleaved 2 of 5

Record length of up to 40 characters. Even or odd length is selected via menu or configuration code. Specific bar code lengths can be selected in transaction configuration. Check digit calculation can be used.

UPC/EAN/JAN

With or without supplements.

Codabar

Supported

Code 128

Supported

4. **Host Communications**

Host communications are provided by either an RS-232 or RS-422 port. There are two communication ports available. The ports provide:

- EIA RS-232/CCITT V.24 Asynchronous ASCII on a standard 9 pin male D-type connector.
- EIA RS-422 on a 9 pin male D-type connector (Com1 port only).
- Character type: 7 or 8 data bits.
- Parity: Even, odd, none, zero, or mark.
- Data Rate: 19,200, 9600, 4800, 2400, 1200, 600, 300, 150, or 75 baud.
- XON/XOFF protocol used by default on RS-232 or RS-422 port.
- ENQ or <CR> can be used in Host polling mode.

Note: Com2 (Aux Port) is RS-232 only.

5. **Network**

- Requires no dedicated concentrator or controller.
- Networking is included in each terminal.
- Each workstation is *always* a full use workstation for data collection and control as well as being a network element.
- The network is a polled network.
- Each station is addressable.
- Fault tolerant architecture.
- Network may be both local and remote.
- Up to 1,024 workstations per network.

Workstation Communication Pin-Out Diagrams

Figure D. 1
RS-232 Workstation/Host 9-Pin Null-Modem

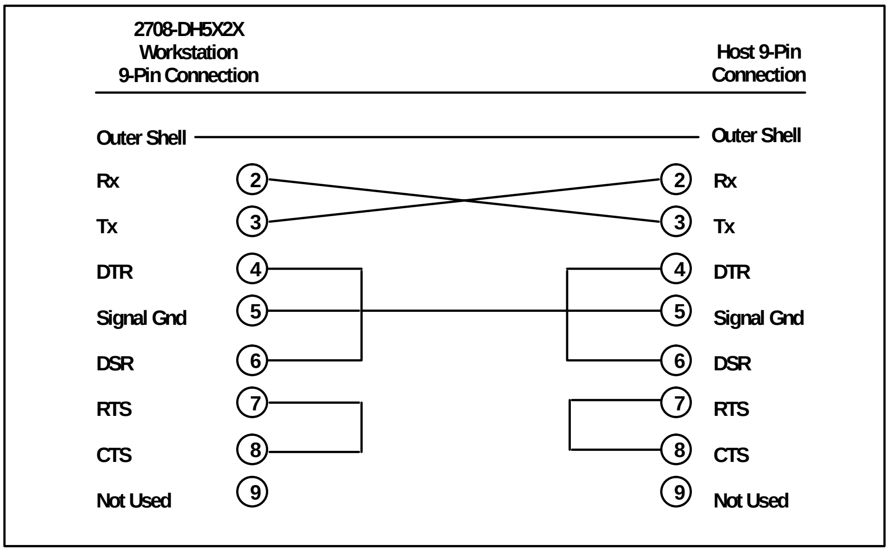


Figure D. 2
RS-232 Workstation/Host 25-Pin Null-Modem

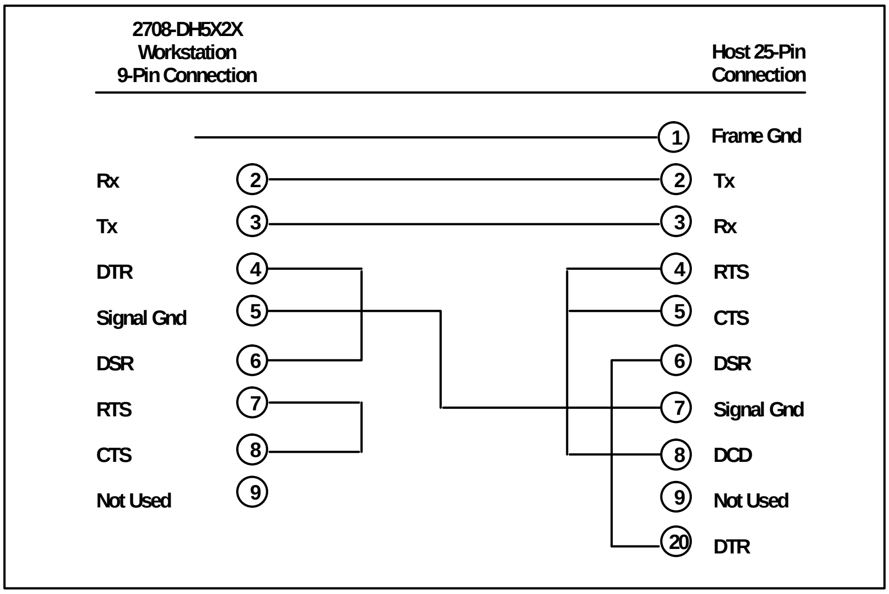


Figure D. 3
RS-232 Workstation 25-Pin Modem

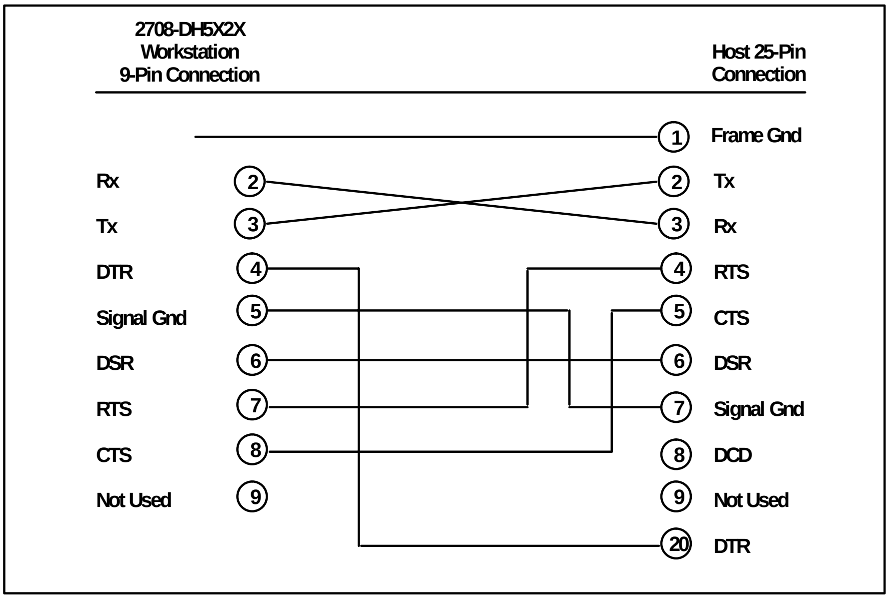


Figure D. 4
RS-232 Workstation/Host 9-Pin DSR Control

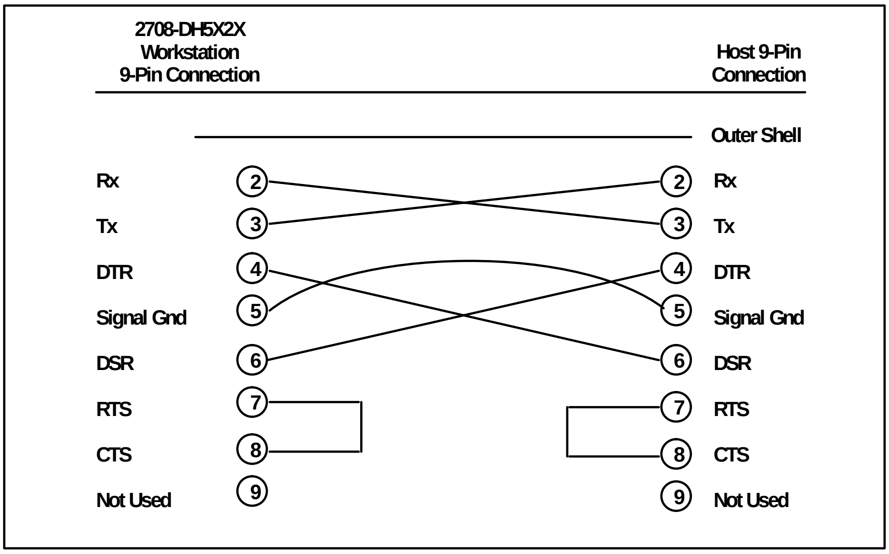


Figure D. 5
RS-232 Workstation/Host 25-Pin Modem

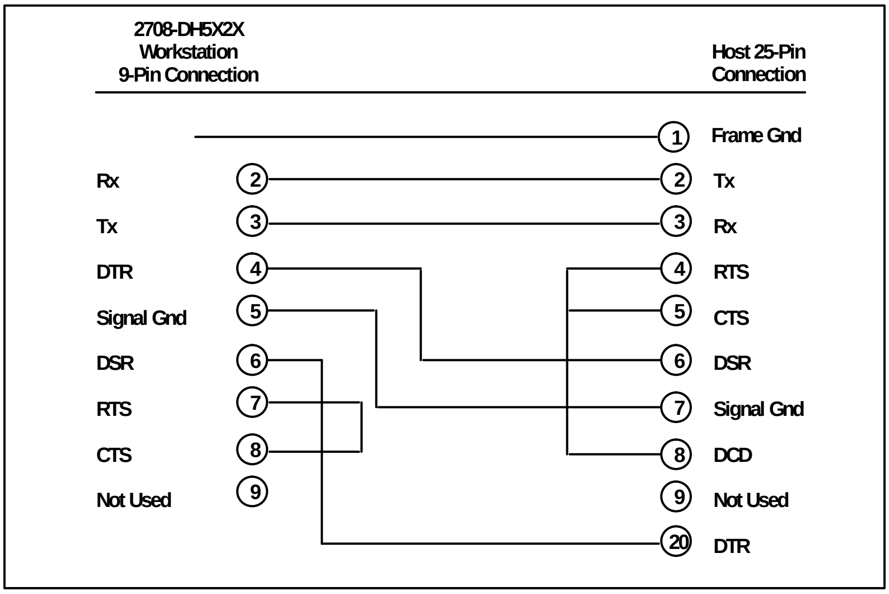


Figure D. 6
RS-232 Concentrator/Submaster

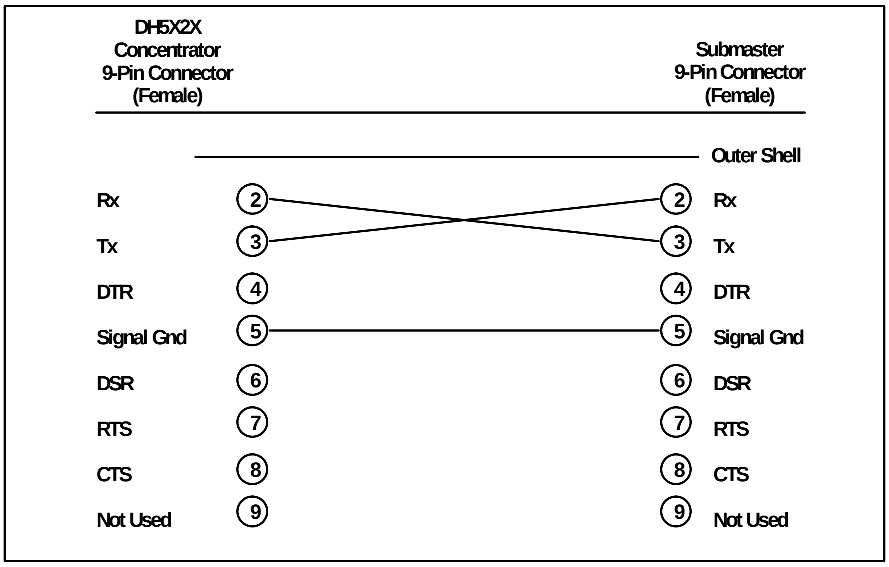


Figure D. 7
RS-422 Workstation/Any Host Connector

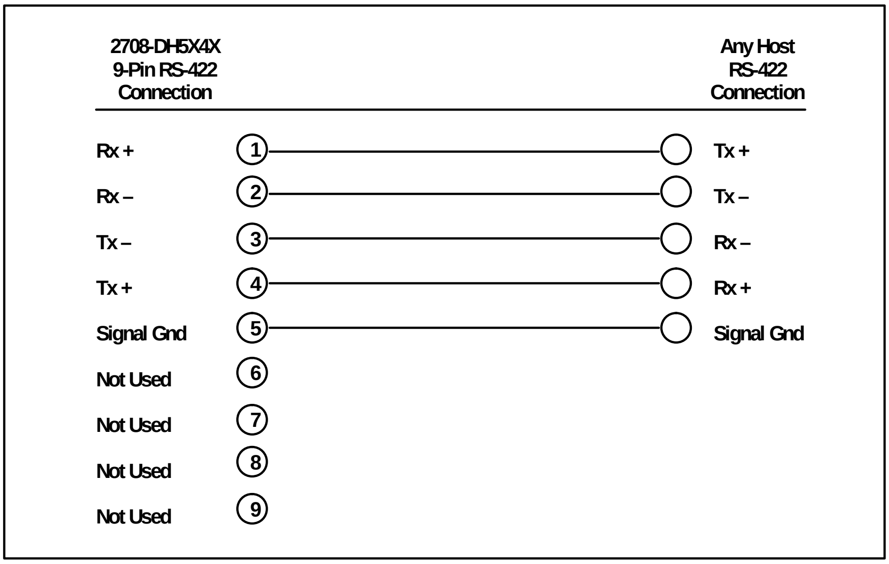
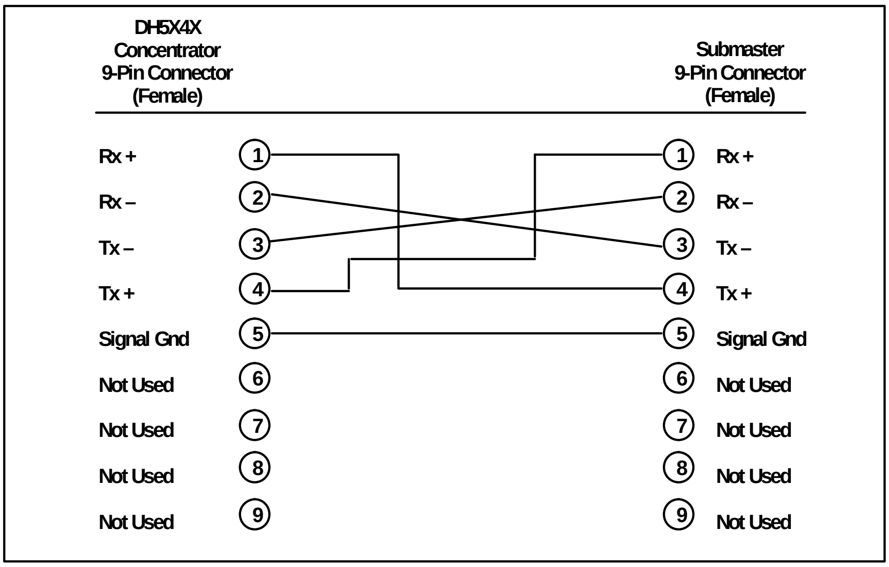


Figure D. 8
RS-422 Concentrator/Submaster



Appendix E

Distance Limitations

Network (RS-485) Cable Length

Terminators are REQUIRED for all network cables longer than 500 feet.

For extremely long network cables, it may be necessary to turn on the terminator switch of the very last workstation in addition to the Master.

No network may have more than 10,000 feet of cable.

If distances longer than 10,000 feet are required, or more than 32 workstations required, see Chapter 2, Complex Networks.

RS-232 (MASTER or HOST) Cable Length

The maximum length depends on baud rate and site specific conditions. It is recommended that only high quality, shielded cable (Belden 8723) be used. The lengths described below should be considered the safe guidelines for layout purposes.

At 9600 baud the RS-232 cable may be 100 feet in length.
At 4800 baud the RS-232 cable may be 200 feet in length.
At 2400 baud the RS-232 cable may be 500 feet in length.
At 1200 baud the RS-232 cable may be up to 1000 feet in length.

If you are using RS-422, you can usually get substantially longer cable lengths than those listed above. Check the information for your Host computer or the EIA RS-422 standard for more information.

Appendix F

Site Parameter List

Location of Master : ______________________________

Workstation Number : ________________
Workstation Type : Master
Workstation Name : ________________
Menu Password : ________________
Clock Mode : ________________
Lower Poll Addr : ________________
Upper Poll Addr : ________________
Offline Cycle : ________________
Max Net Retries : ________________

Communications Parameters for Master

Comm Port Mode : ________________
Comm Baud Rate : ________________
Comm Parity : ________________
Comm Stop Bits : ________________
Comm CRLF : ________________
Comm Echo : ________________
Aux Baud Rate : ________________
Aux Parity : ________________
Aux CRLF : ________________
Aux Echo : ________________

Barcode Parameters

Code 3 of 9 : ________________
Code I 2 of 5 : ________________
Code 3 of 9 Check Dgts : ________________
Code 3 of 9 Mode : ________________
I-2 of 5 Check Dgts : ________________
I-2 of 5 Length #1 : ________________
Codabar : ________________
Code 128 : ________________
UPC : ________________
UPC Supplement : ________________
Bar Header : ________________
Bar Trailer : ________________
Bar Echo : ________________
Bar Devices : ________________

Location of Master : ____________________

Workstation Number : ____________
WorkstationType : Normal
Workstation Name : ____________
Menu Password : ____________
Clock Mode : ____________
Lower Poll Addr : ____________
Upper Poll Addr : ____________
Offline Cycle : ____________
Max Net Retries : ____________

Communications Parameters for Master

Comm Port Mode : ____________
Comm Baud Rate : ____________
Comm Parity : ____________
Comm Stop Bits : ____________
Comm CRLF : ____________
Comm Echo : ____________
Aux Baud Rate : ____________
Aux Parity : ____________
Aux CRLF : ____________
Aux Echo : ____________

Barcode Parameters

Code 3 of 9 : ____________
Code I 2 of 5 : ____________
Code 3 of 9 Check Dgts : ____________
Code 3 of 9 Mode : ____________
I-2 of 5 Check Dgts : ____________
I-2 of 5 Length #1 : ____________
Codabar : ____________
Code 128 : ____________
UPC : ____________
UPC Supplement : ____________
Bar Header : ____________
Bar Trailer : ____________
Bar Echo : ____________
Bar Devices : ____________

Location of Master : ____________________

Workstation Number : __________
Workstation Type : Concentrator
Workstation Name : __________
Menu Password : __________
Clock Mode : __________
Lower Poll Addr : __________
Upper Poll Addr : __________
Offline Cycle : __________
Max Net Retries : __________

Communications Parameters for Master
Comm Port Mode : __________
Comm Baud Rate : __________
Comm Parity : __________
Comm Stop Bits : __________
Comm CRLF : __________
Comm Echo : __________
Aux Baud Rate : __________
Aux Parity : __________
Aux CRLF : __________
Aux Echo : __________

Barcode Parameters
Code 3 of 9 : __________
Code I 2 of 5 : __________
Code 3 of 9 Check Dgts : __________
Code 3 of 9 Mode : __________
I-2 of 5 Check Dgts : __________
I-2 of 5 Length #1 : __________
Codabar : __________
Code 128 : __________
UPC : __________
UPC Supplement : __________
Bar Header : __________
Bar Trailer : __________
Bar Echo : __________
Bar Devices : __________

Location of Master : ____

Workstation Number : ______________________
WorkstationType : Submaster or Alternate
Workstation Name : ______________________
Menu Password : ______________________
Clock Mode : ______________________
Lower Poll Addr : ______________________
Upper Poll Addr : ______________________
Offline Cycle : ______________________
Max Net Retries : ______________________

Communications Parameters for Master

Comm Port Mode : ______________________
Comm Baud Rate : ______________________
Comm Parity : ______________________
Comm Stop Bits : ______________________
Comm CRLF : ______________________
Comm Echo : ______________________
Aux Baud Rate : ______________________
Aux Parity : ______________________
Aux CRLF : ______________________
Aux Echo : ______________________

Barcode Parameters

Code 3 of 9 : ______________________
Code I 2 of 5 : ______________________
Code 3 of 9 Check Dgts : ______________________
Code 3 of 9 Mode : ______________________
I-2 of 5 Check Dgts : ______________________
I-2 of 5 Length #1 : ______________________
Codabar : ______________________
Code 128 : ______________________
UPC : ______________________
UPC Supplement : ______________________
Bar Header : ______________________
Bar Trailer : ______________________
Bar Echo : ______________________
Bar Devices : ______________________

Network Pin-Out Diagrams for DB9 Connector

Figure G. 1
Master Workstation Cabling

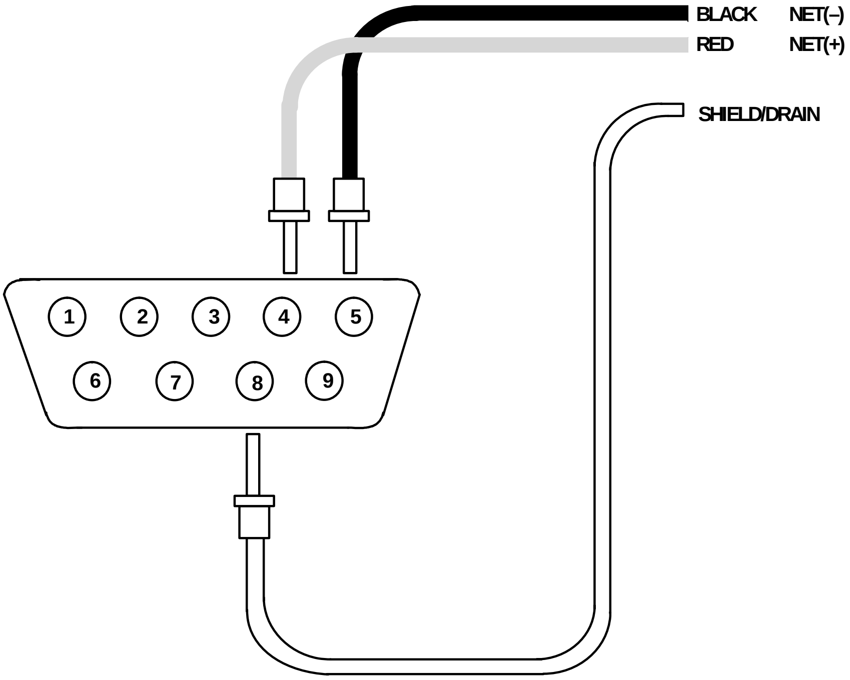


Figure G. 2
Normal/Concentrator Workstation Cabling

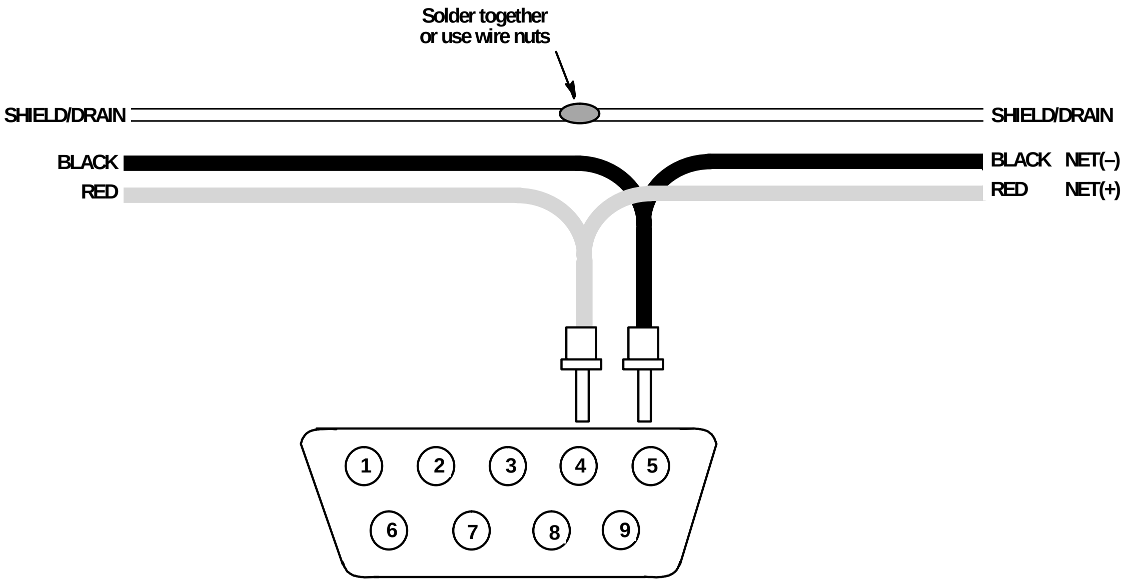
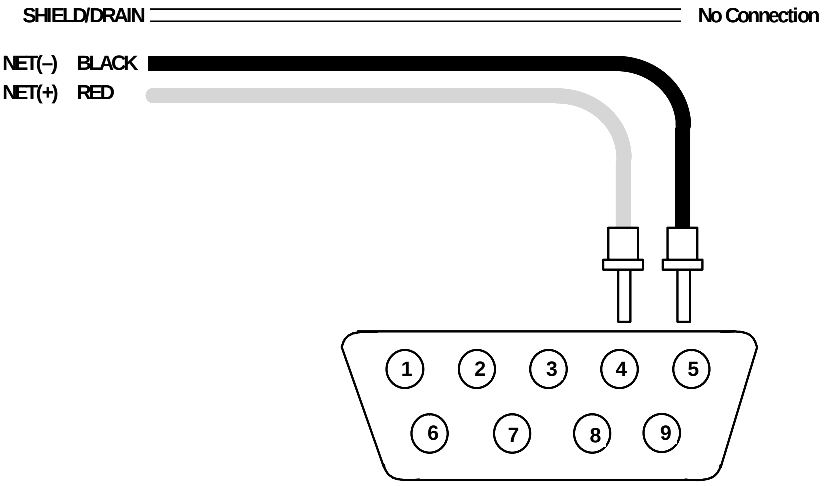


Figure G. 3
Normal/Concentrator End Workstation Cabling



The previous network diagrams are for use in installations where the Network Connector (Catalog No. 2708-NNC) is not used. To fully understand the correct network wiring, it is **highly recommended** that Chapter 2 be carefully read.

Error Messages and Prompts

Errors, Warnings, and Status Messages may appear on the front panel display (Disp), or may be transmitted through the communications port (Comm), or **both**. The "Seen @" column indicates where to look. Any prompt with "YES" in the "Call/Send In" column is an indication that the workstation is defective: contact your Allen-Bradley distributor for repair information.

Message Text	Error	Origin	Seen @	Call/Send In
Alpha display	No	Display Test	Disp	No
AM Timeout	No	Factory use	Both	No
AO	No	Network	Comm	No
Bar Code Speed	No	Factory use	Both	No
Bar Devices	No	Menu Prompt	Both	No
Bar Echo	No	Menu Prompt	Both	No
Bar Header	No	Menu Prompt	Both	No
Bar Trailer	No	Menu Prompt	Both	No
Baud Rate Clock	No	Menu Prompt	Both	No
BC Register	No	Debugger	Both	No
<Bank display and cursor>	No	Standalone	Disp	No
C25 Length #1	No	Menu Prompt	Both	No
C25 Length #2	No	Menu Prompt	Both	No
C25 Start/Stop	No	Menu Prompt	Both	No
Code 3 of 9 Check Dgts	No	Menu Prompt	Both	No
Code 3 of 9 Mode	No	Menu Prompt	Both	No
Clock Mode	No	Menu Prompt	Both	No
CO	No	Network	Comm	No
Code 2 of 5	No	Menu Prompt	Both	No
Code 3 of 5	No	Menu Prompt	Both	No
Code I 2 of 5	No	Menu Prompt	Both	No
Comm Baud Rate	No	Menu Prompt	Both	No
Comm CR Poll	No	Menu Prompt	Both	No
Comm CRLF	No	Menu Prompt	Both	No
Comm Echo	No	Menu Prompt	Both	No
Comm Loopback Test	No	Menu Prompt	Both	No
Comm Parity	No	Menu Prompt	Both	No
Comm Receive Test	No	Menu Prompt	Both	No
Comm Stop Bits	No	Menu Prompt	Both	No

Message Text	Error	Origin	Seen @	Call/Send In
Comm Transmit Test	No	Menu Prompt	Both	No
Concentrator	No	Factory use	Both	No
Config Bad	Sometimes	System	Disp	No
Config Code	No	Menu Prompt	Both	No
Config Error	Yes	System	Disp	No
Config Saved With	Yes	System	Disp	No
Configuration Disp	No	Menu Prompt	Both	No
Constant Memory	No	System	Disp	No
Continuous RAM Test	No	Menu Prompt	Both	No
Count =	No	Sensor Test	Disp	No
CRASH (see RESET) CTC FAILED	Yes	Powerup Test	Disp	YES
Date & Time	No	Clock Status	Disp	No
Date (yymmdd)	No	Menu Prompt	Both	No
Debug Bar Code	No	Factory use	Both	No
Debugger	No	Menu Prompt	Both	No
Destructive RAM Test	No	Menu Prompt	Both	No
Display Text	No	Menu Prompt	Both	No
Done	No	System	Disp	No
DU	Yes	Network	Comm	No
EIA Net State	No	Factory use	Both	No
Enter to start	No	Menu Prompt	Both	No
External Sensor Test	No	Menu Prompt	Both	No
FAIL! bb@aaaa	Yes	Powerup Test	Disp	YES
Failed!	Yes	System	Disp	YES
Final Exit	No	Menu Prompt	Both	No
I25 Check Dgts	No	Menu Prompt	Both	No
I25 Length #1	No	Menu Prompt	Both	No
I25 Length #2	No	Menu Prompt	Both	No
Ignore Checksum	No	Menu Prompt	Both	No
K RAM	No	System	Disp	No
Keyboard Echo	No	Menu Prompt	Both	No
Keypad/Barcode Test	No	Menu Prompt	Both	No
Lamp Test	No	Menu Prompt	Both	No
Unit will reboot after test	No	Menu Prompt	Both	No
Unit will run test forever	No	Menu Prompt	Both	No
Master Timeout	No	Factory use	Both	No
Max Net Retries	No	Factory use	Both	No
Max Net Scans	No	Factory use	Both	No

Message Text	Error	Origin	Seen @	Call/Send In
Memory Error	Yes	System	Disp	No
Menu Password	No	Menu Prompt	Both	No
Misaligned RAM!	Yes	Powerup Test	Disp	YES
MO	No	Network	Comm	No
Network Baud	No	Factory use	Both	No
Network Block Transm	No	Menu Prompt	Both	No
Network Decode to Com	No	Menu Prompt	Both	No
Network Echo to C (raw)	No	Menu Prompt	Both	No
Network Terminal Mode	No	Menu Prompt	Both	No
Network Test	No	Menu Prompt	Both	No
NF	Yes	Network	Comm	No
NO ERRORS SINCE POWER	No	Language	Disp	No
No RAM Detected	Yes	Powerup Test	Disp	YES
OF	Yes	Network	Comm	No
OFF	No	Sensor Test	Disp	No
ON	No	Sensor Test	Disp	No
ON	No	Network	Comm	No
Operation Mode	No	Network Test	Both	No
Password?	No	Menu Prompt	Both	No
PIO FAILED	Yes	Powerup Test	Disp	YES
Power failed at	No	System	Disp	No
RAM OK	No	Powerup Test	Disp	No
RAM Test	No	Powerup test	Disp	No
RESET	Yes	Operating Sys.	Disp	YES
Reset Powerup	No	Menu Prompt	Both	No
Reset Unit to Factory	No	Menu Prompt	Both	No
ROM Checksum Failure	Yes	System	Disp	YES
RTS + CTR + DSR + DTR	No	Comm Tests	Disp	No
Saving...	No	System	Disp	No
Serial Number	No	System	Disp	No
SIO FAILED	Yes	Powerup Test	Disp	YES
Slave Timeout	No	Factory use	Both	No
SO	No	Network	Comm	No
Software Version	No	System	Disp	No

Message Text	Error	Origin	Seen @	Call/Send In
(station number etc)	No	Status line	Disp	No
T <Then numbers>	No	Network Test	Disp	No
Testing RAM	No	Powerup Test	Disp	No
Terminal Mode	No	Factory use	Both	No
Terminal Name	No	Menu Prompt	Both	No
Terminal Number	No	Menu Prompt	Both	No
Terminal State	No	Factory use	Both	No
Terminal Type	No	Menu Prompt	Both	No
The quick brown fox	No	Comm Tests	Both	No
Time =	No	Sensor Test	Disp	No
Time Display	No	Menu Prompt	Both	No
Time (hhmmss)	No	Menu Prompt	Both	No
TIME OF ERROR	No	Language	Disp	No
Tx Block Size	No	Network Test	Both	No
Tx Wait time	No	Network Test	Both	No
Use Backspace to Sel	No	Menu Prompt	Both	No
Use Control-Z to exit	No	Menu Prompt	Comm	No
Use Delete for prev	No	Menu Prompt	Comm	No
Use Return for next	No	Menu Prompt	Comm	No
Weird Top of Ram	Yes	Powerup Test	Disp	YES
XO	Yes	Network	Comm	YES
1-Main Menu	No	Menu Prompt	Both	No
2-Comm Port Menu	No	Menu Prompt	Both	No
3-System Menu	No	Menu Prompt	Both	No
4-Bar code Menu	No	Menu Prompt	Both	No
5-Read-Only Menu	No	Menu Prompt	Both	No
6-Diagnostics	No	Menu Prompt	Both	No
485 Net State	No	Factory use	Both	No
*	No	Factory use	Both	No
—— Menu Mode	No	Menu Prompt	Comm	No

Messages beginning with numbers will be any one of the following:

Clock line, see also **date & time**
Diagnostic menu prompts, such as **1-Configuration Display**
Memory size, see **K RAM**
Memory test fail, see **FAIL**
Status line, see station number
Sub-menu selections 1 to 4; (i.e. **1-Main Menu)**
Version number display, as in **Software Version**

Time Display Formats

These are the possible formats for date and time displays on the LCD. The desired format can be specified by selecting Clock Mode from the System Menu either via the keyboard or via the comm line and date displays. The code selected here does not have any effect on date/time format obtained from BASIC program variables.

Mode	Format
1	9:45:50 PM SUN DEC 3, 1990
2	9:58 PM
3	9:58 PM SUN DEC 3, 1990
5	9:01:15 PM DEC 3, 1990
7	9:46:23 PM SUN DEC 3, 1990
10	10:10:01 PM
12	10:10:12:hh PM
13	10:10:12:hh PM DEC 3, 1990
15	10:11:21:hh PM SUN DEC 3, 1990
16	22:08
17	22:08 DEC 3, 1990
19	22:09 SUN DEC 3, 1990
20	22:10:38
21	22:10:01 DEC 3, 1990
23	22:12:00 SUN DEC 3, 1990
28	22:14:29:hh
29	22:14:59:hh DEC 3, 1990
31	22:15:01:hh SUN DEC 3, 1990
33	DEC 3, 1990
35	SUN DEC 3, 1990

Appendix J

VBASIC Language Development Kit Programming Conventions and Tips

Programming Conventions

The A-B VBASIC Application Library uses a common set of conventions for naming of constants, variables, functions, and subroutines.

Upper and lower case are used within names for legibility.

Global constants, variables, functions, and subroutines begin with an upper case letter.

Global variables and functions end with %, &, !, #, or $ when they are integer, long integer, real, long real, or string.

Local variables always begin with a lower case letter.

All BASIC keywords and functions are in all UPPER case.

Labels are used VERY rarely. GOTO is avoided.

WHILE... WEND is not used. ON ERROR, ON TIMER, etc. are not used.

Indentation is 2 spaces for any bracketing statements such as FOR .. NEXT, TYPE .. END TYPE, SUB .. END SUB, etc. SELECT statements attempt to indent thelines of each case far enough to allow the case selector to be easily notices.

ELSE is required on all SELECT Statements.

Programming Tips

Always put a semicolon (;) on the end of PRINT statements when writing to the second line of the display or scrolling will occur. Always check for the semicolon before running the program since they are easy to leave off.

Use PC1 and PC2 (in READ.BAS) to print centered strings on the first and second lines of the display.

When using Read... and Menu%, with timeouts, make sure to set TIMEOUT% and GLOBALMASK% before each call. While they are not modified by these routines, you may frequently find yourself calling a routine which changes them.

An alternate way to use TIMEOUT%, GLOBALMALSK% and GLOBALATTR% is to set them to the most comonly used values at the start of your program. Then, any routine which changes these values should save the prior value and restore it after use.

Note: The GLOBALMASK% variable should be assigned a value of 0 for keyboard only READs, 1 for keyboard READs which can timeout in TIMEOUT% 100ths of a second, or a 2 for READs from both the keyboard and bar code scanner with a timeout.

If you need your READ to wait for more than 0, 1, or 2 can accomplish, then you must compose GLOBALMASK by (OR)ing together values from: KbdMask, TimeoutMask, BadgeMask, Mask, NetMask, ComMask, AuxMask.

Example:

```
GLOBALMASK% = NetMask OR TimeoutMask
```

So, what’s the common error? Since the read statement returns a value of TimeoutEvent or NetEvent, you might code:

```
GLOBALMASK% = NetEvent OR TimeoutEvent  ‘ !!! WRONG !!!
```

The READ.BAS module contains subroutines whose purpose is formatted input from the keyboard. If you enable the Badge Mask and use ReadStr, ReadInt or another read function, the data must be retrieved from InbBuf$ if e = BadgeEvent. See the details of ReadStr for a sample program.

Appendix K

A-B VBASIC and Visual BASIC Tips

Misspellings

Don’t misspell names. BASIC is unforgiving of such errors since it will just create a new variable which is zero or blank.

Strings in TYPEs

Strings which are defined in TYPE statements are of a fixed length. These are always blank padded on the end.

Variables Beginning with “FN”

Do not start any variable name with FN, Fn, Fn, or fn. BASIC treats these as a reference to the archaic DEF FN.... mechanism and produces a syntax error.

Accidental Omission of %, &, ! # OR $

If you leave the trailing character off of variable names, you will usually get no warning from BASIC. Instead, the variable will be a different one than what you expected. Watch out for this! If you happened to pick a String/Integer mismatch, you will get syntax errors. Integer/Real mismatches are very difficult to locate.

Another peculiarity of trailing characters is that if you have a function named XYZ!, and you attempt to reference that function as XYZ# or XYZ% or anything other than XYZ! or XYZ then you will get a MULTIPLE DEFINITION error at the function declaration even though the reference is many lines later.

Use of Colons as Statement Separators

Use of colon “:” as a statement separator can cause a number of problems with both Visual BASIC and A-B VBASIC. An example follows:

```
CL2  :  PRINT “This is a test” ;
```

The programmer assumed that this statement would clear the second line of the display and then print “This is a test”. But, this is not what actually happens! This is compiled as:

```
CL2 :                    PRINT “This is a test” ;
```

where CL2 is a local label which is effectively ignored.

The rule should be NEVER have a line which looks like:

```
< identifier > :  < rest of line >
```

unless you INTEND for <identifier> to be a label.

CONSTant Declarations

“CONST name = value” does not quite follow the same rules as variable assignments in the same position. The major difference is that the type of ‘name’ is determined by the contents of ‘value’. A DEFINT or DEFSNG #, or $ after the name to set the type explicitly. The trailing symbol is NOT required when the constant is referenced.

PRINT “text”; : <statement>

A problem for Pascal and C programmers is coding: PRINT “text”, <statement> instead of: PRINT “text”; : <statement>

If the statement is a function such as “e = ReadStr%(3,s$)” then the result is for e to retain its previous value, and for an extra 0 or 1 to follow the printed text.

Differences Between A-B VBASIC and Visual BASIC

This document describes the differences between Allen-Bradley VBASIC and Microsoft Visual BASIC. It first lists general characteristics unique to A-B VBASIC, and then provides additional information on keywords supported by A-B VBASIC.

In this discussion, all references to "VBDOS" refer to Visual Basic for DOS. Also any references to "A-B VBASIC" refers to A-B VBASIC, used for programming a DH5 terminal. These references are for our convenience and do not refer to any trademark. Any time the "VBDOS manual" is mentioned, we are referring to the *Visual Basic Reference Manual* for MS–DOS. To some extent, most comments here also apply to QuickBASIC V4.5, Microsoft PDS 7.1, and QBASIC versions of the BASIC language.

General Restrictions

1. All arrays must be DIMensioned.
2. STATIC and DYNAMIC arrays and metacommands do not apply in A-B VBASIC.
3. Periods are not allowed within a variable name, unless that variable is part of a user defined TYPE.
4. The entire A-B VBASIC program (i.e. the input to LXB), must reside in one file.
5. The exponentiation operator (^), may have a positive integer exponent only.
6. "@" AND "[" AND "]" are invalid outside literals.
7. Some of the general syntax implemented by some BASIC compilers is not allowed. The following syntax may be familiar to some users but is not mentioned in the VBDOS manual and is not recognized by the A-B VBASIC cross–compiler (LXB):

   [and] instead of (and) to delimit array subscripts.

   ? as a synonym for PRINT.

   PRINT#, INPUT#, and WRITE# without a space preceding #.
8. DOUBLE precision floating–point data
   A-B VBASIC does not support double precision real arithmetic. Specifically, the interpreter in the terminal is not programmed to do DOUBLE math, and may or may not generate a "Double not supported" error message whenever it encounters anything which has to do with DOUBLE operations, depending on firmware version. However, the A-B VBASIC cross–compiler accepts the following DOUBLE–related syntax in most respects, and you may not see an error message until the program is downloaded into the terminal and executed:

   DEFDBL

# suffix on variables

Floating–point constants with 8 or more significant digits

AS DOUBLE clauses

Functions involving DOUBLE, such as CVD and MKD

9. Restriction on the exponentiation operator
   Exponentiation is implemented by repetitive multiplication, so small exponents are recommended. Full real exponentiation is provided in the function called “Power!” in the BASIC source file MATH.BAS. A-B VBASIC supports exponentiation to positive integer powers only. For example:

   SUPPORTED: X^2

   NOT SUPPORTED : X^5.7 or X^–2

10. Unsupported math intrinsics
    These intrinsic functions, relating to exponent and trigonometric functions are not implemented in the interpreter running in the DH5 terminal, but BASIC source code implementing all of the below is provided in the file MATH.BAS and may be copied into programs as required:

    ATN COS EXP LOG SIN SQR TAN

Supported A-B VBASIC Keywords

ABS(numeric–expression)

Returns the absolute value of a numeric expression. ABS(–1) and ABS(1) are both 1.

ASC(string–expression)

Returns the ASCII value of the first character in string–expression

BEEP

Sounds the speaker. Produces the same sound as PRINT CHR$(7).

CDBL(numeric–expression)

No longer supported. Converts a numeric–expression to a double–precision number. Note the restrictions on DOUBLE precision usage above.

CHAIN filespec

Transfers control from current program to another program residing in file memory. COMMON is NOT supported. Therefore, all variables are lost between the CHAIN unless first stored in a file and retrieved after the CHAINing.

```
LINE INPUT Request$
IF Request$ = “JUMP” THEN CHAIN “JUMP”
```

The interpreter does not tolerate a CHAIN to a non–existent program. Make sure that you have downloaded any program which will be CHAINed to, before any other program attempts to CHAIN to it, or the program will crash with a “Bad Chain File” error message. A special set of Network Directives is required to download a program for the express purpose of a subsequent CHAIN. See the *User's Guide* for a further discussion of these Network Directives.

CHR$(code)

Returns a one–character string whose ASCII code is the argument.

Msg$ = CHR$(34) + “Quoted string” + CHR$(34)

This example adds a double–quote character to the beginning and the end of the string.

CINT(numeric–expression)

Converts a numeric–expression to an integer by rounding the expression's fractional part.

CLNG(numeric–expression)

Converts a numeric–expression to a long (4–byte) integer by rounding the expression's fractional part.

CLOSE [[#]filenumber[,[#]filenumber]...]

Concludes I/O to a file or device. Closing some reserved files, such as HOST, have additional side effects. See the description of those devices for details.

```
OPEN “EMPLOYEE” FOR OUTPUT AS #1
PRINT #1, “Employee –”;EmpBadge$
CLOSE #1
```

CLS [{ 0 | 1 | 2 }]

Clears the front panel LCD, homes the cursor. All forms shown are accepted, but all have the same effect.

CONST constname=expression

In a procedure a CONST overrides a GLOBAL variable of the same name. The text of a string CONST is to be present in one place, regardless of the number of times it is referenced. However, because string CONST statements produce executable code, they should be placed at the start of a program.

```
CONST FALSE = 0, TRUE = NOT FALSE
```

CSNG(numeric–expression)

Converts a numeric expression to a single precision value.

CSRLIN

Returns the current line(row) of the cursor on the front panel display.
See also POS(0).

```
Row = CSRLIN
LOCATE Row, 5
```

CVI, CVS, CVL, (CVD)

(CVD is no longer supported) See VBDOS manual for specific information. TYPE...END TYPE is much more versatile for use with random files.

DATE$

Returns a string containing the current date or sets the date. The format of the date string is yymmddw, where yy is the year, mm is the month, dd is the day, and w is the day of the week
(1 = SUNDAY). This is different than the VBDOS format!

```
DateString$ = DATE$
```

DATE$ = ”yymmddw”

Sets the current date. See format above. Note that A-B VBASIC will automatically compute and update the day of the week (w) if it is omitted or specified incorrectly. This method of setting the actual date is in addition to the Setup Menus and the Network Directives which allow the host to set the date. Note also that this format is different than the VBDOS date! See also TIME$.

```
DATE$ = “931115”          ‘Set the date to “11/15/1993”
```

DECLARE {FUNCTION | SUB} name(parameters)

Declares references to BASIC procedures and invokes argument type checking. Sometimes the VBDOS editor insists on adding a clause reading AS ANY. This syntax is tolerated but is unable to perform full parameter verification. SEE “prototyping”.

```
DECLARE FUNCTION GetTime$()

DECLARE SUB SetTime$()
```

The generic name for declaring a procedure's name and its parameters is "prototyping". LXB.EXE creates a prototype for every procedure encountered whether by the DECLARE statement, the FUNCTION statement, or the SUB statement.

To allow the user to include files of DECLARE statements without regard to whether the code for each procedure is also included, LXB will not issue an error if a procedure is DECLAREd but never defined. Multiple DECLAREs of the same procedure are permitted but should be identical. Use of a procedure without its definition will cause an error. Be aware that the various editors used by Microsoft in their BASICs (QB, QBX, VBDOS, QBASIC, etc.) usually sort subroutines into alphabetic sequence, which can ruin any arrangements you may have made to eliminate DECLARE statements. If prototypes are not present in the source when VBDOS runs a program, it simply creates them. However, if they are missing when the LIB compiler is invoked, a compiler error results.

DEFINT letterrange[,letterrange]...

DEFSNG letterrange[,letterrange]...

(DEFDBL letterrange[,letterrange]...) *No longer supported*

DEFLNG letterrange[,letterrange]...

DEFSTR letterrange[,letterrange]...

Defines the default type of all variables beginning with the indicated letter range as either integer, single precision, double precision, long integer, or string. A-B VBASIC converts any double precision operations to single precision, so see the details in the "General Restrictions" section. Generally it is best to define all variables with the following command at the very beginning of the program, so that all math operations use the fastest form of arithmetic processing. Variables which need to be floating point can then be explicitly typed by using the ! or # trailer.

```
DEFINT A–Z
X! = 123.45        'Overrides DEFINT statement!
```

DIM [SHARED] variable[(subscripts)][AS type]...

Declares a variable and allocates storage space. VBDOS will not allow a fixed length string (nor an array of them) to be passed to a procedure, neither will A-B VBASIC. So, as an alternative, use TYPE..END TYPE to define a variable or array of fixed length strings, and pass it instead.

OPTION BASE is not supported, so in order to set the lower subscript use the following: DIM A(lower TO upper) if zero is not preferred as the lowest subscript.

A declaration using AS precludes variables of the same name, even with type suffixes. For example, NumOfBytes! = 10 will cause an error if there was a preceding DIM NumOfBytes AS INTEGER

```
DIM SHARED ON$, OFF$, Now AS INTEGER
```

DO...LOOP [{WHILE/UNTIL} booleanexpression]

Repeats a block of statements WHILE a condition is TRUE or UNTIL a condition becomes TRUE.

```
DO: X = X + 1: LOOP WHILE X < 200
```

END [{FUNCTION/IF/SELECT/SUB/TYPE}]

Ends a BASIC program, procedure, or block. See FUNCTION, IF, SELECT, SUB, and TYPE for the particular statement being ended. See VBDOS manual for detailed information. See Also SYSTEM.

EOF(filenumber)

Tests for the end of file condition. See the chapter on Special Devices for details about specific devices....

Effect of EOF on a sequential file: TRUE is returned whenever the file position is = file length. (End–of–File is reached)

Effect of EOF on binary or random files: TRUE is returned if the previous GET did not get "all" the data that was requested.

- For random reads, "all" means the number of bytes specified as the LENgth in the OPEN, or the variable's size, whichever is less.
- For binary reads, "all" means the size of the variable.

The difference between binary/random and sequential mode is that, in the former, EOF returns FALSE even though the next GET might not return any data. Therefore, for binary and random files, do a GET but then test EOF. If TRUE is returned, the variable does not contain a full record and may not contain anything at all. Subsequent calls to EOF will continue to return TRUE. EOF "latches" in this state until a SEEK operation is performed. Some statements also reset this latch because they do an implied SEEK as part of their operation. See OPEN example on next page.

```
OPEN "EMPLOYEE" FOR INPUT AS #1
DO WHILE NOT EOF(1)
    LINE INPUT #1, EmpBadge$
    IF EmpBadge$ = BadgeInput$ THEN
```

```
            Found = TRUE
            EXIT DO
        END IF
    LOOP
    CLOSE #1
```

EXIT {DO/FOR/FUNCTION/SUB}

Exits a DO...LOOP or FOR...NEXT loop, FUNCTION, or SUB. See DO, FOR, FUNCTION, and SUB for particular statement being ended. See VBDOS manual for detailed information. See previous entry for example.

FIX(x)

Returns the truncated integer part of x.

FOR counter = start TO end [STEP increment]
...
NEXT [counter]

Repeats a group of instructions a specified number of times. The data type of the counter controls the precision of the start, end and increment expressions. The following needs to be a LONG integer:

```
WRONG:  FOR J% = 1 to 80000: statements: NEXT J%
RIGHT:  FOR J& = 1 TO 80000: statements: NEXT J&
```

In order to count backwards (end < start), you must use the STEP clause and specify a negative value. (Historical note: I and J are commonly used because they are handy integers in FORTRAN. You can make your counter variable anything you want!)

FRE(numeric expression)

FRE(stringexpression)<—NOT VALID
Returns the available memory. Numeric expressions 0 through 3 are the only ones supported, and have different meanings than under VBDOS:

ProgMem% = FRE(0)
When the numeric expression evaluates to 0, an INTEGER is returned representing the number of bytes remaining for program pseudo–code, variable data, and the program's pseudo stack.

FileMem& = FRE(1)
When the numeric expression evaluates to 1, a LONG is returned representing the number of bytes which can be used by files. (Because files are allocated in memory by blocks, rather than a byte at a time, this value will decrement by some multiple of 256.)

FREEFILE

Returns the next free BASIC file number, or 0 when all file numbers are "in use", i.e. are assigned to open files or devices. A-B VBASIC and VBDOS may not return the same file numbers, even in identical programs. Just because a file number is unassigned does not imply that a new file can be created. There is a maximum number of files which can exist, open or not. See the Limits section for specifics on A-B VBASIC file and device limitations.

```
IF NumFilesOpen < 15 THEN NextFileNum = FREEFILE
```

FUNCTION name[(parameterlist)][STATIC]

Declares the name, the parameters, and the code that form the body of a FUNCTION. The appearance of a FUNCTION's name on the right side of an = or in an argument list, is considered to be a call to that function, with or without an "(argument list)". Do not use FUNCTION procedures that perform I/O in I/O statements.

```
CurrTime$ = GetTime$
FUNCTION GetTime$()
      GetTime$ = TIME$
END FUNCTION
```

GET [#]filenumber[,[recordnumber][,variable]]

Reads data from a file in memory into a variable. All 3 items after GET are required, however the record number can be consecutive commas as in, GET #1,,V$. See the chapter on Special Devices for details about input from specific devices. FIELD is not supported, use TYPE..END TYPE.

```
TYPE EmpType
      Badge AS STRING * 8
      Name AS STRING * 25
END TYPE
DIM SHARED Emp AS EmpType
OPEN "EMPLOYEE" FOR RANDOM AS #1 LEN = LEN(Emp)
Rec = 0
DO WHILE NOT EOF(1)
      Rec = Rec + 1
      GET #1, Rec, Emp
      IF Emp.Badge = BadgeInput$ THEN Found = TRUE: EXIT DO
LOOP
CLOSE #1
```

GOSUB {linelabel | linenumber}....RETURN

Branches to and returns from a sub–routine. Linelabel on RETURNs are not supported in A-B VBASIC. BASIC's SUB and FUNCTION procedures provide a more well–structured alternative to GOSUB...RETURN subroutines.

```
DO
      CurrTime$ = LEFT$(GetTime$,4)
      IF CurrTime$ > OldTime$ THEN
            GOSUB UpdateTime
            OldTime$ = CurrTime$
```

```
    END IF
LOOP
UpdateTime:
LOCATE 1, 1, 0
PRINT LEFT$(CurrTime$,2); “:”; RIGHT$(CurrTime$,2);
RETURN
```

GOTO {linelabel/linenumber}

Branches unconditionally to the specified line. See VBDOS manual for detailed information.

HEX$(expression)

Returns a string that represents the hexadecimal argument expression. See VBDOS manual for detailed information.

IF...THEN...ELSE

Allows conditional execution, based on the evaluation of a Boolean expression. See VBDOS manual for detailed information.

```
IF (A > B) AND (C > D) THEN
    Sum = (A – B) + C
ELSEIF (A < B) AND (C < D) THEN
    Sum = (B – A) * D
ELSE
    Sum = A * C
END IF
```

INKEY$

Reads a character from the keyboard. If no key is currently being pressed, it returns a null string. All key codes in a DH5 terminal are a single byte. The codes corresponding to special keys can vary due to differences in keypad configurations. If necessary, use this function to get a keystroke, convert it using ASC, then print the result.

```
A$ = “”
DO WHILE A$ = “”
    A$ = INKEY$
LOOP
```

INPUT$(bytecount[,[#]filenumber])

Returns a string read from the specified file. A common error is switching the byte count and the filenumber. To prevent this, always use the # symbol with the filenumber even though it’s optional. See the chapter on Special Devices for details on INPUT$ from particular devices.

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

INSTR([start,]stringexpression1,stringexpression2)

Returns the character position of the first occurrence of a string in another string. See VBDOS manual for detailed information.

```
i = INSTR(DataIn$, CHR$(13))  ‘Look for a carriage return
IF i > 0 THEN Rec$ = LEFT$(DataIn$, i–1)
```

INT(numeric–expression)

Returns the largest integer less than or equal to numeric–expression.
See VBDOS manual for detailed information.

IOCTL$([#]filenumber)

Remarks in the VBDOS manual limiting IOCTL use to device drivers are not applicable to A-B VBASIC. See the *A-B VBASIC Program Development Guide* for details on IOCTL usage in special devices.

```
OPEN “BAR” FOR INPUT AS #1
DO
    CLS
    PRINT “SWIPE BADGE”
    DO WHILE NOT EOF(1): LOOP         ‘Wait for data...
    SOUND 1400,2
    DataInfo$ = IOCTL$(1)             ‘Get data on barcode input
    Delimiter = INSTR(DataInfo$, “/”)
    DataType$ = LEFT$(DataInfo$, Delimiter – 1)‘What  barcode symbology?
    DataSrce$ = MID$(DataInfo$, Delimiter + 1)‘Slot, Wand, Laser?
    IF DataType$ = “C39” AND DataSrce$ = “SLOT” THEN EXIT DO
LOOP
```

IOCTL[#]filenumber,string

See IOCTL$ statement. See the chapter on Special Devices for details about specific devices.

```
OPEN “HOST” FOR OUTPUT AS #1
IOCTL #1, “33”  ‘Change last 2 digits of record prefix sent to HOST to 33.
```

KILL “filespec”

Deletes file “filespec” from memory and releases that memory space for use by future files. KILL “!” deletes all files (except the QUE) in the DH5 terminal. See also the limits page in the A-B VBASIC manual. “*.*” wildcards are not used to avoid problems with deleting files on the PC. All remarks in VBDOS manual are applicable to A-B VBASIC, except those relating to directories. Like VBDOS, KILL is only valid on a CLOSEd file. However A-B VBASIC will not issue an error message if this is attempted, and the consequences can be dire! The QUE can be forcibly emptied by issuing a KILL “QUE” statement explicitly.

LBOUND(array[,dimension])

Returns the lower bound (smallest available subscript) for the indicated dimension of an array. The default lower bound is zero. Arrays dimensioned using the TO clause in the DIM statement may have any integer value as a lowerbound. Compliment of UBOUND.

LCASE$(stringexpression)

Returns a string expression with all letters in lowercase.

```
A$ = LCASE$(“NOW IS THE TIME...”) ‘Returns, “now is the time...”
```

LEFT$(stringexpression, n)

Returns a string consisting of the leftmost n characters of a string. See also MID$, and RIGHT$. See VBDOS manual for detailed information.

```
CurrTime$ = LEFT$(TIME$,4) ‘Returns time in format HH:MM
```

LEN(stringexpression)

LEN(variable)

Returns the number of characters in a string or the number of bytes required by a variable. See VBDOS manual for detailed information.

```
n = LEN(s$)
```

LINE INPUT[;][“promptstring”;]stringvariable

Inputs an entire line (up to 255 characters) to a string variable, without the use of delimiters. The only editing character that is supported for LINE INPUT is a backspace. The DH5 development files READ.BAS and MENU.BAS provide greatly enhanced input capabilities.

```
LINE INPUT “Enter name: “;Name$
```

LINE INPUT #filenumber,stringvariable

Reads an entire line from a sequential file to a string variable. See the chapter on Special Devices for details about specific devices. See example listed for EOF().

```
OPEN “DATA.DAT” FOR INPUT AS #1
LINE INPUT #1, Title$
```

LOC(filenumber)

Returns the current position within a file. The REMARKS paragraph in the VBDOS manual applies only to some A-B VBASIC devices. See the chapter on Special Devices for details about specific devices.

```
OPEN “COM” FOR INPUT AS #1   ‘Must be a normal terminal.
DO
      DO WHILE LOC(1) = 0: LOOP ‘Wait for any data in the buffer
      R$ = INPUT$(1, #1)
      Rx$ = Rx$ + R$
      i = INSTR(Rx$, CHR$(13))       ‘Look for a carriage return.
      IF i > 0 THEN
            Datain$ = LEFT$(Rx$, i – 1)         ‘Read in data
            CLS
            PRINT Datain$;           ‘Display it
            Rx$ = “”: R$ = “”        ‘Clear the temporary buffer
      END IF
LOOP
```

LOCATE[row][,[column][,[cursor]]]

Moves the cursor to the specified position. The start and stop arguments do not apply to A-B VBASIC.

```
LOCATE 2, 1              ‘Position cursor on line 2
PRINT “Hello world”;     ‘Use of semicolon prevent scrolling
LOCATE 1, 1, 0           ‘Position cursor on line 1
PRINT “Goodbye world”;
```

LOF(filenumber)

Returns the length of the named file in bytes. The REMARKS paragraph in the VBDOS manual applies only to some A-B VBASIC devices. See the chapter on Special Devices for details about specific devices.

```
OPEN “POWER” FOR INPUT AS #1
IF LOF(1) > 0 THEN       ‘If file contains data,
      Powerfail = TRUE   then there must have been a power failure
ENDIF
```

LTRIM$(stringexpression)

Returns a copy of a string with the leading spaces removed.

```
A = 100
A$ = LTRIM$(STR$(A)) ‘Removes leading space in front of 100.
```

MID$(stringexpression, start[, length])

Returns a substring of a string. See VBDOS manual for detailed information. See also MID$ statement, (replaces a portion of a string variable with another string.)

```
A$ = “Now is the time for...”
B$ = MID$(A$, 8, 3)     ‘B$ now equals “the”.
```

MKD$, MKI$, MKL$, MKS$

(MKD$ is no longer supported) Converts numeric values to string values. See VBDOS manual for detailed information.

OCT$(numeric–expression)

Returns a string representing the octal value of the numeric argument. See also HEX$().

ON expression GOSUB {line–number–list/line–label–list}

ON expression GOTO {line–number–list/line–label–list}

Branches to one of several specified lines, depending on the value of an expression. See VBDOS manual for detailed information.

```
N = 3
ON N GOSUB GetTime, GetDate, GetLost    ‘Will gosub GetLost.
```

OPEN file [FOR mode1][ACCESS] AS[#]filenum [LEN=reclen]

Enables I/O to a file or device. All VBDOS manual references to databases and ISAM are unsupported in A-B VBASIC. The LOCK clause is not supported. See the chapter on Special Devices for details on OPENing specific devices.

```
TYPE EmpType
    Badge AS STRING * 8
    Name AS STRING * 25
END TYPE
DIM SHARED Emp AS EmpType
OPEN “EMPLOYEE” FOR RANDOM AS #1 LEN = LEN(Emp)
```

POS(0)

Returns the current horizontal position of the cursor on the LCD display. A single argument is required but is ignored at run–time.

```
Col = POS(0)
LOCATE 1, Col
```

PRINT [expressionlist][{,|;}]

Outputs data to the LCD display. The format for some values may vary between VBDOS and A-B VBASIC. A-B VBASIC divides the line into print zones of 8 spaces each. A semicolon at the end of the print statement keeps the cursor from advancing to the next line.

```
PRINT “Enter your name: “;
LINE INPUT; Name$
```

PRINT #filenumber,[USING stringexpression;] expressionlist[{,|;}]

Writes data to a file in memory. A print field width is 8 characters for the LCD, 14 for others. See the chapter on Special Devices for details on specific devices.

```
OPEN “EMPLOYEE” FOR APPEND AS #1
Format$ = “$####.##”
A = 123.459
PRINT #1, USING Format$; A    ‘Prints A to file #1 as $123.45
```

PRINT USING formatstring; expressionlist[{,|;}]

Prints strings or numbers using specified format. A field width is 8 characters for the LCD. INTEGERs and LONGs will output with .00 even if .## is used. If a number is negative, a minus sign(–) will always precede it. The following formatstring characters are not supported... **, $$, **$, “,”. See the limits page in the A-B VBASIC manual for the maximum USING clause and the maximum output of a single PRINT.

```
Format$ = “$####.##”
A = 123.459
PRINT USING Format$; A    ‘Prints A as $123.45
```

PUT [#]filenumber[,[recordnumber][,variable]]

Writes from a variable or a buffer to a random or binary file. The required syntax is shown above. Omitting the recordnumber such as PUT #1, ,variable is supported, but omitting both the record number and the variable is not supported. See the chapter on Special Devices for details on specific devices. Next page for example...

```
TYPE EmpType
    Badge AS STRING * 8
    Name AS STRING * 25
END TYPE
DIM SHARED Emp AS EmpType
OPEN “EMPLOYEE” FOR RANDOM AS #1 LEN = LEN(Emp)
Rec = Rec + 1
Emp.Badge = “1234”
Emp.Name  = “Johnathan Q. Doe”
PUT #1, Rec, Emp
CLOSE #1
```

RANDOMIZE expression

Initializes (re–seeds) the random number generator. The expression is required and must be numeric. The TIMER function is commonly used to generate a pseudo–random seed as in the example below:

```
RANDOMIZE TIMER    ‘Re–seeds random number generator.
```

REM remark
‘   remark

Allows explanatory remarks to be inserted in a program. Both forms of syntax are supported.

RETURN

Returns control from a sub routine. No line number or line label clauses are supported in A-B VBASIC.

RIGHT$(stringexpression, n)

Returns the rightmost n characters of a string.

```
A$ = “Now is the time for all good men to come to the aid of”
B$ = RIGHT$(A$, 6)   ‘B$ = “aid of”
```

RND

Returns a single–precision random number between 0 and 1. No argument is allowed in the statement. To produce random integers in a given range, use the following formula:

```
INT((upperrange – lowerrange + 1) * RND + lowerrange)
```

RTRIM$(stringexpression)

Returns a string with trailing (right–hand) spaces removed.

```
A$=”When I was younger, so much younger than today     “
A$=RTRIM$(A$)  ‘Removes trailing spaces.
```

SEEK(filenumber)

Returns the current file position. See the chapter on Special Devices for details on specific devices. See VBDOS manual for detailed information.

SEEK [#]filenumber,position

Sets the position in a file for the next read or write. See the chapter on Devices for details on specific devices.

SELECT CASE text_expression

Executes one or more statements depending on the value of text expression. The CASE ELSE clause is mandatory in A-B VBASIC, even if it does nothing. See VBDOS manual for specific details.

```
SELECT CASE text_expression
    CASE expressionlist1
        statements
    CASE expressionlist2
        statements
    CASE ELSE
```

```
            statements
      END SELECT
```

SGN(numeric–expression)

Indicates the sign of a numeric expression. See VBDOS manual for specific details.

SHARED variable [AS type] [,variable [AS type]]...

Gives a SUB or FUNCTION procedure access to variables declared at the module level without passing them as parameters. All arrays in the SHARED statement must have been previously DIMensioned in module level code. LXB also requires non–arrays to have previously appeared at the module level. See example on next page.

```
‘Module level code...
DIM Datain AS STRING
DO
     LINE INPUT; Datain
     CALL ShowDatain
LOOP

‘Sub–routine
SUB ShowDatain
     SHARED Datain AS STRING
     LOCATE 1, 1, 0
     PRINT Datain;
END SUB
```

SLEEP seconds

Suspends execution of the calling program. Seconds may be a non–integer, unlike VBDOS. Sleep continues until the specified number of seconds have elapsed completely. Unlike VBDOS, the DH5 program will NOT wake up early if a key is pressed. ON COM, ON TIMER, and forms are not supported, so references to those in the VBDOS manual are irrelevent. The EGG timer will be disabled when a SLEEP statement is used.

```
SLEEP 5   ‘Suspends execution for 5 seconds.
```

In A-B VBASIC, fractional second delays are supported to a resolution of 1/100ths of a second. This is different from VBDOS, where delays under .5 are rounded down to zero, suspending program execution indefinitely.

SOUND frequency,duration

Generates sound through the speaker. In the DH5, the correspondence between the “frequency” specification and the true sound of that frequency is approximate. Also, ***in certain firmware versions***, unlike VBDOS, the sound is initiated and the program continues without waiting for the sound to complete.

```
SOUND 1400, 2 '1400 Hz for 2 clock ticks (20 ticks per second).
```

SPACE$(n)

Returns a string of spaces of length n.

```
X = 25
A$ = SPACE$(X)   'A$ equals 25 spaces.
```

STATIC variablelist

Makes simple variables or arrays local to either a FUNCTION, or a SUB and preserves values between calls. See VBDOS manual for detailed information. For arrays, STATIC must precede DIM. Also any AS clauses must match. A single variable in STATIC may NOT also appear in a DIM.

STOP

Terminates the program. Status Display #8 will indicate “End by system”. No arguments are allowed. VBDOS manual references to compiler options and line numbers are irrelevent. See also SYSTEM.

STR$(numeric–expression)

Returns a string representation of the value of a numeric expression. The format of the strings returned by A-B VBASIC may not be identical to those returned by VBDOS. For example, given STR$(1.0), VBDOS will return 1, but A-B VBASIC will return 1.000000.

```
X% = 1234
S$ = STR$(X%)   'S$ equals " 1234".
```

STRING$(m,n)

STRING$(m,stringexpression)

Returns a string whose characters all have a given ASCII code or whose characters are all the first character of a string expression. See VBDOS manual for specific details.

```
Header$ = STRING$(80,"*")   'Header$ equals 80 asterisks.
```

SUB globalname[(parameterlist)][STATIC]

...

...

END SUB

Marks the beginning and end of a subprogram. See also STATIC.

```
SUB GetName (Name$)
    DO
        CLS
        LINE INPUT "Enter your name: ";Name$
        PRINT Name$;"Correct? ";
        LINE INPUT; YN$
        YN$ = UCASE$(YN$)
        YN$ = "Y" or YN$ = "" THEN EXIT DO
    LOOP
END SUB
```

SWAP vari1,vari2

Exchanges the values of two variables. See VBDOS manual for specific details. Versions 1.0/1.1 of DH5 firmware do not support swapping single or double precision variables. This will be corrected by future versions.

```
A$ = "1234"
B$ = "4321"
SWAP A$, B$   'A$ = "4321", B$ = "1234"
```

SYSTEM

Terminates program execution. END, STOP, and SYSTEM as well as "reaching the bottom" of a A-B VBASIC program all have the same result: the program is terminated. Program termination causes the following:

Files are left unchanged. In particular, if HOST was OPEN, it remains OPEN;

Status Display #8 and the corresponding read–only menu display show "End by System", and the offset in the program where the termination occurred;

An error: "BASIC ERROR: End by System" is transmitted to the HOST;

Any "End by System" error message with an offset of 0 (zero) is serious and should be reported.

TIME$

Returns the current time from the operating system. An 8 byte string is returned in the form hhmmssnn, representing hours(0–23), minutes, seconds, and hundredths of a second. (The Clock Mode setting of the Setup Menus has no effect on the format of the TIME$ variable.)

```
CurrTime$ = TIME$
```

TIME$ = stringexpression

Sets the time. See preceding entry. This method of setting the actual time is in addition to the Setup Menus and the Network Directives which allow the host to set the time. See also DATE$.

```
TIME$ = "15450000"  ' Sets time to 3:45:00.00
```

TIMER

Returns the number of seconds elapsed since midnight. As a single precision value this is accurate to 1/100th of a second. Measurements with this function can be in error if they span midnight. See also the EGG device.

```
StartTime = TIMER
FOR X = 1 TO 500: NEXT X
EndTime = TIMER
Elapsed = EndTime – StartTime
```

TYPE usertype

elementname AS typename
elementname AS typename

END TYPE

Defines a data type containing one or more elements. An element cannot be the name of an array.

```
TYPE EmpType
    Badge   AS STRING * 8
    Name    AS STRING * 25
    CodeNum AS INTEGER
END TYPE
```

UBOUND(array[,dimension])

Returns the upper bound (largest available subscript) for the indicated dimension of an array. See VBDOS manual for specific details.

UCASE$(stringexpression)

Returns a string expression with all letters in uppercase.

```
A$ = UCASE$("Now is the time for all...")
A$ now contains: NOW IS THE TIME FOR ALL...
```

VAL(stringexpression)

Returns the numeric value of a string of digits. See VBDOS manual for specific details.

```
CheckAmt$ = "123.45"
Amount = VAL(CheckAmt$)        'Amount will now contain 123.45
```

WHILE condition

...[statements]

WEND

Executes a series of statements in a loop, as long as a given condition is true. A-B VBASIC does impose a nested loop limit which should not be exceeded under normal programming conditions.

```
WHILE INKEY$ = “”: WEND   ‘Loops until a key is pressed.
```

WRITE #filenumber [,expressionlist]

Writes data to a file in memory. See the chapter on Special Devices for details on specific devices.

Appendix M

Application Library Subroutines

In ENV.BAS and ENVPC.BAS

OpenLINX	Opens all devices to be used by low level I/O routines
TestEvent%	Tests for an event
Read Event%	Waits for an event
Send	Sends a record directly to the host
SendQue	Sends a record indirectly to the host through the queue
SetLINE	Sets the state of the control line
SetLED	Turns a workstation keyboard LED on or off
SendCom	Sends a record to the comm line
Set DTR	Sets the state of Data Terminal Ready
SetRTS	Sets the state of Request To Send for a comm port
GetDSR%	Gets Data Set Ready status for a comm port
PENDING%	TRUE if Send will result in a pause.
MEMFULL%	TRUE if less than 1024 bytes remain in RAM
ONLINE%	TRUE when ONLINE to the network
GetDATE$	Translates DATE$ into standard form (MM/DD/YYYY)
GetTIME$	Translates TIME$ into standard form (HH:MM:SS)

In READ.BAS

CL1	Clears the top line of the display and homes cursor
CL2	Clears line 2 and left justifies cursor
PC1	Prints a string centered on line 1
PC2	Prints a string centered on line 2
ReadFlush	Flushes the keyboard buffer
ReadStrField%	Edit a string field on the display
ReadStr%	Simple edit a string on the screen
ReadNumSTR%	Simple edit of string of numeric characters
ReadPassword%	Inputs a password from the keyboard
ReadYN%	Wait for a YES/NO response from user
ReadInt%	Input an integer value from the keyboard
ReadReal%	Input a real value from the keyboard
ReadLong%	Input a long value from the keyboard

In MENU.BAS

Menu%	Displays a menu and waits for a selection
LogE!	Returns the natural log of a value
Log10!	Returns the base 10 log a value
Exponential!	Returns e to the x
Power!	Relturns x to the power of y
SquareRoot!	Returns the square root of x
CubeRoot!	Returns the cube root of x

In TRIG.BAS

FullArcTangent!	Returns arc tangent using numerator and denominator
ArcTangent!	Relturns the inverse tangent in radians
ArcSine!	Returns the inverse sine in radians
ArcCosine!	Returns the inverse cosine in radians
Tangent!	Returns the tangent of an angle in radians
Sine!	Returns the sine of an angle in radians
Cosine!	Returns the cosine of an angle in radians

In HYP.BAS

TangentH	Hyperbolic tangent
SineH	Hyperbolic sine
CosineH	Hyperbolic cosine
ArcTangentH	Returns inverse hyperbolic tangent
ArcSineH	Relturns inverse hyperbolic cosine for x = 0
ArcCosineH	Returns inverse hyperbolic cosine for principal values

OpenLINX Opens all devices to be used by low level I/O routines.

This MUST be called before any of the Event or Read routines. This performs the actual BASIC OPEN statements for all of the devices which are accessed by the low level I/O.

Note: The global constant PcMode will be TRUE if th is program is running using EnvPC.BAS instead of Env.BAS. You may use this for any operations which are not fully emulated by the EnvPC environment. This also establishes the global environment variables.

```
DSPWIDTH% = 40 or 16 depending on the type of workstation
TERMNUM% = The current terminal number
TERMTYPE$ = “NORML”, “MASTR”, etc

OpenLINX
SUB OpenLINX
```

TestEvent% Tests for a low level event returns 0 when no event has occurred. Events are either keys read from the workstation keyboard, or special codes. Special codes are always negative, although some special keys also return negative codes. See OpenLINX for initialization information.

The most important events are:

TimeoutEvent	The input timer has expired
NetEvent	Read from network has occurred
ComEvent	Read from the main comm port
AuxEvent	Read from the aux comm port

When ComEvent or AuxEvent has occurred, InCom$ contains the LINE INPUT format line which was read from the comm line. When NetEvent has occurred, InNet$ contains the record from the host. The events which you want to test for are indicated by the "mask" parameter. Each device which you want tested MUST have a bit set in the mask. Bits are set by building a mask using the constants: KbdMask, TimeoutMask, BadgeMask, NetMask, ComMask, AuxMask, and SensorMask.

To simplify matters, some special mask values are also allowed. These are:

0 = Read from keyboard only
1 = Read from keyboard with timeout (see ReadEvent%)
2 = Read from keyboard and SLOT, etc. with timeout

Note: Timeouts only apply to reads which wait for an event. TestEvent% never waits. See ReadEvent% for more info.

```
e = TestEvent%   (  mask%  )

FUNCTION TestEvent%  (  mask%  )
```

SaveEvent Saves the previous event to allow it to happen again.

Saves the event which has just occurred from TestEvent%. The very next TestEvent% will return this event code.

```
SaveEvent eventcode%
SUB SaveEvent   (  e%  )
```

ReadEvent% Waits for a low level event.

Waits for an event to occur. The event(s) to wait for are specified in the same manner as TestEvent%.

For timeouts set the global variable TIMEOUT% to the number of 1/100 second intervals you want to wait before a TimeoutEvent is returned. The value of TIMEOUT% is not modified by %.

```
e = %   (  mask  );
FUNCTION %  (  mask%  )
```

SetDTR Sets the state of Data Terminal Ready.

SetRTS Sets the state of Request To Send for a comm port.

Set state = TRUE to turn DTR or RTS on. You may examine the global variables RTS1%, DTR1%, RTS2%, and DTR2% to get the current state.

```
n% is 1 for COM and 2 for AUX.
SetDTR n%,  state%
SetRTS n%,  state%
SUB SetDTR  (  n%, s% )
SUB SetRTS  (  n%, s% )
```

GetDSR% Gets Data Ready status for a comm port.

A TRUE is returned if DSR is ON. n% is 1 for COM and 2 for AUX.

```
state = GetDSR%(n%)
FUNCTION etDSR% ( n% )
```

SendCom Sends a record to a comm line.

A string is sent to the comm line. The string is sent exactly as is, so append CR or CR and LF if you are sending a line. n% is 1 for COM and 2 for AUX.

Note that COMOPEN% must be true for a send to COM to work. COMOPEN% is true only if the TERMTYPE% is TypeNormal.

```
SendCom  n%,   s$
SUB SendCom  (  n%, s$ + CHR$(CR) )
```

ONLINE% TRUE if the workstation is online.

```
IF ONLINE% THEN . . .
```

MEMFULL% TRUE if less than 1024 bytes remain in RAM.

This should be checked before any SendQue or outputs to the RAM files to prevent memory full.

```
IF MEMFULL% THEN . . .
```

PENDING% TRUE if Send will result in a pause.

This should be checked before any Send, to prevent pauses in execution.

```
WHILE PENDING%
. . .

WEND
```

Send Sends a record directly to the host.

A string is sent to the host from this terminal. You should test ONLINE% and PENDING% if you don't want this to pause.

```
Send    s$
```

SendQue Sends a record indirectly to the host through the que.

A string is placed into the network queue. The record will in turn be sent to the host as soon as possible. SendQue has a lower priority than Send, and will buffer records even when NOT ONLINE.

This subroutine uses the "Host" device, *NOT* the "Que" device. See "Host Device" discussion.

Pause will occur if the unit was not ONLINE% and MEMFULL%.

```
SendQue    s$
```

SetLED Turns a workstation keyboard LED on or off.

A workstation has up to 10 LEDs. The LEDs are numbered 1 to 10. state% should be TRUE for ON and FALSE for OFF.

```
SetLED    n%,    state%
```

**GetTIME$** Translates TIME$ into standard form (HH:MM:SS).

In A-B VBASIC TIME$ is in the form hhmmsshh. This routine drops the hundreth seconds and puts colons between hours/minutes and minute/seconds.

```
GetTIME$
```

**GetDATE$** Translates DATE$ into standard form (MM/DD/YYYY).

In A-B VBASIC DATE$ is in the form yymmddx. This routine ignores the day (the x).

```
GetDATE$
```

Note: In EnvPC, dashes are returned, not slashes (MM-DD-YYYY).

CL1 Clears the top line of the display and homes cursor.

CL2 Clears line 2 and left justifies cursor.

```
SUB  CL1
SUB  CL2
```

PC1 Prints a string centered on line 1.

PC2 Prints a string centered on line 2.

```
PC1  s$
SUB PC1  (  s$  )
SUB PC2  (  s$  )
```

ReadFlush Flushes the keyboard buffer.

This clears the keyboard buffer of any pending keystrokes.

```
ReadFlush
SUB ReadFlush
```

ReadStrField% Input a string on the display

The string$ contents are placed on the screen and may be edited by the user. This default may be inhibited using NODEFAULT.

The attr% is made by adding the following:

AUTOEXIT . . . . . Causes the field to be auto exited
BLANKPAD . . . . . Selects blank padding instead of underscores
SECURE . . . . The field is displayed as asterisks
NOEDIT . . . . Displayed but cannot be edited
NOCLEAR . . . . . . Inhibits auto clear on input
NOCURSOR . . . . Inhibits display of cursor during edit
FORMEXIT . . . . . Allow arrows to exit the field entry
NODEFAULT . . . . Do not use the default value in the string
USETABLE . . . . . Use CHARTABLE$ to restrict legal characters

The fieldlength% is in characters. The startingchar% specifies the offset from the beginning of the field at which editing is to start, this begins at 0. Note that the global EXITOFFSET% is set to the cursor position at exit. These may be used to restart a read which was interrupted by some event.

The global MODIFIED% is TRUE when the string was changed in any way. The strlength is the maximum number of characters to allow in the string (not including the terminal null). This must be at least fieldlength% characters long. The return value "e" is an event code. This is 0 on a normal return (operator pressed CR). The devices which are active are defined by the global variable GLOBALMASK% which is in the same format as the mask% used by % and TestEvent%. The field will start at the current cursor location. The cursor is left at its starting locationi when ReadStrField exits.

```
e = ReadStrField%(  attr%, fldlen%, strtchar%, string$,
stringlen%  )
FUNCTION ReadStrField% (  attr%, flength%, strpos%, s$,
slen%  )
```

ReadStr% Edit a string on the screen.

Thhis is a simplified version of ReadStrField% that does not have as many parameters. Any attributes should be in the GLOBALATTR% variable. Don't forget to set GLOBALMASK% to the devices which can terminate the read. Make sure you include KbdMask. See TestEvent% for more info.

```
e = ReadStr  (  length%, s$  )
FUNCTION ReadStr%  (  n%, s$  )
```

An example of reading from the keyboard is as follows:

```
e = ReadStr(Length%,  s$)
IF e = BadgeEvent  THEN
  . .  s$ = InBuf$
END IF
```

ReadNumStr% Edit a numeric string on the screen.

The string which is edited may contain only 0 through 9. Any attributes should be in the GLOBALATTR% variable.

```
e = ReadNumStr  (  length%,  s$  )
FUNCTION ReadNumStr%  (  n%,  s$  )
```

ReadYN% Wait for a YES/NO response from user.

Returns TRUE or FALSE depending on the user's response. EXITKEY% is set if you really need the event value. Nothing is displayed; this just waits for Enter, Clear, or a Y or N.

```
IF ReadYN% ( default% ) THEN . . .
FUNCTION ReadYN% ( defv% )
```

ReadPassword% Inputs a password from the keyboard.

```
e = ReadPassword%  (  length%, string$  ) ;
FUNCTION ReadPassword%  (  n%,  s$  )
```

ReadInt% Input an integer value from the keyboard.

To suppress display of the default value, use a negative length.

```
e = ReadInt% (  length%, int%  )
FUNCTION ReadInt% (  n%, v%  )
```

ReadLong% Input a long value from the keyboard.

To suppress display of the default value, use a negative length.

```
e = ReadLong% (  length%, long&  )
FUNCTION ReadLong% (  n%, v&  )
```

ReadReal% Input a real value from the keyboard.

The precision specifies how many decimal points to display. It does not affect the precision of the value input by the user. Use a negative length to suppress the default value.

This only8 handles floating point values. NOT scientific forms.

```
e = ReadReal% (  length%, precision%, real!  ) ;
FUNCTION ReadReal% (  n%, p%, v!  )
```

Menu% Displays a menu and waits for a selection.

A menu$ is provided which is used to format a menu on the two lines of the workstation display. The operator can select a menu entry by using 1 of 2 methods; these are:

1. Press a LETTER or NUMBER which corresponds to the first UPPER CASE letter or NUMBER of an entry.
2. Using the cursor keys to move to the item to be selected, then pressing Enter.

Regardless of the selection method used, Menu% will always return an event code of 1 through 10 for the item which was selected. If the operator pressed Clear or Exit, a functioin key, or an event occurred which was enabled by GLOBALMASK%, then these codes will be returned instead of 1 through 10. See Env.BAS for information on use of GLOBALMASK%.

The menu string is a string in which each menu entry is preceded by a “ | ” (vertical bar). Thus a menu$ such as:

“Payment Type: | Mastercard | Visa | Amex \ “ + ” | Other | Cash“

has 5 entries; “Mastercard” is the 1st entry and may also be selected by pressing M. “Cash” is the 4th entry and may also be selected by pressing C. Note the use of “ \ ” to start a new line (the fact that the string was made by adding two strings together cannot be detected by Menu%).

The actual menu displayed will look like:

```
Payment Type:  <Mastercard>    Visa      Amex
                          Other          Cash
```

The startingitem% is a value of 1 to 10, to indicate wh ich entry should be selected first. Note that the global EXITOFFSET% is set to the entry which was selected at exit.

```
e = Menu%  (  startingitem%, menu$  )
FUNCTION Menu%  (  sitem%, m$  )
```

LogE! Returns the natural log of a value.

```
x! = LogE!  (  x!  )
FUNCTION LogE!  (  x  )
```

Log10! Returns the base 10 log of a value.

```
x! – Log10!  (  x!  )
FUNCTION Log10!  (  x  )
```

Exponential! Returns e to the x

```
x! = Exponential!  (  x!  )
FUNCTION Exponential!  (  x  )
```

Power! Returns x to the power of y.

```
z! = Power!  (  x!, y!  )
FUNCTION Powerl!  (  x, y  )
```

CubeRoot! Returns the cube root of x.

```
x! = CubeRoot!  (  x!  )
FUNCTION CubeRoot!  (  x  )
```

SquareRoot! Returns the square root of x.

```
x! = SquareRoot!  (  x!  )
FUNCTION SquareRoot!  (  x  )
```

FullArcTangent! Returns arc tangent using numerator and denominator.

This is similar to ArcTangent (numerator/denominator) except it avoids the divide by 0 problems and sign problems of the normal ArcTangent function. The angle is returned in radians.

Example: Usually the numerator and denominator are y and x respectively. When x is zero, y/x is undefined, but the FullArdcTangent of y,x is pi/2 or pi/2 depending on the sign of y.

```
x! = FullArcTangent!  (  numerator!, denominator!  )
FUNCTION FullcTangent!  (  num, den  )
```

ArcTangent! Returns the inverse tangent in radians.

```
angle! = ArcTangent!  (  y!/x!  )
FUNCTION ArcTangent!  (  x  )
```

ArcSine! Returns the inverse sine in radians.

```
angle! = ArcSine!  (  x!  )
FUNCTION ArcSine!  (  x1  )
```

ArcCosine! Returns the inverse cosine in radians.

```
angle! = ArcCosine!  (  x!  )
FUNCTION ArcCosine!  (  x  )
```

Tangent! Returns the tangent of an angle in radians.

```
x! = Tangent!  (  angle!  )
FUNCTION Tangent!  (  x1  )
```

Sine! Returns the sine of an angle in radians.

```
y! = Sine!  (  angle!  )
FUNCTION Sine!  (  x1  )
```

Cosine! Returns the cosine of an angle in radians.

```
x! = Cosine!  (  angle!  )
FUNCTION Cosine!  (  x  )
```

TangentH! Returns the hyperbolic tangent.

```
y! = TangentH!  (  x!  )
FUNCTION TangentH!  (  x  )
```

SineH! Returns the hyperbolic sine.

```
y! = SineH!  (  x!  )
FUNCTION SineH!  (  x  )
```

CosineH! Returns the hyperbolic cosine.

```
y! = CosineH!  (  x!  )
FUNCTION CosineH!  (  x  )
```

ArcTangentH! Returns the inverse hyperbolic tangent.

```
y! = ArcTangentH!  (  x!  )
FUNCTION ArcTangentH!  (  x  )
```

ArcSineH! Returns the inverse hyperbolic cosine for x = 0.

```
y! = ArcSineH!  (  x!  )
FUNCTION ArcSineH!  (  x  )
```

ArcCosineH! Returns the inverse hyperbolic cosine for principal values.

```
y! = ArcCosineH!  (  x!  )
FUNCTION ArcCosineH!  (  x  )
```

Appendix N

A-B VBASIC Limits

Firmware Version	1.1
Maximum PRINT USING clause	80 characters
Maximum line to PRINT	200 characters
User status display, each line	40 characters
Maximum barcode	80 characters
Maximum record to network	110 characters (system adds another 10 bytes)
Maximum string from INPUTS$	200 characters
Maximum string from LINE INPUT	200 characters
Maximum string length theoretically	32K, but limited by memory
Maximum RAM files, open or closed	10
Maximum number of files and devices simultaneously open	ALL files and all devices
Maximum file number	a value equal to the maximum numbver of files and devicxes = 24
Maximum size for program, variables, and temporaries	13700 bytes
Maximum individual RAM file size	Same as total RAM file size
Available memory for RAM files or programs to be CHAINed	Total Memory Size – 20K

Example: Maximum available memory in a 32K unit is 12K

Maximum recommended individual record size for a file	4K bytes
Maximum characters in a file name	12 characters

Other maximums, such as identifier length, are per Visual BASIC specification.

When compiling programs with the LXBC command, the statistics in the LST listing file show the percent of total compiler capacity used. Maximums can be calculated from the percentages shown.

How to compute memory size required for any application:

Interpreter overhead	6.3K
Program running	13.7K
# of CHAINed programs * 13.7K = . . .	??.? K
# of host records/hour * Hours offline * bytes/rec = ...	??.? K
# of RAM file records for lookup tables, etc. * bytes/rec = ...	??.? K

Total RAM Required = Sum of the above values

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With offices in major cities worldwide.

WORLD HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel:(414) 382–2000
Telex:43 11 016
FAX:(414)382–4444

EUROPE/MIDDLE EAST/
AFRICA HEADQUARTERS
Allen–Bradley Europe B.V.
Amsterdamseweg 15
1422 AC Uithoorn
The Netherlands
Tel:(31) 2975/43500
Telex:(844) 18042
FAX:(31) 2975/60222

ASIA/PACIFIC HEADQUARTERS
Allen–Bradley (Hong Kong) Limited
Room 1006, Block B, Sea View Estate
2-8 Watson Road
Hong Kong
Tel:(852)887-4788
Telex:(780) 64347
FAX:(852)510-9436

CANADA HEADQUARTERS
Allen–Bradley Canada Limited
135 Dundas Street
Cambridge, Ontario N1R 5X1
Canada
Tel:(519)623–1810
FAX:(519)623–8930

LATIN AMERICA
HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel:(414)382–2000
Telex:43 11 016
FAX:(414)382–2400

Publication 2708-800 – July 1994
Supercedes Cat. No. 2708–ND001 — Dated November 1991

40062–286–01(A)