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PRODUCT MANUAL

LTS - 3
Single Chip
Bar Code Decoder

Welch Allyn

Industrial Products Division — Jordan Road, Skaneateles Falls, N.Y. 13153-0187 — Tel. (315) 685-8351 — Telex 325435

8281-1536 Editor

WARNING

THE SCANNER IS STATIC SENSITIVE AND PERSONNEL IN CONTACT WITH EXPOSED WIRES OR CONNECTORS SHOULD BE SUITABLY GROUNDED. INOPERATIVE SCANNERS MAY RESULT FROM IMPROPER HANDLING OF EXPOSED WIRES, BUT THE SCANNER ITSELF IS PROTECTED FROM STATIC DISCHARGE TO THE CASE.

WARRANTY LIMITATIONS

The enclosed scanner is warranteed for a period of one (1) year from date of manufacturing, for materials and workmanship. The warranty will be voided by excessive physical damage or any attempt on the part of the customer to disassemble the scanner.

Due to lack of control by Welch Allyn over voltage and current applied to the scanner the warranty on the electronics is limited to initial inspection on the part of the purchaser.

In no event shall Welch Allyn Inc. or its resellers be liable for any loss, inconvenience or damage whether direct, incidental, consequential or otherwise, and whether caused by negligence or other fault resulting from the breach of any express warranty except as set forth herein. Some states do not allow the exclusion or limitation of incidental or consequental damages, so the above limitations or exclusions may not apply to you.

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This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

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1.0 BARCODE SYSTEM OVERVIEW

1.1 INTRODUCTION

The LTS-3 is a single-chip NMOS bar code decoder which automatically recognizes and decodes five popular bar code symbologies. It can be software configured to send decoded data in 8-bit parallel or serially, via an asynchronous ASCII port to a remote host device, such as a computer.

The purpose of this section is to help familiarize the reader with the basic components of a typical bar code system and to explain how these system components interact. Those already familiar with bar code technology may wish to advance to Section 3.0 of this manual which covers electrical specifications and operation of the LTS-3 decoder.

Bar coding is a fast and cost-effective method of inputting data to a computer system. The technique is used extensively in business and industrial applications where there is a need to accurately identify, locate or track items or parts.

Every bar code system consists of four main components: (1) the label, (2) the scanner or read head, (3) the decoder or data entry terminal, and (4) the interface.

In addition, most advanced bar code applications utilize a computer or similiar 'host' device (5), which has been programmed to interpret, and then initiate commands or actions based on information generated by a bar code label. A 'typical' bar code system showing these components and their interconnections appears in Figure (1-1).

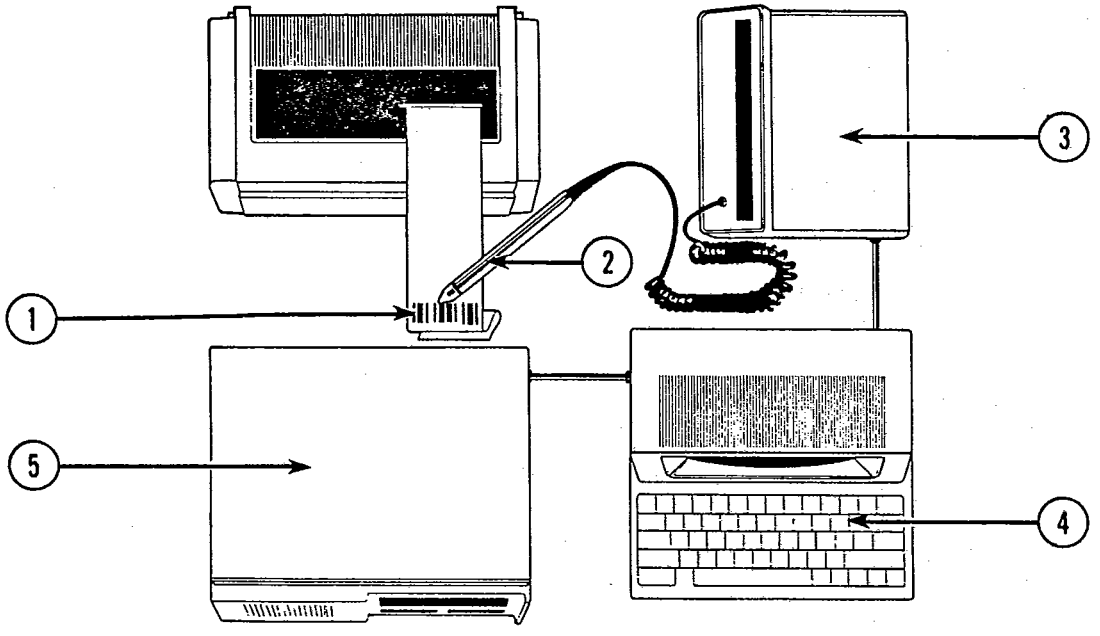
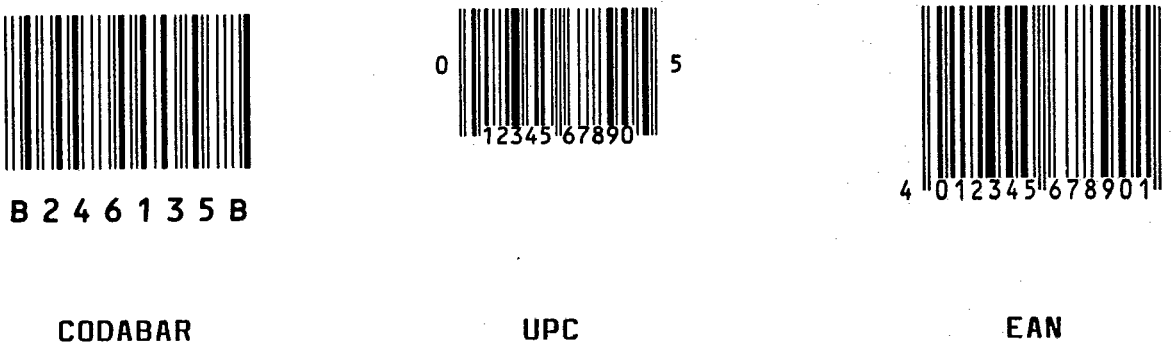


Figure (1-1)

1.2 BARCODE LABEL/SYMBOLS

A bar code symbol is composed of a series of bars (lines) and spaces printed in specified width ratios. These symbols are used to encode numeric and alpha-numeric information, and by systematically designing symbols with different bar (line) and space ratios, it is possible to encode the same information in a variety of ways. These encoding 'systems' are referred to as 'symbologies'. Examples of several bar code symbologies are shown in Figure (1-2). Note that each symbol contains both wide and narrow bars (lines) arranged in a certain sequence and that the lines are separated by spaces.



CODABAR UPC EAN

Figure (1-2)

Over the years, five encoding techniques or 'symbologies' have become most commonly used. They are called Code 3 of 9, Interleaved 2 of 5, UPC, EAN and CODABAR. Each of these encoding techniques has certain advantages and disadvantages and for that reason, certain coding systems are generally utilized in particular bar code applications.

The LTS-3 can be configured to accurately decode any of these symbols and their standard variations. Specific bar code applications and decoding methods are explained in Section 2.0 of this manual.

1.3 SCANNER/READ HEAD

The function of the scanner or read head is to convert the visual image formed by the lines and spaces which make up the symbol, into an electrical signal. Different types of scanners are available and their choice is determined largely by the requirements of the specific bar code application. Common scanner variables include:

- Analog or digital output
- Visible red or infrared illumination
- Contact or non-contact
- Fixed or moving beam

The LTS-3 decoder is designed to accept digitized bar code signals from a Welch Allyn digital scanner and to deliver decoded data to the host computer in standard parallel or serial format.

Digital scanners are available which will 'read' from either visible red or infrared illumination. Because infrared illumination is more tolerant of dirt and contamination, it is commonly used when the bar code scanner will be placed in an industrial environment. Special inks must be used for printing the label depending upon the type of illumination that is selected. More detailed information concerning available scanners and the associated label requirements should be obtained from your Welch Allyn representative.

When the read head of the scanner touches the surface on which the symbol is printed, it is referred to as a 'contact' scanner. Scanners designed to read a bar code without touching the surface are designated as 'non-contact'. In general, contact scanners are less expensive, while non-contact read heads provide greater depth of field and allow more flexibility in positioning.

The LTS-3 can be used with either fixed or moving beam scanners. A 'fixed beam' scanner provides a constant, non-swept beam, so the scanner must be moved past the bar code label or vice-versa. A 'moving beam' scanner contains a mechanism for sweeping the generated light beam, so that the moving beam scans the bar code label. Most bar code applications are designed using a fixed beam scanning device.

A moving beam reader is designed to operate in applications where it is difficult or impossible to touch the printed surface of the label. Instead of moving the read head across the label surface, the projected light beam is optically 'moved' or driven the length of the symbol during the scanning process.

NOTE: To produce accurate output, a bar code must be scanned completely, including the "quiet zone" or clear area before and after the code. When using a hand held scanner, the wand should be moved at a constant speed, at the proper angle and remain in contact with the label surface.

1.4 DECODER

The purpose of a decoder is to interpret the electrical signals generated by the scanner as it moves across the bars and lines which form the bar code signal, and to convert this information into digital signals which can be processed by a computer or other type of host.

Since decoding devices are used to generate and process scanned inputs, factors such as scanner compatibility, output characteristics and the ability to recognize more than one symbology generally influence the choice of decoder unit.

The LTS-3 can be programmed to automatically recognize and decode up to five of the most popular bar code symbologies and their variations. It is designed so that all codes (except UPC or EAN symbols with addendum) can be scanned left-to-right or right-to-left. UPC and EAN codes with addendum were designed to read the addendum on left-to-right scans only. If read right-to-left, the addendum will not be decoded.

The LTS-3 will decode accurately for any scanning speed within the range of 3 to 30 inches per second for high density codes and proportionally faster for lower density printing.

Decoders can be structured to interface with scanners/readers which generate either analog or digital signals. The LTS-3 is designed to accept digitized bar code signals from any Welch Allyn digital-type scanner.

More sophisticated bar code systems utilize decoders which can be automatically programmed to read multiple codes and provide output signal flexibility.

1.5 DECODER INTERFACE

Just as with any type of peripheral system, the bar code system requires a link or interface to the computer or host device. Depending upon the application, and computer protocol, the method of communication may be direct, utilize a modem, or require some type of system controller.

The purpose of the interface is to process and communicate decoded bar code information to the computer. The most common format for decoder output is asychronous ASCII but various synchronous communications as well as keyboard emulation techniques are also used.

The LTS-3 provides two user selectable modes which are under software control. Data may be transmitted using 8-bit parallel with handshaking, or serially, via an asychronous ASCII port with appropriate signal control.

1.6 COMPUTER/HOST DEVICE

An integral component of any advanced bar code system is a computer or other host device which can interpret and display bar code data, and then generate specific commands based upon bar code label information.

Inventory control, monitoring work-in-progress and documenting time/attendance records are a few examples of how bar code data can be utilized by computer-based systems.

This type of system offers an additional benefit that bar code data can be directly input to a computer or host device, thereby minimizing keyboard entry errors.

2.0 BAR CODE SYMBOLOGY

2.1 INTRODUCTION

The LTS-3 Bar Code Decoder automatically recognizes and decodes the five most commonly used bar code symbology in use today. These codes can be scanned either left-to-right or right-to-left.

NOTE: The special cases of UPC and EAN codes with two or five digit addenda were designed to read the addendum on left-to-right scans only. If scanned right-to-left, the main portion of the label will be read, but the addendum will not be read.

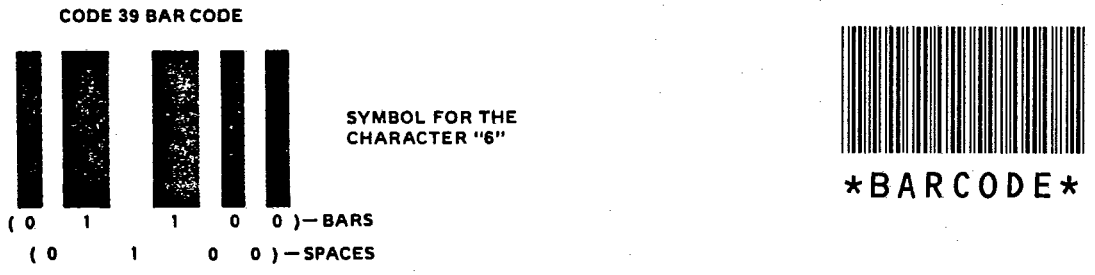
Generally, because of their relative strengths and weaknesses, five of the most popular code symbologies have evolved to form 'special purpose' categories. Factors which influence the choice of symbology include (1) the type of information (alpha and/or numeric) that must be encoded, (2) the maximum density with which characters can be encoded, and (3) accuracy in reading the characters which make up the symbol.

The LTS-3 Decoder can be externally programmed to recognize any of the following bar code symbologies using one or more 8-bit "Hex Code" command words. The specific technique for code enabling is described in Sections 4.0 and 5.0 of this manual.

2.2 CODE 3 OF 9

This symbology can be used to encode all uppercase alphabetic (A-Z) and all numeric characters (0-9), as well as certain special characters such *, $, /, +, and %. Unlike some symbologies, Code 3 of 9 can be used to prepare labels for data fields which are of variable length.

The name '3 of 9' is derived from the way in which each character is encoded. Under Code 3 of 9 symbology, each character is represented by 9 elements, that is, a total combination of 9 bars and spaces. From this total number (9), 3 elements (either bars or spaces) are always wide, hence the name, "3 of 9". Examples of a single character as well as a complete label encoded using the 3 of 9 format are shown in Figure (2-1).



CODE 3 OF 9

Figure (2-1)

The highest 'standard' density used with Code 3 of 9 is 9.8 characters per inch.

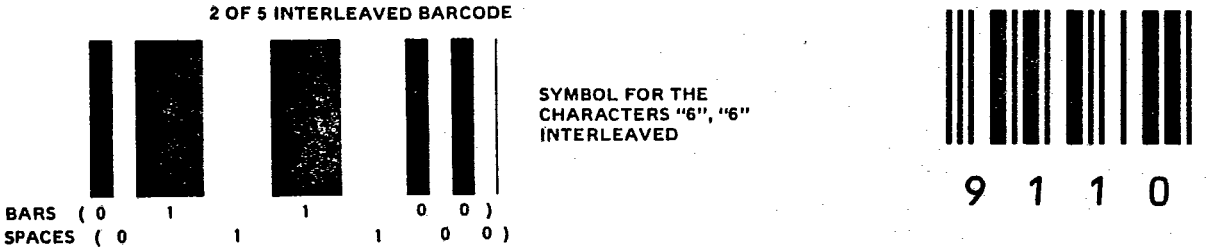
One of the greatest advantages of Code 3 of 9 symbology is that it is highly immune to substitution errors. This type of error occurs when one character is read as another. Because of its reliability, Code 3 of 9 has been adopted for use by the United States Department of Defense, the United States Post Office, various health agencies and many other groups and industrial users.

2.2 INTERLEAVED 2 OF 5

This symbology was designed for applications where only numerical characters need to be encoded.

Interleaved 2 of 5 can be used to encode data fields which contain any even number of digits, and for that reason, the field length is generally described using the terms "character pairs". In this encoding technique, each numerial is represented by a total of 5 bar or 5 space elements.

The name 'Interleaved 2 of 5' signifies that 2 of these elements, (either the bars or the spaces) out of the 5 element grouping must be wide, and that pairs of digits are encoded by representing the first one of the digits using bar widths, and the second character using space widths. Examples of individual numerals and a complete label are shown in Figure (2-2).



Interleaved 2 of 5

Figure (2-2)

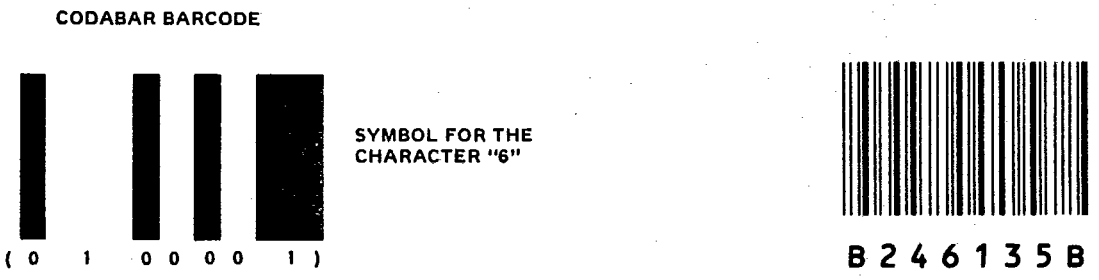
Because of the bar/space relationships, Interleaved 2 of 5 allows a much higher encoding 'density'. Printing densities range from 1.7 to 17.7 charcters per inch.

One disadvantage however, is that under some conditions, this symbology is subject to false reads. Reading accuracy, however, can be optimized by configuring the reading device to accept messages of only a predetermined 'fixed' length. The LTS-3 provides this programming capability for applications which require Interleaved 2 of 5 coding.

2.3 CODABAR

CODABAR can be used to encode numeric characters 0-9, a,b,c,d, and six special characters, in variable length bar code symbols. Each character is represented by a total of 7 elements consisting of bars and spaces.

Each character is encoded to contain either 2 or 3 wide elements (either bars or spaces) out of the total 7, and a maximum printing density of 10 characters per inch is standard. Examples of individual characters and complete bar code symbols are shown in Figure (2-3).



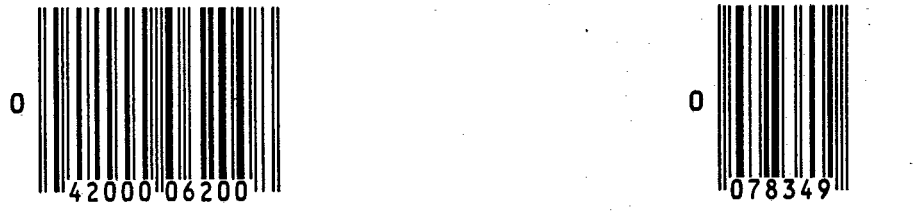
CODABAR

Figure (2-3)

CODABAR is highly immune to substitution errors and for that reason it is used in applications where reading integrity is extremely important. It is used extensively for labeling blood products and in automated systems involving library circulation and parcel tracking.

2.4 UPC

The letters 'UPC' stand for "Universal Product Code". This bar code symbology is widely used in the United States to encode manufacturer and item identification numbers on consumer products. It is a fixed-length code, which means that all symbols must contain that same number of characters in order to provide reading accuracy. UPC is the bar code symbol found on grocery items in either the normal UPC-A or the 'zero-surpressed', UPC-E format. Samples of typical UPC-A and UPC-E symbols are shown in Figure (2-4).



UPC-A **UPC-E**

Figure (2-4)

Formal use of the UPC code is governed by the UPC Council; it is not in the public domain. In addition to UPC-A and UPC-E, other formats of UPC are found in luggage tracking and credit card applications.

Because of its design, UPC provides relatively weak data security.

EAN

This symbology, the "European Article Numbering" code is the UPC counterpart for Europe and it has very similiar technical characteristics.

The most commonly used EAN format contains 13 characters, and is designated EAN-13 or Expanded EAN. This version of the format adds an additional digit to the item identification code to indicate the country of origin.

A shortened version of the EAN format is also in common use. It is referred to as EAN-8 because it utilizes a total of 8 characters. Examples of both EAN versions are shown in Figure (2-5).

EAN-8 **EAN-13**

Figure (2-5)

2.6 BAR CODE LABEL PRODUCTION

Bar code labels can be purchased preprinted, or they can be printed "on site". Generally, the method of production is dependent upon the intended use of the label and/or its application.

There are several advantages to using preprinted labels. First, precise tolerances can be maintained, a fact which is particularily important when using codes of high density. Moreover, labels can be laminated and produced on non-paper substrates and with a wide choice of adhesive backings.

Preprinted labels tend to be of higher quality than labels produced on site, however they generally have a higher unit cost, and require that the label content be pre-determined.

Labels can be produced on-site using thermal, dot matrix as well as more advanced printing methods. Each of these printing methods affords immediate control over label content, but may limit character density and provide poorer label quality. In addition, depending upon label volume requirements, the cost of paper and printing equipment may off-set the values of a preprinted format.

2.7 BAR CODE LABEL SPECIFICATIONS

2.7.1 BACKGROUND SUBSTRATE

The material on which the code is printed should be reflective and have a matte (not glossy) finish. A background diffuse reflectance of 70 to 80% is desirable for optimum contrast.

2.7.2 INK COLOR AND TYPE

The inked bars should not exceed 25% reflectance whether printed with black ink or colored ink. The reflectance value should not vary more than 5% within the same character. The type of ink should be compatible with the type of illumination in the optical scanner. If a scanner with an infrared light source is being used, the ink in the code must be IR absorptive (typically carbon based); otherwise the IR would "see through" the ink and be reflected to the sensor as if off a white surface.

2.7.3 VOIDS AND SPECKS

The code should be printed cleanly, i.e. free of voids, specks, blemishes and lines which could "fool" the scanner. Voids in the bars, specks or blemishes in the white spaces and false or missing bar sections could be interpreted by the reading equipment as part of the code. Generally, the width of such flaws is more serious than their height. Code labels should be rejected if these defects are prevalent.

2.7.4 DEFINITION

The bars in the code should be well defined, i.e. their edges should not be rough or fuzzy, so that the bars and spaces have the proper widths intended for the code. Since a scanners aperture and resolution are chosen to comply with these widths, definition should be sharp and consistent.

2.7.5 CONTRAST

Background reflectance (that of the substrate on which the codes are printed) should always provide a good contrast with the ink reflectance (that of the code bars). The difference between the two should be at least 50%.

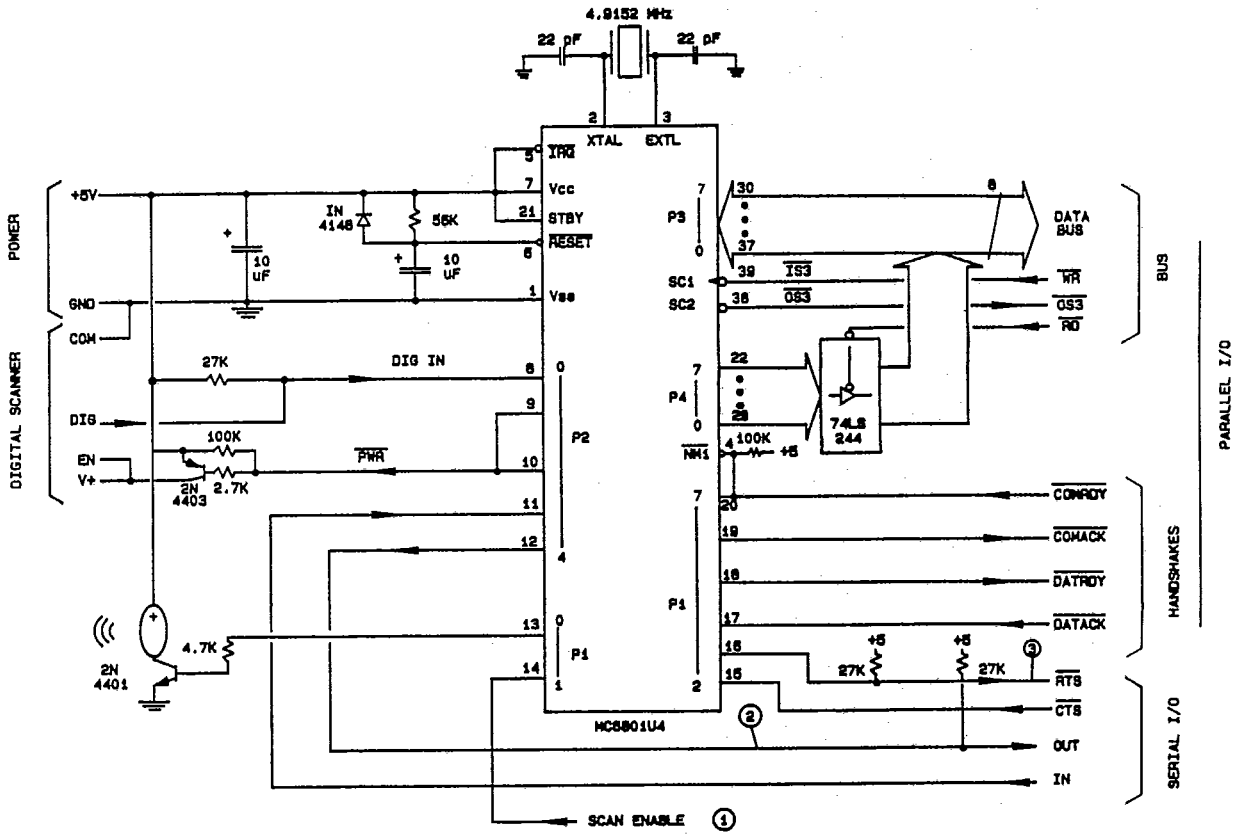
2.7.6 TOLERANCE

The ratio of the bars and spaces in a code must conform to the code specifications and can cause problems if not correct throughout the code. Problems can occur when bar edges are smeared or rough or when they exhibit wide or narrow areas. Such problems are not always obvious to the operator and are difficult to detect unless one measures the bars and spaces, then compares them with the code specifications. If this is not possible, the operator should confirm his/her suspicions by reading known good labels and comparing his reading success.

3.0 LTS-3 HARDWARE INTERFACES

The LTS-3 can be configured to communicate with the host device when operating in either parallel or serial input/output. Each of these modes is user selectable however a dedicated host to LTS interface must be hardwired, and prescribed programming sequences must be used to configure the decoder once an operating mode has been selected.

Key elements of LTS installation include the (1) power source, (2) decoder timing, (3) parallel/serial I/O ports, (4) scanner input, and (5) beeper control.The decoder schematic shown in Figure (3-1) illustrates LTS-3 hardware interfaces for both parallel and serial modes.



NOTES: FOLLOWING A /RESET,

(1) - HIGH ENABLES SCANNING; LOW DISABLES SCANNING.

(2) - HIGH ENABLES SERIAL OUTPUT; LOW DISABLES.

(3) - HIGH SELECTS 9600 BAUD; LOW SELECTS 1200 BAUD.

Figure (3-1)

3.1 SIGNAL CONVENTION

Throughout this manual, signal levels are in standard positive TTL logic convention. If a signal is active low, it is preceeded by a backslash (/); e.g. the signal RESET is an active high level, whereas /RESET is an active low level.

A signal designated as a strobe, e.g. strobe WRITE would be a positive-going pulse, while strobe /WRITE would be a negative-going pulse.The following sections contain general hardware characteristics which are common to LTS operation in either the parallel and serial mode.

3.2 POWER REQUIREMENTS

Decoder power should be supplied to Pins #7 and 21 (+5 VDC), and #1 (Gnd). The LTS chip requires +5.00 +/- 0.25 VDC at 154 +/- 20 mA. In addition, the hand-held digital scanner will draw 35mA. Scanner power should be supplied with less than 15mV ripple and noise.

3.3 CLOCK/TIMING SPECIFICATIONS

The LTS-3 microprocessor has a self-contained crystal oscillator which requires a crystal wired to pins #2 and 3. Alternately, the LTS-3 can be driven by a system clock of the proper frequency. If the LTS-3 is operated in serial mode, the crystal (or system clock) frequency must be 4.9152 MHz to provide the proper serial baud rates. If parallel I/O only will be used, any clock or crystal in the frequency range 4.0 to 5.0 MHz can be used. Clock input connections and recommended crystal parameters are shown in Figure (3-2).

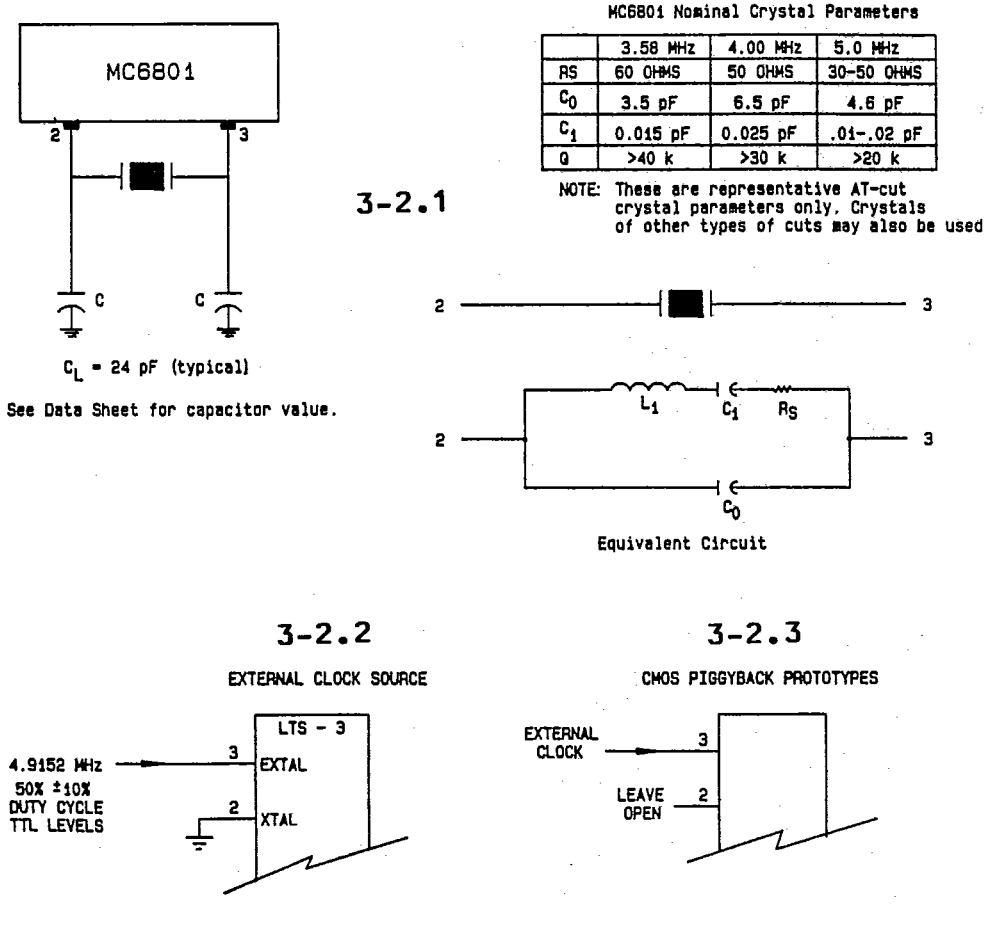


Figure (3-2)

NOTE: Some prototype units use a CMOS 63P01 microprocessor with a piggyback EPROM which, if used with an external clock, must be connected differently as shown in Figure 3-2.3.

3.4 RESET REQUIREMENTS

The LTS-3 can be reset automatically upon power-up, or by a low level reset command from the host. If an automatic reset is desired, the reset is generated from a 56K/10uf tap off the (+) side of the power supply and applied to pin 6 of the LTS. This RC circuit provides the time delay necessary to properly reset the LTS following a cold power-up. Figure 5-1 shows automatic power-up reset circuitry.

Alternately, the LTS can be reset by a low logic level from the host. If this is done from a power-down condition (a cold start), pin 6 must be held low for 100 msec after the +5V supply reaches +4.75V. This delay is necessary to give the internal clock oscillator time to stabilize. Once the +5V supply is up, a warm reset requires only that pin 6 be held low for greater than 5 microseconds.

3.5 INITIALIZATION

The initial status of certain operating parameters is determined by the signal level on three (3) LTS pins immediately following the reset command.

Pin 14:

The level of Pin 14 at reset will either enable or disable the scanner. If pin 14 is high when /RESET goes high, scanning of all codes will be enabled. If the level on pin 14 is low when /RESET goes high, all scanning will be disabled.

Pin 12:

The level on pin 12 controls the serial output from the decoder. If pin 12 is high when /RESET goes high, the serial output will be enabled. If the level on pin 12 is low when /RESET goes high, serial output will be disabled.

Pin 16:

Serial Baud Rate is controlled by the initial level on pin 16. If pin 16 is high when /RESET goes high, the baud rate will be set at 9600. If pin 16 is low when /RESET goes high, the baud rate will be 1200.

3.6 SCANNER CONNECTIONS

THE LTS-3 Decoder can be used with the following Welch Allyn digital scanners:

- SSD Digital Red LED Scanner
- SSID Digital Infrared Scanner
- MSR Slot Reader
- CMM Machine Mount Scanner

These units, when configured to interface with the LTS have an NPN open-collector output. This output design combined with an external pull-up resistor, drives the DIGIN line (pin 8) into the LTS.

As a controlling output, pin 10 from the LTS pulls low and in so doing, enables the supply voltage (+5V) to the scanner, and generates the ENable signal which is applied to the scanner.

The level of pin 10 is software controlled by the ENABLE SCAN and DISABLE SCAN commands entered from the host keyboard. When the level on pin 10 is high, the scanner is disabled, when the level on pin 10 is low, the scanner will be enabled.

Product Bulletins describing each of the scanners listed above and their applications are contained on pages D the Appendix of this Manual.

3.7 BEEPER CONNECTIONS

A DC-driven or "self-oscillating" beeper, or an LED, can be pulsed following a "valid read", or on command from the host. The output pulse is taken from LTS pin 13. When the level on pin 13 is high, the beeper is turned 'ON"; a low level turns it 'OFF'. The output from pin 13 is a single pulse approximately 160ms long, it is not a tone burst.

4.0 CONFIGURING THE LTS-3 BAR CODE DECODER

4.1 LTS-3 OPERATING FEATURES

The following LTS-3 operating features can be controlled. They are configured by commands sent at any time from the Host to the LTS.

BEEP - Enabling this feature will cause the LTS to 'beep' once for each command sent by the Host to the LTS by causing LTS pin 13 to go high for approximately 160 msec. It is particularly useful when commands are being entered from a keyboard device, and should not to be confused with the "good read" beep which is generated by the LTS, and used to indicate a valid scan.

ENABLE/DISABLE SCANNING - Two distinct commands used to enable or disable the scanner. Both the Enable and Disable Scanner commands can be combined with the command entry 'beep' described above.

BAR CODE ENABLE - This command is used to specify which of the five (5) major bar code symbologies will be recognized and decoded by the LTS. The command format allows selection of a single code or multiple combinations of bar codes.

"GOOD READ BEEP" - Permits enabling an automatic beep by the LTS annunciator following every valid scan. This feature is particularly useful when an operator is manually scanning bar codes using a hand held reader.

BAR CODE ID - When this feature is enabled, a single lower letter code preceeds bar code data and is used to identify the symbology of the label that was just read.

SEND START/STOP - When enabled, the LTS will send both the start and stop characters used with Codabar symbology as labels are scanned.

CODE 3 of 9 ASCII - This feature permits full ASCII interpretation of Code 3 of 9 symbols rather than 'regular' decoding. By encoding specific ASCII characters such as (CR), (LF), etc., specific system commands or routines can be initiated based on label information.

UPC/EAN ADDENDA - Using this command, the LTS can be instructed to read and transmit to the Host, the 2 or 5 digit addenda frequently used with UPC and EAN symbology. When this feature is selected the label must be scanned from left-to-right in order to recognize the addenda. If scanning is performed right-to-left, only the main body of the label will be read.

FIXED LENGTH TEST - This LTS capability can be used when Interleaved 2 of 5 symbology is required. The command can be used to establish a length criterion for Interleaved 2 of 5 symbols. To obtain a valid read, the number of scanned characters must agree with the data word length. The number of characters in the label must be even, padded with a leading zero if necessary.

4.2 COMMAND WORD STRUCTURE

The LTS features described in Section 4.1 are controlled by 8-bit command words. The two (2) most significant bits identify the general command category, the remaining five (5) bits are used to delineate specific LTS decoding instructions.

The host can send commands to the LTS-3 at any time in either parallel mode or serial mode. In parallel mode commands are sent to, and interpreted by the LTS in 8-bit binary. In serial mode, data transfer on the serial lines is in ASCII. Commands from the host are converted to 8-bit binary by the LTS.

All commands to the LTS-3 generate interrupts, and are processed immediately. Commands can be sent at any time.

4.3 EXECUTABLE COMMANDS

The commands in Group '1' (MSB's = 11) can be entered at any time the LTS is in operation. They are executed immediately.

Bit #	MSB	7	6	5	4	3	2	1	0	LSB
Command Word		1	1	-	-	-	x	x	x	

Bits 5 - 3 are used to identify the following decoder instructions:

Bit 5 = 1	Beep once	1110 0XXX	(e.g., hex E0)
Bit 4 = 1	Disable scanning	1101 0XXX	(e.g., hex D0)
Bit 3 = 1*	Enable scanning	1100 1XXX	(e.g., hex C8

* - Bit 4 overides bit 3 if both are '1'. (This is the only case of bit overide.)

In these command words, bits 2 - 0 are Unassigned ("don't care").

Any of these commands can be combined by making the appropriate bit assignments. For example, the command word 11110000 (hex F0) will instruct the LTS to beep once, and to disable scanning. The command word 11111000 (hex F8) can also be used, because if they are both sent at the same time, bit 4 overrides bit 3.

4.4 BAR CODE ENABLING

Commands in Group '2' (MSB's = 01) are used to specify which symbology(s) the LTS should recognize and decode. The individual bits in the command word are used to enable (if = 1) or disable (if = 0) a particular code.

Bit #	MSB	7	6	5	4	3	2	1	0	LSB
Command Word		0	1	-	-	-	-	-	x	

Command word bit assignments follow:

Bit 5 = 1	Enables Codabar	0110 0000	(hex 60)
Bit 4 = 1	Enables Code 39	0101 0000	(hex 50)
Bit 3 = 1	Enables UPC-A and -E	0100 1000	(hex 48)
Bit 2 = 1	Enables EAN-8 and EAN-13	0100 0100	(hex 44)
Bit 1 = 1	Enables Interleaved 2-of-5	0100 0010	(hex 42)

Bit 0 is Unassigned ("don't care").

Any combination of the above symbologies may be enabled for decoding at one time by assembling the desired pattern of code enabling and disabling bits into a single command word. For example, sending the command word:

01011100 (hex 5C)

to the LTS will enable decoding of Code 39, UPC and EAN, and will disable Codabar and Interleaved 2-of-5. A subsequent command word of:

01100000 (hex 60)

will enable Codabar, and disable (!) all other codes.

4.5 OUTPUT FORMAT OPTIONS

Group '3' Command Words (MSB's = 10) are used to control the five (5) LTS output options listed in Section 4.1.

Bit #	MSB	7	6	5	4	3	2	1	0	LSB
Command Word		1	0	-	-	-	-	-	x	

where:

Bit 5 = 1 (e.g., hex command word A0) -- The LTS will transmit a lower case letter preceeding the scanned data to identify the symbology which has been read. The following identification codes are used:

a = Codabar
b = Code 39 (regular or full ASCII version)
c = UPC
d = EAN
e = Interleaved 2-of-5

If Bit 5 = 0, the code identification option will be disabled, and no identification character will be transmitted.

Bit 4 = 1 (e.g., hex command word 90) -- If the LTS has been configured to recognize/decode Codabar, the start and stop characters will be transmitted preceeding and following the bar code data.

If Bit 4 = 0, the start and stop characters will not be sent.

Bit 3 = 1 (e.g., hex command word 88) -- When bit 3 of the command word is '1', Code 39 symbols will be recognized (decoded) in "Full ASCII". A complete listing of keyboard characters in "Full ASCII" appears on page C-2 of the Appendix.

If Bit 3 = 0, the LTS will transmit "regular' Code 39 decoding.

Bit 2 = 1 (e.g., hex command word 84) -- 2 or 5 digit addenda following UPC or EAN symbols shall be read and transmited on left-to-right scans. (If bit 2 = 0, conversely, addenda are not decoded). On right-to-left scans. addenda are not recognized as valid in any case, and onyl the main body of the label will be read.

If Bit 2 = 0, the addenda will not be recognized or transmitted regardless of scanning direction.

Bit 1 = 1 (e.g., hex command word 82) -- When bit '1' in the command word is '1', a "good read" beep will be issued following each valid scan for all bar codes which have been selected.

If Bit 1 = 0, there will be no 'beep' following valid scans.

A combination of desired Format Options can be programmed, by combining individual options into one compound command byte. For example, the command word:

1011110 (hex BE)

will enable all of the format options. Note that the MSB bit positions contain the digits '10' indicating that the instructions to be configured are from the group of 'Format Options".

4.6 SETTING INTERLEAVED 2 OF 5 SYMBOL LENGTH

Group '4' Command Words (MSB's = 00) are used to establish fixed bar code length (number of character pairs) when the LTS is configured to recognize Interleaved 2-of-5 symbols.

Bit #	MSB	7	6	5	4	3	2	1	0	LSB
Command Word		0	0	-	-	-	-	-	-	

The six (6) least significant bits express in binary the fixed number of "character pairs" that will be allowed in valid Interleaved 2-of-5 symbols. Remember, that because of the way in which the Interleaved 2-of-5 code has been constructed, encoded digits must occur in pairs. If a desired code number has an odd number of digits, it must be 'padded' with a leading zero to make the total even.

When the LTS has been configured to recognize Interleaved 2-of-5 symbols, and the command word:

00000101 (hex 05)

is transmitted, the LTS will be instructed to recognize and decode only those symbols with exactly five pairs (10 digits).

> **NOTE:** It is possible to configure the LTS to read variable length Interleaved 2-of-5 symbols. However, this special case should be used with caution, since variable length decoding of Interleaved 2-of-5 is prone to mis-reading of partial symbols when a scan slips off the edge in the middle of a symbol. Because these short bar code segments can be read as valid, full message security is assured only when the decoder checks for an expected symbol length.

To configure the LTS to recognize variable length Interleaved 2-of-5 symbols the command word:

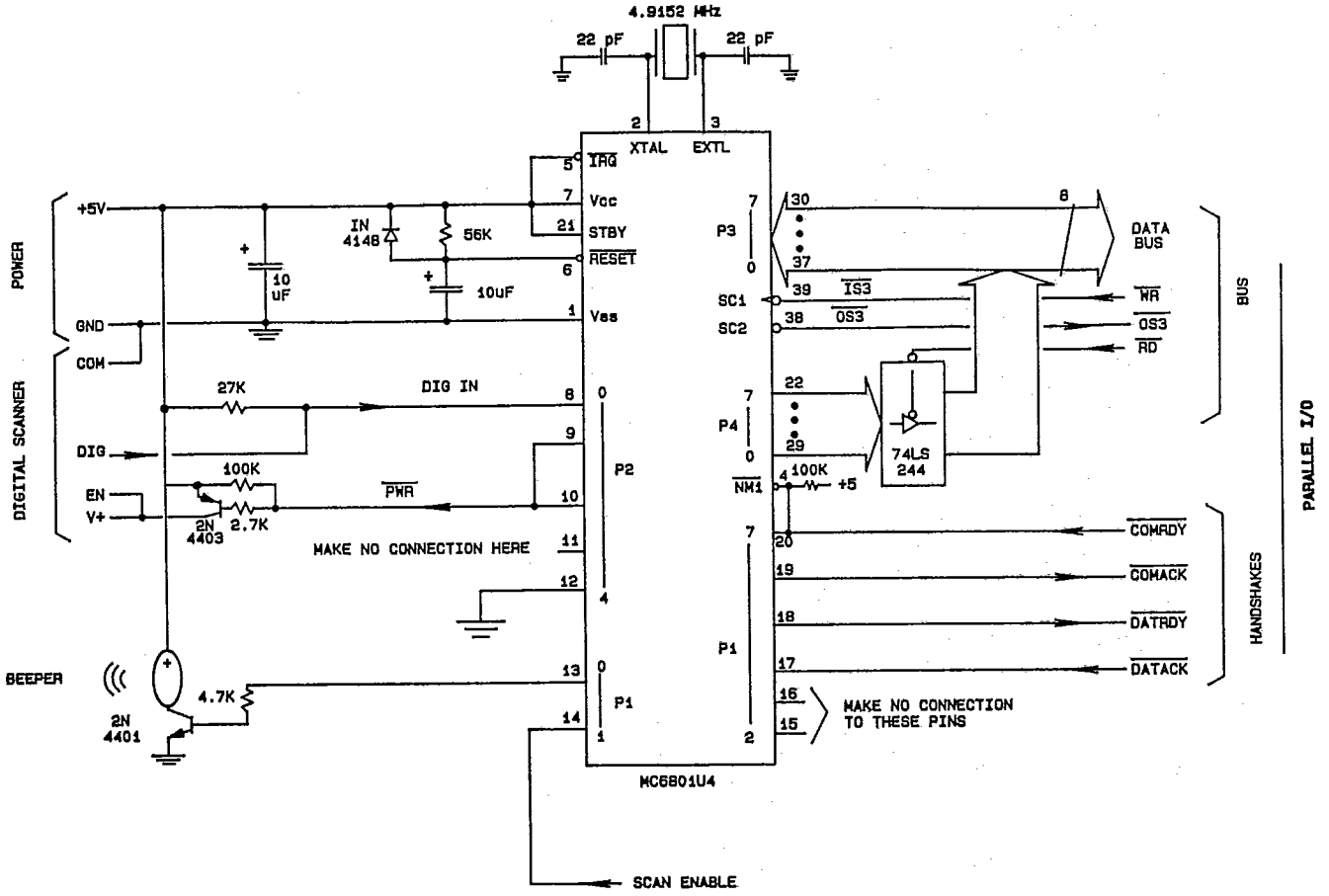
00000000 (hex 00)

should be used. This command enables reading of all Interleaved 2-of-5 symbols which are 4 to 48 digits in length.

5.0 LTS-3 PARALLEL MODE OPERATION

5.1 INPUT/OUPUT PIN ASSIGNMENTS

A schematic diagram indicating pin connections for operating the LTS-3 in the parallel mode is shown in Figure (5-1). In this mode, the LTS decoder module accepts digitzed bar code signals from a Welch Allyn digital scanner, and transmits data to the host in 8-bit parallel, with handshaking.



NOTE: SCAN ENABLE

- HIGH ENABLES SCANNING
- LOW DISABLES SCANNING

FIGURE (5-1)

5.2 GENERAL DATA FLOW

5.2.1 FROM THE HOST

When operating in parallel, LTS Port 3 (pins 30-37) is always an INput which receives commands from the Host. Command bytes are latched into port 3 on the negative edge of /WR (pin 39), or /WR may be held permanently low and the command byte presented statically. Command entry is read into the LTS via a handshake on the /COMRDY and /COMACK lines (pins 4 & 20 and 19). (See Figure 5-2).

To send a command to the LTS, the host should place the desired 8-bit command word on the data bus, and issue a /WR strobe. The command will be latched into Port 3 on the negative-going edge (!) of the /WR strobe, which must have a minimum duration of 0.2 microsec. The host then lowers /COMRDY for a minimum of 1 microsec. to complete the transfer of the command.

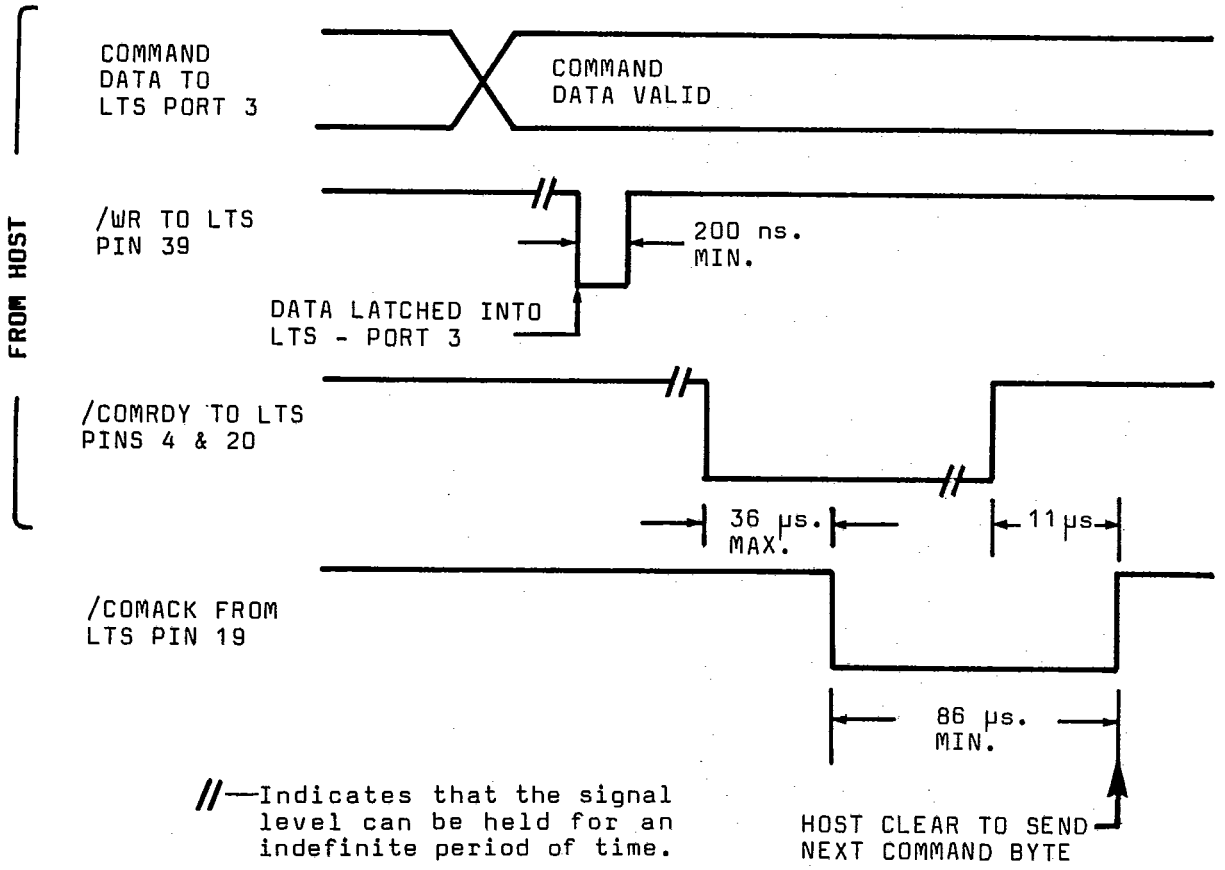


Figure (5-2)

After reading the command byte, the LTS sets /COMACK low in acknowledgement, and executes the command. The LTS then waits (if necessary) for /COMRDY to return to a high status. When this occurs, the LTS returns /COMACK high, signalling the completion of one command 'cycle'.

5.2.2 TO THE HOST

LTS Port 4 (pins 22-29) is always used as an active OUTput to issue bar code data to the host. New data bytes are accompanied by a strobe pulse /OS3 (pin 38). Bar code data transfer is effected via a handshake on the /DATRDY and /DATACK lines (pins 18 and 17 respectively).

5.3 BAR CODE DATA TRANSFER - LTS TO HOST

If scanning has been enabled, and a valid scan is made, bar code data is transferred from the LTS to the host with the following sequence. Timing diagram waveforms associated with this data transfer are shown in Figure (5-3).

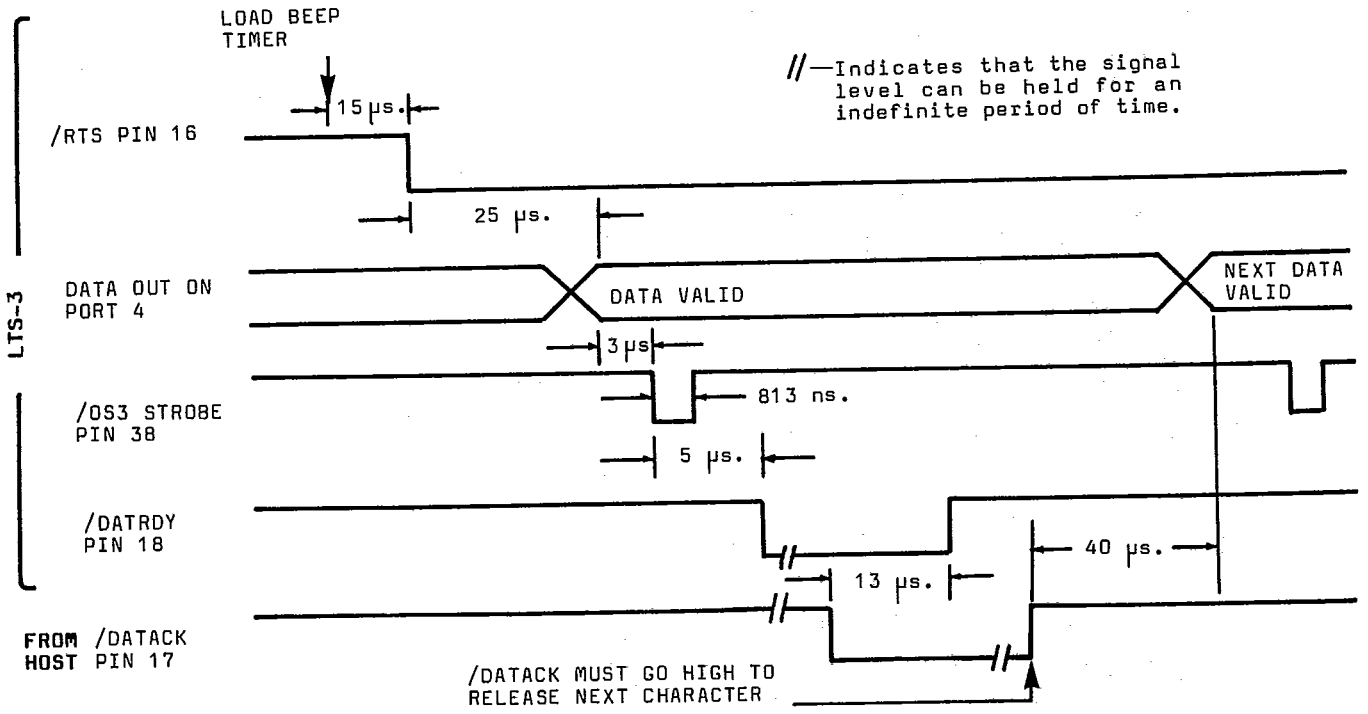


Figure (5-3)

(1) -- If the "good read" beep option has been enabled, the LTS will issue a single 'beep'. Pin 13 goes high for the duration of the beep (160 msec.).

(2) -- The LTS puts the first bar code character out on Port 4, then sends a strobe pulse /OS3 out from pin 38 (duration is 800 nsec.) and drops /DATRDY low. These signal changes indicate to the host that there is a new valid character at Port 4.

(3) -- The host should now read the data character through either an 8-wide parallel port or, as shown in Figure (5-1), a 74LS244 tristate buffer onto a bidirectional data bus by pulsing /RD low.

(4) -- After the character has been read, the host sets /DATACK low in acknowledgement. The LTS responds by returning /DATRDY high and then waits for /DATACK to be returned high.

(5) -- The handshake is completed when the host returns /DATACK back to high. This type of 'handshake' accompanies each data character transfer, and will be repeated until all data has been transferred.

NOTE: Each character in the bar code output string is sent in 7-bit ASCII. All of the characters, except the last one, have the MSB (bit 7) = 0. The last character in the bar code data string is sent with bit 7 = 1. This signal to the host serves as an end-of-string marker. The bar code characters are sent in left-to-right order regardless of the scanning direction. Check characters required by a given symbology are not sent.

The speed or timing of the illustrated pulse sequence is not critical to LTS operation, except that a new or different symbol cannot be decoded until all the bar code data associated with the label that was just read, has been tranferred.

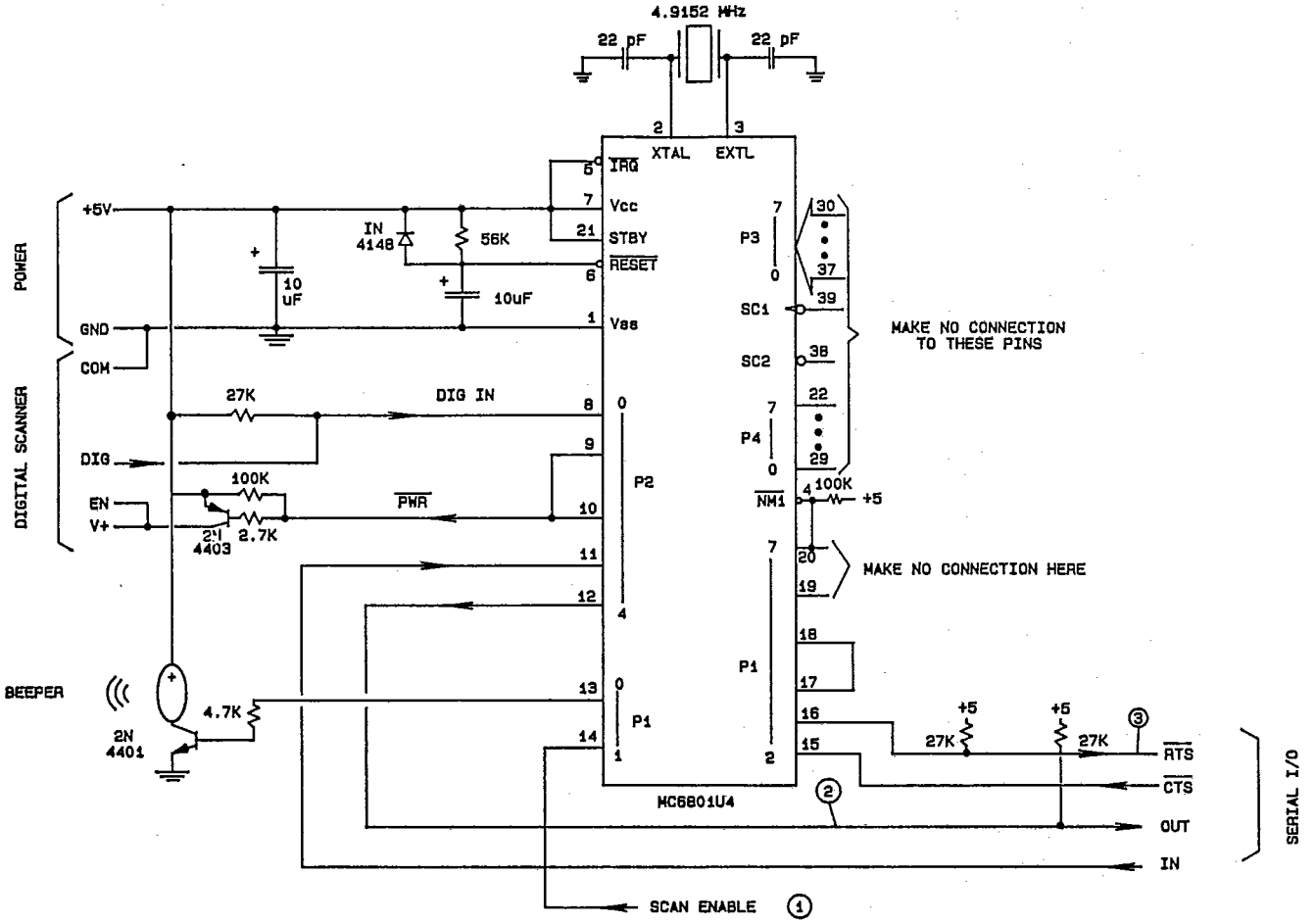
5.4 CONFIGURING THE LTS-3 IN PARALLEL MODE

When operating in parallel mode, the LTS-3 should be configured using the required 8-bit command words described in Section 4.0. For most applications several command words may be required to enable the required decoder features.

6.0 LTS-3 SERIAL MODE OPERATION

6.1 INPUT/OUTPUT PIN ASSIGNMENTS

A schematic diagram indicating connections for operating the LTS-3 in the asynchronous serial mode is shown in Figure (6-1). In this mode the LTS decoder module accepts digitized bar code signals from a Welch Allyn digital scanner, and transmits data to the host serially, via an asychronous ASCII port (at TTL levels) with /RTS - /CTS control.



NOTES: FOLLOWING A /RESET,

(1) - HIGH ENABLES SCANNING; LOW DISABLES SCANNING.

(2) - HIGH ENABLES SERIAL OUTPUT; LOW DISABLES.

(3) - HIGH SELECTS 9600 BAUD; LOW SELECTS 1200 BAUD.

Figure (6-1)

6.2 INITIALIZATION

In order to operate the LTS-3 in Serial Mode, the serial data output must be enabled. This should be done during LTS-3 power-up, and coordinated with proper /RESET signal levels. LTS Reset alternatives are described in Section 3.4.

To enable serial output, the SERIAL DATA OUT line (pin 12) must be at a high level when /RESET returns high. At the same time, the level of /RTS (pin 16) must be set to establish the desired baud rate. If pin 16 is held high, the LTS will be set for 9600 baud; if pin 16 is low, the decoder will be set for 1200 baud.

6.3 SERIAL MODE DATA FLOW

6.3.1 FROM THE HOST

Serial commands from the host to the LTS-3 can be sent at any time. They are sent as ASCII characters at positive TTL logic levels ("mark" is high) and received asychronously by the LTS on the SERIAL IN line (pin 11). Data transfer from host to LTS can take place regardless of whether the serial data output is enabled. The serial characters used to construct a command word from the host must have space parity (bit 7 = 0).

6.3.2 TO THE HOST

When the scanner has been enabled, each valid scan produces a serial ASCII data string at positive TTL logic levels. Bar code data is issued asychronously on the SERIAL OUT line (pin 12).

A conventional RS-232 handshake is performed, at TTL voltage levels, on the lines /RTS and /CTS (pins 16 and 15): the LTS lowers /RTS when it has data to send and waits for /CTS to be low before sending each character of data. Data characters from the LTS have odd parity.

> **NOTE:** The jumper between pins 17 and 18 is required to satisfy the parallel output handshake. Parallel I/O is never actually disabled on the LTS. Therefore, no connections, other than those shown in Figure (6-1) should be made to parallel output pins.

6.4 BAR CODE DATA TRANSFER

If scanning has been enabled, and a valid scan is made, bar code data is transferred from the LTS to the host with the following sequence:

> **(1)** -- If the "good read" feature has been enabled, the LTS will issue a single 'beep'. Pin 13 goes high for the duration of the beep (160 msec.).

(2) -- The LTS lowers /RTS and prepares to issue the serial data string. Data transfer takes place when /CTS goes low. Bar code characters are sent in a left-to-right order regardless of the direction in which the label was scanned.

(3) -- When the bar code data string has been transmitted, the LTS sends a final carriage return (CR) character to terminate the transmission and returns /RTS to high.

NOTE: All characters that are issued serialy by the LTS have odd parity. As a result, there is an inconsistency in parity requirements between the serial input and output. The host can either check the incoming data from the LTS for odd parity, or simply strip the parity bit. However, commands to the LTS must always be sent with "space" parity.

6.5 CONFIGURING THE LTS-3 IN SERIAL MODE

When operating in the serial mode, the LTS is configured using the same set of 8-bit command words described in Section 4.0. However, it is necessary to modify the command format so it is acceptable for serial transmission by encoding each 8-bit command word into equivalent ASCII.

The resulting command in hex code format is XX (CR) where each X is a hex digit represented in ASCII, followed by a carriage return (CR). For example, the 8-bit command word 01001100 will configure the LTS to decode both UPC and EAN symbologies. The hex code equivalent of this command is 4C (CR), which in ASCII becomes 34 43 0D.

The Command Summary Tables contained in the Appendix, illustrate the commands in both the 8-bit and hex code formats.

The LTS will also respond to three special 1-character control commands which can be sent without the carriage return. These include:

BEL	(hex 07)	=	Beep once.
DC1=XON	(hex 11)	=	Enable or restart scanning; turn scanner ON.
DC3=XOFF	(hex 13)	=	Disable scanning; turn scanner OFF.

7.0 LTS-3 OPERATING CONSIDERATIONS

7.1 POWER-UP INITIALIZATION

7.1.1 GENERAL PURPOSE DECODING

Many general purpose bar code applications require common operating features. The LTS can be automatically programmed to enable the following parameters by holding pin 14 of the LTS high during a RESET command.

(1) All symbologies are enabled for decoding.

(2) A lower-case Code ID character preceeds output data to identify the bar code symbology.

(3) Codabar START and STOP characters are issued.

(4) "Regular" Code 39 interpretation is in force.

(5) UPC and EAN addenda are enabled for reading.

(6) A 'beep' will be issued following each valid scan.

(7) Variable field length Interleaved 2-of-5 symbols can be read.

(8) The Decoding function is activiated.

In order to configure the same LTS features using individual commands, the following command word sequence would be required.

To enable all symbologies:

0 1 1 1 1 1 1 0 = hex 7E

To invoke the "format options" described in items #2 - #5 above:

1 0 1 1 0 1 1 0 = hex B6

To enable variable field Interleaved 2-of-5 decoding:

0 0 0 0 0 0 0 0 = hex 00

And to enable the decoder (#8 above):

1 1 0 0 1 0 0 0 = hex C8

7.1.2 DEDICATED DECODING APPLICATIONS

In many cases, the LTS will be used in an application where its decoding capability is 'dedicated' to a particular purpose. For example, consider a tracking situation where a fixed scanner reads codes from items on a carrousel within a machine. The decoder will feed a remote host computer, so the "good read" beep is not required. Finally, the only symbology to be used is 18-digit Interleaved 2-of-5 so no identification ID character is required.

The follow command word sequence will enable the proper LTS parameters. Both 8-bit and equivalent hex commands are shown.

To enable Interleaved 2-of-5 symbology only:

0 1 0 0 0 0 1 0 = hex 42

To establish a fixed field length of 9 pairs (18 characters):

0 0 0 0 1 0 0 1 = hex 09

To disable both the Code ID character and the "good read" beep:

1 0 0 0 0 0 0 0 = hex 80

And finally, to enable decoding:

1 1 0 0 1 0 0 0 = hex C8

The LTS can be configured for dedicated decoding applications at any time following power-up, regardless of whether pin 14 was high or low at reset. The configuration commands can be entered any time and in any order to obtain the desired decoding configuration.

7.2 INITIALIZING PRECAUTIONS

Care must be exercised when sending initializing commands to the LTS. It is critical that there be a minimum of 200 microsec. delay after the /RESET line (pin 6) has risen above 4.0 V before any command is sent to the LTS.

If a host-generated reset is used, a simple delay will suffice. However, if the more common R-C time-delay reset circuit (Section 3.4) is used transfer problems may occur when entering the initial configuration command. Two solutions are available.

First, the host may delay sufficiently long (more than 1 second) after power-on to be sure the LTS has stabilized before issuing the initial configuration command.

The second solution involves monitoring the "beep" line (pin 13). If pin 14 (Scan Enable) is pulled high on reset, then a single "How-do-you-do?" beep will be issued upon power-up. The host could monitor the 'beep' line (pin 13) and wait until pin 13 goes high before issuing configuration commands to the LTS. If this monitoring technique is used however, the possibility exists that the 160 msec beep pulse could come and go before the host starts looking for it.

7.3 RECONFIGURING WHILE RUNNING

The decoder can be re-configured at any time, by sending configuration commands from the host to the LTS. Consider an application where the decoder must repetitively read three (3) different bar code symbologies which always appear in the same order.

Assume the codes appear in the following order: (1) Code 39, (2) 6-digit Interleaved 2-of-5 and last, (3) 14-digit Interleaved 2-of-5. To configure the LTS to read this code sequence, three distinct command word groupings would be required. To show how this could be accomplished when operating in either parallel and serial mode, both 8-bit and hex code commands are illustrated.

The first command word transmitted, would instruct the LTS to read Code 39:

0 1 0 1 0 0 0 0	=	hex 50	instructs the LTS to read and decode Code 39.

After bar code data was transferred, the second command would be sent from the host, telling the LTS to recognize and decode only Interleaved 2-of-5 Codes which have 12 (6 pairs) digits:

0 1 0 0 0 0 1 0	=	hex 42	plus
0 0 0 0 0 0 1 1	=	hex 03	selects 6-digit I 2-of-5.

When data transfer was complete, the following command would configure the LTS to read and decode only Interleaved 2-of-5 Codes having 14 digits (7 pairs).

0 1 0 0 0 0 1 0	=	hex 42	plus
0 0 0 0 0 1 1 1	=	hex 07	selects 14-digit I 2-of-5.

To repeat the read sequence, the same commands would be re-entered by the host.

7.4 AUXILLARY DATA CHECKS

In certain bar code applications it may be necessary to improve data security beyond that afforded by the basic symbology. One method of improving security involves the addition of one or more 'check characters'. When such check characters are added to bar code data,it is important that the LTS does not give a 'valid scan' beep when it reads a label which has the correct symbology, but which does not check correctly. To eliminate this problem, it is possible to verify complete codes by generating either 'read error' or 'good read' signals.

With the first method ('read error'), the LTS would be configured to beep on all valid scans as usual. However, if the check of auxillary digits fails, the host is instructed to issue one or more additional beep commands to the LTS, thus converting the single 'good read' beep into a multiple beep 'read error' signal.

When a 'good read' signal is desired, the LTS 'good beep'on valid scan would be disabled until all data outputs from the LTS are qualified. If the auxillary bits check,the host would be instructed to send a single beep command to the LTS, thereby producing a simulated 'good read' signal.

APPENDIX

COMMAND TABLE SUMMARY

Function	Code ID Letter	Parallel Mode 1 Hexadecimal Character	Serial Mode 3 ASCII Characters
Scanner Features			
Beep Once Upon Command		E0	E 0 (CR)
Disable Scanning		D0	D 0 (CR)
Enable Scanning		C0	C 0 (CR)
Enable Bar Code Symbologies			
Enable Codabar	a	60	6 0 (CR)
Enable Code 3 of 9 (normal mode, not full ASCII)	b	50	5 0 (CR)
Enable UPC A & E	c	48	4 8 (CR)
Enable EAN 8 & 13	d	44	4 4 (CR)
Enable Interleaved 2 of 5	e	42	4 2 (CR)
Enable Format Options			
Send Code ID before data		A0	A 0 (CR)
Send Codabar start/stop characters		90	9 0 (CR)
Interpret Code 39 as 'full ASCII'		88	8 8 (CR)
Send UPC/EAN addenda		84	8 4 (CR)
Beep on valid scan		82	8 2 (CR)
Disable all options		80	8 0 (CR)

COMMAND TABLE SUMMARY

Interleaved 2 of 5 Symbology

Variable Length Mode

# Characters	# Pairs	Parallel Hexadecimal	Serial ASCII
4 to 48	2 to 24*		

* - Scanner will read any even length from a minimum of 4 characters to a maximum of 48 characters.

Fixed Length Mode

# Characters	# Pairs		Parallel Hexadecimal	Serial ASCII
2	1	Min. Length	01	0 1 (CR)
4	2		02	0 2 (CR)
6	3		03	0 3 (CR)
8	4		04	0 4 (CR)
10	5		05	0 5 (CR)
12	6		06	0 6 (CR)
14	7		07	0 7 (CR)
16	8		08	0 8 (CR)
18	9		09	0 9 (CR)
20	10		0A	0 A (CR)
22	11		0B	0 B (CR)
24	12		0C	0 C (CR)
26	13		0D	0 D (CR)
28	14		0E	0 E (CR)
30	15		0F	0 F (CR)
32	16		10	1 0 (CR)
34	17		11	1 1 (CR)
36	18		12	1 2 (CR)
38	19		13	1 3 (CR)
40	20		14	1 4 (CR)
42	21		15	1 5 (CR)
44	22		16	1 6 (CR)
46	23		17	1 7 (CR)
48	24	Max. Length	18	1 8 (CR)

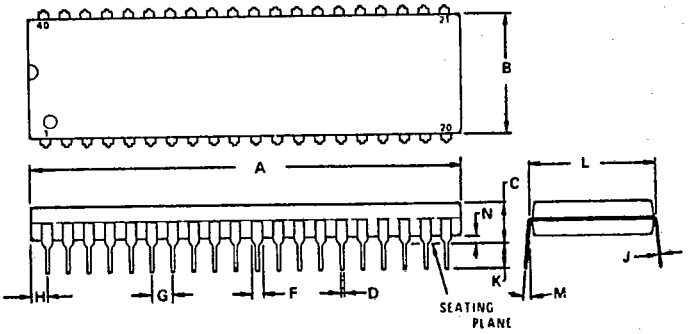
Special Serial Commands

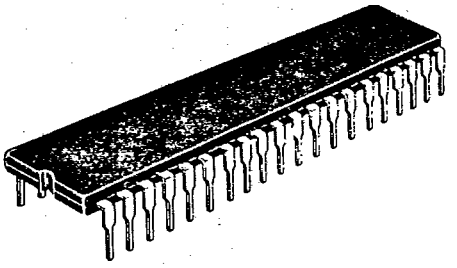
These are single ASCII control characters. They are sent by the host without a carriage return (CR).

Beep Once (BELL)	hex 7
Enable Scanning (DC1=XOFF)	hex 11
Disable Scanning (DC3=XON)	hex 13

DIMENSIONAL DATA - 40-PIN PACKAGES

PLASTIC PACKAGE
CASE 711-03



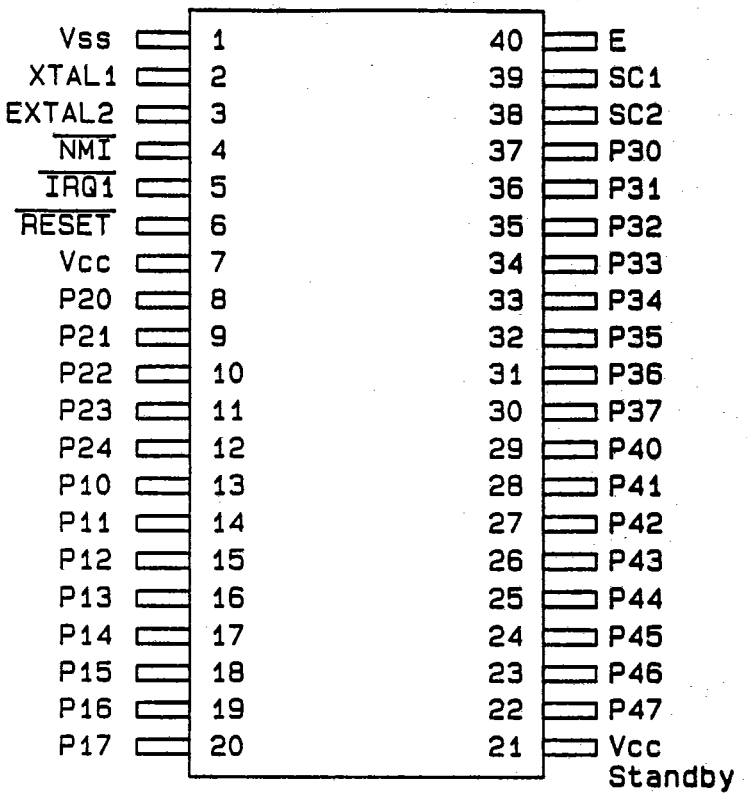


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	51.69	52.45	2.035	2.065
B	13.72	14.22	0.540	0.560
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	1.65	2.16	0.065	0.085
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

NOTES:
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 mm (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

LTS-3 MODULE - PIN ASSIGNMENTS

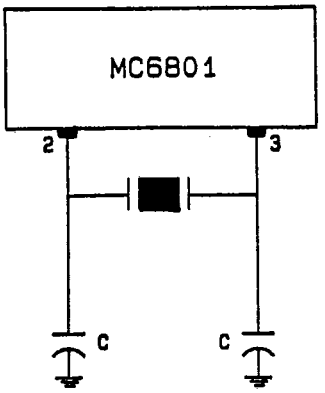
40/24E



LTS-3
WA 31201600

LTS-3 DECODER

TIMING AND CRYSTAL PARAMETERS



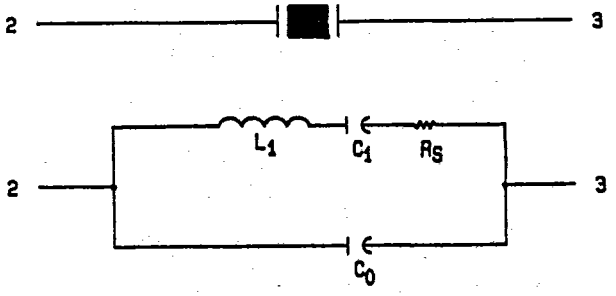
C_L = 24 pF (typical)

See Data Sheet for capacitor value.

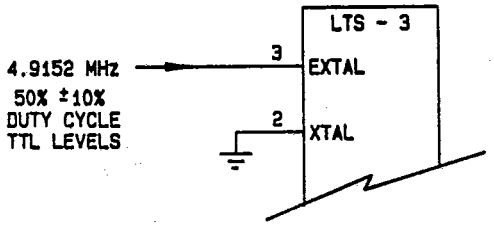
MC6801 Nominal Crystal Parameters

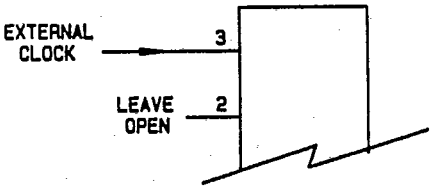
	3.58 MHz	4.00 MHz	5.0 MHz
RS	60 OHMS	50 OHMS	30-50 OHMS
C_0	3.5 pF	6.5 pF	4.6 pF
C_1	0.015 pF	0.025 pF	.01~.02 pF
Q	>40 k	>30 k	>20 k

NOTE: These are representative AT-cut crystal parameters only. Crystals of other types of cuts may also be used



Equivalent Circuit





On PC board layout, allow for a strap option to either ground pin 2 or leave it open.

FULL ASCII CODING - CODE 3 OF 9

ASCII	CODE 39	ASCII	CODE 39	ASCII	CODE 39	ASCII	CODE 39
NUL	%U	SP	Space	@	%V	`	%W
SOH	$A	!	/A	A	A	a	+A
STX	$B	"	/B	B	B	b	+B
ETX	$C	#	/C	C	C	c	+C
EOT	$D	$	/D	D	D	d	+D
ENQ	$E	%	/E	E	E	e	+E
ACK	$F	&	/F	F	F	f	+F
BEL	$G	'	/G	G	G	g	+G
BS	$H	(	/H	H	H	h	+H
HT	$I	)	/I	I	I	i	+I
LF	$J	*	/J	J	J	j	+J
VT	$K	+	/K	K	K	k	+K
FF	$L	,	/L	L	L	l	+L
CR	$M	-	-	M	M	m	+M
SO	$N	.	.	N	N	n	+N
SI	$O	/	/O	O	O	o	+O
DLE	$P	0	0	P	P	p	+P
DC1	$Q	1	1	Q	Q	q	+Q
DC2	$R	2	2	R	R	r	+R
DC3	$S	3	3	S	S	s	+S
DC4	$T	4	4	T	T	t	+T
NAK	$U	5	5	U	U	u	+U
SYN	$V	6	6	V	V	v	+V
ETB	$W	7	7	W	W	w	+W
CAN	$X	8	8	X	X	x	+X
EM	$Y	9	9	Y	Y	y	+Y
SUB	$Z	:	/Z	Z	Z	z	+Z
ESC	%A	;	%F	[	%K	{	%P
FS	%B	<	%G	\	%L	¦	%Q
GS	%C	=	%H	]	%M	}	%R
RS	%D	>	%I	^	%N	~	%S
US	%E	?	%J	_	%O	DEL	%T %X %Y %Z

Note: Character pairs /M and /N decode as a minus sign and a period, respectively. Character pairs /P through /Y decode as 0 through 9.