LNW80 Microcomputer Operations Manual

5000/5200-1082

LNW80 Microcomputer Operations Manual

By
Ciarán McManus

First Edition - October, 1982

TABLE OF CONTENTS

SECTION 0: INTRODUCTION TO THE LNW80 OWNER MANUAL

Congratulations! You have purchased one of the finest personal and small business computers available - the LNW80. The LNW80 is software and hardware compatible with the TRS80 Model I computer. This means that one of the largest and most mature libraries of software will run on the LNW80 without modification. It also means that a huge selection of hardware accessories, such as disk drives, printers, printers, modems, video monitors, data acquisition equipment and much more will plug right in and run. But the LNW80 is more than just a TRS80 work-alike. The LNW features high resolution graphics, color, the interfaces for RS232, 5" and 8" single and double-density floppy disk drives, printer and cassette. The

LNW80 comes complete with 12K ROM, 48K RAM and a 74-key keyboard with numeric entry pad. The LNW80 also comes complete with the DOSPLUS 3.4 Disk Operating System (TRSDOS compatible), Advanced Disk Basic (LNWBASIC) and complete documentation. It is housed in a sleek steel case with a cooling fan for increased reliability.

This owner manual was written to make your first experience with the LNW80 a pleasant one. It also provides the link between your computer and the following other documentation:

1. Level 2 BASIC Manual

Level 2 BASIC is the microsoft BASIC-88 interpreter written for the LNW80. It is the BASIC which is compatible with the TRS-80 Model I LEVEL 2 computer. This BASIC is "BUILT IN" to the LNW80 and is permanently stored an ROM.

2. DOSPLUS 3.4 Disk Operating System Manual

DOSPLUS 3.4 is a DOS (Disk Operating System) which is compatible with TRSDOS (Model I). It is authored by Microsystem Software Inc.

3. LNWBASIC Advanced Disk BASIC Manual

LNWBASIC (written by Nodular Software Associates) is an extension to the Disk BASIC Interpreter supplied in DOSPLUS 3.4, or to NEWDOS80 version 2.0, LDOS 5.1 and TRSDOS 2.3. This is the part that has graphics, color, programmable key functions and some other advanced features.

4. LNW80 Technical Reference Manual

This ls the Service manual for the LNW80. This manual is intended for those technically- inclined individuals. Theory of operations, logic diagrams, trouble-shooting tips, test programs, parts lists, disaasembly and re-assembly instructions are provided.

If you are a first-time computer owner -- sit back, relax and read the following section before proceeding to tear the wrapping off your LNW80 computer. If you have owned a TRS-80 or another personal computer (or if you just cannot wait to get your hands on your LNW80) proceed to section 1, entitled "Unpacking the Hardware".

What is a Computer?

Twenty years ago, the word "COMPUTER" meant an air-conditioned room full of electronics costing millions of dollars. Today the word "computer" can mean anything from a 10 million dollar mainframe computer to the "chip" inside the electronics of your microwave oven. A computer is a machine which can automatically do arithmetic and make logical decisions.

Input Output (I/0) Devices

The computer can also make data available to and from us via input and output, devices. A KEYBOARD (typewriter style keys) is an INPUT device because it allows us to type information into the computer. This information can then be used by the computer to tell it what you want it to do, or it could be data for calculations or even a typed letter. An OUTPUT device is one that allows the computer to make information available to us. A video display is an output device because it allows the computer to "write" to us via the display screen. This display is fast and can be written over and over again, It has a disadvantage that there is no permanent "record" of this information. Once it "ROLLS" off the screen (SCROLLS), it is lost. A printer is also an output device. It "writes" on paper the information that the computer would like to communicate to us in a more permanent manner.

Central Processing Unit (CPU)

To make a computer useful, we must have input devices, output devices, and we must perform computations (arithmetic and logical decisions). The device which performs the computation is called the "CENTRAL PROCESSING UNIT" or CPU. The CPU in the LNW80 is the Z80A MICROPROCESSOR. It is the world's most popular 8-bit microprocessor (small processor) and can do thousands of computations in one second. In order for the CPU to do computations, the CPU must be told what it should do in a step-by-step fashion. Each step is an addition, subtraction, logical operation, or input/output operation. These step-by-step operations are called "instructions," or to be more exact, MACHINE LEVEL INSTRUCTIONS.

Memory

These instructions are stored in main computer storage before being executed. The main computer storage is called MEMORY. Memory as analogous to 65536 mailboxes in a row on a very long street. Each mailbox has an address marked on it from 0 to 65535. Each mailbox may look different on the outside, but can only hold the same amount of materia1 inside. Each location of a mailbox as called a "memory location," or "memory ADDRESS". For an 8-bit CPU, each address can contain a number from 0 to 255. This corresponds to 2 to the eighth power or 2exp(8) or 2x2x2x2x2x2x2x2=256. The reason that there are 65536 memory locations as due to the memory addressing capability of the Z80 microprocessor. Most of the eight-bit microprocessors have this home addressing capability. Smaller CPU's (4-bit) address fewer locations, and larger CPU's (minicomputers and some 16-bit. CPU’s) can address much larger memories (sometimes millions of locations). The advantage of larger memories is the ability to have much larger programs. Since memory is not cheap, this does cost money. There are techniques of storing large programs in modules so that only a few modules need to be in main computer storage at any time, thus allowing larger programs to run in a smaller address space. This as called memory management, or as it is more commonly referred to an the microcomputer world - OVERLAYS. OVERLAYS are just come of the programming techniques made easy by LNWBASIC, and DISK BASIC.

In the LNW80, memory takes two different forms. There is ROM (Read Only Memory) which as a "hard wired" memory that cannot be changed, and there is RAM (Random Access Memory - also called Read/Write Memory), which can be changed, but will disappear when power is removed from the computer. Instructions, when executed as a group to perform a desired function are called PROGRAMS.

Computer Languages

Just as people developed a variety of languages to communicate with each other, so there would become a variety of languages to communicate with computers. COMPUTER LANGUAGES are machine level programs that make communication between us and computer easier. Hundreds of computer languages have been developed, and with time, even dialects of languages developed. Cobol, Snobol, Algol, Fortran 4, Fortran 77, BASIC, Tiny BASIC, Extended BASIC, Level 2 BASIC, Disk BASIC and Advanced Disk BASIC are dialects of some fundamental computer languages. These languages are called HIGH-LEVEL LANGUAGES. By high-level we mean that a single high-level language instruction is translated into multiple machine-level instructions. This reduces the amount of time required to tell the computer what to do - which simplifies programming. This translation can occur during the time that the program is being run (RUN-TIME), or the translation can be done in

advance, with the final translated version of the program (COMPILED OBJECT CODE) stored for later execution.

A run-time translator is known as an INTERPRETER. One of the advantages of an interpreted high-level language is the reduced memory requirement for storing and executing the program. Since the high-level language is in memory during the execution, the program also can take advantage of the error recovery facilities of the high-level language. This makes interpretive languages qenerally easier to program and easier to get the "bugs" out of the program (DEBUG) to make it operational. All the levels of BASIC supplied with the LNW80 are interpretive.

A translator that does the translating in advance of execution is commonly referred to as a COMPILER. A compiler has the advantage of execution speed since it has all the instructions, translated in advance and can directly execute the translated instructions.

Assembly-Language

Assembly-language was the first of the computer languages developed. It allows symbolic notation to represent machine-language instructions. This makes for an easier way of programming machine level instructions. This is sometimes confusing to first-time computer owners, since much literature is written using the terms MACHINE-LANGUAGE and ASSEMBLY-LANGUAGE interchangably. The program that compiles the assembly-language program is called an ASSEMBLER. For more details concerning assembly-level programming, we recommend the following book, available from Radio Shack:

TRS80 Assembly-Language Programming
by William Barden Jr.

BASIC

The most popular language used on the LNW80 computer is BASIC. BASIC (Beginner's All-purpose Symbolic Instruction Code) was developed at Dartmouth College in 1965. It has since become the most widely used language of microcomputers and small business computer systems. Both interpretive and compiled forms of BASIC are commonly used. The LNW80 is supplied with four levels of interpretive BASIC:

1. Level II BASIC (FOOTNOTE - if you are wondering what happened to level 1, it is a small, very limited BASIC that was originally sold on the TRS80 Model I and Model III) occupies 12K (12 X 1024) bytes of memory, and is permanently stored in ROM. It has full line editing features, string variables, multiple dimension arrays, 14-digit accuracy, low

resolution graphics, cassette I/0, Video I/0, Printer I/0,

scientific functions, string-handling operations, etc.

2. DOSPLUS 3.4 TINY DISK BASIC - This is supplied on the DOSPLUS 3.4 diskette and provides an extension to the above BASIC. It adds floppy disk file handling, advanced keyboard I/0, in-string search command, programmer-defined BASIC instructions, and loading, saving, killing, merging BASIC programs to and from the floppy disk drive.

3. DOSPLUS 3.4 EXTENDED DISK BASIC - This BASIC adds to the above BASIC the following features:

1. Execute DOS commands from BASIC
2. Advanced editing features
3. Program line renumbering
4. BASIC array sort verb
5. Controlled screen input routine

4. LNWBASIC Advanced Disk BASIC - This adds even more commands to the above BASIC and is supplied on a 35-track single-density data disk. It can be used with either Extended Disk BASIC or Tiny Disk BASIC. It adds up to 40 new commands to BASIC. It has a "creator" mode which allows the programmer to create the BASIC he wants by selecting from a menu of new commands which include:

1. High resolution graphics and color commands
2. Programmable keyboard features
3. Programming shorthand notation
4. Machine Language "CALL" command
5. Sound command
6. RS232 communications from BASIC
7. Printer Spooler
8. Execute string as BASIC statement
9. Block and blinking cursor
10. Do/Until Construct and Much more...

BASIC Compilers

There is quite a variety of BASIC Compilers available for the LNW80 computer. The biggest disadvantage of most of these compilers is the lack of compatibilty with their interpretive counterparts. The Compiler BASIC available from Radio Shack is not compatible at all. The Microsoft BASIC Compiler (for the R/S Model I) is almost completely compatible with the DOSPLUS 3.4 Tiny Disk BASIC (including disk I/0), but it does have its limitations and cannot take advantage of some of the advanced features of DOSPLUS 3.4 Advanced Disk BASIC or LNWBASIC. There are other compilers that vary in price and features end can be found advertised in the computer magazines or available from your local computer dealer.

Other Languages

One of the reasons for the many computer languages is that the high-level language programmers have different needs as to the high-level instructions they would prefer to use. For example, scientific applications require fast data computation, scientific accuracy, easy formula evaluation and special scientific functions (trigonometry functions, etc.) FORTRAN (FORmula TRANslation) provides this by having instructions which can do these types of functions easily. Fortran is not a good language for business since it does not have some of the high-level instructions for manipulating business data. Cobol (COmmon Business Oriented Language) was developed for this purpose. Both Fortran and Cobol are compiler languages. FORTRAN, COBOL and ASSEMBLER are available for the LNW80 from a variety of sources including RADIO SHACK. Some of the other languages that run on the LNW80 are PASCAL, FORTH, "C" and many others,

What is an Operating System?

The Level II BASIC ROM in the LNW80 computer has a CASSETTE OPERATING SYSTEM built in. This means that it provides a method for loading, storing, and executing BASIC programs to and from cassette and the loading and executing of machine level programs from cassette. It also provides the overhead functions, such as communicating with the keyboard and the video display. In addition, it provides a method of loading in from disk, the DISK OPERATING SYSTEM (DOS). This loading of the DOS from the disk drive is called the BOOTSTRAP LOADER. This is commonly referred to as "booting the disk." When the disk is "booted," the first 256 memory locations on the disk drive are loaded into main memory and executed. These first 256 locations are called the BOOT SECTOR. This 256-byte program then loads the rest of the operating system from the disk into main memory where it can be executed.

The disk operating system supplied with the LNW80 is DOSPLUS 3.4. This is a very powerful, yet easy-to-use system that provides the following functions:

1. Keeps track of programs and data (sometimes referred to as FILES) stored on the disk. A DIRECTORY of programs and data is kept. DOSPLUS allocates space on the disk for programs and data, and the DIR command allows the operator to view the contents of the disk at any time.

2. Provides a set of functions that the operator can use to manipulate the programs and data on the disk and other useful tasks. This set of commands is called the LIBRARY of disk commands. The LIB command will display all available functions. Here are a few examples of these functions:

COPY - Allows the transfer of a program or data from one diskette to another.
AUTO - Automatically execute an application program when the disk is "booted."
DIR - Display the contents of a selected disk.
CLOCK - Display the time of day on the screen.
RENAME - Change the name of a file.
KILL - Delete a file from the disk.
BUILD - Create a file that is a series of DOS commands or programs to be linked together to run automatically.

3. Provides some specialized utility programs such as:

BACKUP - Duplicate the entire contents of one disk onto another disk.
FORMAT - Initialize a blank diskette in such a way that it has a directory of disk space and contains fields designed for storing information.
DEBUG - Display and manipulate the contents of memory and display the contents of the internal Z80A CPU registers. Debug also provides the abilty to set stopping points to assist in getting a machine level program to work.
DISKZAP - Display, modify or verify the contents of the diskette itself.
SPOOL - Store what would nomally print on the printer in

main memory and print as a background function (the printer is usually very slow) while the operator is running another program.

DO - Execute a BUILD file. A build file is a series of DOS commands or programs which can be linked together (using the BUILD command) to operate automatically. In the larger computers this program control language is called a Job Control Language (JCL) and is used to link programs together to increase the efficiency of running a computer.

4. Provides the following BASIC interpreters:

TBASIC - The TRSDOS 2.3 compatible BASIC
BASIC - The Extended Disk BASIC

For more details concerning the above features of DOSPLUS 3.4, refer to the manual entitled:

USER MANUAL Ver A.x
for
DOSPLUS 3.4
DISK OPERATING SYSTEM

Utility Programs

These are generally (but not necessarily) written in machine-language and provide some useful function for programmers. An example of a utility program available from

your dealer is CHARM. This program allows the you to create new character sets for use in BASIC programs. As mentioned earlier, there are many utility programs supplied with DOSPLUS 3.4.

Application Programs

An application program is a program which is written in machine-language or a high-level language that performs some specialized application. Games, accounting and financial programs, word processing and text editing programs, and specialized industrial or business programs are all examples of application programs. The entire manuscript of this manual was prepared using the ELECTRIC PENCIL program. The ELECTRIC PENCIL is a word processing and text editing program available from your local dealer.

SECTION 1: UNPACKING THE HARDWARE

Now that the LNW80 Computer is in your possession, let's get it out of the box and have a look at it. Decide where you are going to put the computer before unpacking. Avoid the temptation of setting it up on the floor, where the wayward foot is a very plausible source of destruction! Clear a space on a convenient table or desk that is near a power plug. You should also have a power strip or plug bar for the various pieces of equipment that will need 110V AC power.

The LNW80 is packed within a special protective foam cushion. Fold back the packing, lift out your LNW80 Computer and set it on the desk or table top.

After you have removed the computer, you will notice that there is a package of printed material on the bottom of the carton. This package contains your warranty information. Read it carefully; fill out the warranty card and then mail it as soon as possible.

This packing list contains the equipment list. To ensure that you have everything, check the list now. If you do not have all of the equipment listed, notify your dealer immediately.

Now that your LNW80 Computer has been unleashed from its package, let’s sit back for a minute and describe the LNW80 in a little more detail.

Note: Keep all packing materials. In the event that you have to transport your computer, the packing material will help to ensure safe passage.

SECTION 2: A DESCRIPTION OF THE LNW80 COMPUTER

The LNW80 computer comes to you with keyboard encased in a steel housing. At first sight the most conspicuous features are the 62-key keyboard and the 12-key numeric pad. Above the numeric pad is the POWER-ON light. The input/output (I/0) panel (for connecting peripheral equipment) is situated at the rear of the housing. The following is a list outlining the main features of the LNW80 Computer:

* 74-key keyboard (including a 12-key numeric pad) for inputting data and programs.
* Z80A microprocessor with a 4Mhz clock.
* 12K Read Only Memory (ROM) containing the Microsoft BASIC Language interpreter.
* 48K Random Access Memory (RAM) to store your programs and data.
* Real time clock.
* Parallel Printer interface.
* Cassette interface.
* RS232C communications interface.
* Single and double-density floppy disk controllers with 5-1/4 and 8 inch drive zero switch.
* 24 by 80 character screen capability.
* High resolution graphics in color and b/w.
* Upper and lower case character sets.
* 4MHz or 1.77MHz processor speeds.
* Cassette I/0 at either 500 or 1000 baud.
* Three video output jacks.
* Heavy duty power supply.
* All gold-plated edge card connectors.

All of these components are housed in a single steel case and are powered by a single power cord.

Figure 2.0 - 3/4 Front view of the computer.

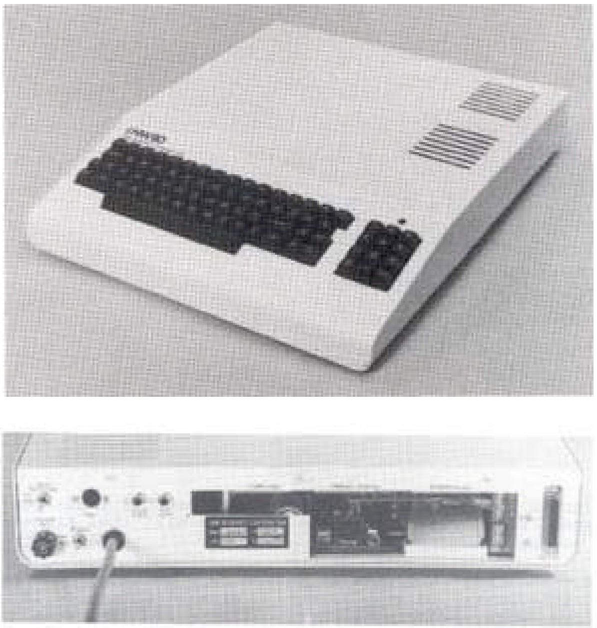


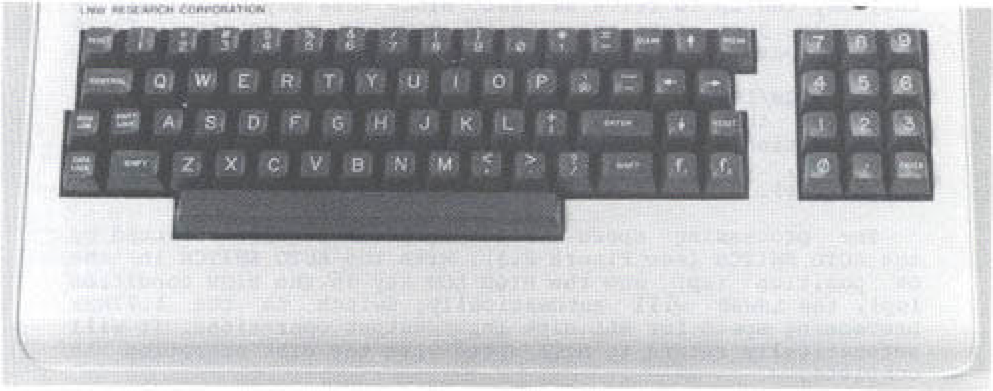
Figure 2.1 - 3/4 Rear view.

Keyboard

The LNW80 keyboard is pictured in Figure 2.2. The keyboard allows you to interact with the computer. You enter data, programs and control characters by typing on the computer keyboard. The main section of the keyboard is similar to that of a typewriter, with some extra keys which relate strictly to computer functions.

To the right of the keyboard is a numeric pad to facilitate data entry in accounting or mathematical applications.

Figure 2.2 - Photo of LNW80 Keyboard



RESET - There are two reset keys, one on each side of the main part of the key board. The RESET keys are used to reset the computer AFTER it has been initially turned on.

If you don’t have disks, reset the system by holding down the BREAK key and then pressing both RESET keys simultaneously. If you have disks, reset the system by pressing both RESET keys.

ENTER - When you type or enter data into the computer, you

must press the ENTER key to signal the computer that you are finished with your input. The computer will then process the data you have entered.

BREAK - This key generates an escape code which is used by the BASIC interpreter to stop execution of a program. It is also used in word processing applications and in some system programs, e.g., DISKZAP, which comes with the DOSPLUS disk operating system. BREAK will not usually return control to you when the system 'hangs.' For example, if you try to CLOAD a program from cassette and it’s not set up correctly, the system hangs. It will now ignore your incessant pounding on the BREAK key until you either hook-up the cassette recorder correctly or RESET the system.

CONTROL - This key is used to generate special codes when used with another key. It is especially useful in data communications and word processing.

HIGH/LOW - Ordinarily the LNW80 Computer runs at a clock speed of 4MHz (4 million cycles per second). Certain input/output (I/0) situations may require a slower processing cycle, in which case, this key may be pressed to give a clock speed of 1.77MHz.

The 4MHz speed is over twice the speed of the TRS80 Model I. When programs written for the Model I are run on the LNW80, they may run up to twice as fast. Since this may not always be desirable, just press the HIGH/LOW key down to return to TRS80 model I speed.

The HIGH/LOW key also serves to select the data transfer rate for the cassette interface. When the H/L key is in the HIGH position, data as SAVERS or LOADed at 1000 baud. With the key down, data transfer is at 500 baud (TRS80 model I compatible).

The processing speed of the computer is also affected by the AUTO SWITCH (see Figure 2.3) . With the AUTO SWITCH in the ON position (up) and the HIGH LOW key in the HIGH condition (up), the LNW80 will automatically switch to the 1.77MHz processing speed for ALL disk input/output operations. It will automatically return to HIGH speed when the disk operation is complete.

This allows programs written on TRSDOS 2.1 & 2.3 (as well as NEWDOS 2.1 and operating systems listed in Section 11, Table 11.0 which have a NO in the '4MHz OK' column) to operate at the high CPU speed except for disk I/0. If these operating systems are run at 4MHz during disk I/0, a "DISK ERROR" message will be displayed.

Note: NEWDOS80 2.0 will run at 1.77MHz all the time if the AUTO SWITCH is ON (up).

RIGHT ARROW - Tab key. Tabs 8 spaces to the right.

LEFT ARROW - Backspace one position and delete.

CLEAR - Clears screen, homes cursor, switches to 64 characters per line.

Fl and F2 - The Fl key generates a down arrow. The F2 generates a right arrow. Disk operators use key to effect same; otherwise, Fl generates an elongated colon (|) which can be used to make lines down the page, and the F2 key generates the Yen character

These characters may by used for normal input or as special program keys in applications programs since they generate normal ASCII characters. These ASCII codes are:

Down arrow	92	Right arrow	94
Elongated colon	124	Yen character	126

Since these keys are not present in the TRS80 Model I, they can be reprogrammed using LNWBASIC while still maintaining the normal functions of all the standard keys. (See DEFKEY in the LNWBASIC Manual).

CAPS LOCK - This key provides you with a means of locking all the alphabetic keys into upper case. Fl, F2, "0" and the underscore key (to the left of the down arrow) are also affected. Fl generates a down arrow, F2 generatee a right arrow, "0" generates "0" and the underscore key generates an underscore when the CAPS LOCK is down.

The CAPS LOCK is only sensed by programs which use it during the program LOAD. For example, when DOSPLUS is first booted, the switch is sensed. If the CAPS LOCK is down, all alphabetic characters will appear as upper case characters, regardless of the SHIFT key operation. The same applies to

application programs such as Visicalc, where it is useful if you only want to make your entries in upper case. The CAPS LOCK is similarly sensed in Electric Pencil, ST80 and many other application programs.

Note: Set the CAPS LOCK just prior to loading your program. Changing the setting while the program is running will give rise to unintelligible displays and may cause data loss.

The SHIFT Key:

As with a typewriter, the SHIFT key is used to print the upper symbol on dual-symbol keys. The SHIFT key is, in fact, used in a number of combinations as listed below in DOSPLUS, BASIC (all kinds), Electric Pencil and most application programs:

KEY	FUNCTION
<SHIFT><right arrow>	Switches to 32 charaters/line
<SHIFT><left arrow>	Backspace to beginning of line & erase
<SHIFT><@>	Stalls program execution, e.g., a listing. Hit any key to continue
<SHIFT> 0	Toggle between: (a) capitals only, or (b) capitals and lower case on the A - Z keys. In mode (b), switch from upper to lower, or vice versa

using . Available to
disk operators only.

Changing key definition

Using the LNWBASIC command DEFKEY, you may redefine any 10 keys as strings of ASCII character codes of length 1 or more. You may also use the Quickey option in LNWBASIC to enter entire commands by just pressing one key. See the LNWBASIC manual for more details.

Z80A Microprocessor

Often called the Central Processing Unit (CPU), this is the focal point of all events taking place within the computer. All the calculations and logical operations are carried out here and then routed or addressed for storage, video display, printing, etc. Sometimes the CPU is referred to as the "brains" of the computer.

The microprocessor has two operating speeds. The higher operating speed is 4MHz. A lower operating speed is obtained at the flick of a switch, as explained in the HIGH-LOW notes above.

The Z80A belongs to the 8080 family of microprocessors. It has 158 machine-language instructions (including all 78 8080 instructions) and 16 internal registers, It is capable of processing approximately 400,000 instructions per second.

ROM

ROM stands for Read Only Memory. The ROM memory is preprogrammed. There is 12K of ROM in your LNW80 Computer. The "K" unit refers to 1024 single units of storage. These units are known as "bytes." The ROM contains the MICROSOFT BASIC and

other information required by the CPU. As the name implies, information may only be read from ROM. You cannot write or store information in ROM.

RAM

RAM refers to Random Access Memory. A more accurate name would be Read/Write Memory. As this latter name suggests, RAM can be either written to or read from. It is true that RAM is accessed randomly, but so is ROM. However, unlike ROM, RAM loses the information stored in it when the power to the computer is turned off. The contents of RAM can also be changed at any time, whereas those of ROM cannot be changed.

You can address a total of 65K of memory address space in the LNW80 computer. Of this, 48K is available for programming use; 16K x 6 bits is used for graphics, and the remaining 1K is tied up for video use.

Parallel Printer Interface

The parallel printer interface allows you to attach any Centronics-compatible parallel printer and get a "hard copy" of your programs and other files. It is invaluable if you intend to use your computer for word processing, invoicing or other applications where the printed word is a must.

Cassette Interface

If you do not intend to use disk drives, the need will arise for you to store your programs for later recall. You will also find that many programs (even programs for disk) are distributed on cassettes. A cassette player can be attached to your LNW80 computer that will allow you to read and write programs and data to cassette tape. The LNW80 allows you to output data to tape at either 1000 or 500 baud (bits per second).

The baud rate is controlled by the HIGH/LOW speed switch. In the HIGH position, the tape is recorded at 1000 baud; and in the LOW position, it is recorded at 500 baud.

Standard TRS-80 Model I cassette tapes are recorded at 500 baud.

RS232C Communications Interface

This interface will allow you to communicate via a modem and telephone with any other computer similarly equipped. It also serves as a serial printer interface. The RS232C port may be configured to the various settings required by serial

devices by setting switches located on the rear panel (see Figure 2.3) or by software.

Expansion Port

The expansion interface is located on the I/0 panel at rear. This interface allows you to connect such devices as speech and music synthesizers to your LNW80 computer. For more details see section 13 and the LNW80 Technical Reference manual.

Single- & Double-Density Floppy Disk Controller

Your LNW80 Computer has a single/double-density disk controller that will support 5-1/4 and 8 inch, dual or single headed, floppy disk drives. 5-1/4 and 8 inch drives may be hooked up in any order on the disk drive cable.

When applied to storage on disks, density refers to the amount of information that, can be stored on a storage medium. Specifically, in the case of floppy disks, it refers to the number of bits per track. Double-density offers 80% more capacity and twice the data transfer rate of single-density. Single-density is retained for compatibility reasons.

To take advantage of this increased potential for storage, a microcomputer must have, as part of the hardware, a double-density floppy disk controller (as does the LNW80). Also, the disk operating system (DOS) used in a disk drive system must take advantage of this hardware.

The big advantage of double-density storage is that it helps to reduce costs by minimizing the number of disk drives required.

The Input/Output Panel

At the opposite end of the computer from the keyboard is the input/output (I/0) panel. It is to this panel that all of the peripheral devices are connected. And, as a picture is worth a thousand words, see Figure 2.3.

Figure 2.3 The I/0 Panel

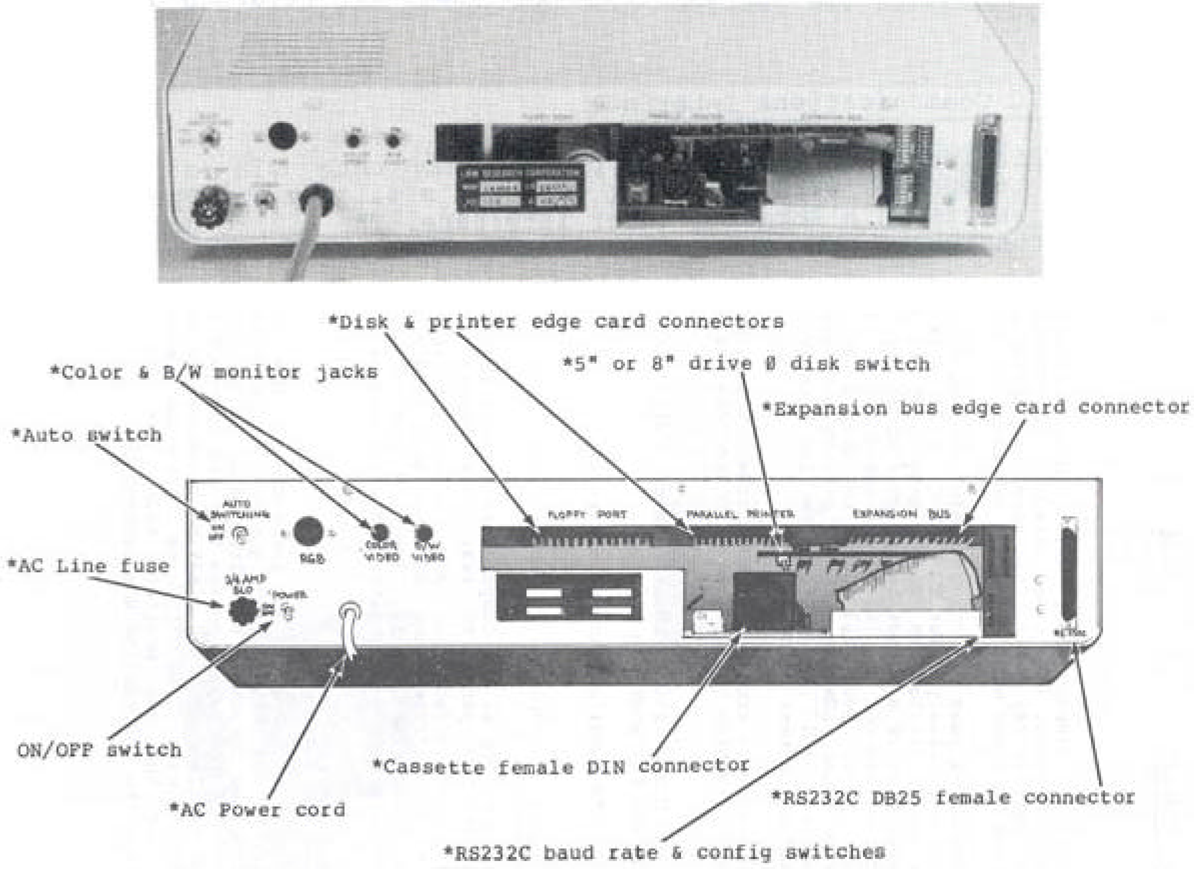

*Disk & printer edge card connectors
*Color & B/W monitor jacks
*5" or 8" drive Ø disk switch
*Expansion bus edge card connector
*Auto switch
AUTO SWITCHING ON OFF
RGB
COLOR VIDEO
B/W VIDEO
FLOPPY PORT
PARALLEL PRINTER
EXPANSION BUS
*AC Line fuse
3/4 AMP SLO
POWER
RS232
ON/OFF switch
*Cassette female DIN connector
*RS232C DB25 female connector
*AC Power cord
*RS232C baud rate & config switches

Figure 2.4 - The I/O Panel

SECTION 3: VIDEO DISPLAY

Introduction

You will require a video display unit (VDU or monitor) to operate your LNW80 Computer (The video display is sometimes called a CRT or Cathode Ray Tube). Your selection of VDU will no doubt depend on what you want from your computer.

If color graphics is your bag, then a color monitor of some sort is required. An ordinary color TV (NTSC) will suffice, but there are some limitations when using a TV set as a monitor. The resolution of a TV set is not sufficient for the display of text unless the display is set for a screen width of 32 characters. Also, you will need to attach an R/F modulator between your LNW80 and the TV set. TV sets aren’t very good monitors, and because of the low resolution, graphics displays are rather fuzzy.

An NSTC color monitor, with composite video input, will provide good color graphics and text an 32 characters per line mode.

An RGB (Red Green Blue) color monitor will provide excellent resolution for graphics and text.

See Appendix A, "A Buyer's Guide to Monitors".

Connecting a Monitor

Set the monitor on top of the computer and locate the three monitor jacks on the I/0 panel at rear (see Figure 3.1). Notice there are separate jacks for B/W, color TV with RF modulator or color monitor, and RGB monitors. Attach your monitor with the appropriate cable. The B/W and color TV cables are standard computer-to-monitor connector cables.

Connecting an RGB Monitor

The RGB monitor has a separate gun for each of the three colors red, green and blue. Each gun requires a distinct signal, and hence, the computer-to-monitor cable is a little more sophisticated. You will notice that the RGB jack is a six-pin DIN type female connector. A mating connector for this jack is provided; however, you will have to provide the cable and connector for the RGB monitor. Below are the pin specifications for the monitor and RGB connectors:

LNW80 RGB Connector	Signal	Monitor Connector
Pin 1	Vertical Sync	Pin 8
Pin 2	Blue	Pin 4
Pin 3	Green	Pin 3
Pin 4	Red	Pin 2
Pin 5	Horizontal Sync	Pin 7
Pin 6	Ground	Pin 5,6

The RGB interface is shown below with pin numbering.

Figure 3.1 - LNW80 RGB Monitor Jack

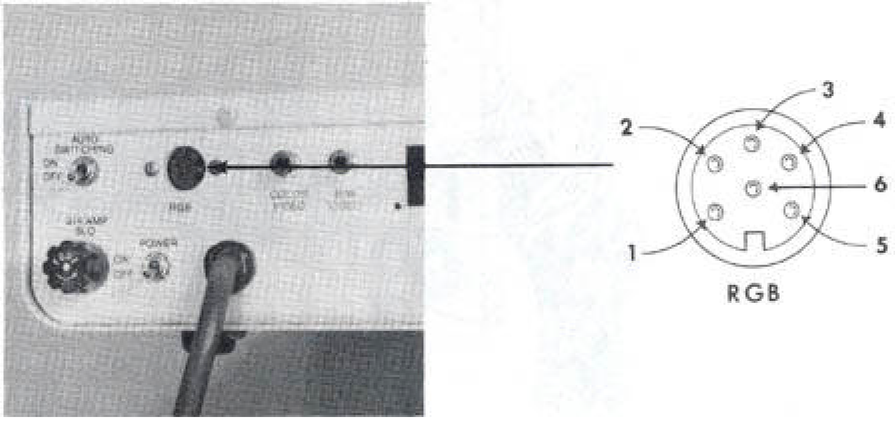


Figure 3.2 - LNW80 Video Display

Note: For "First Time Through The Manual" People . . .

If this is your first time reading through the manual, please move on to the next section at this point. When you have made your way through Section 6, entitled "Power On," the rest of this section will make more sense.

Using the Monitor with BASIC

Cursor

After performing an operation, BASIC announces its return to the immediate mode as follows:

```
READY
>_
```

(">" = PROMPT, "_" = CURSOR)

The cursor may be moved along the line by the space bar or the right arrow, which tabs eight spaces to the right.

Scrolling

When the cursor is positioned on the bottom line of the display and ,you depress the ENTER key, another line is added to the display. At the same time, all the lines currently displayed move upwards, and the line at the top is erased.

Inverse Video

Inverse video can be generated by the following program. You may have to brighten the screen to observe the effect. (Results can vary with different monitor types).

```
10 A=INP (254)
20 A=A OR 1
30 OUT 254,A
```

Inverse video is only good for black and white. It is not defined for color.

Text Characters

The BASIC program below displays the text characters together with their ASCII codes that are available from the character generator.

```
10 '......TEXT GENERATOR
15 CLS: X=0
20 FOR K=32 TO 127
30  PRINT @ (X),Z; CHR$(Z)
40  LET X=X+8
50 NEXT Z
```

You may alter the text and graphics characters by using the CHARM program, which is available from your dealer.

Graphics Characters

The low-resolution graphics characters available from the character generator and their accompanying ASCII codes are displayed by this next program.

```
10 ’.....GRAPHICS GENERATOR
20 CLS: X=0: Y=0
30 FOR Z=128 TO 191
40  PRINT @ (X),Z; CHR$(Z)
50  LET X=X+8: LET Y=Y+1
60  IF Y/8=INT(Y/8) THEN X=X+64
70 NEXT
80 GOTO 80
```

to exit program.
You can display any of the characters yourself by typing:

```
PRINT CHR$(nnn)
```

... where nnn is a whole number from 128 to 191 inclusive.

Character Size

32 Characters per Line:

The 32 characters per line mode can be effected from the keyboard by using the combination. Return to 64 c.p.l. by CLEARing the screen.

80 Characters per line:

This feature is only available to Disk Operating Systems (DOS) owners. The program to generate this display, called a "driver," is loaded from disk after booting up the system. These drivers are available from your dealer. Before trying to load the drivers, read Section 5 concerning the disk interface.

Drivers are available to generate both an 80xl6 and an 80x24 display. These drivers have limitations, however, in that they cannot be used (to date) in word processing applications.

40 Characters per line:

Depending on which 80x24 driver is in use (or up), using introduces the 40x24 display mode.

Programmable Character Font

With the use of CHARM (available from your computer dealer) the LNW80 can have user programmable character sets. The user can program foreign language, scientific and even special graphics symbols, and then save them to disk. CHARM features three display formats: 80 x 24 80 x 16 and 64 x 16. CHARM also features standard video as well as inverse video on a character by character basis.

SECTION 4: CASSETTE INTERFACE

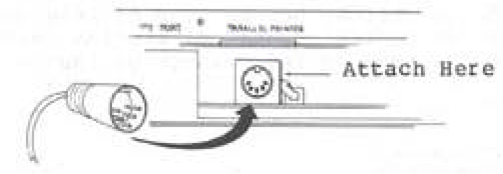
Hooking up a Cassette Recorder

Any good quality cassette tape unit may be attached to the LNW80 Computer with a cassette cable (Figure 4.0). The cassette cable is available from your local Radio Shack store (Radio Shack Catalog No. 26-1207).

A cassette player is not required for immediate operation. However, if you have one available and intend to store programs and data on tape, now would be an appropriate time to attach it to the computer.

The cable has a DIN plug at one end and three color-coded miniature phone plugs at the other. The DIN plug is attached to the cassette jack on the I/0 panel (Figure 4.0). The DIN plug may be attached to the computer only one way, so there is no danger of plugging it in backwards.

Figure 4.0 - Cassette Cable Attachment



The phone plugs are connected to the cassette player by color code as follows:

```
      GREY - connects to the AUXillary input
SMALL GREY - connects  MIC REMote control
     BLACK - connects to the EAR phone input
```

The AUX line carries information from the computer to the cassette tape.

The EAR line carries information in the other direction, from the cassette to the computer.

The MIC REM line carries a signal from the computer which controls the motor in the cassette player.

Using a Cassette Recorder

A cassette player provides a handy, low-cost method of loading and storing programs. If this is your first computer, experiment to get familiar with cassette player operation before storing any close-to-your-heart programs. Before playing with the cassette recorder, it would be a good idea to clean the tape heads and the rubber pinch roller with isopropyl alcohol. An alcohol swab after every few hours of use, will keep the heads and roller clean. So called "cleaning tapes" are not recommended, as their abrasive action may damage the heads. Cheap tapes are not recommended.

Transfer Speed

Programs and data can be transferred to and from the tape surface at two different transfer speeds. The faster transfer rate is 1000 bits per second (baud), and the slower rate is 500 baud. By using the key, you switch to fast or slow, respectively.

The faster transfer rate (1000 baud) allows you to save and load programs twice as fast as the slower rate, and in addition it saves tape. The faster rate is also more sensitive to tape noise while loading. For this reason, the tape should be well erased (see below) before SAVEing programs or data to it. Always note at which speed a program was saved, as programs saved at one speed cannot be loaded at the other speed.

SAVEing a BASIC Program

Begin with a blank tape. To blank a tape, run a commercial tape eraser slowly over the surface of the cassette a few times. Alternatively, you may put a shorting plug in the AUX input, insert the cassette and place the recorder in record mode.

1) Mount the cassette in the recorder and run it forward a little to clear the non-magnetic strip at the ends of the tape. Note position of tape counter and transfer speed.

2) Put recorder in record mode.

3) Type:

```
CSAVE"N"
```

where N is a one-character name of the program.

LOADing a BASIC Program

1) Mount cassette and set recorder in play mode just a little before start of the program on tape. Set the transfer speed and adjust volume control to mid-range.

2) Enter:

```
                     CLOAD"N"
```

where N is the name of the program. If no program name is specified, the first program or file encountered will be LOADed.

When the program begins LOADing, an asterisk will appear in the upper-right corner of the screen. This means that it has found the synchronization pattern that leads the file on tape. So far, so good! Next the file name is read and compared with the requested filename. If the names match, the file will be LOADed. WhiIe the file is being loaded, a second asterisk will appear to the right of the first. If the LOAD is successful, this second asterisk blinks.

If the file names do not match, the first asterisk remains on display while the next synchronization pattern is searched for.

So It Won't Load

If the second asterisk doesn't appear after a short time, or appears and fails to blink, the program is not LOADing correctly.

Go through the list below. The solution will most likely lie within the bounds of steps 1 through 3.

1) Check that all electrical connections are secure.

2) Check that the transfer speed is correct.

3) Starting with the lowest volume setting, proceed a half-step at a time for each LOAD attempt.

4) If there is a tone control, adjust it.

5) Demagnetize the head of the recorder.

6) REWIND and FAST FORWARD the tape a few times to remove any tape surface debris.

7) If you have just turned on the computer, let it warm up for a few minutes before attempting another LOAD.

8) Unplug the earphone jack and play the tape to check where the program begins and to make sure you have a program.

9) Try another cassette recorder.

Verifying a LOAD or SAVE

When a SAVE is complete, the computer responds with

```
                   READY
                   >_
```

To ensure that no errors have occurred during the transfer of data, rewind the tape and ENTER

```
                   CLOAD? "N"
```

This will compare the version of the program loaded into the computer with the program on tape. If all went well, the computer replies with

```
READY
>_
```

In the event of an incorrect read, the response will be

```
BAD
```

SAVE the program again and repeat the procedure.

In the case of LOADing, rewind the tape after the LOAD and proceed as above.

If the program continues to misbehave during the SAVEing or LOADing procedure, take a break before you drive yourself crazy! On your return, take a look at the cassette recorder. Examine the rubber pinch roller. If it's smooth and shiney, it may not be gripping the tape properly, with tape slip resulting. Clean it with isopropyl alcohol and then rough it up lightly with a strip of emery paper.

If the program loads but fails to run, and upon scrutiny reveals erroneous characters here, there and yonder, then you have probably CSAVEd your progran on a tape that wasn’t fully blanked.

Loading a Machine Language Program

As with the BASIC program, mount the cassette in the recorder and rewind to the correct position. Then enter the command

```
SYSTEM
```

The computer responds with

```
*?
```

to which you add the program name

```
*? PROGRAM
```

Press the PLAY button on the recorder. As the program loads, an asterisk will appear on the top right hand corner of the screen, followed by a second blinking asterisk immediately to its right. When the program has loaded, the prompt reappears ...

```
*?
```

You are presented with three options at this point:

(i) respond with to return to BASIC
(ii) you may load a second program
(iii) respond with

```
*? / ENTRY ADDRESS
```

if you want to execute the program at a specific location in memory, or,

```
*? /
```

if the entry address is specified by the program.

Lower Case With a Cassette Based LNW80 Computer

The LNW80 computer has the hardware necessary to implement lower case characters. Since hardware does not function without software, the following program is included. Note that

this program is not necessary when the LNW80 is used with cassette or disk versions of word processors such as ELECTRIC PENCIL since they contain their own display drivers that support lower case. This program is also not necessary when the LNW80 is used with disk drives and one of the following operating systems:

1) DOSPLUS
2) NEWDOS80
3) MULTIDOS
4) LDOS
5) VTOS
6) Any other operating system or program that supports lower case.

Complete Lower Case Program

This program allows the full implementation of the lower case in BASIC. It has only one known peculiarity, - the "@" key will display as the monetary pound symbol in the unshifted position. Before typing in the program, type in a short program and verify that it can be saved to cassette. Once this is done, begin typing in the program. Check carefully for typing errors. Once you have the program typed in, save the program out to cassette at least twice. Then perform a cassette verify with the CLOAD? command, Make sure that your recorder is correctly set to playback before attempting this. Once the program has been entered and saved to cassette, you may now attempt to use it. This is done by setting the memory size to 65375 on power up and then loading the program off cassette. List the program to verify a good load and then type RUN. The program will then ask the operator if both upper and lower case is desired. Unless you respond with N the program will assume that you want both upper and lower case characters.

LOWER CASE PROGRAM

```
10 REM SET MEMORY SIZE AT 65375
20 FOR X=-160 TO -1:READ I: POKE X,I:NEXTX
30 POKE 16414,96:POKE16415,255:POKE16422,167:POKE16423,255
40 INPUT"WOULD YOU LIKE UPPER AND LOWER CASE (N=NO)";A$
50 IF A$="N"THENPOKE16409,0ELSEPOKE16409,1
60 DATA 245,58,24,64,254,01,32,6,121,197,205,59,0,193,58,25
70 DATA 64,254,1,40,4,241,195,88,4,241,221,110,3,221,102,4
80 DATA 218,154,4,221,126,5,183,40,1,119,121,254,128,210,166,4
90 DATA 254,32,218,6,5,254,64,218,125,4,254,96,48,5,246,32
100 DATA 195,125,4,230,159,195,125,4,58,25,64,254,1,32,20,121
110 DATA 254,65,56,14,254,122,48,l0,254,91,56,4,254,32,56,2
120 DATA 238,32,79,58,26,64,254,1,194,141,5,l21,254,13,40,5
130 DATA 254,l0,194,141,5,l7,0,32,27,122,179,32,251,62,13,50
140 DATA 232,55,17,00,32,27,122,179,32,251,62,10,50,232,55
150 DATA 17,0,48,27,122,179,32,254,l4,13,201,0,0,0,0,0,0
```

SECTION 5: DISK INTERFACE

Introduction

A disk drive system has the great advantage over tape in that it permits greater dexterity in handling masses of information. Large amounts of information can be stored or accessed quickly, reliably and with a minimum of fuss. Programs and files can be loaded from disk about 250 times faster than from tape. Files can be manipulated with relative ease and can be designed to suit a particular application.

In a disk operating system (DOS), the operating system for the computer resides on disk. A DOS is more powerful than the ROM operating system. It affords flexibility as regards data storage and makes available problem-solving programs (debugging software) to observe data at almost any memory location within the system.

The LNW80 allows you to attach up to four disk drive units to the disk interface. These may be 5 1/4 inch or 8 inch drives, a combination of both, or even hard disk drives. Dual headed drives (two read/write heads) may also be used, but in this case, only 3 drives are allowed. Disks may be formatted in single-or double-density.

As an introduction to disk drives and their development, you might want to read through Appendix B before reading this section.

What kind of Disk Drives should you use?

The LNW80 will work with virtually any type of disk drive (once configured for the LNW) and any floppy disk. Armed with this knowledge, you may be tempted to use the cheapest disk drives you can find. However, these may prove to be quite a frustation, so with your long term mental health in mind, we make the following suggestions:

1). Use double-density rated disk drives.
Single-density drives may work, but the proper operation in double-density cannot be guaranteed for the life of the drive (See list of compatible drives in appendix).

2). Clean and align your drives according to manufacturer specifications.

Configuring 5-1/4" & 8" Disk Drives for the LNW80

Disk drives and cables which are configured to run on the TRS-80 Model I are fully compatible with the LNW80. Any eight inch drive which is Shugart compatible should run on the LNW80. If you are about to purchase drives and are unfamiliar with the concept of drive configuration, Appendix B should set you straight.

Proper configuration for drives and cables should be provided by your computer dealer.

Connecting a 5 1/4" Disk Drive

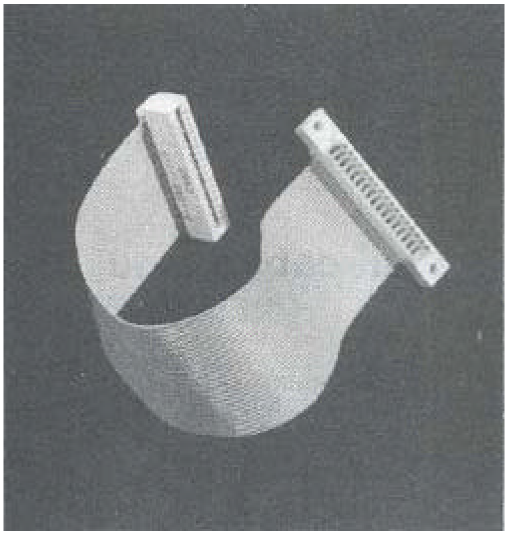
Disk drives are connected to the computer's disk interface with a ribbon cable. 5-1/4" drives require a 34-wire cable with a card edge connector at each end. The drive cover must be removed to connect the ribbon cable. It is a good idea to fit the drive with an extender cable so that connection and removal are made easier.

Table 5.0 - Pin specifications for the 34-pin 5-1/4"

drive bus. The unlisted pins are used as grounds.

Pin #	Description
2	Not Used
4	Not Used
6	Not Used
8	Index
10	Drive Select 1
12	Drive Select 2
14	Drive Select 3
16	Motor On
18	Direction Select
20	Step
22	Write Data
24	Write Gate
26	Track 0
28	Write Protect (Active Low)
30	Read Data
32	Side Select (Dual Sided Drives)
34	Not Used

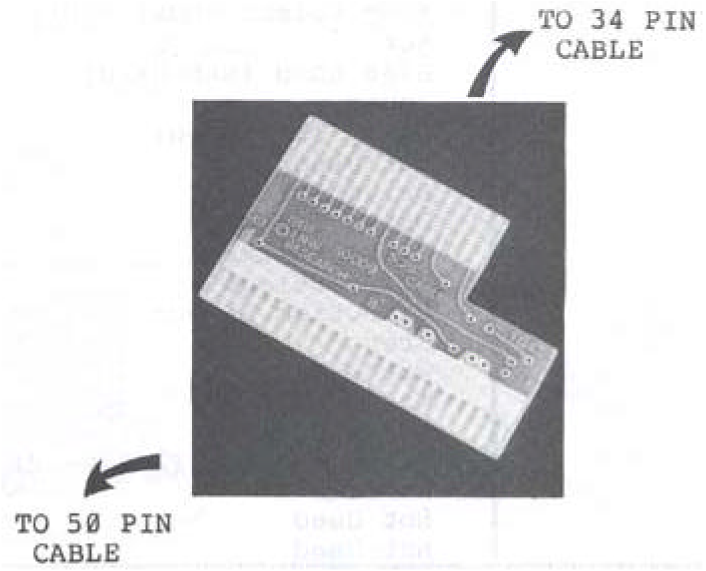
Figure 5.0 - Extender Cable



<u>Connecting an 8" Disk Drive</u>

Eight-inch drives require 50 - wire ribbon cables for operation, You will notice that the disk interface on the computer is made for a 34-wire cable (17 connections on each side). A 50-to-34 adapter board is available from LNW (stock# 1096) to connect the 8" drive to the 34-wire cable. One end of this board plugs into the 8" drive cable-connector (50-pin), the other into the 5-1/4" drive cable-connector (34-pin) as shown in Figure 5.1. If the connector on the 34-pin cable has pins pulled, you may only connect one 8" drive per adapter. Otherwise, the drive select process will not be able to "see" any 8" drive after the first one it encounters. If the cable is not of the pulled pin type, then you may connect a few 8" drives to the 34-pin cable using just one adapter. Figures 5.2 and 5.3 outline the rights and wrongs of the matter.

Figure 5.1 - 34 to 50 Pin Adapter



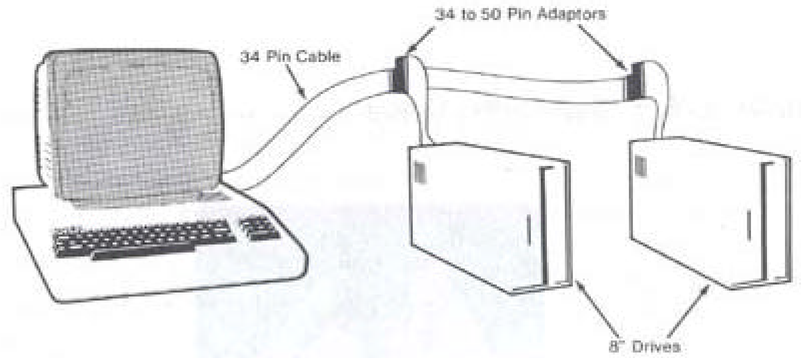


Figure 5.2 - Pulled pin cable and 8" drive

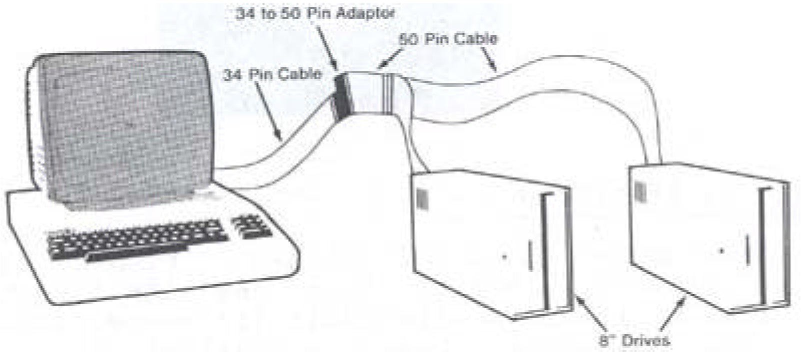


Figure 5.3 - No pins pulled cable and 8" drive hook-up.

Table 5.1 - Pin Specifications for the 50-pin 8-inch Drive Bus

Pin #	Description
2	Ground or Lower Write
4	Not Used / Reserved
6	Not Used

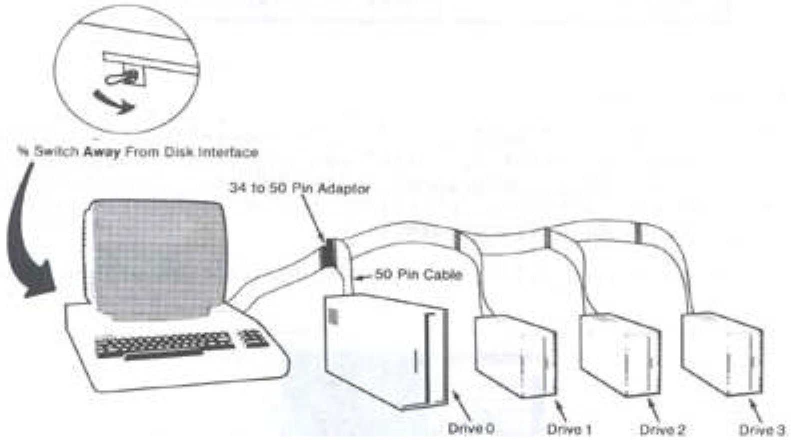
8	Not Used
10	Two Sided (Not Used)
l2	Disk Change (Not Used)
14	Side Select (Dual-sided drives)
16	Activity / In Use
18	Head Load (Not Used)
20	Index
22	Ready (Not Used)
24	Not Used
26	Drive Select 1
28	Drive Select 2
30	Drive Select 3
32	Drive Select 4
34	Direction Select
36	Step
38	Write Data
40	Write Gate
42	Track 0
44	Write Protect (Active High)
46	Read Data
48	Not Used
50	Not Used

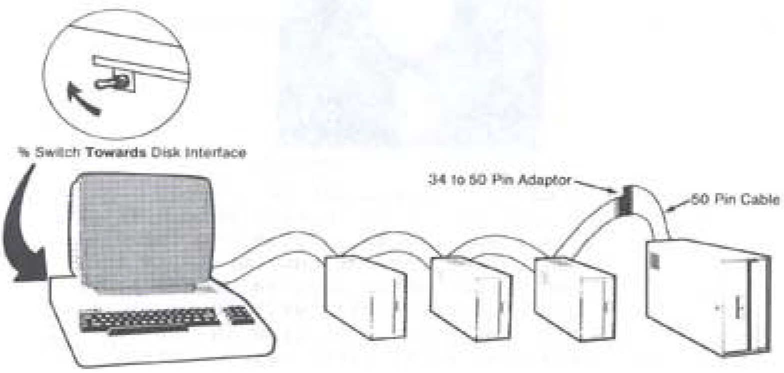
In the RARE event that you haVe an 8" disk drive which requires the "write current" line on the disk drive to be driven when using double-density above track 43, the adapter requires a small modification. A jumper cable (LNW stock# 1097) must be soldered between TG43 on the adapter board to pin 2 of the 50-pin bus. Test out your drives first, and if you're having trouble above track 43 in double-density, get out the soldering iron!

Disk Drive Set-up and the 5/8 Switch

The layout for a typical disk drive system is shown in Figure 5.4.

Figure 5.4 - Typical Disk Drive System Showing
Mixed Drive Setup & 5/8 Switch





5-1/4" or 8" disk drives may be used together in a mixed set-up, although you must make the computer aware of the size of drive zero (whether it is 5-1/4 inch or 8 inch). You do this by way of the 5/8 Switch, This is located in o recessed position above the cassette jack on the I/0 panel. The information relevant to this switch is shown in Table 5.2.

Table 5.2 - Drive 0 and the 5/8 Switch

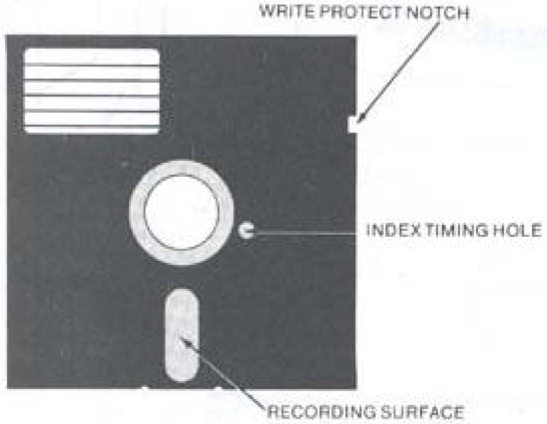
Drive 0 Type	5/8 Switch
5-1/4 Inch	Towards Floppy Port
8 Inch	Away from Floppy Port

Disk Description

The names "disk" and "diskette" have become interchangeable. Formerly, "disk" was reserved to describe the large rigid disks associated with bigger computers, and "diskette" was used to describe the smaller flexible or "floppy" disks of microcomputers.

Refer to Figure 5.5 for a graphic description of the disk.

Figure 5.5



1) Protective cover - should not be opened.
2) Read/write opening. It is through this aperture that data is read from and written to the disk.
3) Write protect notch. In the case of 5 1/4 inch disks, covering the notch with an opaque label protects the disk from being written to accidentally. The reverse is true in the case of

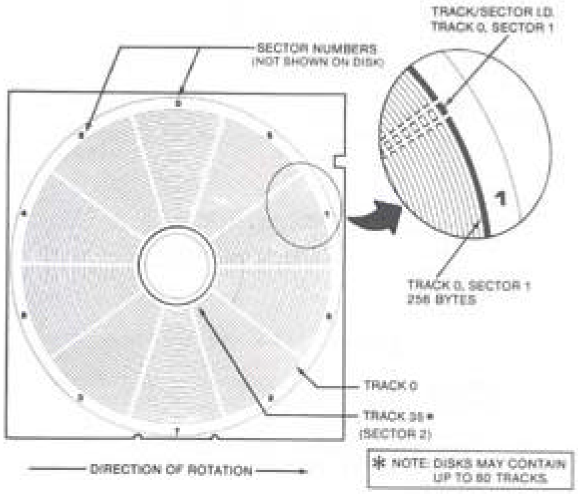
8 inch disks - no label gives write protect status.

4) Timing aperture. The disk also has a small hole in it. When the disk is rotating, each time the hole is aligned with the timing aperture, a beam of light passes through. This triggers an electronic signal, letting the computer know that the disk has made one revolution.
5) Disk label. Use only a felt-tipped pen when writing on the label. Ballpoints and lead pencils may leave impressions on the disk.
6) Disk envelope. Inner lining helps to keep the disk clean.

Floppy disks are made of a thin plastic material which is coated on one or both sides with a thin, uniform layer of metal oxide. Data is stored on the disk on concentric tracks, which are arranged on the disk by the read/write head of the disk drive. This process is called formatting, and is carried out under control of the disk operating system (DOS).

The number of tracks is optional, but is usually 35, 40, 77 or 80. The tracks are numbered from the outer edge inwards. Each track is divided into sectors. The number of sectors per track depends on the DOS used to format the disk and whether single or double-density is involved. Most TRSDOS-like DOSes use 10 sectors per track in single-density and 18 sectors per track in double-density, Figure 5.6 clarifies this information.

Figure 5.6 - Sketch of disk, tracks a sector.



<u>Disk Care</u>

- Keep disks away from magnetic fields. Many domestic appliances have transformers which are capable of generating a magnetic field strong enough to erose all or part of a disk. Refrigerators, telephones a TV's are among these.

- Avoid touching disk surface. Keep the disk in its envelope when not in the drive.

- Remove disks from drives before turning drives or computer on or off.

- In dry climates guard against static. Ground yourself by touching something metallic before handling disks.

- Store disks standing on edge (not flat).

- Store in a clean, dust-free environment between 50 and 125 degrees Fahrenheit (10 - 50 degrees C). Avoid leaving disks in the sunlight.

Next page | TOC

SECTION 6: POWER ON

Connecting AC Power

As you prepare to hook up to the main power supply, ensure that the computer and all peripherals are switched OFF.

Locate the power cord exiting from the rear of the computer and plug it inta a 110V AC outlet. All peripherals attached to the computer must also be supplied with AC power independently.

Turn on the monitor and let it warm up for a minute or two,

Power Up & Reset for Non-Disk Owners

Press the BREAK key and switch the computer on. After a moment's hesitation, the computer will respond with the following prompt:

```
MEMORY SIZE?
MEMORY SIZE? _
```

(If this is not displayed clearly or if the monitor is not in a cooperative mood, see the relevant sub-sections below on monitor adjustment).

We may ignore the MEMORY SIZE? question for the moment (see SECTION 10) and simply press the ENTER key.

The computer in its turn replies with,

```
READY
>_
```

To restart the system in ROM once the power is on, press the BREAK key first and then the two RESET keys simultaneously.

Power Up and Reset for Disk Owners

- Switch on drive(s).
- Switch on computer.
- Wait until drives stop running.
- Insert the system disk in drive 0, with the label facing the arm of the door (see Figure 6.0).
- Close the drive door gently. The door will not close if the disk is not fully inserted.
- Press both RESET keys simultaneously. The computer responds with the system logo.

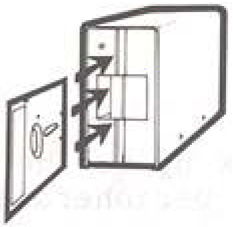


Figure 6.0

You should now make a backup copy of your system disk before proceeding any further. This is most important. It is not beyond the realms of possibility to destroy the information on disk at this initial phase of investigation and experimentation.

The BACKUP utility is described on page 80 of the DOSPLUS manual.

Disk Power Up Malfunctions

If the drives fail to stop running after switching the computer on or the system fails to boot, check the following:

- Are the drive cables connected correctly and securely at both the computer and drive outlets? Note that the drive connection is "backwards" relative to TRS80 Model I, with cable up vs. down.

- Is the disk in drive 0 a system disk?

- Is the drive running smoothly? If not, the disk is not securely mounted on the drive spindle. Re-insert the disk.

To RESET the disk operating system (to "boot" the system), hit the two RESET keys simultaneously.

Monochrome Monitor Adjustment

1. BRIGHTNESS - turn fully clockwise.
2. CONTRAST - turn fully clockwise.

If the display is not stable (ie. rolls vertically, horizontally or tears diagonally) make the following two adjustments. If the display is stable, then skip this section and go on to final adjustments.

3. HORIZONTAL HOLD - adjust for a picture that does not "tear" diagonally and is stable horizontally. It may still have vertical roll at this point.

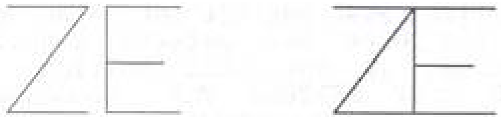
4. VERTICAL HOLD - adjust for a picture that does not roll vertically and does not have any multiple or overlayed images.

Make the following final adjustments:

5. BRIGHTNESS - turn counterclockwise till the background scan lines are just no longer visible (but the letters should still be brightly displayed.

6. CONTRAST - turn counterclockwise for the sharpest, roundest characters with a bright, easy-to-read display. The individual dots that make the letters should be visible, and the black space between the letters Z and E at the top and bottom of the letters should be seen. The following drawing illustrates this:

Figure 6.1 - High and normal contrast drawings



GOOD CONTRAST CONTRAST TOO HIGH

If you cannot achieve crisp characters with the following adjustments, then either - adjust the SIGNAL ADJUSTMENT (if any) to reduce the amplitude of the video OR install a series resistor in line (10 - 33 ohm) with the "hot side" of the video cable.

If you intend to use the LNW80 computer in the inverse video display mode, then you will have to repeat the above adjustments while in the inverse display mode. Most monitors will probably not be properly adjusted for both inverse and normal display modes with the same settings. When you turn on the inverse display mode, don't, be suprised to see the screen go blank. When adjusting for BOTH display modes simply adjust to your own preference.

NTSC Color Monitor Adjustment

An NTSC color monitor has some of the same adjustments as your home television: BRIGHTNESS (may be called BACKGROUND), CONTRAST, COLOR, TINT, VERTICAL H0LD, HORIZONTAL HOLD and SHARPNESS (sometimes called FOCUS). The first step of alignment is to perform the same adjustments, as with a monochrome monitor (the procedure is listed in the previous section). Some of the controls found in a monochrome monitor (i.e., horizontal and vertical sync) may, or may not be present in your color monitor. If the control cannot be found, then it should be assumed that the control is automatically set internally and needs no adjustment. Check the owner's manual for more details concerning your monitor.

Monochrome Operation

The NTSC color monitor cannot display the 64-column text screen with clarity. With some monitors it may be possible to read the characters in this mode, but it will require the optimum setting of the above-mentioned controls and a very high quality set with a +6MHz luminance bandwidth. It may also require that the NTSC color monitor be connected to the B/W video output since the bandwidth is higher through that display channel, and the color setting on the set should be turned completely off.

Color Operation

In order to align your monitor for color operation, you must first display the color bar pattern generated by the program listed below. IF THE NTSC MONITOR IS YOUR ONLY MONITOR, THEN YOU MUST PERFORM THE MONOCHROME DISPLAY ADJUSTMENTS MENTIONED IN THE PREVIOUS SECTION TO MAKE THE DISPLAY READABLE WHILE TYPING IN THE PROGRAM THAT IS LISTED BELOW. This program is written using LNWBASIC and is easy to type in. It does require that the programmer has a working knowledge of DOSPLUS 3.4 and LNWBASIC. These details can be found elsewhere in this manual and in the LNWBASIC USER MANUAL or the DOSPLUS 3.4 USER MANUAL.

```
1  'LNWBASIC Color Bar Test Program
10 MODE2
20 PCLS
30 FLS(191)
40 FOR X=0 TO 7
50 COLORX
60 Xi=16*X:Y1=0:X2=(16*X+14):Y2=191
70 LINE Xl,YlgX2,Y2,SET,BF
80 NEXTX
```

```
          90 END
```

Once you have typed in the program, save it for future use by typing:

```
                  SAVE"COLOR/BAS"
```

This program should generate 8 color bars in the following order:

White Green Yellow Red Magenta Blue Blue-green Black.

Once the color bar program has been run, make the following adjustments:

1. BRIGHTNESS (May be Called BACKGROUND) - adjust such that 7 color bars (may appear as 7 grey areas) appear, but the BLACK bar (eighth bar) at the right of the screen is completely black.

2. CONTRAST - adjust so that the bars have adequate range of intensity. The BLACK bar should be black, and the WHITE bar should be a bright white. The thin black borders between the color bars should have the sharpest edges attainable.

3. COLOR - adjust so that the colors (may not be the correct colors yet) are bright and clean, but not saturated so much that there is color "bleeding" and distortion in the black borders between the color bars.

4. TINT - adjust the tint so that the colors displayed on the screen match the 8 color bars and suit your individual preference. From left to right:
white green yellow red magenta blue blue-green black

5. SHARPNESS - Between the color bars are thin, two-pixel borders of black. Adjust the sharpness or focus such that the sharpest edges are obtained.

RGB Monitor Adjustment and Operation

The RGB monitor generally requires no more adjustments than a monochrome monitor:

l. Perform the MONOCHROME MONITOR ADJUSTMENTS
2. Type in the COLOR BAR program listed in the previous section and run it using LNWBASIC.

Power Off

When turning off your computer, allow at least 15 seconds before turning it on again. This time allows any power that may not have drained away in the electrical circuitry to do so,

Memory Test

Although your LNW80 has been thoroughly tested at our manufacturing plant, we include this memory test in case you ever need to use it in the years ahead.

```
     10 REM  Memory Test for LNW80
     20 REM  This is a simple test of computer memory.
     30 REM  Each memory location is tested by using the
     40 REM  the GOSUB instruction. It should run
     50 REM  continously until it reaches location 100

     60 REM  or so. Total memory is printed on the top
     65 REM  left hand corner of the screen.
     70 CLS
     80 PRINT CHR$(23)
     85 PRINT @ 0,MEM
     90 PRINT @ 470,MEM
     100 IF MEM < 100 THEN STOP ELSE GOSUB 90
```

Now type:

```
                         RUN
```

means that you press the ENTER key after typing RUN.

The program should run continuously until location 100 or so is encountered.

High Speed / Low Speed Test

We can make convenient use of this program to do another test. As was indicated earlier, the LNW80's microprocessor operates at two clock speeds: 4MHz and 1.77MHz. By timing the program with the key in the up position (HIGH) and down position (LOW), the following approximate results should be obtained:

HIGH	119 seconds
LOW	222 seconds

You may wonder why the result for the faster clock speed is not twice that of the slower. The reason it isn't is that the CPU works at a faster clock speed than the Level II ROMs are capable of. As a result, the CPU must slow slightly (using "wait states") so that the ROMs can keep up.

Graphics Test

Running the program below will fill the display with the standard text and low-resolution graphics characters available from the character generator.

```
        10 REM Mode 0 text and graphics test.
        20 LET Y=0
        30 FQR X=15360 TO 16363
        40 IF Y>192 LET Y=0
        50 POKE X,Y
        60 LET Y=Y+1
        70 NEXT X
        80 GOTO 80
```

To exit from this program, you must press the key. Line 80 in the program puts the program into an infinite loop so as not to disrupt the display on the screen.

SECTION 7: LNW80 GRAPHICS

Introduction

The color graphics capabilities of the LNW80 make up one of the computer's real highlights. You now have a machine which not only allows good data manipulation, but also has high resolution graphics. The LNW80 comes to you with LNWBASIC, a tailor made BASIC, designed to extract the maximum potential from the machine in terms of color and black and white graphics.

This section introduces you to the machine's graphics capabilities and lays the foundation for your adventures into LNWBASIC. The second half of this section was written for the benefit of machine-language programmers. It is not vital reading for the novice.

Note: As LNWBASIC is only supplied on disk, a subsection is included for non-disk owners on how to generate both black 6 white and color graphics.

Graphics Modes

The LNW80 has four different graphics modes:

Mode 0 — Low Resolution (LORES) graphics mixed with text. Control of 128 x 48 picture elements (pixels).

Mode l — High Resolution (HIRES) graphics mixed with LORES graphics and text. Control of 480 x 192 pixels.

Mode 2 — LORES Color, with control of 128 x 192 pixels. There are 8 colores available in this mode.

Mode 3 — HIRES Color. Control of 480 x 192 pixels. The screen may be mapped in color blocks of 128 x 16 pixels. There are 8 colors available in this mode.

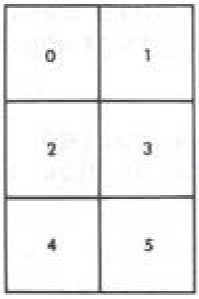
Note that the picture element (pixel) size depends on the graphics mode in operation.

Mode 0 - Low Resolution Graphics a Text

In this mode you have 128 (64x2) points of reference across the screen and 48 (16x3) points down the screen.

Mode 0 is the normal operating mode. The mode 0 screen is laid out as shown on the video display worksheet in Appendix D. Turning your attention to this for a moment, you will see that there are 64 character positions across the screen, numbered from 0 to 63. There are 16 lines of 64 characters each, ending up at character position 1023 on the lower right-hand corner. You will notice also that each character which is outlined in dark ink is subdivided into 6 smaller units. These smaller units are called graphics cells. Neither character positions nor graphic cells are physical areas on the screen, but rather areas of the screen that the computer has chosen.

Figure 7.0 - character position and Graphics cell



The mode 0 graphics cell corresponds to the mode 0 pixel. The term graphics cell is retained here, as it is often used to describe the size of pixel which is controllable using SET and RESET in BASIC.

To see the size of one mode zero pixel, use the following BASIC statement:

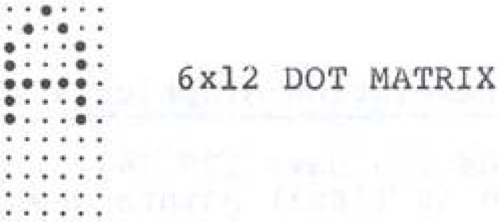
```
CLS : PRINTS 480, CHR$(129)
```

or

```
CLS : SET (64,21)
```

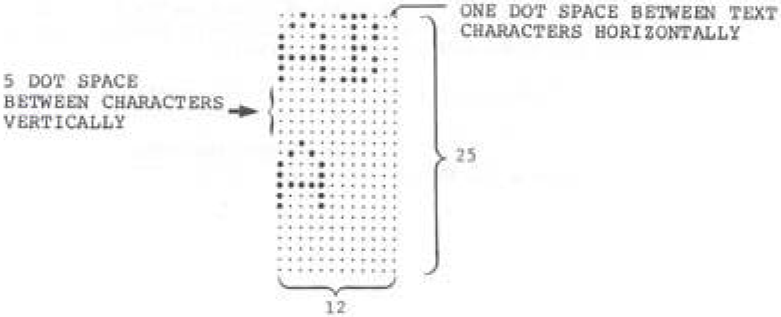
A text character appears as a 5 x 7 matrix within the sounds of the 12 x 6 dot matrix that makes up a character position.

Figure 7.1 - 12 x 6 dot matrix of character posn with 5 x 7 text character imposed on it.



The 5 x 7 format allows a one dot space between characters and a 5 dot space between lines.

Figure 7.2 - Interspacing of text characters


ONE DOT SPACE BETWEEN TEXT CHARACTERS HORIZONTALLY
5 DOT SPACE BETWEEN CHARACTERS VERTICALLY
25
12

Mode 1 - High Resolution Graphics & LORES Graphics a Text.

In this mode, you may reference 480 dots across the screen and 192 down the screen, giving you the highest resolution possible on the LNW80. The normal screen width of 64 characters is extended to 80 character positions in this mode. These additional 16 character positions give you an extra 96

(16x6) pixels per line. This mode allows you to turn on or off the smallest dots which we saw in the mode 0 character position.

This mode can be entered in LNWBASIC by simply typing,

```
MODE 1
```

The pixel size in this mode can be seen by RUNning the following LNWBASIC program:

```
 l ' LNWBASIC program to light up mode 1 pixel
10 MODE 1: CLS: PCLS
20 PSET 240,96
30 CIRCLE 240,96,40
40 GOTO 40
```

Press the BREAK key to exit the program.

A drawing program is included in Appendix C to illustrate some of the possibilities in this mode.

Mode 2 - Low Resolution Color

This color mode is the highest resolution mode possible for NTSC composite video. The resolution in this mode offers you 128 pixels across the screen and 192 pixels down the screen. To give you an idea of the size of pixel we're talking about, the following figure shows the relationship between the mode 0 character position and the mode 2 pixel.

Figure 7.3 - Mode 0 character position with mode 2 pixel outlined.

As you can see, four vertically-stacked mode 2 pixels are equivalent to a mode zero graphics cell.

To enter this mode in LNWBASIC, use the mode command,

```
MODE 2
```

The mode 2 pixel can be displayed on the screen using this LNWBASIC program. Press BREAK to exit the program.

```
 1 ' LNWBASIC program to display mode 2 pixel
10 MODE 2 : PCLS 2 : CLS
20 COLOR 5 : FLS REM FLS 'WHITES' MODE 0 SCREEN TO DISPLAY COLOR
30 PSET 63,97
40 CIRCLE 63,97,15
50 GOTO 50
```

To get the most of the computer's color capabilities in this mode, examine the COLOR, FLS and PCLS commands in the LNWBASIC manual.

Mode 3 Graphics - High Resolution Color

This high resolution graphics display mode allows the high resolution graphics monochrome (MODE1) information to be displayed on an RGB color monitor. This high resolution information is displayed with limited color control. This means that while the number of individually controllable color dots that can be displayed is 480H (horizontal) by 192V (vertical), the colors that they can be set to are limited to

128H by 16V color fields. These color fields have a

relationship to. the high resolution position such that one color field controls the color of 36 high resolution pixels (dots). Color information is provided by the MODE0 text memory (memory from 3C00H to 3FFFH). The data stored in a given character position will determine the color of the high resolution graphics at that position. To better understand this, we will run the following program in LNWBASIC:

```
 10 MODEl:PCLS:CLS' set to high res and clear all screens
 20 LINE 0,3,383,3,SET ' draw high res line
 30 MODE3 ? note the line above can be drawn in mode 3 also
 40 FORC=0T07 ' step through all the colors
 50 FOR I=0 TO 3'PUT EACH COLOR FIELD FOUR TIMES
 60 AD=&H3C00+C*4+I? COLOR FIELD ADDRESS
 70 POKEAD,C*9 'must use poke to output
 80 NEXT I
 90 NEXTC
 100 GOTO 100 'wait forever and do not disturb screen
```

When this program is run with a monochrome monitor installed, a high res (MODE1) LINE is drawn across the top of the screen, followed by characters overlapping the line on the screen. If we install an RGB monitor to the LNW80 now, we would see that the various characters cause the line to change colors. This overlapping of characters with high resolution graphics is how MODE3 graphics works. You might have noticed that after the color bars there was a blank space (color black) and then the rest of the line is displayed as alternating violet and white dots. Each of these dots represents the width of the smallest unit of color field which is one-half of a character position. This example used an entire character position as a color field with four consecutive color fields set to the same color. If we wanted to use the maximum color resolution, we could change the program to the following:

```
 10 MODE1:PCLS:CLS? set to high res and clear all screens
 20 LINE 0,7,479,11,SET,BF  ' draw a high res line
 30 MODE3 ? note the line above can be drawn in mode 3 also
 40 FOR I=0 TO 15
 50 FORC=0T07 ' step through all the colors
 60 IF(C AND l)=0THEN90ELSE70 'is the pixel even or odd?
 70 AD=INT(C/2)+I*4:D=PEEK(6H3C00+AD)?ODD find address and get
data
 80  D=DAND&H38:D=DORC:POKE(6H3C00+AD),D:GOT0110 'mask  upr   3
bits, output
 90 AD=INT(C/2)+I*4:D=PEEK(aH3C00+AD)'EVEN find  address,  get
data
 100   D=DAND7:D=DOR(C*8):POKEfaH3C00+AD),D'mask,   or   data,
output
 110 NEXTC
 120 NEXTI
 130 FOR Z=1T01000:NEXTZ
 140 LINE 0,0,479,11,SET,BF
 150 GOTO 150
```

This program draws a high res bar that extends beyond 383, and you should have noticed on the monochrome monitor that the characters that appear above the high res bar change the color of the bar on the RGB color monitor. Note that characters do not appear above the bar beyond character position 64 or high res position 383. Run the program again and watch the extension region while the inner region is writing the color fields. You will see that while colors are written to the inner region there is a duplication into the outer region. Due to the design of the hardware, the color information for any horizontal position past 383 is taken from color information from the same vertical position but from an assortment of horizontal positions (with values less than 383). This means that. if you use high resolution graphics beyond 383, you cannot be guaranteed the color unless all the color fields for pixels less than 383 are set to the same color.

Mode 3 With LNWBASIC

The initial release of LNWBASIC does not totally support MODE3 graphics. The mode command will set the LNW80 to the correct setting, but lines drawn in MODE3 are the same as lines drawn in MODEl with no color information provided. Later versions of LNWBASIC (if you registered with MODULAR SOFTWARE ASSOCIATES, you will be notified when this new version is ready) will fully support MODE3. In order to use the high resolution capability at this time, special subroutines must be written to write the color fields to match the high res graphics of LNWBASIC. The following programs provide rudimentary routines to fill fields and do limited line drawings in MODE3.

```
1 'THIS PROGRAM CONTAINS 3  MODULES.  THE  FIRST  STARTING  AT
LINE
  10 WILL DRAW A SINGLE LINE FROM 0,0 TO 383,191 AND THEN USE
  A COLOR FIELD TO MAKE THE LINE A GIVEN COLOR
2 ?THE SECOND MODULE (AT LINE 200) IS A DEMONSTRATION OF THE
  WAY LINES CAN BE DRAWN AND MADE TO HAVE A SPECIFIED COLOR
    USING MODE 3. THE ACTUAL SUBROUTINE TO DRAW THE LINE IS
      LOCATED AT LINE 1000
3 ?THE THIRD MODULE IS A DEMONSTRATION OF THE ABILITY TO
  CREATE BLOCKS OF COLORS. IT STARTS AT LINE 300. THE ACTUAL
    ROUTINE TO CREATE BLOCKS IS FOUND AT LINE 1000. NOTE THAT
      THIS THIRD MODULE DOES REQUIRE MODULE 2.
4 'IF ALL  THIS  SEEMS  TERRIBLY  CLUMSY-  IT  IS.  THE  FIRST
RELEASE
  OF LNWBASIC DID NOT HAVE ANY MENTION OF MODE3  LATER
    RELEASES OF LNWBASIC WILL ALLOW THE USER THE ABILITY TO
      DRAW LINES' BOXES' CIRCLES' ETC  IN MODE3
5 ?NOTE THAT THE PROGRAM TO DRAW LINES IS TERRIBLY
  INACCURATE
10 INPUT"COLOR";C
20 INPUT"X";X:INPUT"Y";Y

30 CLS
40 PCLS
50 MODE3
60 LINE 0,0,383,191,SET
70 MODE3
80 FLS(191)
90 POKE (&H3C00+Y*64+X),C*9
100 FOR X=1 TO 64
110 Y=INT(X/4)
120 POKE (6H3C00+Y*64+X),C*9
130 NEXTX
140 GOTO 140
200 'THIS DEMONSTRATES DRAWING A MODE 3 LINE
210 FOR P=1 TO 10
220 GOSUB 510
230 GOSUB 1040
240 NEXTP
250 GOTO 250

300 'THIS DEMONSTRATES DRAWING BLOCKS OF COLORS IN MODE3
```

```
310 FOR P=1 TO 10
320 GOSUB 510
330 GOSUB 2000
340 NEXTP
350 GOT0350
510 Xl=RND(383):X2=RND(383):Yl=RND(191):Y2=RND(191):C=RND(7)
515 RETURN
1000  REM  THE  FOLLOWING  ROUTINE DRAWS A LINE OF A SPECIFIED
COLOR IN MODE3
1010 INPUT"DESIRED COLOR";C
1020 INPUT"Xl,Yl";Xl,Yl
1030 INPUT"X2,Y2";X2,Y2
1040 MODE1
1050 CLS:PCLS:LINE Xl,Yl,X2,Y2,SET
1055 GOSUB 1060
1056 GOTO 1075
1060
Xl=INT(X1/6+.5):X2=INT(X2/6+.5):Yl=INT(Yl/12+.5):Y2=INT(Y2/12
+.5)
1070                                                        IF
Xl>63THENX1=63ELSE:IFX2>63THENX2=63ELSE:IFYl>15THENY1=15ELSE:
IFY2>15THENY2=15
1072 RETURN
1075  IF100*Xl+Yl>100*X2+Y2  THEN  T=Xl:Xl=X2:X2=T:T=Yl:Yl=Y2:
Y2=T
1080 IF Xl=X2THENGOT01090ELSEGOT01100
1090 MODE3:FORY=YlTO Y2:POKESH3C00+Y"64+Xl,C*9:NEXTY:GOT01210
1100 M=(Y2-Yl)/(X2-Xl)
1110 B=Yl-M*Xl
1120 MODE3
1125 IFM>0
          THENIFM<=1THEN1130ELSE1300
          ELSEIFM>=-1THEN1130ELSE1350
1130 FORX=X1TOX2-1


1140 Y=INT((M*X+B)+.5)
1145 GOSUB1150
1146 NEXTX:RETURN
1150 Z=&H3C00+Y*64+X:IFZ<&H3C00ORZ>6tH3FFFTHENGOT01210
1160 POKE Z,C*9
1165 IF(X-2)>=0THENPOKE(&H3C00+Y*64+X-l),C*9 ELSEGOT01170
1170 IF(X-l)>0THEN POKE(&H3C00+Y*64+X-1),C*9 ELSEGOT01180
1180 IF(X+1)<65THENPOKE(&H3C00+Y*64+X+l),C*9 ELSEGOT01190
1190 IF(X+2)<64THENPOKE(&H3C00+Y*64+X+2),C*9 ELSE GOT01200
1200 RETURN
1210 RETURN
1220 Xl=0:Y1=0:X2=63:Y2=15
1230 MODE1
1240 LINE 0,0,377,179,SET
1250 MODE3
1260 GOTO 1100
1300 FORY=Y1TOY2'SLOPE BETWEEN -1 AND 1
1310 X=INT((Y-B)/M+.5)
1320 GOSUB 1150
1330 NEXTY
1340 RETURN
1350 T=Y1:Yl=Y2:Y2=T? SLOPE BETWEEN -1 AND -INFINITY
1360 GOT01300
2000 IFXl=X2THEN1050ELSEIFYl=Y2THENGOT01050
2010 LINE Xl,Y1,X2,Y2,SET,B
2020 M0DE3
2030 GOSUB 1060
2040 IFY1<Y2THEN2060
2050 T=Y1:Yl=Y2:Y2=T
2060 IFXl<X2THEN2080
2070 T=X2:X2=X1:X1=T
```

```
2080 IFY1=0THENY1=1ELSE:IFX1=0THENX1=1
2090
FORY=Y1-1T0Y2:FORX=X1-1TOX2:POKE&H3C00+Y*64+X,C*9:NEXTX:NEXTY
2100 RETURN
```

High Resolution Graphics for Non-Disk Owners

The program listed below sets up tables in memory which hold information on the coordinates of points to be SET, RESET or POINTed. (The machine-language program encoded in the DATA statements is listed at the end of this section).

```
0 REM  This program POKES 2 tables into memory. The first one
1 REM  generates 2 bytes for each horizontal coordinate (X).
2 REM  This two byte pair consists of (a) the character
3 REM  position (0-79) and (b) the one of six pattern
4 REM  selecting the pixel within the character position.
5 REM  The second table gives the vertical coordinate. It
6 REM  consists of 192 locations each of which holds the
7 REM  row (D4-7) and the line (D0-3).The tables start at
8 REM  30000.
10 X=30000


20 FOR Y=0 TO 79
30  GOSUB 100
40 NEXT Y
50 X=31024
55 FOR L=0 TO 15
60  FOR R=0 TO 11
65   N=(16*R)+L
70   POKE X,N
75   X=X+1
80  NEXT R
85 NEXT L
90 GOTO 171
100 N=l
101 FOR Z=0 TO 5
120  POKE X,Y
130  X=X+1
140  POKE X,N
150  X=X+1
155  N=N*2
160 NEXT Z
165 RETURN
166 REM  This routine POKES the machine-language USR program
168 REM  (encoded in the DATA statements) into RAM from
167 REM  location 79F0H (31216) to 7A90H (31376)
169 REM  (31376).
171 FOR X=31216 TO 31376
172  READ Y
173  POKE K,Y
174 NEXT X
175 REM The POKE command at line 200 gives the entry point of
177 REM the one USR call. The low order byte must be changed
179 REM to point to one of the other routines if desired:
185 REM To select SET,RESET,POINT use the following values:
187 REM    SET  - POKE 16526,240:POKE 16527,121
189 REM    RESET - POKE 16526,243:POKE 16527,121
191 REM    POINT - POKE 16526,246:POKE 16527,I21
182 REM  Remember that these address locations are decimal.
193 REM  Once you have POKEd these values out, you need only
195 REM  POKE the LOW ORDER BYTE to change to a different
197 REM  routine (e.g. POKE 16526,246 gives POINT).
199 REM
200 POKE 16526,240:POKE 16527,121   ' SET Routine
210 CLS             ?Clears LORES screen
```

```
220 OUT 254,2       'Turns HIRES (Mode 1) on
230 FOR X=0 TO 479  'Bumps through all X
240  FOR Y=0 TO 191 'Bumps through all Y
250   POKE 31257,Y  ?POKES Y value to 31257 (in USR)
260   A=USR(X)      'X is passed to USR routine
270  NEXT Y
280 NEXT X
290 END
300 DATA 195,67,122,195,88,122,195,113,122,205,127,10
310 DATA 1,48,117,4lg9,126,254,64,242,35,122,205,19,122
320 DATA 203,60,203,29,203,60,203,29,201,35,70,33,48,121
330 DATA 17,0,0,25,102,111,203,37,203,37,201,205,19,122


340 DATA 203,37,203,37,203,4,203,4,203,60,203,29,203,60
350 DATA 203,29,203,60,203,29,203,60,203,29,124,198,48
360 DATA 103,20l,205,249,121,219,254,246,8,211,254,126
370 DATA l76,ll9,219,254,230,247,211,254,195,154,10,205
380 DATA 249,121,219,254,246,8,211,254,120,238,255,71
390 DATA 126,160,119,219,254,230,247,211,254,195,154,10
400 DATA 205,249,121,219,254,246,8,211,254,126,160,194,133
410 DATA 122,33,0,0,195,l36,l22,33,1,0,219,254,230,247
420 DATA 211,254,195,154,10
```

Color Graphics for Non-Disk Owners

The following listing demonstrates how to generate colors on the LNW80 without using LNWBASIC.

```
10 REM         COLOR BAR TEST PROGRAM
20 REM         CASSETTE (16K) VERSION
30 REM This test should generate the following colors:
35 REM White Green Yellow Red Magenta Blue Blue-Green Black

36 CLS:PRINTCHR$(23)
40 PRINT "LNW RESEARCH COLOR BAR TEST"
45 REM Delay before starting test
50 FOR Z=0 TO 1000
60 NEXT Z
70 OUT 254,4
72 FOR X=15360 TO 16383
74 POKE X,255
76 NEXT X
80 FOR X=32512 TO 32533
90 READ D
100 POKE X,D
110 NEXT X
120 POKE 16526,0:POKE 16527,127
125 FOR X=0 TO 12288
130 FOR Y=0 TO 7
135 FOR Z=0 TO 7
150 POKE 32522,Y*9
180 A=USR(X)
190 LET X=X+1
200 NEXT Z
210 NEXT Y
220 LET X=X-1
230 NEXT X
240 END
270 DATA 205,127,l0,219,254,246,8,211,254,54,0,0,110,38,0
280 DATA 230,247,211,254,195,154,10
```

GRAPHICS FOR MACHINE-LANGUAGE PROGRAMMERS

Machine-Language Overview

The four different graphics modes are selected by I/0 port 254 (FE Hex). The definition of port 254 is shown schematically in Figure 7.4.

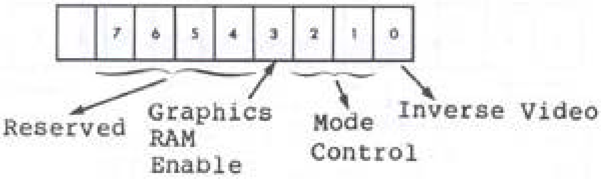


Figure 7.4 - 8 bit address of port 254 showing bit definition.

Data bit 0 controls inverse video operation in modes 0 and 1 only. Data bits 1 and 2 together give mode control, as can be seen from Table 7.1.

Table 7.1 - Mode Control Using Port 254

D2	D1	Mode
0	0	0
0	1	1
1	0	2
1	1	3

Data bit 3 controls graphics RAM enable. Data bits 4 to 7 are reserved and should not be used.

When modifying port 254, first read the port and then change only the bits that you want to change. As an example, consider the following LNWBASIC program (any level of BASIC will do) which sets data bit 0 of port 254, thus changing over to inverse video.

```
 1 ?PROGRAM TO SET DATA BIT 0 OF PORT 254
10 A=IMP(254)
20 A=1 OR A
30 OUT 254,A
```

To return to normal white on black, substitute 0 for 1 in line 20.

Mode 0 Adressing

Video display memory for this mode runs from 15360 (3C00 Hex) to 16383 (3FFF HEX) . A two-byte address is used to point to a location in video RAM. The relationship between the memory location and the visibly displayed character is defined by the following address chart:

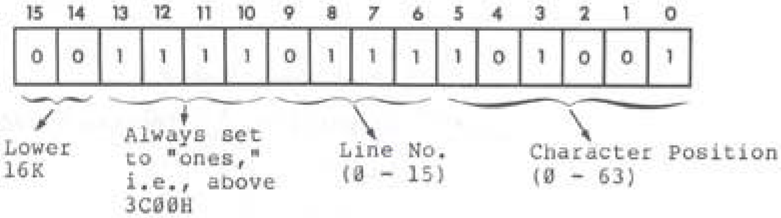

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
0
1
1
1
1
0
1
1
1
1
0
1
0
0
1
Lower 16K
Always set to "ones," i.e., above 3CØØH
Line No. (Ø - 15)
Character Position (Ø - 63)

Figure 7.5 - Mode 0 addressing as in p. 64 of original LNW manual.

The least significant (rightmost) 6 bits, bits 0 to 5, of the address specify the character position. With all 6 bits on for example, character position 63 would be specified. Bits 6 to 9 inclusive store the binary code for the line (0 - 15) on which the character posit.3.on is found.

Take, for example, address 3C97. Filling the address chart we get:

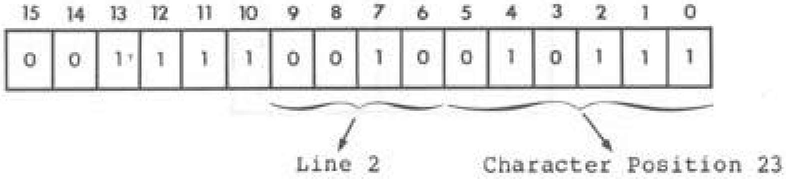


Figure 7.6 - Mode 0 address chart with 3C97 displayed.

This translates to line 2, character position 23, as shown in Figure 7.7.

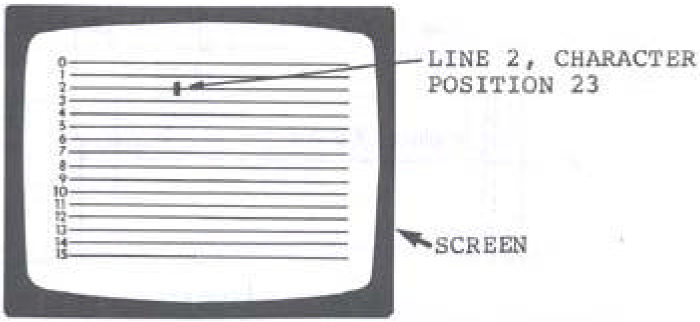


Figure 7.7 - Screen with character 23, line 3 highlighted.

We have seen how screen positions are addressed and how both graphics characters and text characters are constituted. But how does the computer know whether a graphics character or a text character is to be displayed? The answer is encoded in the data byte to be displayed. When data bit 7 of the data byte is on, bits 0 to 5 select all possible combinations of graphics characters. With data bit 7 off, bits 0 to 5 are together interpreted as an ASCII text code. See figure 7.8.

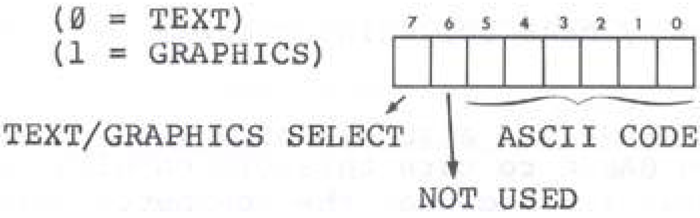


Figure 7.8 - Data byte, 8 bits, bit 7 on/off - graphics/text respectfully. Bit 6 not used, bits 0 to 5 store code.

Note that graphics RAM is not used in this mode.

Accessing Graphics RAM

Graphics modes I, 2 and 3 make use of graphics RAM. The graphics RAM, running from address 0 to 3FFF (hex), is located in the lower 16K of LNW80 address space. This is also where the the Level II ROMs, keyboard, mode 0 video RAM, and miscellaneous I/0 is mapped.

I/0 port 254, data bit 3 (D3), selects which block of memory is enabled in the lower 16K. With D3 on (1), the graphics memory is enabled. With D3 off (0), the keyboard, video RAM, 12K ROM and anything else which might be mapped in the lower 16K of address space are enabled. Figure 7.9 illustrates this bank switching operation.

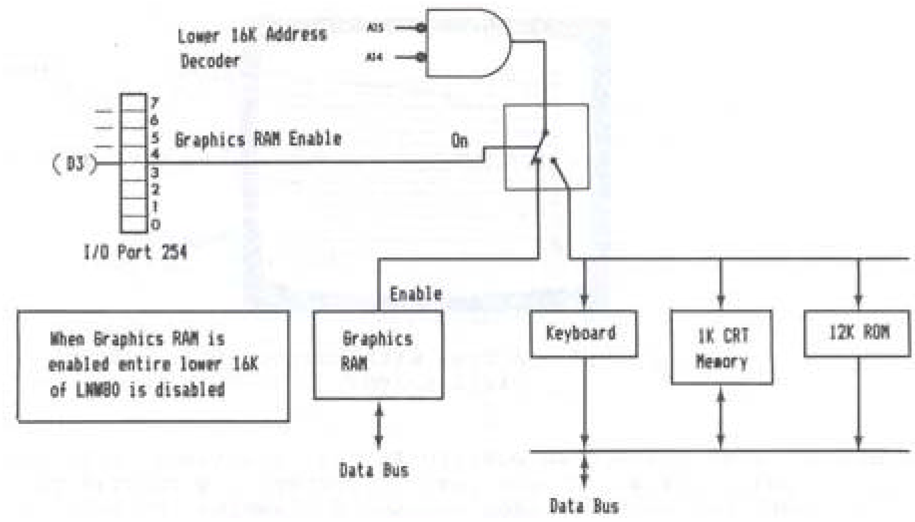


Figure 7.9 - Memory bank switching diagram

Since the Level II ROMs are also disabled when D3 is on, using the out command in BASIC to turn this bit on will cause a system "crash." This is because the computer will be operating out of graphics RAM instead of ROM. The implication of this is that D3 can only be accessed by a machine-language program (or USR call from BASIC). Note that while the graphics RAM is enabled, the lower 16K is inaccessible.

Mode 1 Addressing

The high resolution graphics RAM is located between 0 and 3FFF (hex). The 16K x 6 bits of graphics memory allows individual control of 480 x 192 dots. The addressing is not simple X,Y addressing, but is optimized for rapid character generation, In this scheme of things, the video memory map is broken into two fegiona: an inner region comprised of 384 x 192 dots, and an extension region comprised of 96 x 192 dots. Figure 7.10 shows this screen breakdown.

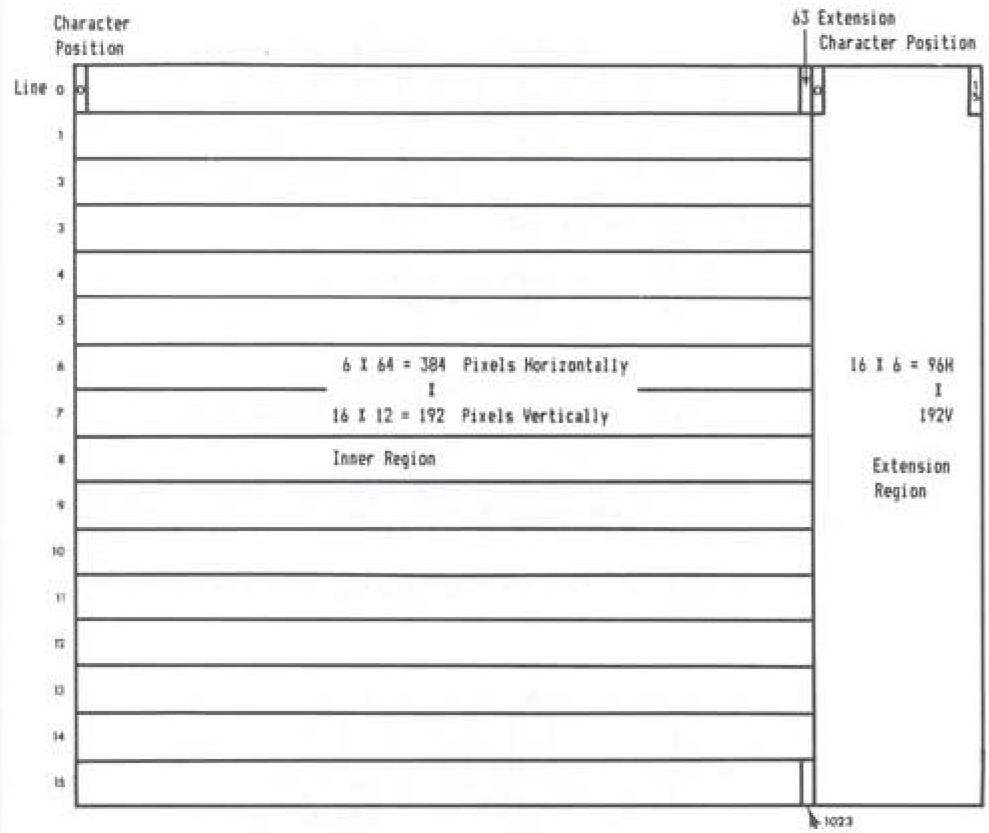


Figure 7.10 - Screen inner and extension regions.

The 384 x 192 inner region runs from address 0 to 2FFF (hex). The address chart for the inner region is as follows:

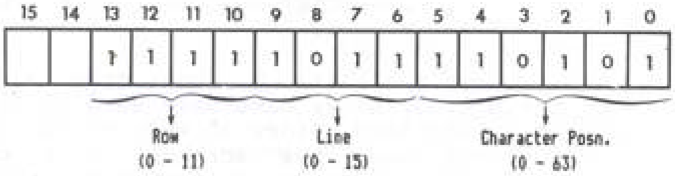


Figure 7.11 - Inner region address chart.

Figure 7.11 - Inner region address chart.

The 96 x 192 extension region is addressed from 3000 to 3FFF (hex). The address chart for the inner region is given below. In this case, the row field has been divided in two: bits 10 and 11 holding the two least significant bits (LSB), and bits 4 and 5 holding the two most significant bits (MSB). This was done for hardware implementation reasons only.

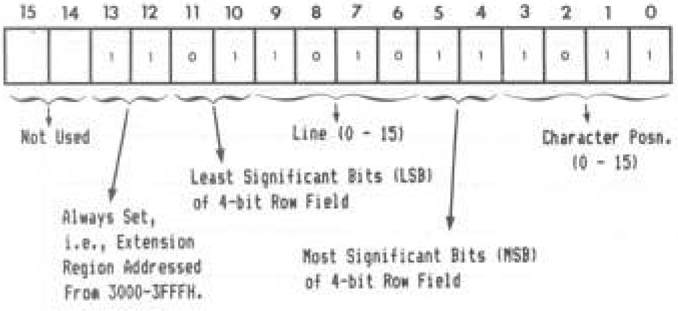

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
1 1 0 1 1 0 1 0 1 1 1 0 1 1
Not Used
Always Set, i.e., Extension Region Addressed From 3000-3FFFH.
Least Significant Bits (LSB) of 4-bit Row Field
Line (0 - 15)
Most Significant Bits (MSB) of 4-bit Row Field
Character Posn. (0 - 15)

Figure 7.12 - Extension region addressing.

We said that the addressing was not simple X,Y addressing. So what does that mean? An example will help to illustrate the situation.

Take address 2000H. Going to the address chart and filling in 2000H, we get:

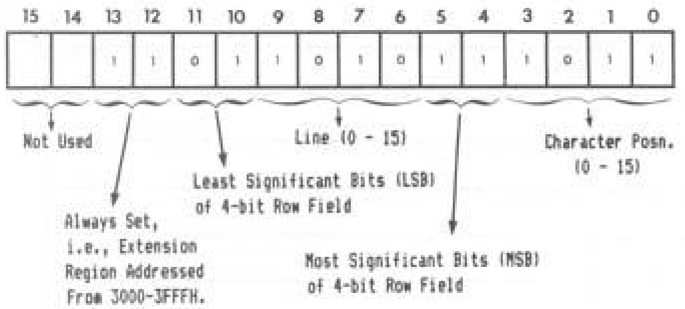


Figure 7.13 - Address chart with 2000H, and character position, line & row, marked.

This takes us to row 8 of line 0, character position 0. This is a bit unexpected, as we have been used to the idea of starting at the top left hand corner of the screen and then addressing all points down the screen, in a contiguous fashion. If we start with address 0 and sequentially move through to address 2FFF, examining the positions pointed to on the screen by each address, we will see that row 0 of all character positions is addressed first, then row 1 of all character positions, then row 2... and so on. The same holds for the extension region. (Try a few examples).

The information telling us which pixels are on in a particular row, comes from the 6 bit-datum byte located in graphics RAM:

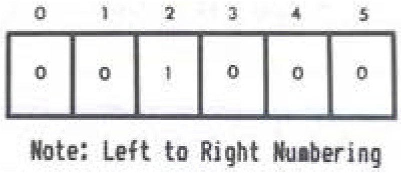


Figure 7.14 - Graphics Data Byte in LSB (0-2) and MSB (3-5) Format

Each bit in the byte corresponds to one of the pixels in the row, pointed to by the address we just deciphered.

Mode 2 Addressing

The mode 2 pixel differs from the mode l pixel in that it is 3 times larger, being composed of 3 horizontal dots, The loss of resolution is compensated for by way of color information for each pixel. Mode 2 addressing is similar to mode 1 inner region addressing (see Fig. 7.15). In this case however, the data byte holds information for two adjacent color pixels, each half of the byte containing three bits specifying one of 8 colors.

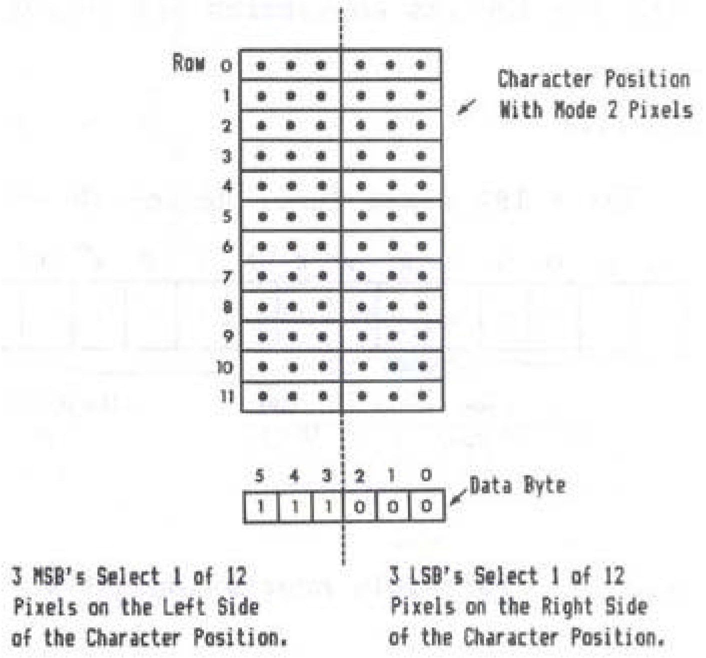

Row
0
1
2
3
4
5
6
7
8
9
10
11
Character Position With Mode 2 Pixels
5 4 3 2 1 0
1 1 1 0 0 0
Data Byte
3 MSB's Select 1 of 12 Pixels on the Left Side of the Character Position.
3 LSB's Select 1 of 12 Pixels on the Right Side of the Character Position.

Figure 7.15- Mode 0 character position w/mode 2 pixel outlined, and data byte underneath.

Bits 3, 4 and 5 contain color information for the pixels on the left hand aide of the character position. Bits 0, 1 and 2 contain color information for the right-hand side of the character position. The codes for the 8 colors available are as follows:

Table 7.2 - Color coding for mode 2 pixels.

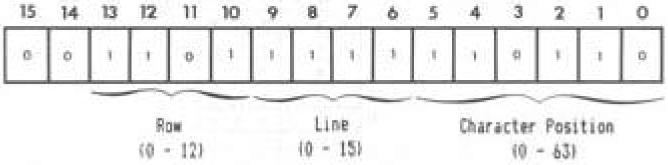
Data	Color
000	White
001	Green
010	Yellow
011	Red
100	Magenta
101	Blue
110	Blue/Green
111	Black

Mode 3 Addressing

A simple relationship exists between the high resolution video and the mode 3 color fields. This relationship is due to the fact that the low res text memory and the high res memory share the same addressing in the hardware. The inner region addressing and the low res addressing are compared below:

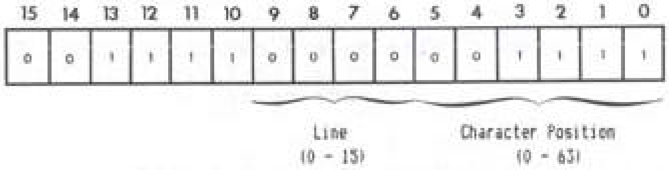
Figure 7.16

384 X 192 Pixel Inner Region (Ø - 3ØØØH)



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	1	1	1	1	1	1	1	0	1	1	0

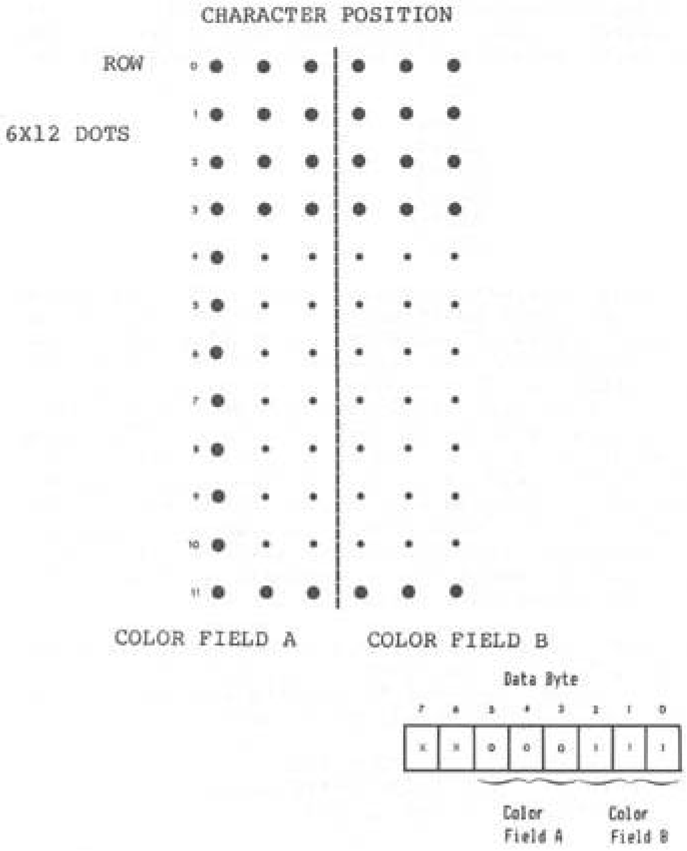
Mode 3 Color Field Addressing (3CØØ - 3FFF)



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1

It should be noted that the character position of the MODE3 color field addressing is divided into two color fields. When a byte is written to 3C00H to 3FFFH, two color fields are set as illustrated below:

Figure 7.17 Mode 3 Character Position With Color Fields



7	6	5	4	3	2	1	0
x	x	0	0	0	1	1	1

WITH COLORS DEFINED AS:

5 4 3	or	
2 1 0		
0 0 0	0	white
0 0 1	1	green
0 1 0	2	yellow
0 1 1	3	red
1 0 0	4	magenta
1 0 1	5	blue
1 1 0	6	blue-green
1 1 1	7	black

The second LNWBASIC program in this section illustrates how MODE 3 graphics is done from BASIC. Once this is clearly understood, machine-language use should be simple. When using MODE 3 to draw lines, circles, etc., setting the correct color field can be easily done at the same time that the machine-language routine is outputting to the high res screen. If the high res address has been computed or looked-up via some form of address computation table, this address needs only to have the most significant 6 bits masked and set as follows:

A15=0
A14=0
A13=1
A12=1
All=1
A10=1

The only additional consideration is which color field is to be written at that character position? Is it color field A or B? The software that writes the high res information must have some method of knowing which high res data bit was the one that was being written to. If the data bit(s) of the high res memory was 0, 1 or 2 (the leftmost 3 dots on the screen) then the color field to be written to is color field A. If the data bit(s) of high res are 3, 4 or 5 (the right three bits) then the appropriate color field is B. In order to write only the desired color field, the program must first read the entire byte (both color fields) with masking and ORing to put the 3-bit color information in the right place without disturbing the other color field. Refer to the LNWBASIC program in the above section for the conceptual details.

Remember that when the high res video memory is enabled via port 254 data bit 3, the low res video memory 3C00 to 3FFFH is not accessible. This means that before writing the color field you must turn off the graphics enable as follows:

```
        IN        A,(0FEH) ; INPUT FROM 254
        AND       0F7H     ; TURN OFF GRAPHICS RAM
        OUT       (0FEH),A ; OUTPUT TO 254
```

Then the graphics mode must again be turned on before writing more graphics.

Machine-language Routine to SET, RESET, POINT

The following is the machine-language listing to SET, RESET or POINT a video RAM location. This is the listing for the machine-language that was encoded in the DATA statements in the program listed under the subsection entitled "Graphics for Non-Disk Owners."

```
79F0           00100           ORG   79F0H
79F0 C3437A    00101 SET    JP    SETR     ;SET ROUTINE ENTRY
79F3 C3587A    00102 RESET  JP    RESR     ;RESET  ENTRY
79F6 C3717A    00103 POINT  JP    POIR     ;POINT ROUTINE
79F9 CD7F0A    00110 ADCAL  CALL  INPX      GET X POSITION IN
                                            HL PAIR
79FC  013075      00120               LD   BC,7530H  ;START OF
HORIZONTAL
                                            TBL
79FF 29        00125        ADD  HL,HL     ;DOUBLE HL IN TABLE
7A00 09        00130       ADD     HL,BC   ;POINT TO
                                            CHARACTER POS. IN TBL
7A01 7E        00140          LD      A,(HL)  ;INPUT CHARACTER
                                            POSITION
7A02 FE40      00150          CP      64      ;IS > THAN CHAR 64
                                            (IN EXTENSION)
7A04 F2237A    00160          JP   P,EXTEND   ;YES USE
                                            EXT. ALGORlTHM
7A07 CD137A    00170       CALL    VERT    ;GET
                                            ROW.LINE,CHARACTER
                                            ADJUSTED
7A0A CB3C      00180         SRL     H           ;SHIFT  LSB  OF  H
INTO
                                           CARRY
7A0C CB1D      00190         RR      L     ;GET LSB OF H INTO
                                           MSB OF L REG
7A0E CB3C      00200         SRL     H     ;SHFT LSB OF H INTO
                                           MSB OF L
7A10 CB1D      00210         RR      L     ;ONCE AGAIN
7A12 C9        00220         RET               ;NOW HL HAS ADDRESS
                                           OF GRAPHICS
7A13 23        00240 VERT    INC     HL    ;ThlS PUTS ROW.LINE
                                           INTO H AND
               00245                          ;PUTS CHARACTER
                                           POSITION SHIFTED
               00247                          ;LEFT TWO BITS INTO
                                           L WITH THE
               00249                          ;TWO LSB SET TO
                                           ZERO
7A14 46        00250         LD    B,(HL)  ;NOW B REG HAS ONE
                                           OF SIX PATERN
7A15 213079    00260         LD  HL,7930H  ;START OF VERTICAL
                                           LOOKUP TABLE
7A18 110000    00265            LD    DE,0H   ;POKE DATA HERE
7A1B 19        00270            ADD   HL,DE   ;POINT TO VALUE IN
                                           TABLE
7A1C 66        00280         LD    H,(HL)  ;PUT ROW.LINE INTO
                                           H
7AlD 6F        00290         LD    L,A     ;COPY CHARACTER
                                           POSITION TO L
7A1E CB25      00300         SLA     L     ;SHIFT LEFT ONE
                                           PLACE


7A20 CB25      00310            SLA     L     ;NOW L HAS LEFT
                                           JUSTIFIED CHAR
7A22 C9        00320         RET
7A23 CD137A    00330 EXTEND  CALL    VERT  ;GET VERT IN H,CHAR
                                           IN L,DAT IN B
7A26 CB25      00340         SLA     L      ;ROTATE  2  MSB  OF
ROW
                                           AND
7A28 CB25      00350            SLA     L     ;PUT THEM IN THE 2
                                           LSB OF H
7A2A CB04      00360         RLC     H
7A2C CB04      00370            RLC H
7A2E CB3C      00375            SBL     H     ;NOW SHIFT HL RIGHT
```

```
                                          4 PLACES
7A30 CB1D     00380            RR      L
7A32 CB3C     00398         SRL     H
7A34 CB1D     00400         RR      L
7A36 CB3C     00410         SRL     H
7A38 CB1D     00420            RR      L
7A3A CB3C     00430         SRL     H
7A3C CB10     00440         RR      L           ;HL OK NOW
7A3R 7C       00445         LD      A,H
7A3F C630     00447         ADD     A,30H  ;MAKE ADDRESS
                                           ABOVE ROW 11
7A41 67        00449         LD      H,A
7A42 C9       00460         RET
7A43 CDF979   00478 SETR    CALL    ADCAL
7A46 DBFE     00480         IN      A,(0FEH) ;INPUT FROM 254
7A48 F688     08498            OR      8        ;TURN ON
GRAPHICS
                                             RAM ENABLE BIT
7A4A D3PE     00500         OUT     (0FEH),A ;OUTPUT TO 254
7A4C  7E      00510            LD      A,(HL)   OLD DATA IN A
REG
7A4D BS       80520         OR      B             ;SET BIT
7A4E 77       00530         LD      (HL),A   ;WRITE DATA BACK
                                             OUT
7A4F DBFE     00540         IN      A,(0FEH) ;INPU AGAIN
7A51  E6F7          00550            AND     0F7H    ;TURN OF
GRAPHICS
                                              RAM
7A53 D3FE     00560         OUT     (0FEH),A ;OUTPUT PORT 254
7A55 C39A0A   00570         JP      RETURN
7A58 CDF979   00580 RKSR    CALL    ADCAL
7A58 DBFE     00590         IN      A,(0FEH) ;INPUT PORT 254
7A5D F608     00600         OR      8           ;SET  GRAPHICS
RAM
                                               ENABLE BIT
7A5F  D3FE      00610         OUT     (0FEH),A ;OUTPUT TO PORT
254
7A61 78       00620         LD      A,B
7A62 EEFF     00630         XOR     0FFH    ;COMPLEMENT A
7A64 47       00640            LD      B,A
7A65 7E       00650            LD      A,(HL)
7A66 A0       00660         AND     B


7A67 77       00670            LD      (HL),A   ;WRITE DATA  BACK
OUT
7A68 DBFZ     00688         IN      A,(0FEH) ;INPUT AGAIN
7A6A EGF7     00690            AND     0F7H     ;TURN OFF
                                              GRAPHICS RAM
7A6C D3FE     00700            OUT     (0FEH) ,A
7A6E C39A0A   00710         JP      RETURN
7A71 CDF979   00720 POIR    CALL    ADCAL
7A74 DBPR     00730         IN      A,(0FEH)
7A76 F608     08748         OR      8
7A78 D3FE     00750         OUT     (0FEH),A
7A7A 7E       00760         LD      A,(HL)   ;GET SIX BITS OF
                                              DATA
7A7B A0        00770         AND     8        ;MASK ALL BUT
SELECTED BIT
7A7C C2857A   00780         JP      NZ,SETHL ;MAKE L=l IF NOT
ZERO
7A7F 210000   00790         LD      HL,0H    ;MAKE BL PAIR 0
7A82 C3887A   00800         JP      QUIT     ;EXIT
7A85 210100   00810 SETHL   LD      HL,1H    ;SET HL=00018
7A88 DBFE     00812 QUIT    IN      A,(0FEH) ;INPUT PORT
7A8A E6F7     00814         AND     0F7H     ;TURN OFF
GRAPHICS     RAM
```

```
BIT
7A8C D3FE     00816         OUT     (0FEH),A ;0UTPUT  TO  PORT
254
7A8E C39A0A   00820         JP      RETURN
0A9A           00838 RETURN  EQU     0A9AH
0A7P           00840 INPX    EQU     0A7FH    ;THIS PUTS
                                              VARIABLE    INTO
HL
0000    00850         END
00000 TOTAL ERRORS
```

Next page | TOC

SECTION 8: LINE PRINTER INTERFACE

Line Printers

There are two types of line printer:

1. Serial line printer
2. Parallel line printer

You can connect either type to the LNW80 Computer. The physical connections for each differ from one another, as they carry data differently.

A serial line printer handles a byte of information by receiving the basic elements of information (the bits) in serial fashion, i.e., one after another, or bit-by-bit, like eight cars following any behind the other on a single-lane road. On reception of eight bits the printer reconstructs the appropriate character.

Parallel printers, on the other hand, receive information byte-by-byte. At any one time, at least 8 bits are travelling parallel to one another along the ribbon cable, much like 8 cars abreast on an 8-lane freeway.

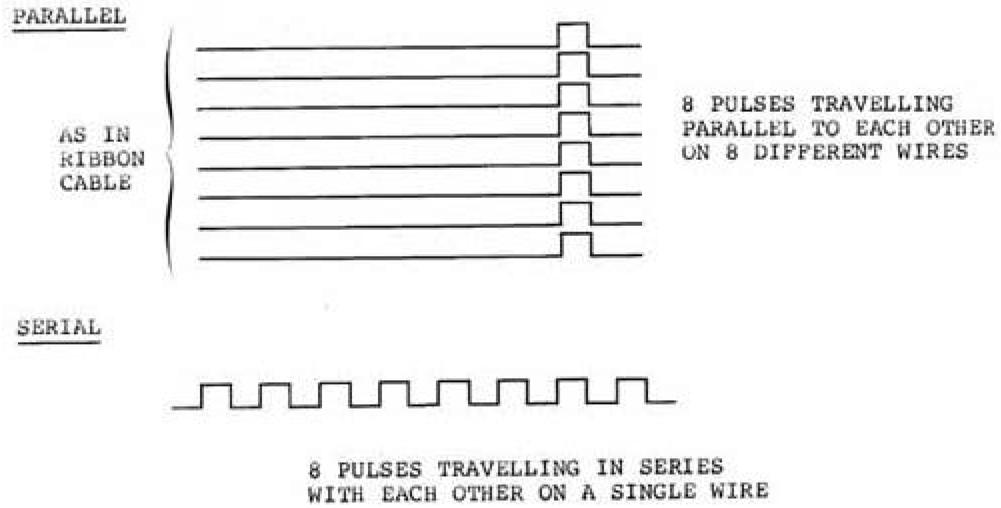

PARALLEL
AS IN RIBBON CABLE
8 PULSES TRAVELLING PARALLEL TO EACH OTHER ON 8 DIFFERENT WIRES
SERIAL
8 PULSES TRAVELLING IN SERIES WITH EACH OTHER ON A SINGLE WIRE

Figure 8.0 - Parallel and Serial Data Flow

Serial Line Printer

Serial line printers must be connected to the RS-232 serial communications interface. A DB25 socket is required to make this connection. The transmitting rate must be set on the TX switch to the right of the interface. You will also, in all probability, have to modify the the printer line so that it can interface with the RS-232 interface. Because connection of a serial printer requires some knowledge of RS-232 operation, details on tne "how tos" of serial printer connection are found in Section 9.

If you are currently on the hunt for a printer, do yourself a favor and make it a parallel one.

Note: In order that the LPRINT and LLIST commands of BASIC work properly, a special program must be used. This program is resident in DOSPLUS 3.4 as part of the forms command. For serial printers which require handshaking, this can be configured the RS232 command in DOSPLUS 3.4. LNWBASIC allows a serial printer (no handshaking) with the RSOUT command. For cassette based systems or other DOSes, a serial printer driver program is supplied at the end of Section 9.

Parallel Line Printer

The LNW80 8-bit parallel printer interface is CENTRONICS compatible. Parallel line printers are hooked up to the line printer interface via a card edge connector and a ribbon cable.

Outputting to the Printer using BASIC

There are two BASIC commands which output material to the printer:

```
                LLIST                   LPRINT
```

These correspond to the commands:

```
                LIST                    PRINT
```

which display material on the video display. The PRINT @ command does not have a line printer equivalent. Also, not all line printers are able to display the ASCII coded graphics characters 128 through 151. Some line printers may have their own graphics characters.

Page Length

The page length may be controlled from the keyboard. Memory location 16424 stores the number of lines per page plus one.

The value stored at this location can be examined by using:

```
                     PRINT PEEK (16424)
```

The reply is:

```
                            67
```

The page length being ll inches and the printing rate being set at 66 lines per inch for most printers, the number of lines per page is 66. Some line printers, however, require that this value be adjusted (see adjusting printer controls) .

Line Count

The line count plus 1 is stored at the adjacent memory location, address 16425. This value can be retrieved as before by using:

```
                     PRINT PEEK (16425)
```

the reply at boot up being 0. This value should be initialized to 1 or more.

Printer Availability

The next location we PEEK at is memory address 14312. This contains a code depicting printer status.

Table 8.0 - Line Printer Status

CODE	EXPLANATION
16	Cable connection upside down
48	Hooked up and on-line
128	Hooked up, not on-line
192	Printer out of paper
240	Printer not available

The 4 most significant bits (MSB) at byte 14312 are used to code printer status. Each of these bits represents a particular aspect of printer status. For example, when bit 6 is on (set) it means the printer is out of paper. When it's off, it means the printer has paper. The 4 least significant bits (LSB), which are not used, are always set. The codes above are a result of a combination of the various conditions. (For a detailed account of printer status coding and Microsoft BASIC coding in general, see "Microsoft BASIC Decoded" by James Farvour, available through your IJG dealer).

Adjusting Printer Controls

The value at any RAM address in the computer can be changed using the POKE verb in BASIC. A good idea is to initialize the line count and page length at the beginning of every program in which there is line printer output. At this point, printer status can also be ascertained.

```
     l0 REM Program code to alter page-length and
     20 REM line-count and to check line printer status.
     30 POKE 16424,nnn       ' Number of lines per page.
     40 POKE 16425,nnn       ' Line-count
     50 A = PEEK(143l2)
     55 B = A AND 240
     60 IF B <> 48 THEN PRINT " PRINTER NOT READY"
```

SECTION 9: RS232C INTERFACING

This section is a bit long, so you might want to grab a cup of tea, coffee or whatever before launching into it.

The RS-232-C interface was mentioned fleetingly in Section 3 in connection with serial printers. How come we had all of this to-do about an RS-232-C when all we wanted was to hook-up a serial printer? Parallel printers, being good little printers, provided no problem at all!

Serial devices handle digital data in serial form; whereas, the computer handles data in parallel form. The circuitry associated with the RS-232-C asynchronous serial communications interface, to give it its full name, performs the change over from parallel form to serial form and vice-versa.

Note: A program is required that supports the RS-232-C. See page 85.

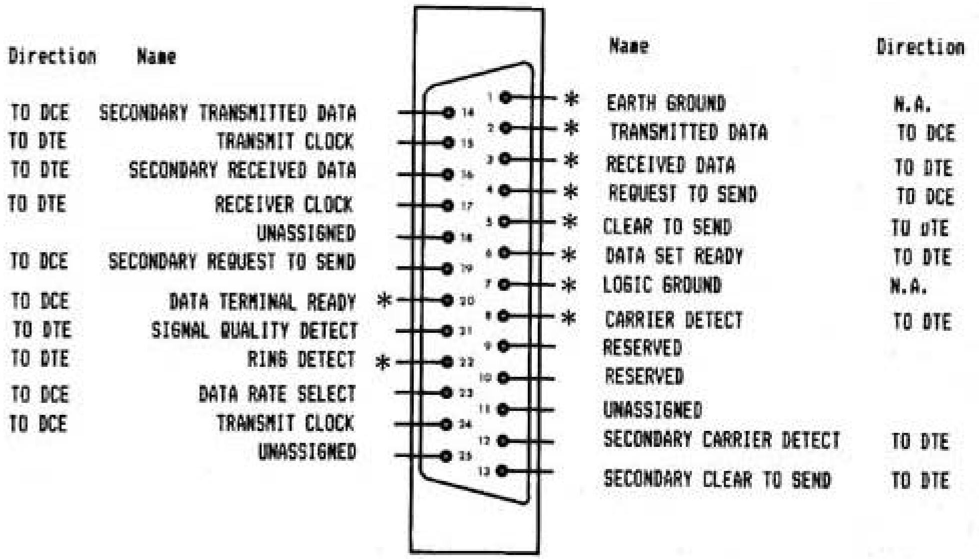
History of Serial Data Communication

Not long after Babbage introduced his "Analytical Machine" in 1822, Andre Ampere toyed with various concepts for communicating information over electrical wires. In the 1830's, Samuel Morse took Ampere's idea and went on to develop the telegraph using a code he developed, - Morse Code. This was the first step in communication over wires, using electrical signals to encode human symbols.

From that time to the development of computers, coding information over single wires in serial fashion, gave rise to various standards. As a result, when it came to interfacing computers with the serial communications network, which is now the phone system, computer manufacturers had to develop their own standard: the RS-232.

RS-232-C Standard

The "C" in RS-232-C refers to the particular version of the standard. The LNW80'S RS-232-C interface conforms to the Electronic Industries Association (EIA) standard RS-232-C. However, different computers employing the RS-232-C standard often interpret it differently. As a result, various makes of computer claiming RS-232-C compatibility will not necessarily communicate or "talk" with each other without some adjustment. Figure 9.0 shows the pin specifications on the 25-pin connector, as defined by the RS-232-C standard.


Direction
Name
TO DCE SECONDARY TRANSMITTED DATA 14
TO DTE TRANSMIT CLOCK 15
TO DTE SECONDARY RECEIVED DATA 16
TO DTE RECEIVER CLOCK 17
UNASSIGNED 18
TO DCE SECONDARY REQUEST TO SEND 19
TO DCE DATA TERMINAL READY * 20
TO DTE SIGNAL QUALITY DETECT 21
TO DTE RING DETECT * 22
TO DCE DATA RATE SELECT 23
TO DCE TRANSMIT CLOCK 24
UNASSIGNED 25
Name
Direction
1 * EARTH GROUND N.A.
2 * TRANSMITTED DATA TO DCE
3 * RECEIVED DATA TO DTE
4 * REQUEST TO SEND TO DCE
5 * CLEAR TO SEND TO DTE
6 * DATA SET READY TO DTE
7 * LOGIC GROUND N.A.
8 * CARRIER DETECT TO DTE
9 RESERVED
10 RESERVED
11 UNASSIGNED
12 SECONDARY CARRIER DETECT TO DTE
13 SECONDARY CLEAR TO SEND TO DTE

Only pins marked with an asterisk are connected in the LNW80.

Figure 9.0 - RS-232-C pin connector as defined by EIA.

Some equipment which is attached to computers only uses pins 2, 3 (data lines) and pin 7 (ground), while other equipment may use the unassigned and reserved pins while still going under the label 'RS-232-C Standard’.

The Baud

The BAUD, like many of the terms in RS232 jargon, has a bit of history behind it. Named after Baudot, a pioneer in telegraphic communications, the baud was the unit of transmision speed for serial data communication. It represented the number of half-dot cycles transmitted continuously in one second (which is in fact the modulation rate). We can think of the modulation rate as being the rate at which a carrier wave is adjusted to accomodate data transmission,

In the present-day scheme of things, when the data signalling rate (measured in bits per second) is equal to the modulation rate (expressed as baud), then the number of bits transmitted per second is equal to the baud rate. (Long sentence, that!). In our situation of asynchronous data transmission, the baud rate is equal to the bit rate when one stop bit is used.

Transmission Techniques

Inter-computer communication over a distance is almost always achieved using serial data transmission, as the communications,network is already there (the phone system).

As we have seen, data in the form of characters is encoded in bits. The character length is optional here and can be either 5, 6, 7 or 8 bits. This is to allow for various word lengths that have arisen as standard over the years.

Each bit is transmitted as an electrical pulse along the transmission line. The pulses are of a definite time duration.

At the other end of the line, the receiver must somehow be in synchronization with the pulses it receives. It must be able to recognize when a bit starts and how long it lasts, and when a character starts and ends. There are two modes of operation to achieve synchronization between receiver and transmitter:

- asynchronous operation
- synchronous operation

The LNW80 uses the asynchronous method, as do most microcomputers.

With asynchronous communication, characters can be dumped on to the transmission line raggle-taggle fashion, i.e., the timing of character placement on the line is not important. In allowing this, however, the receiver demands that each character must be transmitted at a fixed rate and must be framed with a start-bit and stop-bit(s).

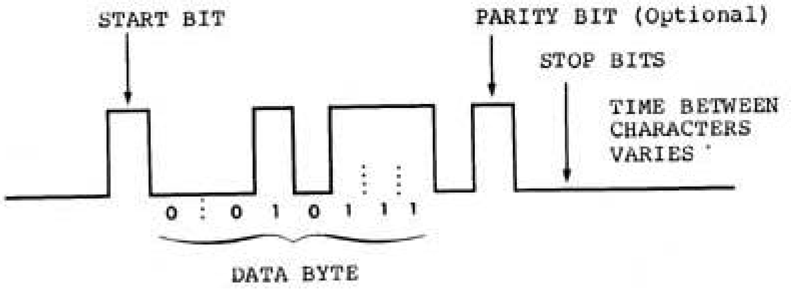


Figure 9.1 - asynchronous transmission showing character with start and stop bits.

Connecting Equipment to the RS-232-C

When connecting equipment to the RS-232-C interface, we must take into account whether it is:

Data Terminal Equipment (DTE), or
Data Communications Equipment (DCE).

DTE includes serial printers, teletypes and Decwriters. DCE refers to modems.

As is, the LNW80’s RS-232-C interface is configured to interact with DCE.

Serial Printer a the RS232

Serial printers and teletypes (DTE) have the same signals on the RS232 cable as the LNW80. This is because Teletypes were designed to interface directly with modems (as is the LNW80) to act as a remote terminals. This means that there will be conflicts on the RS232 lines since the printer's outputs are the same as the computer’s. Fortunately not all of the RS232 signals are required when connecting to a serial printer. Usually only the Transmit Data (TD) for the computer is tied to the Receive Data (RD) of the printer along with the chassis and signal ground (see table 9.0).

Some printers also require the use of handshaking lines. Handshaking is the printers way of telling the computer that it's buffers are full, and to hold off until it has printed their contents. The computer must then wait until the printer is ready to recieve data again. This signal should be received on DSR (pin 6) and may be output by the serial printer on either DTR (pin 20) or a separate RS232 handshaking signal. For handshaking to operate properly, the handshaking signals should be "ON" (+12V) when ready to receive more data, and "OFF" (-12V) when busy. Check with the operations manual of your printer if in doubt.

The following drawing illustates the lines connected. Some serial printers require that CTS (pin 5) or DSR (pin 6) of the printer be tied to either +12V or -12V for proper operation. The operating manual for the printer should provide the details.

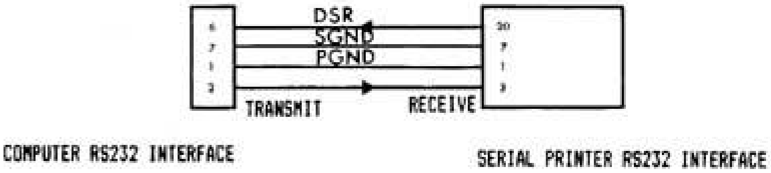


Figure 9.2 - Serial printer interfacing with the computer.

Table 9.0 - Specifications for the LNW80's RS-232-C Interface

Pin Number	Signal
1	PGND (protective ground)
2	TD (transmit data)
3	RD (receive data)
4	RTS (request to send)
5	CTS (clear to send)
6	DSR (data set ready)
7	SGND (signal ground)
8	CD (carrier detect)
20	DTR (data terminal ready)
22	RI (ring indicator)

TD -- Serial data is output to external device.
RD -- Serial data is received from external device.
RTS - Outputs a request to the external device to allow the computer to transmit serial data.

CTS - Inputs a response from an external device to a RTS saying that the external device is ready to receive serial data.
DSR - Input to the computer saying that the receiving device (at the other end of the telephone) is ready to receive from the computer. In the case of a modem, this signal acknowledges that it is not in test, talk or dial mode.
CD -- Input to the computer saying that the modem has sensed a carrier signal over the telephone.
DTR - Output by the computer to tell the external device that the computer is ready to transmit or receive serial data.
RI -- Input to the computer indicating that the modem has received a ringing tone at the other end of the telephone.

Connecting a Modem

This device allows information to be transmitted from one computer to another over the telephone lines. Telephone lines, however, were designed, not for transmitting data, but with the human voice in mind. The result is a system designed to reproduce an analog signal representing the fluctuations of the human voice in the frequency range 300 to 3400 Hertz (cycles per second). Analog signals vary continuously with time, rising and falling between high and low values. Digital signals, on the other hand, have either a constant high value or a constant low value at any one instant, changing from one value to the other over a negligible period of time.

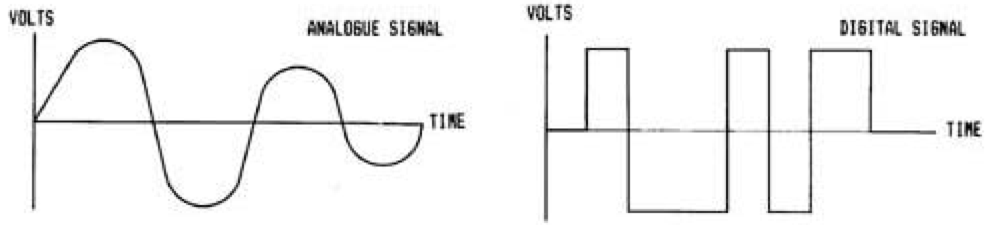


Figure 9.3 - Analogue and Digital Signals

The modem forges the gap between the two worlds. The word modem is an acronym for MOdulator/DEModulator, indicating the two functions a modem performs. When serial digital data from the computer presents itself to the modem for transmission over the telephone lines, it is first coded as an analog signal, and then "applied" to a carrier wave resident in the telephone network. This "applying" is called modulation.

A modulated signal arriving at the computer must be demodulated. That is, the analog information imposed on the carrier wave must be stripped off and converted into serial digital information.

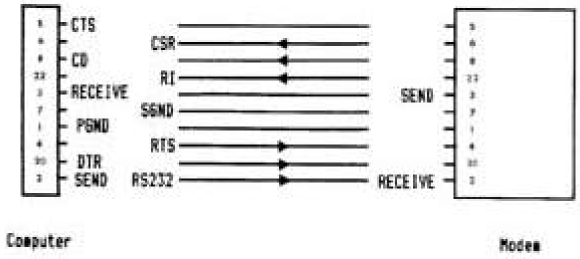


Figure 9.4 - Modem Interfacing With the Computer

Acoustic modems convert transmission data received into audible tones which are fed to the computer via the earpiece of the phone.

When data is going in the other direction, from the computer to the transmission line, the modem converts data into audible tones which are fed to the transmission line via the phone mouthpiece.

A modem is DCE and, as a result, interfaces directly with the RS-232-C serial communications interface. (Pin 2 on the modem receives data, and pin 3 transmits). A cable with a male DB25 plug is required to make this connection.

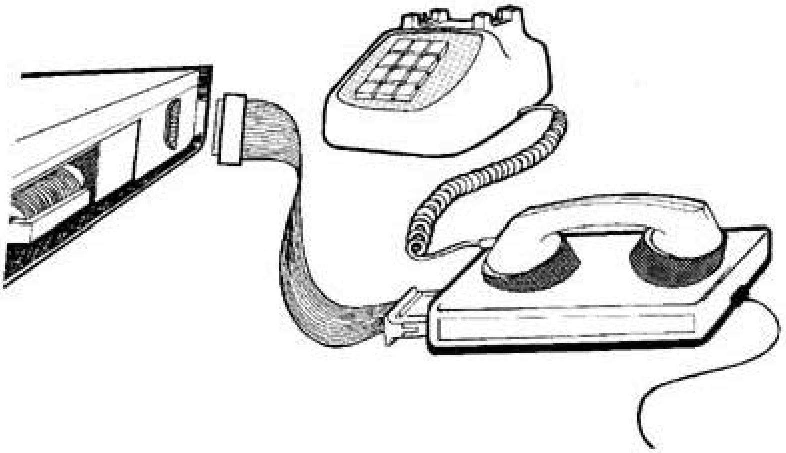


Figure 9.5 - Hooking Up a Modem

Switch Settings on the RS232C Interface

Located on the I/0 panel, next to the RS232 DB25 connector, are 3 sets of small DIP switches, as shown in figure 9.6. These switches are used to set the BAUD RATE and the UART (see RS232 Operation 6 Programing) configuration settings (parity, word length and number of stop bits).

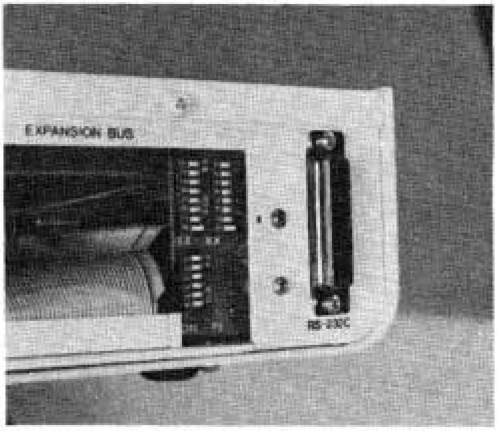


Figure 9.6 - Close up of RS232C dip switches.

The two BAUD RATE switches select the actual baud clocks (for both receive and transmit) to the UART. The baud rate is not software selectable on the LNW80 as it was on the TRS80 Model I. Almost all TRS80 Model I software can still be used even if it thinks it can set the baud rate under software control.

Only applications where the baud rates MUST be controlled by the application program will the LNW80 not be compatible with the TRS80 Model I . Some programs will attempt to display or otherwise indicate the current baud rate setting under software control. This is not possible on the LNW80 and this information should be ignored.

The configuration switches for parity, word length, and number of stop bits do not actually set these values directly in the UART. These switches simply are present to allow the application program to read back what they have been set to. Since many existing TRS80 model 1 RS232 programs require that these switches are present, it is also included on the LNW80. These switches can be read by inputting from port E9H. For more information on these configuration switches refer to the section on programming the RS232 interface.

Transmitting and Receiving

The programmer has a number of things to consider before communicating via the RS-232-C interface:

- Transmit and receive rates

- Parity

- Word length

- Start and stop bits

Setting Transmit and Receive Rates

For most applications the Transmit (TX) and Receive (RX) switches (located next to the RS232 interface) will be both set at the same value. Only one switch on the TX and one switch on the RX should be on at any one time.

Table 9.1 - Setting Tx and Rx Rates

TX & RX Switch	Baud rate
1	9600
2	2400
3	4800
4	1200
5	150
6	110
7	600
8	300

Setting Parity

When data is transmitted, errors often occur due to electrical interference, or "noise," on the line. This may result in an extra bit being included in a character, for example. To provide a check on this, a parity bit is appended to the word making the total number of "ones" in the word odd or even, depending on whether you have chosen odd or even parity for transmission.

The configuration switches on the I/0 panel are used to set parity.

Table 9.2 - Setting Parity With the Configuration Switches

Parity	Con Switch	Position

Inhibit	1	Off
	2	Off
Even	1	On
	2	Off
Odd	1	On
	2	On

Setting Word Length

A word (character) length of 5, 6, 7 or 8 bits may be used. The reason for the various word lengths (just when we had gotten used to 8 bits to a character) is that older machines have different word lengths. For example, teletypes use a 5-bit word length.

Table 9.3 - Setting Word Length

Word Length	Con Switch	Position
5	4	On
	5	On
6	4	Off
	5	On
7	4	On
	5	Off
8	4	Off
	5	Off

Setting Stop Bits

You may select 1 or 2 stop bits. When using a 5-bit word length, the configuration corresponding to 2 bits is, in actual fact, 1.5 atop bits. You may well wonder how a half-bit is arrived at. A hali-bit is represented by a time pulse half that of full bit.

Table 9.4 - Setting Stop Bits

Stop Bits	Con Switch	Position
1	3	On
2	3	Off

Note: Configuration switch 6 is not used for anything.

RS-232-C Operation

The circuitry associated with the RS-232-C has as its centerpiece a small dedicated processor, - the UART (Universal Asynchronous Transmitter/Receiver). It is dedicated in the sense that it has nothing else to do except to look after the RS-232-C's goings on.

It is within the UART that the parallel data structure of the computer is interfaced with the serial data structure of the communications channel. The transmitter section of the UART takes a parallel byte from the CPU bus (information route) and converts it to a serial word with start, stop and parity bits. The receiver section accepts a serial word from a serial device complete with its adornment of stop, start and parity bits, checks its validity, and then reconstitutes a parallel byte.

Programming the RS232C Interface

In order for the UART to function to receive and transmit serial data, a program within the LNW80 must communicate with the UART writing commands, configuration information, and data to its internal registers and reacting status and data back. Here is a list of the requirements for programming the UART:

1. MASTER RESET

After power has been applied to the UART, it must be reset before attempting to program any of the internal registers. This can be done by outputting anything to port location E8 (hex). Here is an example of the assembly language source code.

```
          OUT    (0E8H),A    ;OUTPUT ANYTHING
```

2. CONFIGURATION OF UART

The UART will transmit and receive at the baud rate that is provided by the switch settings but it must be told how it is to transmit the serial data. Should there be PARITY? If so, should it be EVEN PARITY or ODD PARITY? Should 5,6,7 or 8 bits of data be transmitted? Should the STOP BITS be set at 1 or 2? This information is programmed into the UART by certain bits set or not set in the UART CONTROL REGISTER. This register is addressed at port location EAH. The upper 5 bits of this location determine the setting of this configuration while the lower 3 bits are also used to set some of the handshaking output lines.

The relationship between these switches and the UART CONTROL REGISTER is such that by manually setting the switches, your program can simply read the switches, mask the lower 3 bits and then output that value to the UART CONTROL REGISTER at EAH. This feature is provided for the purpose of remaining compatible with programs written for the TRS80 Model 1 that read the switches and do not allow the user to select this configuration under software control. Since both DOSPLUS 3.4 and LNWBASIC allow programming of the configuration AND it is done in the BASIC programs provided at the end of this section it is not recommended that new programs be written that depend on these switches. Here is an example of how the UART CONTROL REGISTER is set:

```
            LD      A,(CONFIG)  ;load value from memory
            OUT     (EAH),A     ; actually output to UART

  CONFIG    DEFB          ; here is where the BASIC
                                ; program put the
                                ; configuration settings.
```

The example programs are provided at the end of this section to illustrate how the configuration settings are selected from a basic program.

Or if you are using the configuration switches...

```
            IN          A,(0E9H)  ;  INPUT  FROM CONFIGURATION
SWITCHES
            AND    0F8H    ; MASK OFF LOWER 3 BITS
            OR     05H      ; SET THE LOWER 3 BITS AS  DESIRED
FOR HANDSHAKING (BRK,DTR,RTS)
            OUT    (0EAH),A ; OUTPUT TO UART
```

3. TRANSMIT AND RECEIVE DATA

In order for the UART to transmit data, data must output to the UART TRANSMIT REGISTER (EBH). Data can be input from the UART RECEIVE REGISTER (EBH). Status concerning data received, data transmitted, and errors can be read back on the UART STATUS REGISTER (EAH). The status bits are defined in figure 2 above. For more details in programming the UART, refer to the LNW80 TECHNICAL REFERENCE MANUAL and the data sheets on the TR1602B.

4. MODEM STATUS REGISTER

When communicating over voice grade telephone lines and using a modem, various modem status conditions can be read back. CTS, DSR, CD, RI can all be input at port location E8H. See page 40 of the LNW80 Technical Reference Manual for the bits associated with these status signals.

The assembly listing of the serial terminal program which follows illustrates how the RS232 interface and the UART are programmed.

```
;
;    Assembly-language Listing of Terminal Program
;
0033           00010 DSP     EQU     338
002B           00020 KBD     EQU     2BH
FF70           00100         ORG     0FF70H
FF70 3E1C      00110 START   LD      A,1CH   ;HOME CURSOR
FF72 CD3300    00120         CALL    DSP
FF75 3E1F      00130         LD      A,lFH   ;CLEAR SCREEN
FF77 CD3300    00140         CALL    DSP
FF7A 3E0E      00150         LD      A,0EH   ;TURN ON CURSOR
FF7C CD3300    00160         CALL    DSP
FF7F D3E8      00170 IUART   OUT     (MR),A  ;RESET UART WITH
                                              ANYTHING
FF81 DBE9      00180         IN      A,(CONFIG) ;GET TERM
                                                 CONFIG
JUMPERS
FF83 E6F8      00190         AND     0FSH   ;MASK LOWER 3 BITS
FF85 F605      00200         OR      5H     ;SET BRK, RESET,
                                             DTR, SET RTS
FF87 D3EA      00210         OUT     (CTRL),A;PUT IN CONTROL
REG
FF89 DBEA      00220 RSRD    IN      A;(CTRL)
FFSB CB7F      00230         BIT     07H,A  ;IS RECEIVE DATA
                                             AVAILABLE
FFSD 2817      00240         JR      Z,SEROUT
FFSF DBEB      00250         IN      A;(DATA) ;GET DATA
FF91 B7        00260         OR      A
FF92 2812      00270            JR      Z;SEROUT ;IF NO INPUT LOOK
                                               TO OUT
FF94 E67F      00280         AND     7FH     ;STRIP PARITY


FF96 FE60      00290         CP      60H
FF98 FA9DFF    00300         JP      M,AAT
FF9B  E65F        00310         AND     5FH    ;LOWER TO UPPER
CASE
FF9D FE0A      00320 AAT     CP      0AH
FF9F 28E8      00330         JR      Z,RSRD
FFA1 CD3300    00340         CALL    DSP    ;DISPLAY
                                             CHARACTER
FFA4 18E3      00350         JR      RSRD
FFA6 CD2B00    00360 SEROUT  CALL    KBD    ;INPUT FROM
                                             KEYBOARD?
```

```
FFA9 B7  00370          OR      A
FFAA 28DD     00380          JR      Z,RSRD ;IF NOTHING THEN
                                            BACK TO INPUT
FFAC FE05     00390          CP      5H
FFAE F2B9FF   00400          JP      P,NOSPCH ;NOT A SPECIAL
                                               CHARACTER
FFB1 21CSFF   00410          LD      HL,SPCHTB-1 ;SPECIAL
                                                 CHARACTER
                                                 TABLE
FFB4 4F       00420          LD      C,A
FFB5 0600     00430          LD      B,0H
FFB7 09       00440          ADD     HL,BC  ;HL POINTS TO
                                            SPEC.  CHARACTER
FFB8 7E       00450          LD      A,(HL) ;GET SPECIAL
                                            CHARACTER CODE
FFB9 FE1A     00460 NOSPCH  CP      1AH
FFBB 28CC     00470          JR      Z,RSRD ;IS SHIFT DOWN
                                            ARROW? IGNORE
FFBD 4F       00480 RSWR    LD      C,A     ;SAVE DATA
FFBE DBEA     00490          IN      A,(CTRL) ;GET UART STATUS
FFC0 CB77     00500          BIT     06H,A  ;IS TRANSMIT
                                            REGISTER EMPTY
FFC2 28F9     00510          JR      Z,RSWR ;IF NOT LOOP
FFC4 79       00520          LD      A,C    ;PUT CHAR IN A
FFC5 D3EB     00530          OUT     (DATA),A gOUTPUT CHAR
FFC7  18C0        00540    JR      RSRD   ;BACK TO INPUT
ROUTINE
FFC9   03                    00550  SPCHTB    DEFB        03H
; DEFAULT: EOT-CNT "A"
FFCA   1B              00560                  DEFB        1BH
;DEFAULT:ESC-CNT"B"
FFCB 7C       00570          DEFB    7CH   ;DEFAULT:VERT BAR
                                            -CNT"C"
FFCC   7F              00580       DEFB        7FH
;DEFAULT:DEL-CNT"D"
00E8          00720 MR      EQU     00E8H
00E9           00730 CONFIG  EQU     00E9H
00EA           00740 CTRL    EQU     00EAH
00KB          00750 DATA    EQU     00EBH
FF70          00770          END     START 00000 TOTAL ERRORS
```

Getting the Most From the RS-232-C

The RS-232-C may well be one of the most important features on your LNW80. It allows you to communicate with your local community college computer (educational budget permitting), or work computer, your LNW80 acting as a terminal. Thus you can interact with large computer systems from your home.

The ramifications of this kind of setup could have dramatic effects on society in the not so distant future. Ponder for a moment if you will, on the work habits of people in metropolitan areas. Every morning large numbers of citizens from the suburbs pile into their automobiles and drive towards downtown. Once there, they assume positions at desks where they write on paper and pass information, one to the other, again on paper.

Adding up the cost of this kind of modus operandi, a number of inefficiences come rushing to mind. Think of the time spent commuting and the cost of this on both pocket and environment. The astronomical cost of harboring thousands of people in one big building also springs to the fore. If only we could communicate, perform more direct accounting and commit information to store without all of this paper!

Let's be glib here. Instead of spending the tons of money (literally) on office construction and maintenance, why not give all of the employees a microcomputer and modem (I have just the system in mind!) and the resources for a small bureau at home. The employees could log on every morning to a central computer and find out what was wanted of them today. They could submit work to the computer, which would spout out the facts to the company president and his aides. The considerable savings on gasoline could be used to improve the communications network.

This rather loosely strung together train of thought hints at the real possibilities the RS-232-C communications unit could present.

BASIC RS232C Serial Printer & Terminal Programs

The following program can be used as a terminal program, which allows your computer to communicate with other computers via a modem.

```
10 REM SERIAL CRT TERMINAL PROGRAM
20 REM
30 REM   This program allows the use of the LNW80 computer
40 REM   system as a CRT terminal. This program may also be
50 REM   used for testing the serial interface by connecting
60 REM   pins 2 & 3 of the RS232C DB25 connector together.
65 REM   BE SURE TO SET HIGH MEMORY TO 65390


70 FOR X=-144 TO -52
80  READ D
90  POKE X,D
100 NEXT X
110 POKE 16526,112   '070H
120 POKE 16527,255   '0FFH
130 A=USR(N)
200 DATA 62,28,205,51,0,62,31,205,51,0,62,14,205,51,0,211
210 DATA 232,219,233,230,248,246,5,211,234,219,234,203,127
220 DATA 40,23,219,235,183,40,18,230,127,254,96,250,157,255
230 DATA 230,95,254,10,40,232,205,51,0,24,227,205,43,0,183
240 DATA 40,221,254,5,242,285,255,33,200,255,79,6,0,9,126
250 DATA 254,26,40,204,79,219,234,203,119,40,249,121,2ll
260 DATA 235,24,192,3,27,124,127
```

Serial Printer Program

```
10 REM     BASIC SERIAL PRINTER PROGRAM
30 REM     This program allows the use of a serial printer
40 REM     with the LNW80. This program is left in memory
50 REM     unaltered by BASIC and user programs. The program
60 REM     is executed during each LPRINT and LLIST statement
70 REM     Handshaking is supported as the software reads the
71 REM     the printer busy (DSR) before outputting a
72 REM     character. If your printer does not support
73 REM     handshaking, change line number 340 to:
74 REM     340  DATA  219,232,203,119,0,0,219,234
75 REM     BE SURE TO SET HIGH MEMORY TO 65278 BEFORE
76 REM     entering BASIC.
77 REM
78 REM
80   CLS:PRINTCHR$(23):PRINT"LNW  RESEARCH  CORP.":PRINT"BASIC
SERIAL PRINTER PROGRAM"
90 FOR X=-256 TO -207
100 READ D
110 POKE X,D
120 NEXT X
```

```
130 A$="E":P=128:L=0:WL=1:SB=7:B=32
140 'INITALLY SET FOR 1 START BIT, SEVEN BITS DATA, EVEN
     PARITY,ONE STOP BIT
150 POKE 16421,2:POKE 16422,0:POKE 16423,255 'POKE NEW DCB
160 FORZX=1T0600:NEXTZX:CLS:PRINT"CONFIGURATION MENU":
    PRINT: PRINT"RS232 CONFIGURATION SETTINGS"
170 PRINT"1) PAR1TY (E-EVEN)g(O-ODD),(D-DISABLED) ";A$
180 PRINT"2) STOP BITS ";WL
190 PRINT"3) WORD LENGTH ";SB
200 PRINT"4) RUN TERMINAL PROGRAM":PRINT"SELECT FUNCTION"
210 Z$ =INKEY$:IFZ$=""THENGOT0210ELSEIFZ$="1"THENGOT0220ELSE
    IFZ$=" 2" THENGOT0270ELSEIFZ$="3"THENGOT0240ELSEIFZ$="4"
    THEN GOT0290ELSE GOT0210
220 P=0:INPUT"PARITY EVEN (E), ODD (0), OR DISABLED (D)";
    A$:IFA$="E" THENP=POR128ELSEIFA$="0"THENP=PAND127ELSE
    IFA$="D"THENP=POR8 ELSEGOT0220
230 GOTO 160


240 INPUT"WORD LENGTH (5,6,7,8)";SB:IF SB<5THEN240ELSE
    IFSB>8THEN240
250 IFSB=5THENB=0ELSEIFSB=6THENB=64ELSEIFSB=7THENB=32ELSE
    IFSB=STH ENB=96
260 GOT0160
270         INPUT"STOP          BITS          (1           OR
2)";WL:IFWL>2THENGOT0270ELSEIFWL
```

SECTION 10: MEMORY UTILIZATION

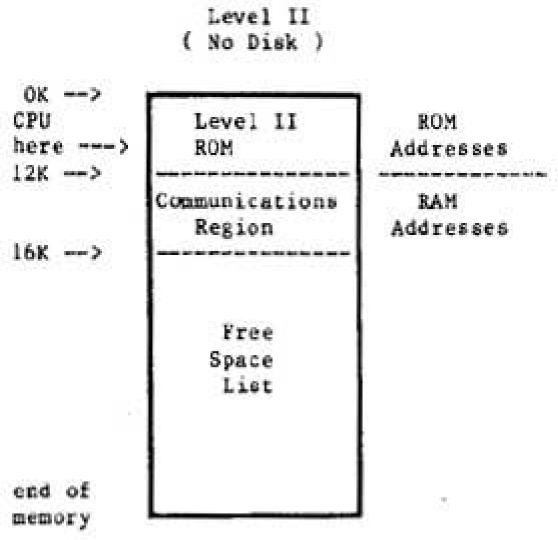
A Look at Memory in a Non-Disk System

The computer is now operating out of ROM using the Level II BASIC language.

On power up we have 64K of memory address space in the machine. 12K of this is Read Only Memory (ROM), which we cannot use to hold programs or data. In addition, the computer takes up just over 2K bytes of memory space which it uses to operate the keyboard, the video, I/0 routines and other computer "housekeeping" functions. Almost 2K is not used for anything.

So, of the 64K of memory space that we started out with, the computer has earmarked 16K for its own purposes. This leaves us, the programmers, with 48K or thereabouts. See figure 10.0 for a schematic presentation of memory allocation.

Figure 10.0 - Simple Rectangular Memory Block Diagram.



A Look at Memory in a Disk System

With system start-up from disk, the DOSPLUS disk operating system is loaded from disk into RAM. The system doesn't just load into memory at any old position. No, the DOS loads in at the 16K mark in memory and extends for 5K to 21K. The memory up to 16K is the same as that in a non-disk system. In fact the DOS enhances the ROM based system ay acting in cooperation with it. Figure 10.1 is a schematic drawing of memory allocation in a disk system.

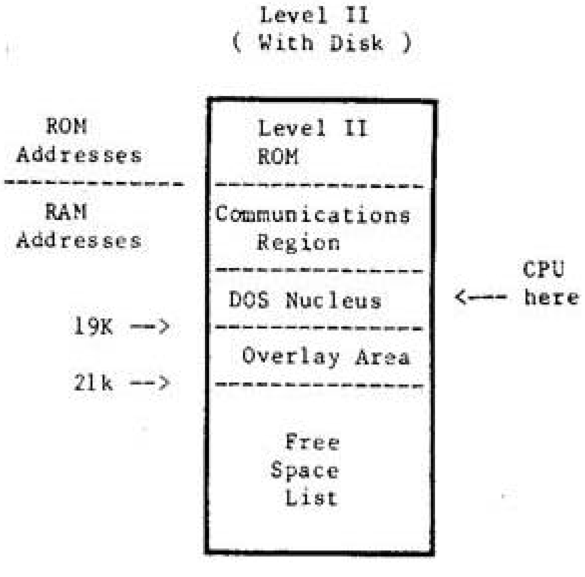


Figure 10.1 - Memory block diagram for a disk system. (Before BASIC is called).

A disk operating system takes up more memory than the ROM based system. However, the availability of a large amount of quickly accessible storage on disk, more than compensates for the extra 5K of memory we have sacrificed.

High Memory Protection

The BASIC interpreter uses as much memory as you will allow it. In a ROM based system, BASIC uses a variable amount of space beyond the 16K region, where it stores tables and variables. In the case of a disk system, these tables and variables are stored just beyond the 26K region. In both cases, BASIC also stores information way up there in high memory (in the 40K+ region).

You may put a ceiling on BASIC's use of memory by replying to the MEMORY SIZE? question on power up or reset. By replying with say 32768, you will keep BASIC out of memory locations above 32K. This is important if you want to use assembly-language programs.

For a memory map showing how Level II BASIC uses memory, see Appendix D of the Radio Shack Level Il manual. This is not vital information if you are a beginner, but it is important if you are an assembly-language enthusiast.

SECTION ll: CHOOSING AND USING A DISK OPERATING SYSTEM

Introduction

The LNW80 supports a wide number of disk operating systems (DOS). A full list is supplied in Table 11.0. This versatility towards software will be welcome news to those programmers who want to continue using the same software that wooed them towards microcomputers in the first place. However, the first time owner may find the choice of DOSes a bit bewildering, and for this reason we include DOSPLUS 3.4 in the LNW80 package. We think this is a well-documented and easy to use DOS. Knowing full well that the first operating system that you come to know generates a feeling not unlike that towards your first car, this section includes detailed instructions on how to set up a disk system for a number of DOSes.

But first, as a backdrop (hey, this is southern Californian) to all of this technical mumbo jumbo, let’s take a vague look at microcomputer operating systems and their background. (For a detailed description of a disk operating system, see the introduction to this manual).

Important Aspects of a DOS

From a programmer’s point of view, a DOS should be transparent and fast. Transparent means that it should perform the various data manipulations in such a way that the programmer is hardly aware of what's going on. When the DOS needs to look up system tables, or bring another system module from disk into RAM (overlaying), we, the programmers, want it to do so without bothering us as we slave away at the keyboard. We would also like to have some data recovery facilities, in the event that the DOS tells us it can’t read a disk sector. Ideally, the DOS should do all of this using a minimum of valuable RAM.

A very important aspect of any operating system is its documentation. If the documentation is not very clear, and you can't find out how to use the system, or you find yourself encountering difficulties which are not explained, then the system ends up being of little use and a real pain in the byte.

A Brief History of the TRS80 Model I Operating Systems

Since the introduction in 1978 of tba TRS80 Model I microcomputer and its disk operating system, TRSDOS, a wide variety of operating systems have been developed to operate on the TRS80 Model I. These systems were developed, for the most part, to improve upon a poor TRSDOS 2.1. One of the operating systems to emerge was NEWDOS. This operating system was

written because its owners, Apparat Inc., needed a DOS for their own internal use that actually worked. Before long, others heard that a DOS really did exist that worked and Apparat became a DOS company.

Meanwhile, the original author of the Radio Shack TRSDOS 2.1, Randy Cook, began improving on what he had written and created what would be known as VTOS 3.0. He marketed the DOS under the company name of Virtual Technology Inc. Apparat continued to improve the NEWDOS and released NEWDOS 2.1, NEWDOS+, and NEWDOS80 1.0. VTOS 3.0 evolved to VTOS 4.0 as more features were added.

At about the same time, a young programmer in Florida had written a DOS for both single-density and for the new double-density adaptor from Percom Data Co. This DOS became widely known as DOSPLUS 3.2 and 3.2D, and was marketed by a company known as Microsystems Software. This DOS evolved to 3.3D, which became the standard DOS supplied with the LNDOUBLER. At about the same time, other DOS systems were springing up almost from nowhere. The DOS WAR had just begun.

Radio Shack did not sit still during the DOS WAR. They improved upon TRSDOS and finally developed a DOS which both worked and offered some usable features, - TRSDOS 2.3.

VTOS was sold to Lobo Drives fox use on their LX80 interface, and with a major effort in both programming and documentation, LDOS 5.0 and 5.1 emerged. LDOS was a powerful "device independent" system with the features of VTOS, but without the bugs. LDOS uses the same syntax as TRSDOS, but has many additional features and capabilities. With the LDOS PATCH (available from your LNW dealer), diskettes that were written using the LX80 interface under LDOS (5-1/4" and 8" double or single-sided, single or double-density) can be read or written to with an LNW80 or LNDOUBLER 5/8 (with a speed-up kit) and the appropriate disk drives under LDOS 5.0 or 5.1.

With the emergence of the standard of double-density, Apparat released NEWDOS80 version 2.0. This DOS was by far the most powerful and flexible system ever developed. It would interface not only 5-1/4" disk drives but, with the use of the LNDOUBLER 5/8, would interface both single and double-density (double-density required a speed-up kit on the TRS80 Mod I) 8-inch floppy disk drives, The only drawback of this outstanding system was the complexity of operation and the differences in syntax between TRSDOS 2.3 and NEWDOS. Microsystems Software had also developed a new DOS with the 8 inch and hard drive features, as well as adding many other powerful functions. This was to be called DOSPLUS 3.4.

DOSPLUS 3.4 has become the standard DOS supplied with both the LNW80 and the LNDOUBLER 5/8 double-density adaptor. This DOS has the great advantage of simplicity. It matches TRSDOS syntax, has clear and concise documentation, and thus, is a good DOS for the first-time owner.

Looking at the Various Disk Operating Systems

There are two important points to note at this juncture:

NOTE 1

Some of the operating systems that will operate on the TRS80 will not support the 4MHz CPU speed of the LNW80. Some of the operating systems may operate at the 4HMz speed with special configuration of the operating system. Others will operate at the high speed, but will not properly boot (reset) at the high speed. For these reasons, we recommend that the HIGH/LOW speed switch on the keyboard be set to LOW (down) before booting a previously untested DOS. Table 11.0 lists the known compatible systems.

NOTE 2

The double-density disks created on the following DOSes are not necessarily read/write compatible with each other. Of all the DOSes listed, only MULTIDOS has the ability to read the formats of the other operating systems (note that MULTIDOS will not read double-sided or 8 inch formats). Single-density disks created using any of the operating systems listed in Table 11.0 are, for the most part, fully interchangeable.

Table 11.0 - LNW80 Compatible DOSes

OPERATING SYSTEM NAME	4MHZ OK	5-1/4" SD	DISK DRIVE SUPPORT			DUAL
			5-1/4" DD	8" SD	8" DD	
DOSPLUS 3.2S	NO	S,D				YES
DOSPLUS 3.2D	NO	D	S			YES
DOSPLUS 3.4	YES	D	S,D	D	S,D	YES
DBLDOS	NO	D	S,D			YES
EZ-DOS	YES	S,D	S,D	S,D	S,D	YES
LDOS 5.0	YES	S,D	S,D(2)	S,D(2)	D(2)	YES
LDOS 5.1	YES	S,D	S,D	S,D(2)	D(2)	YES
MULTIDOS	YES	S,D	S,D			
NEWDOS 2.1	NO	S,D				
MEWDOS+	NO	S,D				
NEWDOS80 1.0	NO	S,D	S,D(l)			YES
NEWDOS80 2.0	YES	S,D	S,D	S,D	S,D	YES
OS-80	NO	S,D	S,D			YES
TRSDOS 2.3	NO	S,D				
ULTRADOS	NO	S,D				
VTOS 4.0	NO	S,D	S,D(1)			YES

S = system disk, D = data disk,
SD = single-density, DD = double-density
DUAL = dual-sided drive support
1 = Double Zapii from Software Etc. required
2 = LDOSPATCH from LNW Research required

The Top Five Operating Systems

TRSDOS 2.3
DOSPLUS 3.4
NEWDOS80 U 2.0
LDOS 5.0 AND 5.1
MULTIDOS

TRSDOS 2.3

While probably the most popular of all the DOSes, TRSDOS is the simplest, will only operate with single-density, 5-1/4" 35-track floppy drives and has a limited BASIC as well as a limited set of library commands. The TRSDOS manual is by far the finest piece of documention written on any of these operating systems and is available at Radio Shack stores around the world:

TRSDOS & DISK BASIC Reference Manual
For the TRS80 TRSDOS 2.3
Disk BASIC Version 2.2

LNWBASIC is fully compatible with the DISK BASIC in TRSDOS 2.3.

DOSPLUS 3.4

DOSPLUS 3.4 is a powerful, easy-to-use system that is well documented and is fully TRSDOS compatible. DOSPLUS 3.4 was supplied on either a

5-1/4 inch 35 track double-density system disk, OR
An 8 inch double-density 77 track system disk

with your LNW80 computer. In order to make a back-up copy, simply use the BACKUP command while referring to the first six pages of the DOSPLUS 3.4 USER manual.

Eight-inch Data Disks

In order to tell the operating system that you have installed an eight-inch drive on your system, DOSPLUS 3.4 requires that you use the CONFIG command. The following example assumes that an eight-inch drive is installed at position 3.

1. For Eight-inch Single-sided type:

```
CONFIG :3 (SIZE=8,SIDES=1)
```

For Eight-inch Double-sided type:

```
CONFIG :3 (SIZE=8,SIDES=2)
```

2. Next type:

```
CONFIG (SAVE)
```

The CONFIG command can also be used to set the LNW80 computer to inverse video on power up. This is done by typing

```
CONFIG :0 (MODE=1)
```

and then typing

```
CONFIG (SAVE)
```

To restore to standard video on power up, type:

```
CONFIG :0 (MODE=0)
```

and then:

```
CONFIG (SAVE)
```

For more details on the CONFIG command, refer to page 32 of the DOSPLUS 3.4 USER MANUAL.

DOSPLUS 3.4 and LNWBASIC

LNWBASIC is 100% compatible with DOSPLUS 3.4. In order to bring a program written in LNWBASIC to execute automatically, create a DO file using the BUILD command. For example, say we wanted to automatically power up and run a demonstration program called DEMO/LNW. First we would create a DO file like this:

```
BUILD DEMO:0
```

After the system asks you to type in commands of 64 characters or less:

```
LNWBASIC
RUN "DEMO/LNW"
```

Using the AUTO library command, now make the DO file execute on BOOT or power up:

```
AUTO DO DEMO
```

Now the demo program will run automatically when your DOSPLUS disk with LNWBASIC is booted.

NEWDOS80 VERSION 2.0

BEFORE ATTEMPTING TO USE THIS OPERATING SYSTEM,
READ THIS SECTION CAREFULLY!

This operating system is by far the most powerful of the operating systems that will run on the LNW80 computer. It has so many options and features that it can leave many owners lost attempting to sift through the huge manual. The manual, like the operating system, is not intended for the first-time computer owner, and if you can read faithfully through the second page, you are instructed to spend a couple of hours reading through the manual before even touching the diskette. It is the first 50 pages in the manual that provide the key to the operation of the DOS, and we recommend that you slowly read through these first two sections before even attempting to use the DOS.

NEWDOS80 System Configuration

When using NEWDOS80 V2 at the high CPU speed (HIGH/LOW UP and AUTO SWITCHING DOWN) the SYSTEM option BJ must be set to 3. In order to set this, boot a copy of the MASTER system disk (not write protected) with the HIGH/LOW switch set to the low position. Type:

```
SYSTEM,0,BJ=3
```

Now RESET your computer again before proceeding. You may now use this system disk (or copies made from it) with the HIGH/LOW switch set to the high position (mandatory for 8 inch drives).

Disk Drives and NEWDOS80 Version 2.0

NB: Proper 8 inch operation requires that ZAPS up to and including 047 must be applied to the NEWDOS80 system disk. If you are in doubt, contact Apparat Inc. or your computer dealer. LNW Research cannot distribute this zap information.

Also, since proper electrical configuration of your drives must be assured BEFORE proceed, you must have operated your drives under DOSPLUS 3.4 before attempting to use any other operating system.

NEWDOS80 2.0 allows the programmer a tremendous degree of flexibility in choosing the type of disk drive to be used with the system. Disks can be set as single-density, double-density, any number of tracks, 5-1/4 and 8 eight-inch, single or double-sided. Configuring the operating system such that it knows what type of drives you have connected to your LNW80 is accomplished with the PDRIVE library command. This is a more complex form of the CONFIG command in DOSPLUS. Section 2.37, on pages 2 - 33 of the NEWBOS80 manual, details just how

to use this command. You will notice that LNW has its own interface setting TI=E. This means that although your system will boot with the TI=A setting, as set on the diskette supplied from Apparat, in order to use double-density or 8 inch disk drives, the TI=E flag must be set for ALL of the drives (all 10 of them) REGARDLESS of whether or not you have a drive at that position. Double-density, single-density, 5 inch, 8 inch, single-sided, dual-sided system disks can be made by correctly setting the PDRIVE specification and using the correct form of the COPY command. To simplify things a bit, the following sections will illustrate just how to make some of the most common forms of SYSTEM as well as DATA disks.

Backing Up

Before proceeding, lets make sure that we have made a "back-up" of our one and only copy of the NEWDOS80 V 2 SYSTEM DISK. How to make a backup is found on pages 1 - 4. Since there is no BACKUP command, the COPY command is used:

for SINGLE drive system configuration

```
COPY,0,0,,FMT,USD
```

for MULTIPLE drive configuration

```
COPY,0,l,,FMT,USD
```

Now, using the backup copy of the operating system, a double-density system disk can be made.

Making a NEWDOS80 2.0 Double Density 5-1/4" System Disk

The NEWDOS80 VERSION 2.0 system disk comes in single-density format and requires that a DOUBLE-DENSITY SYSTEM DISK be created using the procedure which follows. Read the section in the NEWDOS80 2.0 manual on PDRIVE specification (pages 2 – 33) before proceeding, and do not attempt to create a double-density system disk without reading the following instructions. Going to double-density is not as simple as just changing the pdrive specifications for your single-density diskette. A NEW diskette must be created!

Instructions

l. Insert the backup NEWDOS80 system disk into drive 0 and put the master system disk away.

2. After each of the following commands in STEP 3,the system will respond by listing the PDRIVE specifications for

all drives and also print an error message. Wait for the NEWDOS80 READY prompt and then type in the next command. Do not reset the computer until instructed to. Resetting the computer with an error in the PDRIVE specifications will result in the destruction of your system diskette.

3. Type in the following commands and then return :

```
PDRIVE 0,0,TI=E,TC=40
PDRIVE 0,l,TI=EK,TD=E,TC=39,SPT=18
PDRIVE 0,2=0
PDRIVE 0,3=0
PDRIVE 0,4=0
PDRIVE 0,5=0
PDRIVE 0,6=0
PDRIVE 0,7=0
PDRIVE 0,8=0
PDRIVE 0,9=0,A
```

The error message should disappear after the last entry is made. If it does not, redo the entire procedure, exercising more care this time. Once this process is complete, the DOUBLE DENSITY system disk can be generated.

Multiple Drive Systems

1. Insert a blank diskette in drive 1
2. Type COPY 0 1,,CBF
   Type "Y" to FORMAT prompt
   and "Y" to the SYSTEM 0 prompt.
   Enter return
   to the DESTINATION DRIVE prompt.
3. When the copy is done, type DIR :1

You should be able to verify that there are considerably more granules (grans) free on the new double-density disk than on the single-density system disk in drive 0.

4. Remove the system disk from drive 0 and replace it with the newly created double-density system disk from drive 1. Press RESET and now the double-density disk should boot.
Type:

```
PDRIVE 0
```

Notice that the pdrive specifications for both drive 1 and drive 0 are the same (double-density).

Single Drive Systems
With the system disk in drive 0 type:

```
COPY,0,0,,FMT,USD,CBF,DPDN=l
```

The system will instruct you when to remove the source disk and insert the destination (blank) disk. Follow as instructed, remembering that your original diskette is the source and the blank diskette is the destination diskette. Usa great care not to become confused as to which disk is which since you will have to do this several times.

When the copy is complete, replace the system disk in drive 0 with the destination diskette and reset the system. Type DIR . More grans should be available on this newly created disk.

Special Note

NEWDOS80 2.0 does not have automatic density recognition as does DOSPLUS 3.3D, 3.4 and the zaps from CIRCLE J. This means that if you would like to look at the directory or copy files to and from or execute a file from a single-density diskette, you cannot do it without first changing the PDRIVE specifications on your NEWDOS80 2.0 drive 0 disk. Automatic density recognition for NEWDOS80 2.0 is available from TAS (The Alternate Source, 704 North Pennsylvania Ave., Lansing, MI., 48906 (517) 482-TAS0) under the product name of DDSD/CMD. Without this program, switching PDRIVE specifications manually can be done by typing:

```
PDRIVE 0,1=3,A
```

This assumes that drive 1 is the drive that the single-density disk will be inserted into. To change back to double-density on drive 1, simply type:

```
PDRIVE 0,1=0,A
```

This sets (or equates) the pdrive specifications for drive 1 to be the same as drive 0 (double-density).

Other Types of Drives

NEWDOS80 supports any type of disk drive from single-sided, single-density five inch to dual-sided eight-inch double-density. Even system disks can be made on any drive type. This flexibility offers potential problems for the uninitiated owner. The following should help clear up some possible points of confusion:

Double-sided Disk Drives

Going to dual-sided disk drives is similar to upgrading to double-density. A NEW diskette must be created using the correct PDRIVE spec.

Eight-inch Disk Drives

For proper double-density operation, the HIGH/LOW key on the keyboard must be UP and the AUTO SWITCHING control on the I/0 panel. By setting the PDRIVE specs as listed below, eight-inch system or data disks can be made.

Making an Eight-inch System Disk with NEWDSO80

An eight-inch single or double-sided, single or double-density system disk can be created from the NEWDOS80 system disk created above (with NO write-protect tab). The following example assumes that an eight-inch drive is on drive 2 and a five-inch drive is on drive 0.

1. Depending on which type of disk you want to create type one of the following:

For
Single-density, 77 Track, Single-sided Eight-inch type:

```
PDRIVE,0,2,TI=EH,TD=B,TC=77,SPT=l7,TSR=3,GPL=3,DDSL=17,DDGA=6
```

For
Single-density, 77 Track, Double-sided Eight-inch type:

```
PDRIVE,0,2,TI=EH,TD=D,TC=77,SPT=34,TSR=3,GPL=3,DDSL=17,DDGA=6
```

For
Double-density, 77 Track, Single-sided Eight-inch type:

```
PDRIVE,0,2,TI=EHK,TD=F,TC=76,SPT=30,TSR=3,GPL=3,DDSL=17,DDGA=4
```

For
Double-density, 77 Track, Double-sided Eight-inch type:

```
PDRIVE,0,2,TI=EHK,TD=H,TC=76,SPT=60,TSR=3,GPL=3,DDSL=17,DDGA=4
```

2. The complete PDRIVE table should have been displayed. If an error was indicated, then either you do not have the proper PDRIVE settings OR you do not have ZAPS up to and including 047 installed on your system disk.

3. RESET the computer.

4. Install a blank 8 inch disk in drive 2 and type:

```
COPY,0,2,,CBF,NDMW,FMT
```

5. Once the format and copy are complete, this new eight-inch disk drive can be booted by:

a. Changing the drive select such that an eight-inch drive is set for drive 0.

b. Change the position of the 5/8 switch on the LNDOUBLER 5/8 circuit board inside the LNW80 such that it is set to the 8 position. This means the switch lever faces AWAY from the floppy disk connector.

c. Reset the computer (make sure that the computer has had power applied for at least 10 seconds).

77 or 80 Track 5-1/4 Inch Drives and NEWDOS80

If you have ONLY this type of drive, a special system disk must be obtained from Apparat since the standard 35 track diskette cannot be used as a system disk on reset.

List of the Most Common NEWDOS80 PDRIVE Specifications

System Disks

SIZE	DENSITY	TRACKS	SIDES	TI	TD	TC	SPT	TSR	GPL	DDSL	DDGA
5	SINGLE	35	1	E	A	35	10	3	2	17	2
5	SINGLE	35	2	E	C	35	20	3	2	17	2
5	SINGLE	40	1	E	A	40	10	3	2	17	2
5	SINGLE	40	2	E	C	40	20	3	2	17	2
5	SINGLE	80	1	E	A	80	10	3	2	35	2
5	SINGLE	80	2	E	C	80	20	3	2	35	2
5	DOUBLE	35	1	EK	E	34	18	3	2	17	2
5	DOUBLE	35	2	EK	G	34	36	3	2	17	2
5	DOUBLE	40	1	EK	E	39	18	3	2	17	2
5	DOUBLE	40	2	EK	G	39	36	3	2	17	2
5	DOUBLE	80	1	EK	E	79	18	3	2	35	4
5	DOUBLE	80	2	EK	G	79	36	3	2	35	4
8	SINGLE	77	1	EH	B	77	17	3	3	17	6
8	SINGLE	77	2	EH	D	77	34	3	3	17	6
8	DOUBLE	77	1	EHK	F	76	30	3	3	17	4

8	DOUBLE	77	2	EHK	H	76	60	3	3	17	4

Data Disks

When using diskettes simply for storing data, the following formats will increase slightly your storage space over the above system disk capacity. If possible, stay with the above formats and STANDARDIZE on the formats that you use such that you do not forget which PDRIVE spec is used on which diskette. This will reduce frustration later when reviewing old diskettes. Use the FORMAT command in NEWDOS80 with the correct PDRIVE specification to properly initialize data diskettes (even when using the above formats).

SIZE	DENSITY	TRACKS	SIDES	TI	TD	TC	SPT	TSR	GPL	DDSL	DDGA
5	SINGLE	35	1	E	A	35	10	3	2	17	2
5	SINGLE	35	2	E	C	35	20	3	2	17	2
5	SINGLE	40	1	E	A	40	10	3	2	17	2
5	SINGLE	40	2	E	C	40	20	3	2	17	2
5	SINGLE	80	1	E	A	80	10	3	2	35	2
5	SINGLE	80	2	E	C	80	20	3	2	35	2
5	DOUBLE	35	1	E	E	35	18	3	2	17	2
5	DOUBLE	35	2	E	G	35	36	3	2	17	2
5	DOUBLE	40	1	E	E	40	18	3	2	17	2
5	DOUBLE	40	2	E	G	40	36	3	2	17	2
5	DOUBLE	80	1	E	E	80	18	3	2	35	2
5	DOUBLE	80	2	E	G	80	36	3	2	35	25
8	SINGLE	77	1	EH	B	77	17	3	3	17	6
8	SINGLE	77	2	EH	D	77	34	3	3	17	6
8	DOUBLE	77	1	EH	F	77	30	3	3	17	4
8	DOUBLE	77	2	EH	H	77	60	3	3	17	4

LNWBASIC and NEWDOS80 2.0

LNWBASIC is fully compatible with NEWDOS80 2.0. In order to run LNWBASIC, simply type: LNWBASIC. To chain automatic execution of programs written in LNWBASIC, the programmer can either chain together the commands in a DO file (like DOSPLUS 3.4) using the CHAINBLD/BAS program or a simple one-line command can be used to bring up the program:

```
LNWBASIC RUN"DEMO/LNW"
```

LDOS 5.0 AND 5.1

Before attempting to use this DOS, please read this section carefully!

> NOTE: LDOS WILL NOT BOOT AT THE HIGH CPU SPEED
> OF THE LNW80 COMPUTER ALWAYS MAKE SURE THAT THE
> HIGH/LOW SWITCH IS DEPRESSED PRIOR TO RESETTING
> THE SYSTEM

LDOS is a powerful and well-documented operating system for the LNW80. It is a good system for the first-time owner since it uses the same syntax as TRSDOS 2.3 yet offers quite a few additional features. As supplied from Logical Systems Inc., LDOS will operate with 5 inch single or double-density, single or double-sided disk drives. LDOS is supplied on two single-density, single-sided diskettes. These diskettes should be backed up according to the instructions supplied in the owner manual's introductory section BEFORE using LDOS. Disregard the constant mention of the LX80 interface when it is referenced in their manual. This interface can only be used with the TRS80 Model I. A program called LDOSPATCH is available from your dealer. This program allows the LNW80 computer and LDOS to operate with 5 or 8 inch disk drives in single or double-density and single and double-sided operation fully compatible with the LX80 interface. LDOSPATCH also provides AUTO DENSITY recognition such that either single or double-density diskettes can be read with the density set automatically by the operating system.

Setting the LDOS System

The SYSTEM library command allows the programmer to configure many parameters in LDOS. The system FAST command does allows the LNW80 to operate (except on reset) at the high CPU speed. It unfortunately has one bad side effect, - it turns on inverse video. This can be eliminated by outputting OUT 254,0 during BASIC.

LNWBASIC and LDOS

The resident DISK BASIC on LDOS is called LBASIC. Its name on the diskette creates an incompatibility with LNWBASIC. In order to use LNWBASIC with LDOS, LBASIC must be renamed in the directory. Type in the statement below exactly as shown.

```
        RENAME LBASIC/CMD.RS0LT0FF TO BASIC/CMD
```

Note: The character between the S and L and again between the T and F is a ZERO and not "O".

The mechanism for bringing up a program written in LNWBASIC to automatically run (CHAIN or AUTO) DOES NOT WORK in LDOS. THIS DOES NOT MEAN THAT LNWBASIC WILL NOT WORK IN LDOS, IT MEANS THAT AUTOMATIC EXECUTION OF A BASIC PROGRAM WRITTEN IN LNWBASIC CANNOT BE DONE.

Using Eight-inch and Double-density

For proper double-density operation on EIGHT INCH drives the HIGH/LOW key on the keyboard must be UP and the AUTO SWITCHING control on the I/0 panel should be down.

Important Note:

Since proper electrical configuration of your drives must be assured BEFORE proceed, you must have operated your drives under DOSPLUS 3.4 before attempting to use any other operating system.

LDOSPATCH provides the necessary routines to allow LDOS to support all the common disk drive types. To use LDOSPATCH, simply copy the program called LPATCH/CMD from the LDOSPATCH diskette to your working LDOS system disk using the copy command. When you have it copied, your drive settings can then be configured by typing:

```
            LNW (N0,N1,N2,N3)
```

Where N0 indicates the drive size for the drive at location 0 (5 or 8), Nl indicates either 5 or 8 at drive position 1, etc. For example, if you had five inch drives at 0 and 1 and eight-inch drives at 2 and 3 you would enter the following:

```
            LNW (5,5,8,8)
```

Remember that for 8 inch double-density operation, the HIGH/LOW switch must be high and the AUTO SWITCH must be set low. Refer to the instructions supplied with LDOSPATCH for more information concerning its use.

Limitations of LDOS

Eight-inch SYSTEM disks cannot be made using the BACKUP utility in LDOS from a 5 inch master. A single-density 8" system disk is available (referred to as OMIKRON format) from Logical Systems Inc. for those that only have eight-inch disk drives. ONLY single-density system disks are available for 8 and 5 inch systems.

MULTIDOS MULTIDOS

MULTIDOS is so named because of a unique feature of supporting the different double-density disk formats that are used by NEWDOS80, DOSPLUS, DOUBLEDOS, LDOS and others. MULTIDOS also features a very powerful disk basic called SUPERBASIC. MULTIDOS is quite simple to use and is very much like TRSDOS 2.3 in syntax.

MULTIDOS is also compatible with LNWBASIC, and a chained DO file can be used (as with DOSPLUS) to automatically bring a BASIC application program up and running.

SECTION 12: COMPATIBILITY FEATURES OF THE LNW80

Introduction

It has been more the rule than the exception that new microcomputers which introduce new hardware also introduce a whole new software system. This has led to a great diversification of hardware and software in the growth of the microcomputer. Enter the exception! The LNW80 stands at a new juncture in computer development. While providing new hardware features which allow greater disk drive support (5-1/4" or 8" single or double-headed drives operating under single or double-density), and color high resolution graphics, the LNW80 remains faithful to proven software. Rather than starting out on a new evolutionary limb, the LNW80 stands along side that software which has had a precocious development since the birth of the TRS80 Model I. Supporting ALL software ever conceived for the Model I, the LNW80 will also accept Model II and Model III file use with the aid of the CONVERT utility in DOSPLUS 3.4, which is supplied with the documentation.

LNWBASIC is upward compatible with all of the disk BASICs which evolved under the TRS80 Model I umbrella. Model II BASIC files may be transferred across to the LNW80 using a variation of the CONVERT command. LNWBASIC retains close similarity to TRS COLOR BASIC.

LNWBASIC goes on to offer you many more functions, such as changing key function (DEFKEY), conditional loops (DO UNTIL), locating strings in files (LOG.), saving graphics memory to disk (PSAVE) and many others.

DOSPLUS 3.4 CONVERT Command

DOSPLUS allows the conversion of both the TRS80 Model II (8 inch double-density) AND Model III (5-1/4 inch double-density) disks to DOSPLUS on the LNW80 (any drive type and any density).

Converting TRS80 Model III Disks to DOSPLUS

DOSPLUS 3.4 allows the conversion of files that were created on the Model III with TRSDOS Versions l.l, 1.2 or 1.3. In order to copy files across to a DOSPLUS formatted diskette, type:

```
CONVERT FILENAME :S :D (V13)
```

where S is the source drive number, D is the destination drive number and (V13) is an optional flag to indicate that the source disk is a Version 1.3 format (not necessary if 1.1 or 1.2). Filename is a wild card mask that allows you to select either a file name, extension or part of a file name, or if no file name is entered, the entire disk will be converted. Note that not all TRS80 Model III programs are fully compatible with the LNW80 computer. For more details, refer to page 84 of your DOSPLUS 3.4 user manual.

Eight Inch Drives

For proper double-density operation, the HIGH/LOW key on the keyboard must be UP and the AUTO SWITCHING control on the I/0 panel should be down.

Eight-inch System Disks

DOSPLUS 3.4 is also available on an 8 inch double-density SYSTEM DISK. On this disk is a program called CONV2/CMD. This program allows the conversion of programs from Radio Shack Model II disks to DOSPLUS on the LNW80. BASIC programs must be stored in ASCII format to be converted properly. NOTE THAT THERE ARE SOME DIFFERENCES BETWEEN MODEL2 BASIC and the LNWBASIC. Other ASCII files, such as SCRIPSIT files (not the program) can also be transferred using this program. The program can be used in two ways:

1. Convert entire disk by typing:

```
CONV2 :S :D
```

where S is the number of the source disk drive and D is the number of the destination disk drive.

2. Convert one program at a time by typing:

```
CONV2 FILESPEC:S :D
```

where FILESPEC is the name of the file or program to be converted, S is the source drive and D is the number of the destination drive.

CONV2/CM3 is also available on a 35 track single-density data disk. Contact your LNW dealer for additional details.

Color Mapping - TRS80 Black/White Games in Color

While MAP/BAS may be used as a color "etch-a-sketch" type program, one of the uses to which this program may also be put is to take to take graphics games written for the TRS80 Model I and convert them to color. This is done in a 3-step process.

1. Load in the TRS80 game with the color monitor connected. While running the program, mark the different areas of the screen that you would like to see appear as different colors

with a grease pencil or erasable felt tip marker.

2. Run the MAP/BAS program from LNWBASIC. Move the cursor to the left top edge of the rectangular region to be set and mark that point using selection 1. Then move the cursor to the bottom rightmost point of the rectangular color region and mark that using selection 2. Now, using selection 3, set the region to your desired color. Continue to map all the color regions that you desire. Now save the final mapped screen to disk using the name of your game as a guide (i.e. ANDROID/GRF for the ANDROID/NIM game).

3. Now create a BLD file which:
   a. Loads LNWBASIC
   b. PLOAD" your file"
   c. Sets the LNW80 to NODE2
   d. Exits LNWBASIC and loads and executes the machine-language game OR
   a. Runs your BASIC game.

For the game called GAME/CMD and our color file named GAME/GRF, here is how the BLD file would appear:

```
LNWBASIC
PLOAD"GAME/GRF"
MODE2
EXIT
GAME/CMD
```

In this manner your old TRS80 games will automatically load and run in beautiful living color!

MAP/BAS Program Listing

```
10 CLEAR1000
20 CLS:PRINT"WELCOME TO THE COLOR MAP AND DRAW PROGRAM":PRINT
30 PRINT"0. CURSOR IS THE TINY FLASHING  DOT  (UPPER  LEFT  OF
SCREEN)":PRINT"1, TYPE  FROM MAP SCREEN TO ENTER SYSTEM
MENU
40 PRINT"2. USE ARROWS TO DIRECT CURSOR
50 PRINT"3' DEPRESS THE HIGH/LOW SWITCH TO SLOW MOVEMENTS WHEN
DESIRED
60 PRINT"4. EACH TIME THE SYSTEM MENU  IS  ENTERED,  THE  DRAW
FUNCTION
70 PRINT"   (SELECTION 8) IS TURNED OFF'
80  PRINT"5.  LIFT  FINGERS  COMPLETELY  OFF  ARROWS TO CHANGE
DIRECTION"
90  PRINT"6   THE  SCREEN  IS CLEARED EACH TIME THE PROGRAM IS
RUN"
100 PRINT"7. YOU MUST USE A COLOR MONITORED WITH THIS PROGRAM"
110 PRINT:PRINT
120 INPUT"TO BEGIN THE PROGRAM DEPRESS ";X$
130 CLS
140 FLS(191)
150 PCLS


160 MODE2
170 COLOR7
180 X=0:Y=0:X1=0:Y1=0
```

```
190 Cl=POINT(Xl,Yl):IFM8=1THENCl=C
200 PSETXl,Yl:A$=INKEY$:IFA$=""THEN210ELSE230
210 I=I+1:IFI=5THENGOT0220ELSEGOT0200
220 I=0:COLOR0:PSETX1,Y1:COLOR7:GOT0200
 230 IF A$=CHRS(10)THEN660 ELSE 240
 240 IFA$=CHR$(91)THEN690
250 IFA$=CHR$(08)THEN720
260 IFA$=CHR$(09)THEN750
270 IFA$="
"ORA$=CHR$(13)THENGOT0290
280 GOTO 200
290 MODE0:CLS:C0=0:MS=0
300 PRINT"X,Y  COORDINATES  OF  CURRENT  CURSOR  POSITION  ARE
";X;",";Y
310 PRINT"X1,Y1 IS MARKED AS ";21;",''Z2
320 PRINT"X2,Y2 IS MARKED AS" 23;",0;24
330 PRINT"COLOR IS SET TO ";C
340     PRINT:PRINT"SELECT     ONE     OF     THE    FOLLOWING
FUNCTIONS:0:PRINT"1. MARK CURRENT CURSOR POSITION AS X1,Y1"
350 PRINT"2. MARK CURRENT CURSOR POSITION AS X2,Y2"
360 PRINT"3. SET COLOR VALUE AND MAP COLOR FIELD"
370 PRINT"4. SET CURSOR POINT TO NEW POSITIONS
380 PRINT"5  SET ENTIRE SCREEN TO A COLOR"
390 PRINT"6. LOAD SCREEN FROM DISK"
400 PRINT"7. SAVE SCREEN TO DISKS
410  PRINT"8.  DRAW  SCREEN FROM CURRENT CURSOR POSITION USING
CURRENT COLOR"
420 PRINT" TO RETURN TO MAP SCREEN"
430 A$=INKEY$:IFA$=""THEN430
440 IF A$="1"THENGOT0540
450 IF A$="2"THENGOT0550
460 IF A$="3"THENGOT0560
470 IF A$="4"THENGoT0570
480 IF A$="5"TBENGOT0640
490 IFA$="6"THENGOT0630
500 IFA$="7"THENGOT0600
510 IF A$="8"THENGOT0650
520 IFA$=CHR$(13)THENGOT0590
 530 GOTO 430
540 21=X:22=Y:FLS:MODE2:COLOR7:GOT0200
550 Z3=X:Z4=Y:GOT0290
560
INPUT"COLOR";C:COLORC:MODE2:LINEZ1,Z2,Z3,Z4,SET,BF:GOT0580
570                 INPUT"X                COORDINATE";X:INPUT"Y
COORDINATE";Y:GOSUB780:FLS:GOT0200
580 FLS:MODE2:COLOR7!GOT0190
590 FLS:MODE2:COLOR7:GOT0200
600 INPUT"FILE NAME TO SAVE TO";F1$:MODE2
610 COLORCl:PSETXl,Yl
620 PSAVE F1$:GOT0290
 630 INPUT"FILE NAME TO LOAD";F1$:PLOAD F1$:MODE2:FLS:GOT0190
640      INPUT"BACKGROUND      COLOR      (0-      SET      TO
WHITE)";C3:MODE2:PCLS(C3):FLS:GOT0190


650 M8=1:INPUT"WRITE COLOR";C0:NODE2:FLS:GOTO200
660 Y=Y+1:IFY=192THENY=0'MOVE Y UP ONE
670 GOSUB 780 ’ CLEAR SCREEN AND WRITE NEW SCREEN
680 GOSUB S0 0: IFA=1THENGOT0660ELSEGOT0200
690 Y=Y-1:IFY=-1THENY=191
700 GOSUB 780 '
710 GOSUB800:IFA=1THENGOT0690ELSEGOT0200
720 X=X-1:IFX=-1THENX=127
730 GOSUB 780
740 GOSUB800:IFA=lTHENGOT0720ELSEGOT0200
750 X=X+1:IFX=128THENX=0
760 GOSUB 780
```

```
770 GOSUB800:IFA=1THENGOT0750ELSEGOT0200
780
MODE2:COLORCl:PSETXl,Yl:COLORH:Cl=POINT(X,Y):PSETX,Y:Xl=X:Y1=
Y:COLOR7:PSETX,Y:IFM8=0THENRETURNELSECl=C0
790 RETURN
800 A=PEEK(&H38FF):IFA=0THENRETURNELSEA=1
810 A=1:RETURN
```

LNWBASIC and TRS EXTENDED COLOR BASIC

Because of the hardware differences between the TRS COLOR computer and the LNW80, there are some differences between LNWBASIC and TRS EXTENDED COLOR BASIC. However, the similarities between the two remains most striking.

Below is a table showing the similarity between the graphics commands,

Table 12.0 - Similarity Between LNWBASIC & TRS EXTENDED COLOR BASIC Graphics.

Command	LNW80	Color Computer
Circle	CIRCLE X,Y,XR(,YR)(,SA)	CIRCLE (X,Y),R,HW,l,SPEP
Color	COLOR C	COLOR Cl,C2
Draw	DRAW + numerous options	DRAW + numerous options
Fill Screen	FLS X	SCREEN
Line	LINE Xl,Y1,X2,Y2,SET (,B)	LINE (Xl,Yl)-(X2,Y2) PSET(,B)
Resolution	MODE X	PMODE X,Y
Clear memory,set color	PCLS X	PCLS X graphics
Point	POINT(X,Y)	POINT (X,Y)
Set, reset point	PSET X,Y PRESET X,Y	SET(X,Y(,C)) PRESET (X,Y)

Next page | TOC

SECTION 13: LNW80 DETAILED DESCRIPTION AND SPECIFICATIONS

General

The LNW80 base unit measures 16.5"W x 3.5"H x 22"D and weighs 26 lbs. The base unit contains the CPU, Memory, Keyboard, Video and peripheral controllers, power supply and cooling fan. All peripherals and accessories connect to the LNW80 via connectors on the rear panel. The optional color or monochrome monitor fits easily on the large surface of the LNW80 .

The LNW80 is available in TWO different models:

#105000 LNW80 120 VAC 60Hz
NTSC VIDEO (525 LINES USA/JAPAN)

#105001 LNW80 as listed above with optional RGB
interface installed.

CENTRAL PROCESSING UNIT (CPU)

Processor:	Z80A
Features:	158 instructions (with all 78 of the 8080 CPU instructions)
Clock Speed:	4MHz
ROM Wait States:	1 (250ns)
RAM Wait States:	NONE

MEMORY

User RAM:	48K Bytes
Graphics RAM:	16K X 6 Bits
Video RAM:	1K Bytes
ROM:	12K Bytes MICROSOFT BASIC-80 (Level 2 compatible)

KEYBOARD

73 KEY expanded professional typewriter style keyboard including:

1. 11 key numeric pad
2. Control key
3. Shift lock and caps lock keys
4. Localized cursor control keys (arrows)
5. Cassette speed switch (500/1000 baud)
6. Underline key
7. Contains all the TRS-80 Model I keys plus more

The keyboard also includes two RESET (RST) Keys which, when depressed together, cause a system master reset.

MICROSOFT BASIC-80 Interpreter

BASIC Functions:

ABS ASC ATN
CDBL CHRIS CINT
COS CSGN ERL
ERR EXP FIX
FRE FRE($) INKEY$
INP INT LEFTY
LEN LOG MEN
MID$ PEEK POINT
POS RIGHT$ RND

FGN SIN SQR
STR$ STRING$ TAN
USR VAL VARPTR

BASIC Statements:

AUTO CLEAR CLOAD
CLOAD? CLS CONT
CSAVE DATA DEFDBL
DEFINT DEFSGN DEFSTR
DELETE DIM EDIT
END ERROR FOR..TO..STEP/NEXT
GOSUB GOTO IF...THEN...ELSE
INPUT LET LIST
LLIST LPRINT LPRINTTAB
LPRINTUSING NEW ONERROR GOTO
ON..GOSUB ON..GOTO OUT
POKE PRINT PRINT0
PRINTS PRINTTAB PRINTUSING
RANDOM READ REM
RESET RESTORE RESUME
RETURN RUN SET
STOP SYSTEM TROFF
TRON

OTHER FEATURES

Auto Line Numbering
Full Editing Features
Keyboard Rollover
16 Digits Accuracy
Unlimit Array Dimensions
255 Character String Length
Upward Compatible with Disk BASIC
100% TRS80 Model I Level 2 Compatible

VIDEO DISPLAY SPECIFICATIONS
Text Modes:

l. 64 Characters per line, 16 lines.
2. 32 Characters per line, 16 lines.

Each character is a 5x8 matrix in a 6xl2 rectangle. The hardware character generator supports both upper and lower case (with descenders) for a total of 96 characters and symbols.

Graphics Display Modes

Table 13.1 - Graphics display mode details

GRAPHICS MODES	GRAPHICS RESOLUTION		
	TEXT MODE 1	TEXT MODE 2	COMMENTS
"0" LOW RES	128X48	64X48	+TEXT
1" HIGH RES BSM	128X48+ 480X192	64X48 240X192	+TEXT +TEXT
"2" LOW RES COLOR	12SX192 (8)	64X192(8)	+TEXT NOTEl
"3" HI RES COLOR color defined by:	48SX192 pixels 128X16 (8)	240X192 pixels 64X16 (8)	

NOTEl: If text is displayed in text mode l and graphics mode 2 then the display will exceed the bandwidth of NTSC video. An RGB monitor will display this mode accurately, however.

Software Character Generation

Besides using the capabilities of mode 1 and mode 3 for graphics alone, these modes can be used to extend the TEXT DISPLAY modes. With the special character generation software supplied with the LNW80, the following additional text modes are usable both at the operating system level and from BASICS

STANDARD TEXT MODE	GRAPHICS TEXT NODE
l. 64 characters, 16 lines	80 characters, 16 lines OR 88 characters, 24 lines
2. 32 characters, 16 lines	40 characters, 16 lines OR 40 characters, 24 lines

In this software, each character is a 5x8 matrix in a 6xl2 rectangle (16 lines) or a 5x8 matrix in a 6x8 rectangle (24 lines).

VIDEO DISPLAY OUTPUTS

Table 13.2 - Video display output specifications

Standard:

OUTPUT	SPECIFICATIONS
1 . B&W VIDEO	IMPEDANCE: 75 OHM SIGNAL : 1.8V p-p (+/-.25V) SYNC : NEGATIVE
2. LOW RES COLOR OUTPUT	IMPEDANCE: 75 OHM SIGNAL : 1.5V p-p (+/-.35V) SYNC : NEGATIVE CHROMA : 3.579 MHz (NTSC)

Optional

OUTPUT	SPECIFICATIONS
3. HIGH RES COLOR	IMPEDANCE: 330 OHM
(RGB)	SIGNAL : TTL OPEN COLLECTOR
	SIGNAL POLARITY
RED, GREEN, BLUE	POSITIVE
HORIZONTAL SYNC	POSITIVE
VERTICAL SYNC	POSITIVE

The following chart defines the display content of the three display outputs under the four display modes.

DISPLAY MODE #	B&W VIDEO	LOW RES COLOR	HIGH RES COLOR
MODE 0	X	X	X
MODE 1	X	X	X
NODE 2		X	X
MODE 3			X

Recommended Monitor Types

The following chart details the recommended video peripherals which can be connected to the LNW80.

Table 13.3 - Video Peripheral Types

OUTPUT	DEVICE	COMMENTS
B&W VIDEO	l. MONOCHROME MONITOR	>10MHz bandwidth
	2 VIDEO COLOR MONITOR	32 & 40 CHARS/LINE ONLY
	3. TELEVISION SET With user supplied RF modulator	32 & 40 CHARS/LINE ONLY
LOWRES COLOR	1. VIDEO COLOR MONITOR	32 6 40 CHARS/LINE TEXT 128X192 COLOR OK,NO TEXT
	2. COLOR TELEVISION With user supplied RF modulator	32 & 40 CHARS/LINE TEXT 128X192 LIMITED CLARITY
	3. MONOCHROME MONITOR	USE ON B&W VIDEO OUTPUT
RGB COLOR	1. LOW RES RGB MONITOR <320 lines horiz. resolution	GOOD CLARITY IN LOW RES FAIR CLARITY IN HIGH RES
	2. MEDIUM RES RGB MONITOR	EXCELLENT DISPLAY IN ALL DISPLAY MODES

FLOPPY DISK DRIVE INTERFACE

Drive Types:	5-1/4" and 8" SHUGART compatible
Number of Drives:	4 Single-sided or 3 dual-sided drives
Interface:	34 Contact 5-1/4" floppy drive compatible Optional 34 to 50 conductor cable adaptor required to connect 8" disk drives.
Drive Density:	Single or Double
Data Separation:	Analog Phase Locked Loop
Maximum Storage:	3,550,000 Bytes on 3 dual-sided 8" drives

Other Features

5-1/4" and 8" drives in any mix.
Single and double-density in any mix.
35, 40, 77, 80 track drive support
5-1/4" or 8" system disk (drive 0).
Precision Write Precompensation.

Double-Density Storage Capacity:

Five Inch Drives (formatted storage per drive).

161,280 bytes -35 track ss
322,560 bytes -35 track ds
184,320 bytes -40 track ss
368,640 bytes -40 track ds
368,640 bytes -80 track ss
737,280 bytes -80 track ds

Eight Inch Drives (formatted storage per drive).

591,360 bytes -77 track ss
1,182,720 bytes -77 track ds

PRINTER INTERFACE

Type: Industry Standard Centronics 8-bit parallel
100% TRS-80 compatible

NOTE: The RS232C serial communication interface can be configured for operation with printers which require a serial RS232 port. Routing the printer output from most application software requires that a program (listing supplied in the LNW80 computer documentation) be resident (usually high memory) in memory. Software which uses its own printer driver software may not function with this arrangement.

CASSETTE INTERFACE

Format: Amplitude Nodulated.
TRS-80 Model I and III (500 baud only)
compatible.

Data Rate:	Baud Rate	CPU Speed
	500	1.77MHz
	1000	4.00MHz

Recorder Type: Inexpensive Battery or Line-Powered Portable.

RS232-C ASYNCHRONOUS SERIAL INTERFACE

Type: Full Duplex.
Handshaking: Fully supported under software control.
Baud Rates: Switch selectable at the following rates:
110, 155, 300, 600, 1200, 2400, 4800, 9600
Parity: Even, odd, or disabled (sofware selectable)
Word Length: 5, 6, 7, 8 BITS (software selectable).
Stop Bits: 1, 1.5, 2 (software selectable),
Connector: FEMALE DB25, mounted on the rear panel.
Config: Factory configured to connect to Data Communication Equipment (DCE, e.g., modems). Proper cable wiring will allow connection of Data Terminal Equipment (DTE, e.g., serial printers and other LNW80 computers).

TERMINAL EMULATION CAPABILTY

A large amount of dumb and intelligent terminal software is available to run on the LNW80. A listing of a dumb terminal program is supplied in the LNW80 documentation.

EXPANSION PORT

This 40-pin CPU bus has all the ADDRESS, DATA, and control lines to expand the capabilities of the LNW80. This bus is electrically equivalent to the SCREEN PRINTER" bus on the TRS-80 Model I. Here are just some of the products which connect to the EXPANSION BUS and are available from independent hardware suppliers:

* Exatron Stringy Floppy
* Eprom add-on memory/ programmers
* Corvus Hard Disk/ Constellation
* TCHRON-Battery-powered clock calender
* Data aquisition equipment
* Industrial controllers

- * Speech synthesizers
- * Voice recognition equipment
- * Orchestra85-stereo,multi-voice,music synthesizer

PLUS ANY ACCESSORY designed to connect to the TRS-80 Model I screen printer port.

REAL TIME CLOCK

Type: Interrupt "heartbeat" type
Frequency: 40 HZ

NOTE: The real time clock feature is not available on the cassette only systems without one of the following programs:

1. Microsoft Level 3 BASIC
2. Radio Shack Real Time Clock Cassette program

WE RESERVE THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE

LNWBASIC (C) MODULAR SOFTWARE ASSOCIATES
AN ADVANCED DISK BASIC FOR THE LNW80

Specifications

LNWBASIC provides an EXTENSION to the DISK BASIC in DOSPLUS, NEWDOS80 2.0, or TRS-DOS 2.3 to add high resolution graphics, color, special keyboard functions, sound, RS232 communications and advanced programming commands. LNWBASIC features a CREATOR which allows the user to select from the more than 40 new commands to make a custom-tailored BASIC interpreter. Syntactically similar to the R/S Color Computer Extended Color Basic, LNWBASIC offers such commands as DRAW, LINE, COLOR, CIRCLE, MODE and SOUND. The following is a brief

list of the commands:

BLINK - Switch blinking cursor on/off

CALL - Execute a machine-language subroutine

CIRCLE - Draw circle with parameters

COLOR - Set color for mode 2 graphics (color)

CONV - Convert input to hex, decimal, or ASCII

DEFKEY - Modify 10 user-definable keys

DISKEY - Display the current set of defined keys

DLOAD - Load an object code file from disk

DO/UNTIL - Do/Until construct

DRAW - Draw lines with Turtle Graphics, rotation and scale parameters

DRUN - Exit LNWBASIC and execute disk object program

EXIT - Exit LNWBASIC to DOS

FLS - Fill the text screen with ASCII character

GSUB - GOSUB or

GTO - GOTO or

HIMEM - Change MEMORY SIZE? from BASIC

#"label" - Make this line referenced by a label rather than line number

LCASE - Toggle CAPS LOCK on and off

LINE - Set or reset line, box, or box with fill

LOADKEY - Load a user-definable key definition file from disk

LOC. - Locate a string or BASIC token(s)

MODE - Set the graphics display mode

NTROFF/ON- Turn NEW TRACE UTILITY off/on

PCLS - Fill the graphics screen with a specific value

PLOAD - Load the graphics screen from a disk file

PON/POFF - Route video to the printer also

POINT - Test graphics point/return color

PSAVE - Save the graphics memory to a specified disk file

PSET - Set a point (with color parameter if in mode 2)

PRESET - Reset a point (in color will be set to white)

QUICKEY - Turn on/off key to enter shorthand BASIC keywords

REPEAT - Turn on/off repeating key functions

REST - ’RESTORE' to a specified data line

RS232 - Set RS232 initialization

RSIN - Input from the RS232C device or from the keyboard

RSOUT - Route the printer output to the RS232 port

SAVEKEY - Output the current user-definable key list to a specified disk file

SOUND - Output tone to the cassette port with frequency, duration, and waveform

SPOOLON - Direct the printer output to a specified disk file

SPOOLOFF - Turn off spooling

XSTR$() - Execute a string as a BASIC statement(s)

SECTION 14: SHOOTING TROUBLE

Every now and then (usually Monday mornings) the computer will not behave as desired. We are faced with the sudden realization that the noble computer has its own defects, just like any other manufactured contraption.

The majority of problems arise at electrical or data path connections. If we stop for a minute and focus our thoughts on what actually happens at electrical junctions, we might get a better appreciation as to why good connections are important. There are the electrons travelling merrily along the surface of the wires, when suddenly they encounter a break (as in the case of a socket). If the the two sockets are only loosely interconnected, and as a result only making contact at a few points, then you have a situation similar to that at the exit points of a crowded building during a fire. The pile up of electrons causes heat generation. This melee results in distortion of data signals, and voltage fluctuations on power lines. The moral: Look after your connections.

Below is a list of symptoms, causes and cures.

Symptom.	Cause.	Cure.
No video response.	Bad connections or monitor.	Check all connections and switches. Are you using the correct monitor jack? Adjust brightness & contrast.
Screen full of gibberish after ROM reset.	BREAK not depressed during power up, or CAPS LOCK pressed.	Depress BREAK & both RESET keys. For disk system, depress both RESET keys only.
Cassette program will not load.	Various.	See "So It Won't Load," page 29.
Computer "hangs."	Programming error. improper use of POKE, calling a peripheral which is not connected or somehow damaged. Loose electrical or peripheral contact.	Uarious
Disk system won’t boot	Is drive zero 5/8 switch set correctly? Are drives connected correctly?	See page 37.

Outside Interference

AC power supplies vary slightly in their output during peak usage periods. This rarely presents a problem, and most people never become aware of it. As a precaution, the LNW80 contains a line filter to smooth out any fluctuations. In some areas, voltage fluctuations may be large (noticeable in sudden dimming of lights, for example). Local heavy electrical industry, home-grown power source or faulty electrical equipment on the same circuit as the computer can present problems.

Voltage fluctuations outside of your control can be resolved by fitting a line filter designed for microcomputers.

In extreme cases, an alternate power supply may be the only answer.

APPENDIX A: A BUYER’S GUIDE TO MONITORS

The LNW80 interfaces with three different types of video monitors:

1. Monochrome (commonly called Black and White) or Green Phosphor Monitor
2. NTSC Composite Color Monitor (a TV set with an RF modulator may be used)
3. RGB TTL TYPE direct drive monitor

Ask your dealer to recommend the monitor that he feels will best suit your needs. Remember that only the Monochrome and the RGB monitors will deliver a sharp 80-column text display and crisp, high resolution graphics.

Monitors come in a variety of prices and levels of quality, and since you cannot tell how well it will work before you hook it up, we suggest you ask your dealer for his recommendation. Here is a list of monitors known to interface properly with the LNW80 computer. We have included only 12" monochrome and 13" color monitor tube sizes. Other sizes are available, but we recommend these sizes for optimum viewing. To see if other monitors not listed here will work properly, refer to the complete LNW80 and the monitor’s specifications, or ask your dealer for his recommendations. This is by no means an all inclusive list. We regret that we cannot test and approve all the monitors that will work properly with the LNW80 due to the vast number of monitors available.

Monochrome Monitors

There is an abundance of low cost monochrome monitors that will work with the LNW80. There are two basic types of monochrome monitors - (1)STANDARD and (2) GREEN PHOSPHOR. The green phosphor type monitor displays the characters in green and is easy to read for extended periods of time. Whichever monitor type you choose, be sure to select a monitor that can use the 1.8VP-P video signal output by the LNW80 through a low cost RCA type phono jack. The TRS80 Model I monitor will not work with the LNW80 because it requires a special connection with +5V DC power, and it cannot handle the 80-column display width. In addition, it lacks the overall bandwidth and clarity to display the high resolution graphics.

There are some brands of monitors which may not function properly with the LNW80 computer without reducing the signal level driving the monitor. These monitors are too sensitive to the video signal and will display characters in such a manner as to make them appear "block-like" or smeared. These monitors can have their input signal reduced by installing a resistor in series with the "hot side" of the cable. The value of this resistor should be somewhere in the neighborhood of 33 to 75 ohms. The following monitors may or may not require this modification:

NEC JB1201M
HEATH/ZENITH ZVM 121
AMDEK VIDEO 300-G

Recommended List of Monochrome Monitors

The following two monitors are known to function ideally with the LNW80. The AMDEK monitor has a strange connector and an "RCA PHONO JACK to UHF" cable must be purchased from your dealer. The BMC monitor uses a simple, low-cost "RCA to RCA" cable just like the HI-FI cables on your stereo system. The AMDEK 100G and the BMC monitors are both GREEN PHOSPHOR types. Of the two monitors, the BMC has the highest quality display.

Table A.0 - Green Phosphor Monitors for the LNW80

MANUFACTURER/MODEL#		BANDWIDTH	COLOR/STYLING	COMMENTS
ANDEK	VIDEO 100/100G	12MHz	WHITE/GRAY	LOW COST
BMC	KG12/BN12A	18MHZ	TAN/GRAY	HIGH Quality

NTSC Composite Video Color Monitors

As with the monochrome monitors, there is a wide choice of monitors to choose from. All the following monitors use a standard "RCA to RCA" cable (HI-FI type) to connect to the computer. A color television with an RF modulator will not achieve the resolution of these monitors:

AMDEK COLOR 1
ZENITH 13" COLOR MONITOR (HEATHKIT)
BNC BM1400CLU
SANYO 13" COLOR
NEC 12" JC1201 M(A) COLOR

RGB Color Monitors

Due to the wide differences in the electrical requirements of the many RGB monitors that are on the market, it is important that you check with the LNW80 specifications or your dealer before purchasing an RGB monitor. There are two basic resolution levels in RGB monitors - high and low. The high resolution RGB monitors allow for a very crisp, clear display in both graphics and text for up to 80 characters/line and 24 lines. These monitors use a picture tube that has tiny round dots that make up the picture (one dot/color).

The selection of RGB monitors for the LNW80 is more limited than the other monitor types. The monitors that will work on the LNW80 computer without modification to either the monitor or the computer (they may require modification to the connecting cable) are:

AMDEK COLOR 2
AMDEK COLOR 3
HITACHI CM1472

There are firms modifying other monitors for use on the IBM PC, and these may be compatible with the LNW80. If the monitor has been modified to accept positive TTL data, positive TTL horizontal sync, positive TTL vertical sync and the monitor has internal pull up resistors for termination on the RGB input lines, then it should be compatible with the LNW80. For more details on the RGB interface in the LNW80, refer to the LNW80 Technical Reference Manual or contact your LNW Research dealer.

The monitors that WILL NOT WORK without modification to either the computer or the monitor are:

NEC 1202DH RGB
TECO RGB

No details are available for connection to these monitor types, and therefore, we do not recommended using these monitors.

APPENDIX B: DISK DRIVE TUTORIAL

The LNW80 computer can interface with a wide variety of flexible disk drives. Connecting disk drives to your LNW80 computer, when the drives are properly configured, is as easy as plugging the drivers) cable into the rear of the computer. Disk drives and cables which are configured to run on a TRS80 Model I are fully compatible with the LNW80. Up to 4 single-sided drives and 3 dual-sided drives can be attached to the LNW80. Proper configuration for drives and cables should be provided by your computer dealer.

In the event that the computer retailer cannot provide this configuration or you have drives that are not configured properly or there is some aspect of the configuration that you do not understand, this section is written for you.

The History of the TRS80 Disk

When Tandy introduced their minidisk drive for the TRS80 Model I, they developed some unique conventions. The 34-pin SHUGART (Shugart Associates was the first to set the standard in flexible disk drives) compatible minifloppy (5-1/4") interface was already the standard in the industry. The 50-pin Shugart-compatible 8 inch drive interface had been developed years earlier and was adopted by most of the disk drive manufacturers. The way Shugart-compatible disk systems work is that the operator can daisy-chain (parallel) up to four disk drives on the same cable. While the disk interface circuits can only talk to one drive at a time, there is a mechanism for selecting which of the four drives the interface is talking to. This mechanism of selection is done by providing four unique signals (would be known as select lines, - DS1 to DS4) that would be on the cable. Each drive would be selected by only one of these signals, Since no two would be on at one time, each drive could be told when the disk interface wanted to talk to that drive. The other non-selected drives would then act as though they were not even on the cable. Tandy then only had to develop a system of SELECTING the four disk drives from the expansion interface to the minifloppy through the 34-pin cable. Drive selection was accomplished on the disk drive itself through a DIP shunt or DIP switch that could be set by the operator. Most of the original disk drives had only 3 drive-select positions, DSl-DS3.

Termination Resistors

Since the data to and from the disk drive was high-speed information and it had to travel a long distance along the cable, TERMINATION was required of the last drive along the cable, Termination resistors varied from drive to drive. Termination is a process by which a transmitted signal is absorbed so as not to allow any reflection of the signal on the line. Some drives had permanently wired resistors and a DIP shunt to select whether the drive would be terminating or not. Other drives had termination resistor packs mounted in a DIP package (mounted in a socket) that could be removed if the drive was not to be the terminating drive.

Termination, cabling and drive selects were just some of the problems that had to be overcome in developing a system of connecting disk drives to the TRS80.

Drive Selection & Pulled-Pin Drive Cables

Tandy wanted to select up to 4 drives, To do this, the customer was required to open up his drives and change the settings as new drives were added to the system. This was impractical. A mechanism was developed that would use the cable to perform the task of assigning the drive numbers based on their position along the cable. The mechanism would become known as "pulled pins". Here is how it works:

Each drive is made the same. Pins 10, 12, 14 on the edge card of the drive are tied together. Since the fourth drive select did not exist on the EARLY GENERATION drives, the disk drive is modified to connect pin 32 of the edge card to the drive select lines on the edge card at pins 10, 12, and 14. The disk drive cable is a 34-pin ribbon-cable assembly with termination-type edge card plugs at the head (where the computer connects) of the cable and at each of the 4 drive positions along the cable. Each connector along the cable has a different set of pins pulled, such that only one of the 4 drive select pins is installed at each location.

Table B.0 - Drive Selection by Pulled Pins

Drive	Pins Pulled	Drive Select Line
0	12, 14, 32	10
1	10, 14, 32	12
2	10, 12, 32	14
3	10, 12, 14	32

Tandy sells the FIRST drive with the cable and the termination installed. The second, third and fourth drives do not have the termination installed. They sell the first drive as a different part from the rest. The following chart illustrates the drive select lines on the cable and the drive:

Table B.l - Drive Select Lines on Cable 6 Drive
(* = Early Generation Drives
** = Later Generation Drives)

Disk Drive	Drive Select	Disk Drive Pinout	Interface Pinout
0	DS1	10	10
1	DS2	12	12
2	DS3	14	14
3 *	N/A	N/A	32

3 **	DS4	6	N/A

If it is so simple, why are we spending so much time talking about it? Because before too long, Tandy wasn't the only company selling disk drives for the Model I. There were VISTA, MTI, PERCOM, AEROCOMP and many others trying to sell drives a little less expensive. These firms do not actually build the disk drive mechanism and electronics themselves (neither did Tandy at the time). They simply purchase the disk drive from manufacturers such as TANDON, MPI, SHUGART, TEAC, QUME, PERTEC and others and supply the disk drive installed with a power supply in a metal enclosure. This made life difficult since these firms supplied little, if any documentation, to assist the first-time computer owner. This mail-order business grew rapidly since the lower prices attracted many.

The powerpack on the back of the Radio Shack supplied TRS-80 disk drive allowed the case to be designed to allow the cable to be connected from outside the drive. When the user adds a new drive to his system, he simply plugs the cable into the rear of the drive. The other manufacturers, in their effort to save a few dollars, have designed drive cases with the power supply inside the case, thus making it too deep for the disk drive's edge card to be accessible from the outside of the drive. So what happens next? Extender cables must be used to allow the edge card to be extended to the rear of the case, making it accessible without opening the drive's case. Are our problems now solved? No, they just began...

Double-Sided Disk Drives: Two Heads Are Better than One

Double-sided disk drives meant another problem for the disk drive business. Pin 32 of the Radio Shack interface and the LNW SYSTEM EXPANSION was used for the fourth drive select, and the disk drive manufacturers (of these new dual-sided drives) used that pin for the side select control. This did mean that through a bit of luck double-sided disk drives could be easily configured for operation by using the fourth drive select as the side select. But it did not happen that easily.

When double-sided drives were introduced, no operating system would support double-sided operation. The disk drive manufacturers did not modify the drives when they sold them, but instead provided difficult instructions for the user to modify the drive himself, This modification used the drive selects to select a different side of the same drive. It was messy, very difficult to do, and it never caught on. When double-sided operation was finally accepted by the operating system companies (NEWDOS80 and DOSPLUS) there were differences in opinion on how it would be implemented. Dosplus 3.3 treats each side of a double-sided disk as a separate volume with its own directory, On Dosplus 3.4, this would be changed and double-sided operation would allow each dual-sided diskette to represent one volume with only one directory. Newdos80 V2.0 and LDOS 5.0 and 5.1 have a similar structure.

Double-Density Catches On

Double-density operation became popular with the PERCOM DOUBLER. LNW Research released the LNDoubler soon after. After that, a wide variety of doublers appeared. Even Tandy has introduced a doubler. Eight-inch drives became popular with the OMIKRON CP/M adaptor and eight-inch adaptor board. When the LNDoubler 5/8 was announced, eight-inch support for double-density had already been developed by Microsystems (DOSPLUS 3.4) and by Apparat (NEWDOS80 VERSION 2). Double-density also provided its own problems. Shugart SA400 drives (early Tandy drives) would only access 35 tracks, and the drive heads did not have adequate resolution for double-density operation. The OLD Shugart SA800,801 8-inch disk drives (newer 800, 801's work perfectly) also did not have the resolution for double-density operation. The newer Shugart drives, and almost all other drives, can handle double-density operation with no problem.

Number of tracks, head-stepping rate, and bead-load delay have also been drive parameters that have caused some interfacing problems between operating systems and disk drives. Drives should be configured such that when the motor comes on, the heads load regardless of the drive select. Be sure to set the stepping rate (programmable in DOSPLUS and NEWDOS80) to the appropriate setting. These operating systems are initially set at 40ms (milliseconds) and should work with any disk drive as initially configured.

Configuring 5-1/4 Inch Drives

The pulled-pin cable will work adequately with four single-sided drives, but fails to function with the dual-sided drives, since pin 32 (side select) is only available to the last drive on the cable. A pulled-pin cable may be "fixed" by removing the keys in the cable-connectors (small piece of plastic that prevents the connector from being plugged in backwards) and turning the cable around. The pulled pins will then become unused ground lines, and all the drive selects will be available on each connector. This means that the drives themselves must be designed to accomodate the drive selection on the drive and not on the cable. Older drives did not have four drive-select positions, but this is not important since we are using up to 3 dual-sided drives.

Table B.2 shows the pin specifications for the 34-pin drive bus.

Pin #	Description
2	Not Used
4	Not Used
6	Not Used
8	Index
10	Drive Select 1
12	Drive Select 2
14	Drive Select 3
16	Motor On
18	Direction Select
20	Step
22	Write Data
24	Write Gate
26	Track 0
28	Write Protect (Active Low)
30	Read Data
32	Side Select (Dual Sided Drives)
34	Not Used

The following describes the configuration shunt settings for the most popular minifloppy disk drives. Double-sided drives already use pin 32 for the side select.

MPI Disk Drives

This description follows for these models only:

51, 52, 91 and 92

Shunt	Description	No Pins Pulled	Pins Pulled
1	Head load on select	Open	
2	Drive select 1	On if drive 0	On
3	Drive select 2	On if drive 1	On
4	Drive select 3	On if drive 2	On
5	Mux	Open	Open
6	Drive select 4	On if drive 3	On

Note: If drive 4 is selected, a jumper must be installed between pin 32 and pin 6 of the edge card. For double-sided operation, do not use more than three drives total.

Tandon Disk Drives

Models TM100-1,TM100-2,TM100-3 and TM100-4

Shunt Pins at 1E

Shunt	Description	Correct Setting
1	Head load on select	Open
2	Drive select 1	On if drive 0
3	Drive select 2	On if drive 1
4	Drive select 3	On if drive 2
5	Drive select 4	On if drive 3
6	MUX	Open
7	Not used	
8	HM On	

Note: If drive 4 is selected, a jumper must be installed between pin 32 and pin 6 of the edge card. For double-sided operation, do not use more than three drives total.

Siemens/Wangco Model 82

Shunt	Description	Correct Setting
1	Head load on select	Open
2	Drive select 1	On if drive 0
3	Drive select 2	On if drive 1
4	Drive select 3	On if drive 2
5	Mux	Open
6	Not used	
7	Head load, motor on	On

Note: If configuring for drive number 4, a wire must connected between pin 32 of the edge card and pin 1 of IC 1D. All the rest of the drive selects should be off.

Teac Model FD50 Series

Switch	Description	No Pins Pulled	Pins Pulled
HS	Head load on select	Open	
DSO	Drive select 0	On if drive 0	On
DSl	Drive select 1	On if drive 1	On
DS2	Drive select 2	On if drive 2	On

MX	MUX	Open	Open
DS3	Drive select 3	On if drive 3	On
HM	Head load on motor	On	On

Note: If configuring for drive number 4, a jumper must be installed between pin 32 and pin 6 of the edge card. For double-sided operation, do not use more than three drives total.

Other 5-1/4 Inch Drives

If you have a drive that is not listed above, refer to the user manual for that disk drive. Most drives are similar to one of the above types.

Eight-inch Drives

Eight-inch disk drives have a 50-pin edge card to interface to a 50-pin cable instead of the 34-pin cable used on the 5-1/4" drives. It is then necessary to use some type of cable-adaptor between a 34-pin cable connected to the rear of the LNW80 and a 50-pin disk drive cable for the 8" drives. This 34-to-50 pin cable-adaptor is available from your computer retailer under the LNW part number 1096, and it has two gold contact edge cards which mate the 34-pin cable and the 50-pin cable. The 34-pin cable must not be of the pulled-pin type since missing pins will not allow drive select lines to pass to the 8" drive 50-pin cable. Here is a drawing to illustrate a typical multidrive setup with both 5-1/4" and 8" disk drives. Note that an 8" disk drive may be the system disk (drive select 0) if the 5/8 SWITCH inside the LNW80 is positioned to the 8" side. (See Figure 5.4 - 5/8 switch in action).

Configuring 8-inch Drives

The LNW80 is designed to interface with 8" disk drives without the drives themselves requiring modification. As with 5-1/4" disk drives, drive select shunts or switches on the drives themselves, as well as termination resistors must be properly configured. Note that termination resistor packs are still only required on one of the disk drives. A properly configured disk drive and cable requires only the simple connection between the 34-pin cable, the cable-adaptor and the 50-pin 8" drive cable, Proper configuration for drives and cables should be provided by your computer dealer. In the event that the computer retailer cannot provide this configuration or you have drives that are not configured properly or there is some aspect of the configuration that you do not understand, this section is written for you.

Eight-inch Disk Drive Specifications

Eight-inch disk drives are different from five-inch drives in many ways. As mentioned earlier, the interface between the drive and the controller is a 50-pin bus. The pin specifications for the 50-pin bus are given below.

Table B.3 - Pin Specifications for the 50-pin 8-inch Drive Bus

Pin #	Description
2	Ground or Lower Write
4	Not Used / Reserved

6	Not Used
8	Not Used
10	Two Sided (Not Used)
12	Disk Change (Not Used)
14	Side Select (Dual-sided drives)
16	Activity / In Use
18	Head Load (Not Used)
20	Index
22	Ready (Not Used)
24	Not Used
26	Drive Select 1
28	Drive Select 2
30	Drive Select 3
32	Drive Select 4
34	Direction Select
36	Step
38	Write Data
40	Write Gate
42	Track 0
44	Write Protect (Active High)
46	Read Data
48	Not Used
50	Not Used

Note: In the eight-inch drive manuals, - "NOT USED" may be referred to as alternate I/0 or reserved.

If the drive that you would like to use has a cable interface that differs radically from the above, then it is possible that you do not have a Shugart-compatible disk drive. If that's the case, then it will not properly interface with the LNW80. The following drives are the ONLY drives that have been used extensively with the LNW80 computer and the DOSPLUS 3.4 operating systems

Table B.4 - 8 Inch Drives Tested With LNW80 & DOSPLUS 3.4.

MANUFACTURER	MODEL NUMBER	SIDES
Shugart	SA800/801	Single
Shugart	SA850/851	Dual
Qume	DATA TRACK 8	Dual
Tandon	TM848-1	Single
Tandon	TM848-2	Dual

Eight-inch drives also provide more configuration options. Luckily, most of the manufacturers have retained the Shugart notation for the most part. The proper configuration for the drives is such that the drives have not been modified in any manner, and the jumper (or trace) options are installed just as the drive is delivered from the factory.

Some 8-inch drives that are sold through many mail-order disk drive firms, are specially configured for other computers, and may not operate on the LNW80 as configured. Make sure that the drive that you purchase is configured just as it came from the factory OR CONFIGURED SPECIFICALLY FOR THE LNW80 COMPUTER. The proper configuration for the drives listed in Table B.5 is detailed below.

Shugart SA800/801:

There is a bit of confusion between the Shugart SA800 and

SA801. The correct drive is the SA800. An SA801 can be easily converted to an SA800 by moving the shorting plug on the drive’s PCB from the 801 position to the 800 position. The summary of the correct option settings is listed below:

Table B.5 - Correct Option Settings for Shugart SA80 0/80 I.

Trace Designator	Description	Correct Setting
T3,T4,T5,T6	Termination for mux inputs For last drive on cable	Open Closed
T1	Termination for drive select	Closed
T2	Spare termination	Open
DS1	Drive select 1 - drive 1 - others	Closed Open
DS2	Drive select 2 - drive 2 - others	Closed Open
Ds3	Drive select 3 - drive 3 - others	Closed Open
DS4	Drive select 4 - drive 4 - others	Closed Open
RR	Radial ready	Closed
RI	Radial index 6 sector	Closed
R,I,S	Ready, Index, Sector alternate	Closed
HL	Stepper power from head load	Closed
DS	Stepper power from drive select	Open
WP	Enable write protect feature	Closed
NP	Disable write protect	Open
8,16,32	8,16,32 Sectors (801 only)	Don't care
D	Alternate input-in use	Open
2,4,6,8,10, 12,14,16,18	Nine alternate I/0 pins	Open
D1,D2,D4,DDS	Drive select decode option	Open
A,B,X	Radial head load	Closed
C	Alternate input-head load	Open
Z	In use from drive select	Closed
Y	In use from head load	Open
DC	Alternate output-disk change	Open

NOTE: The above options are selected via pins or circuit trace. CLOSED means that either a Berg pin-shorting-plug or a circuit trace is making continuity. OPEN means that a shorting-pin is not present or that the circuit etch is broken. For more information, refer to the SA800/801 diskette storage drive OEM manual.

Qume Data Track 8

The Data Track 8 (DT-8) is a Shugart-compatible, dual-sided disk drive that is compatible with the LNW80 computer. It has virtually the same option settings and factory configuration as the Shugart SA850. It should require no modification other than the setting of the drive selects and the proper termination, The termination resistors consist of two (2) dual-inline IC type packages mounted in sockets on the disk drive's PCB. They should only be installed in the last drive on the cable. Remember that only one set of termination resistors is required for both 5" and 8" drives. A 16-pin dip shunt is provided for the seven most commonly used trace cut options. These options include:

Table B.6 - Qume Data Track 8 Option Settings

Trace Designator	Description	Correct Setting
R	READY IN THE MUX MODE	CLOSED
I	INDEX IN THE MUX NODE	CLOSED
HL	STEPPER POWER FROM HEAD LOAD	CLOSED
A	DRIVE SELECT ACTIVE	CLOSED
B	DRIVE SELECT ACTIVE	CLOSED
X	HEAD LOAD ACTIVE ON DRIVE SLCT	CLOSED
Z	IN USE FROM DRIVE SELECT	CLOSED

This shunt should be installed with no positions broken.

OTHER OPTION SETTINGS

Table B.7 - Other Option Settings for 8 Inch Drives.

TRACE DESIGNATOR	DESCRIPTION	CORRECT SETTING
DS1	DRIVE SELECT 1	FOR DRIVE l: CLOSED OTHERS: OPEN
DS2	DRIVE SELECT 2	FOR DRIVE 2: CLOSED OTHERS: OPEN
DS3	DRIVE SELECT 3	FOR DRIVE 3: CLOSED OTHERS: OPEN
DS4	DRIVE SELECT 4	FOR DRIVE 4: CLOSED OTHERS: OPEN
RR	RADIAL READY	CLOSED
RI	RADIAL INDEX AND SECTOR	CLOSED
R,I	READY, INDEX ALTERNATE	CLOSED
HL	STEPPER POWER FROM HEAD LOAD	CLOSED
DS	STEPPER POWER FROM DRIVE SELECT	OPEN
WP	ENABLE WRITE PROTECT FEATURE	CLOSED
NP	DISABLE WRITE PROTECT	OPEN
D	ALTERNATE INPUT-IN USE	OPEN
6,8,l0,12, 16,18,24	SEVEN ALTERNATE I/0 PINS	OPEN
Dl,D2,D4,DDS	DRIVE SELECT DECODE OPTION	OPEN
A,B,X	RADIAL HEAD LOAD	CLOSED
C	ALTERNATE INPUT-HEAD LOAD	OPEN
Z	IN USE FROM DRIVE SELECT	CLOSED
Y	IN USE FROM HEAD LOAD	OPEN
2S	ALTERNATE OUTPUT DISK 2 SENSE	OPEN
DL	DOOR LOCK LATCH	OPEN
Bl-B4	TWO, DOUBLE SIDED DRIVE SELECT	OPEN
S2	HEAD SELECT FROM SIDE SELECT	CLOSED
Sl,S3	CONFIGURATION FOR HEAD SELECT	OPEN

NOTE: The above options are selected via pins or circuit trace. CLOSED means that either a Berg pin-shorting-plug or a circuit trace is making continuity. OPEN means that a shorting-pin is not present or that the circuit etch is broken. For more information refer to the Qume Memory Products Data Trak 8 Maintenance Manual.

Tandon 848-1 and 848-2

These drives are the single (-1) and dual-sided (-2) disk drives that occupy one-half the space of a standard 8-inch drive. These drives also feature DC-only operation. These drives do not have a head-load solenoid as a standard feature (the heads are loaded all the time). WE RECOMMEND, for the sake of media and head wear, that the spindle motor should be configured to be turned on and off by the MOTOR ON line on the output of the LNW80 disk controller. This modification procedure is detailed in the next section. The TM848 is fully Shugart-compatible, with the following exceptions:

Table B.8 - TM848 Exceptions to Shugart Compatibility

PIN #	DESCRIPTION	COMMENTS
6	MOTOR OFF	WILL BE MODIFIED TO BE MOTOR ON
18	NOT USED	IS HEAD LOAD ON OTHER DRIVES

The factory options are configured via a DIP shunt at U3, pins and circuit traces. The factory settings require no changes with the exception of drive selects and the removal of the termination resistor DIP pack from all the drives except the last drive on the cable. Table B.9 is a summary of the factory selected options.

Table B.9 - TM848 Factory Selected Options

Trace Settings	Description	Correct Settings
R	READY IN THE MUX MODE	CLOSED
I	INDEX IN THE MUX MODE	CLOSED
HL	STEPPER POWER FROM HEAD LOAD	CLOSED
A	DRIVE SELECT ACTIVE	CLOSED
B	DRIVE SELECT ACTIVE	CLOSED
X	HEAD LOAD ACTIVE ON DRIVE SLCT	CLOSED
Z	IN USE FROM DRIVE SELECT	CLOSED

This shunt should be installed with no positions broken

Other Options

Table B.10 - Other Options for the Tandon 848-1 and 848-2 Drives.

TRACE DESIGNATOR	DESCRIPTION		CORRECT SETTING
DS1	DRIVE SELECT 1	FOR DRIVE 1:	CLOSED
		OTHERS:	OPEN
DS2	DRIVE SELECT 2	FOR DRIVE 2:	CLOSED
		OTHERS:	OPEN
DS3	DRIVE SELECT 3	FOR DR1VE 3:	CLOSED
		OTHERS:	OPEN
DS4	DRIVE SELECT 4	FOR DRIVE 4:	CLOSED
		OTHERS:	OPEN
RR	RADIAL READY		CLOSED
RI	RADIAL INDEX AND SECTOR		CLOSED
R,I	READY, INDEX ALTERNATE		CLOSED
DS	STEPPER POWER FROM DRIVE SELECT		OPEN
WP	ENABLE WRITE PROTECT FEATURE		CLOSED
NP	DISABLE WRITE PROTECT		OPEN
DC	ALTERNATE DISK CHANGE		OPEN
D	ALTERNATE INPUT-IN USE		OPEN
Z	IN USE FROM DRIVE SELECT		CLOSED
2S	ALTERNATE OUTPUT DISK 2 SENSE		OPEN
DL	DOOR LOCK LATCH (OPTIONAL)		OPEN
Bl-B4	TWO, DOUBLE SIDED DRIVE SELECT		OPEN
S2	HEAD SELECT FROM SIDE SELECT		CLOSED
Sl,S3	CONFIGURATION FOR HEAD SELECT		OPEN
Y (OPTIONAL)	IN USE FROM HEAD LOAD		OPEN
HL (OPTIONAL)	STEPPER POWER FROM HEAD LOAD		CLOSED
MC1	MOTOR ON CONTROL FROM PIN 4		CLOSED

Configuring the TM848 for MOTOR-ON Controlled Operation

If the TM848 that you are using does not have the HEAD LOAD SOLENOID OPTION OR it is desired that the TM848 motor control operates like a minifloppy (for noise or media wear considerations), the following procedure can be performed to configure the drive to operate in this manner:

1. Modify the Disk Drive:

Install a jumper from Pin 6 of the drive’s 50-pin edge card (a pad is provided at MC2) to U35-10 (available at one side of jumper strap M2). This can be accomplished using a 30 AWG wire of sufficient length soldered properly and mechanically secured with some type of glue or tape to keep it close to the surface of the PCB. Refer to the silkscreen on the circuit board and, if possible, the schematic diagrams (Tandon Dwg. # 210092-00) and the technical documentation on the drive.

2. Install a Jumper on the 34 to 50 Cable Adapter

The motor-on control (from the 5-1/4" 34-pin cable) should then be routed to Pin 6 of the 50-pin 8" disk drive bus so that the motor-on control will drive the 8" disk drive(s). This can be accomplished by installing a jumper (soldering a small wire) across the pads that are conveniently provided on the 34-to-50 pin adaptor-cable LNW STK# 1096. To find these unmarked pads, simply trace Pin 6 of the 50-pin side to a "dead end" pad. Another pad is located nearby and should be connected to Pin 16 of the 34 pin 5-1/4" side of the adaptor board.

Other Considerations.

Now that the 8" drives act similar in nature to the 5-1/4" drives, there is a small problem with the DOSPLUS 3.4 operating system. DOSPLUS does not wait for the drive to come up to speed on the 8" disk drives (since this burdens the performance of the other type of drives). In order to use DOSPLUS, a patch is required to allow the disk drive adequate time for the drive to come up to speed. Here it is:

5-1/4 or 8 Inch System Disk

Using the DISKZAP utility program in DOSPLUS, modify the following two bytes ON A BACKUP OF YOUR DOSPLUS MASTER DISKETTE:

```
                 Track:    F
                 Sector:   3
```

Bytes	Was	Should Be
CF D0	20 09	00 00

Table B.11 - Zaps to 5-1/4 or 8 Inch System Disk

APPENDIX C: DRAWING PROGRAM FOR LNWBASIC MODE 1

```
10 '...DRAWING PROGRAM - This program allows you to draw
20 '...lines and circles on the screen
30 CLEAR200:CLS:PCLS:MODE 1
40 GSUB #"MENU"
60 DRAW"B,M240,96"     ' Start at centre of screen
```

```
90 CLS:PCLS
100 IN$="UDLREFGHBZCSO"
120 A=PEEK(SH4099)IFA=0THEN120
140 A$=CHRS(A)
160 AX=INSTR(IN$gA$)
180      ON                 AX                  GOSUB
500,500,500,500,500,500,500,500,600,700,800,900,950
190 GOT0100         '...Erroneus entry disregarded
499 '...Main draw section
500 B$=A$
520 DO
540 DRAWAS+"1"
560   A=PEEK(kH4099):A$=CHR$(A)
580 UNTIL (A$
900 INPUT"Name of graphics screen to be saved  ";S$
910 PSAVE S$: CLS: RETURN
950 INPUT"Name of graphics screen to be loaded  ";O$
960 PLOAD O$: CLS: RETURN
1000 4"MENU"
1010 PRINT @0,STRING$(64,131)
1020 PRINT @85,"DRAWING PROGRAM MENU"
1030 PRINT @128,STRING$(64,131)
1040  PRINT @259,"By pressing any of the keys U,D,L,R,E,F,G or
H, you may draw lines as indiated in the diagram"
1050 DRAW"B,N100,120"
1060 DRAW"N,U20,N,D20,N,L20,N,R20,N,E20,N,F20,N,G20,N,H20"
1070
PRINT@460,"H";:PRINT@464,"U";:PRINT@469,"E";:PRINT@651,"L";:P
RINT@662("R";
1080 PRINT0780,"G";:PRINT@784,"D";:PRINT@789,"F";
1090 PRINT@480,"Z = Zero (erase) last line   ";:RINT@544,"B =
Move to new start point";
1100 PRINT@800,"Press space-bar to halt a line";
1110 PRINT@608,"C = Draw circle";
1120  PRINT@896,"S  =  Save  graphics screen";: PRINT@928,"0 =
Load graphics screen";
1130 A=PEEK(&H4099): IF A=0 THEN 1130 ELSE RETURN
```

notes

APPENDIX D

Video Display Worksheet

Video Display Worksheet

notes

APPENDIX E

GLOSSARY

access
The operation of seeking, reading or writing data on a storage unit (in this case, the diskette).

access time
The time that elapses between any instruction being given to access some data and that data becoming available for use.

address
An identification (number, name, or label) for a location in which data is stored.

algorithm
A computational procedure.

alphanumeric (characters)
A generic term for numeric digits and alphabetic characters.

alphanumeric string
A group of characters which may include digits, alphabetic characters, punctuation characters and special characters, and may include spaces. (Note: a space is a ’character' to the computer, as it must generate a code for spaces as well as symbols.)

ASCII
Abbreviation for American Standard Code for Information Interchange. Pronounced: ’ass-key'. Usually refers to a standard method of encoding letter, numeral, symbol and special function characters, as used by the computer industry.

assembly language
A machine-oriented language for programming mnemonics and machine readable code from the mnemonics.

base
Quantity of characters for use in each of the digital positions of a numbering system.

base 2
The 'binary’ numbering system consisting of more than one symbol, representing a sum, in which the individual quantity

represented by each figure is based on a multiple of 2.

base 10
The 'decimal' numbering system HMD consisting of more than one symbol, representing a sum, in which the individual quantity represented by each symbol is based on a multiple of 10.

base 16
The 'hexadecimal' numbering s stem HMD consisting or more than one symbol representing sum, in which the individual quantity represented by eac symbol is based on a multiple of 16.

binary
See 'base 2'

bit
a. single 'binary' digit whose value is 'zero' or 'one'.

Boolean
This word isn't really bere (for you folks who paid attention to the general information section). A form of algebra applied to binary numbers which is similar in form to ordinary algebra. It is especially useful for logical analysis of binary numbers as used in computers.

'BOOT' -- BOOTSTRAP
A machine language program file that is put onto every diskette by the 'FORMAT' routine. This routing is invoked when reset or power-on occurs. It automatically loads the necessary programs (SYS0/SYS) to cause the computer to respond to the DOS commands; i.e., the machine is 'BOOTSTRAPPED' or 'BOOTED' into operation,

buffer
A small area of memory used for the temporary storage of data to be processed.

buffer track
A track on a diskette used for the temporary storage of data or program material during a recovery process.

bug
A Software fault that results in the malfunction of a program. May also refer to hardware malfunctions.

byte
Eight 'bits'. A 'byte' may represent any numerical value between '0' and '255'.

command file
A file consisting of a list of commands, to be executed in sequence.

contiguous
Adjacent or adjoining.

control code
In programming, instructions which determine conditional jumps are often referred to as control instructions and the time sequence of execution of instructions is called the flow of control.

CRC error
Cyclic Redundancy Check. A means of checking for errors by using redundant information used primarily to check disk I/0

while verifying

data base
A collection of interrelated data stored together with controlled redundancy to serve one or more applications. The data are stored so that they are independent of programs which use the data. A common and controlled approach is used in adding new data and in modifying and retrieving existing data within a data base. A system is said to contain a collection of data-based information if they are disjoint in structure.

data-base management system
The collection of software required for using a data base.

data element
Synonymous with ’data item' or 'field’

data type
The form in which data is stored; i.e., integer, single precision, double precision, ’alphanumeric' character strings or 'strings'.

DEC
Initials for Directory Entry Code.

decimal
See 'base 10'.

direct access
Retrieval or storage of data by a reference to its location on a disk, rather than relative to the previously retrieved or stored data.

DIRECT STATEMENT (IN FILE)
A program statement that exists in the disk file that is not assigned a line number.

DIRECTORY
A table giving the relationships between items of data. Sometimes a table or an index giving the addresses of data.

displacement
A specified number of sectors, at the top or beginning of the file, in which the 'bookkeeping’ and file parameters are stored for later use by various program modules.

distributed free space
Space left empty at intervals in a data lay out to permit the possible insertion of new data.

double precision
A positive or negative numeric value, 16 digits in length, not including a decimal point (Example: 99999999999999.99).

DUMP
To transfer all or part of the contents of one section of computer memory or disk into another section, or to some other computer device.

embedded pointers
Pointers in the data records rather than in a directory.

entity
Something about which data is recorded.

EOF
Initials for 'end of file’. It is common practice to say that the EOF is record number nn or that the EOF is byte 15 of sector 12. Hence, it is a convenient term to use in describing the location of the last record or last byte in a file.

extent
A contiguous area of data storage.

file
A collection of related records treated as a unit; The word file is used in the general sense to mean any collection of informational items similar to one another in purpose, form and content.

file parameters
The data that describes or defines the structure of the file.

FILESPEC
A file specification and may include the 'file name', the 'the file name extension', 'password', and 'disk drive' specification.

field
See ’data item’.

file area
The physical location of the file, on the disk, or in memory.

header record
A record containing common, constant or identifying information for a group of records which follow.

hexadecimal
See 'base 16’

index
A table used to determine the location of a record.

indirect addressing
Any method of specifying or locating a storage location, whereby, the key (of itself or through calculation) does not represent an address. For example, locating an address through indices,

INSTRING
Refers to the capability of locating a substring of characters that may exist in another character string. An example would be: Substring = 'THE' String = 'NOW IS THE TIME'. An INSTRING routine would locate the substring and return its starting position within that string. In this example, it would return a value of eight.

integer
A natural or whole number with no decimal point..

inverted file
A file structure which permits fast spontaneous searching for previous unspecified information. Independent lists or indices are maintained in records' keys which are accessible according to the values of specific fields.

inverted list
A list organized by a secondary key HMD not a primary key.

IPL

Initials for Initialize Program Loader; a program usually executed upon pressing of the 'RESET’ button.

key
A data item used to identify or locate a record or other data grouping.

label
A set of symbols used to identify or describe an item, record, message or file. Occasionally, it may be the same as the address in storage.

least significant byte
The significant byte contributing the smallest quantity to the value of a numeral.

list
An ordered set of data items. A 'chain'.

load module
A program developed for loading into storage and being executed when control is passed to the program.

logical
An adjective describing the form of data organization, hardware or system that is perceived by an application program, programmer, or user; it may be different than the real (physical) form.

logical data-base description
A schema. A description of the overall data-base structure, as perceived for the users, which is employed by the data base management software.

logical file
A file as perceived by an application program; it may be in a completely different form from that in which it is stored on the storage units.

logical operator
A mathematical symbol that represents a mathematical process to be performed on an associated operand. Such operators are ’AND’, 'OR’, 'NOT’, ’AND NOT’ and ’OR NOT'.

logical record
A record or data item as perceived by an application program; it may be in a completely different form from that in which it is stored on the storage units.

LSB
See least significant byte.

machine-language
See assembly language.

maintenance of a file
(1) The addition, deletion, changing or updating of records in the database.
(2) Periodic reorganization of a file to better accommodate items that have been added.

monitor
A program that may supervise the operation of another program for operation or debugging or other purposes.

most significant byte
The significant byte contributinq the greatest quantity to the value of a numeral.

MSB
See most significant byte.

multiple-key retrieval
Retrieval which requires searches of data based on the values of several key fields (some or all of which are secondary keys).

nibble
The four right most or left most binary digits of a byte.

null
An absence of information as contrasted with zero or blank for the presence of no information.

on-line
An on-line system is one in which the input data enter the computer directly from their point of origin, and/or output data are transmitted directly to where they are used. The intermediate stages such as writing tape, loading disks or off-line printing are avoided.

on-line storage
Storage devices and especially the storage media which they contain under the direct control of a computing system, not off-line or in a volume library.

operating system
Software which enables a computer to supervise its own operations, automatically calling in programs, routines, language and data as needed for continuous throughput of different types of jobs.

parity
Parity relates to the maintenance of a sameness of level or count, i.e., keeping the same number of binary ones in a computer word to thus be able to perform a check based on an even or odd number for all words under examination.

physical
An adjective, contrasted with logical, which refers to the form in which data or systems exist in reality. data is often converted by software from the form in which it is physically stored to a form in which a user or programmer perceives it.

physical data base
A data base in the form in which it is stored on the storage media, including pointers or other means of interconnecting it. Multiple logical data bases may be derived from one or more physical data bases.

physical record
A collection of bits that are physically recorded on the storage medium and which are read or written by one machine input/output instruction.

pointer
The address or a record (or other data groupings) contained in another record so that a program may access the former record when it has retrieved the latter record. The address can be absolute, relative, symbolic, hence, the pointer is referred to as absolute, relative, or symbolic.

primary entry
The main entry made to the directory.

random access
To obtain data directly from any storage location regardless of its position, with respect to the previously referenced information. Also called 'direct access'.

random access storage
A storage technique in which the time required to obtain information is independent of the location of the information most recently obtained.

read
To accept or copy information or data from input devices or a memory register; i.e., to read out, to read in.

record
A group of related fields of information treated as a unit by an application program.

relational operator
A mathematical symbol that represents a mathematical process to perform a comparison describing the relationship between two values (e.g. < less than . . . .> greater than . equal . . . and combinations thereof).

search
To examine a,series of items for any that have a desired property or properties.

secondary index
An index composed of secondary keys rather than primary keys.

sector
The smallest addressable portion of storage on a diskette.

seek
To position the access mechanism of a direct-access storage device at a specified location.

sequential access
Access in which records must be read serially or sequentially one after the other; i.e., ASCII files, tape.

single precision
A positive or negative numerical value of 6 digits in length, not including a decimal point (Example: 99999.9).

sort
To arrange a file or data in a sequence by a specified key (may be alphabetic or numeric and in descending or ascending order).

source code
The text from which executable code is derived.

system file
A program used by the operating system to manage the executing program and/or the computer's resources.

sub-strings
See INSTRING

table
A collection of data suitable for quick reference, each item being uniquely identified either by a label or its relative position.

tally
To add or subtract a digit from a quantity.

token
A one byte code representing a larger word consisting of 2 or more characters.

track
The circular recording surface transcribed by a read/write head on the disk.

transaction
An input record applied to an established file. The input record describes some "event" that will either cause a new file record to be generated, an existing record to be changed or an existing record to be deleted.

transparent
Complexities that are hidden from the programmers or users (made transparent to them) by the software.

vector
A line representing the properties of magnitude and direction. Since such a 'line' can be described in mathematical terms, a mathematical description (expressed in numbers, of course) of a given 'direction' and ’magnitude' is referred to as a 'vector'.

verify
To check a data transfer or transcription.

working storage
A portion of storage, usually computer main memory, reserved for the temporary results of operations.

write
To record information on a storage device.

zap
To change a byte or bytes of data in memory on on diskette by using a software utility program.
INDEX

INDEX

* = Discussion
# = Proqram listing

notes

notes

notes

USER'S RESPONSE SHEET
manual Title: The LNW80 Owner's Manual
Manual Date: October, 1982 Date of This Letter:
User's Name: Telephone ( )
Company: Office/Dept.:
Street Address:
City/State/Zip Code:

Please list any discrepancy found in this manual by page, paragraph, figure or table number in the following space. If there are any other suggestions that you wish to make, feel free to include them. Thank you.

manual Location Comment/Suggestion
-

FOLD ON TWO LINES (LOCATED ON REVERSE SIDE), STAPLE AND MAIL

FOLD

PLACE POSTAGE
HERE

LNW RESEARCH CORP. 2620 WALNUT AVE.
TUSTIN, CA. 92680

ATT: PUBLICATIONS DEPT.

FOLD

TOC