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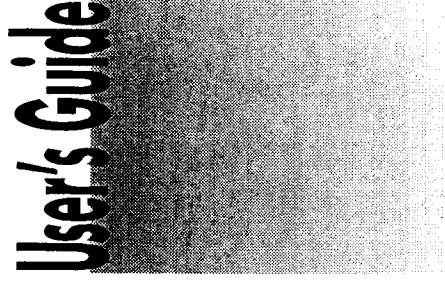
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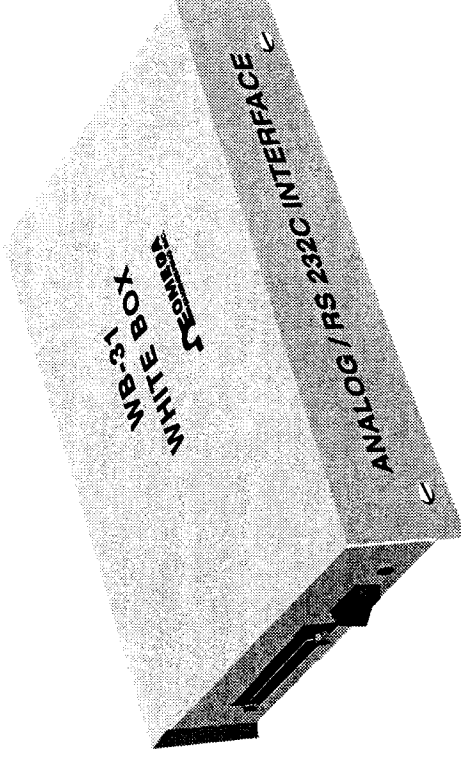


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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® WB-31 is an analog to serial interface. Essentially an intelligent A/D converter, the WB-31/31B is designed to interface with instruments possessing an analog output and computers with a serial communications port. Two analog input channels are provided with a standard full scale input range of ± 5 V and selectable resolution of either 1 mV or 250 μ V.

No special programming is required to use the WB-31. The WB-31 responds just like a computer peripheral. Simple control commands tell it what is to be done and a C will start conversions and transmit data to your computer.

The WB-31 has four addressable TTL outputs. Not only can your computer monitor your process, it can control it, too. The four outputs can sound alarms, work heaters and air conditioners, start motors, etc., all through solid state switching devices.

The WB-31B is an intelligent interface. The WB-31B is like the WB-31, except that it is programmable. The WB-31B includes 2k RAM (random access memory), and the OMEGABASIC programming language. With the WB-31B, the interface doesn't have to be attached to a computer—it is one. Simply program the WB-31B through a dumb terminal, and then let it run your data acquisition and control program by itself.

1.2

INTRODUCTORY NOTES

Please note the following points before powering up the unit for the first time:

1. **Serial Connection**—The WB-31/WB-31B is standard DTE. Refer to paragraph 3.2 and the WB-31/31B schematic.
2. **Hardware Handshaking**—The WB-31/31B comes standard with DTR/DSR and RTS/CTS handshaking requirements disabled (switch 2, position 6 ON). If this switch is OFF, thus enabling DTR/DSR and RTS/CTS handshaking, then both DSR and CTS must be pulled high before any data will be output. Refer to paragraphs 3.1.2, 3.2 and the WB-31/31B schematic.
3. **Modes of Operation**—There are two distinct modes of operation available; the Command Mode and the BASIC Mode. The WB-31 may use only the Command Mode, while the WB-31B may use either. Refer to Section 4.
4. **Commands**—All commands must be in capital letters.

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list to check off actual equipment received. If there are any questions about the shipment, please call OMEGA Customer Service Department at (203) 359-1660.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

2.2

INSTALLATION

The WB-31/31B is housed in a rugged metal benchtop case. Connection to the serial communications link is accomplished using an industry standard 25-pin male sub-D connector. A terminal strip is provided for the two analog inputs and four digital outputs. Internal switches and jumpers are provided to allow selection of various options. The cover must be removed to gain access to these switches.

2.3

WIRING

Figures 2-1 and 2-2 illustrate the wiring for 110 and 220 Vac.

SECTION 3 OPERATION

3.1 SETTING THE SWITCHES

There are two sets of eight-position switches mounted on the main printed circuit board, protruding through the upper PC board (refer to Figure 3-1). Switch 1 is used to select serial baud rate and word format; switch 2 is used for system options. An asterisk (*) denotes the factory configuration.

3.1.1 Switch 1

Switch 1, positions 1, 2, and 3 are used to select serial transmission rate.

Position	3	2	1	
	ON	ON	ON	110 baud
	ON	ON	OFF	134 baud
	ON	OFF	ON	300 baud
	ON	OFF	OFF	600 baud
	OFF	ON	ON	1200 baud
	OFF	ON	OFF	2400 baud
	OFF	OFF	ON	4800 baud
	*OFF	OFF	OFF	9600 baud

Switch 1, position 4 and 5 determine parity characteristics.

Position	4	
	ON	Parity enabled
	*OFF	Parity disabled

Position	5	
	ON	Odd
	*OFF	Even

Switch 1, position 6 selects the desired number of stop bits to be used.

Position	6	
	*ON	1 stop bit
	OFF	2 stop bits

Switch 1, position 7 and 8, select word length (number of bits per character).

Position	8	7	
	ON	ON	8 bits per character
	*ON	OFF	7 bits per character

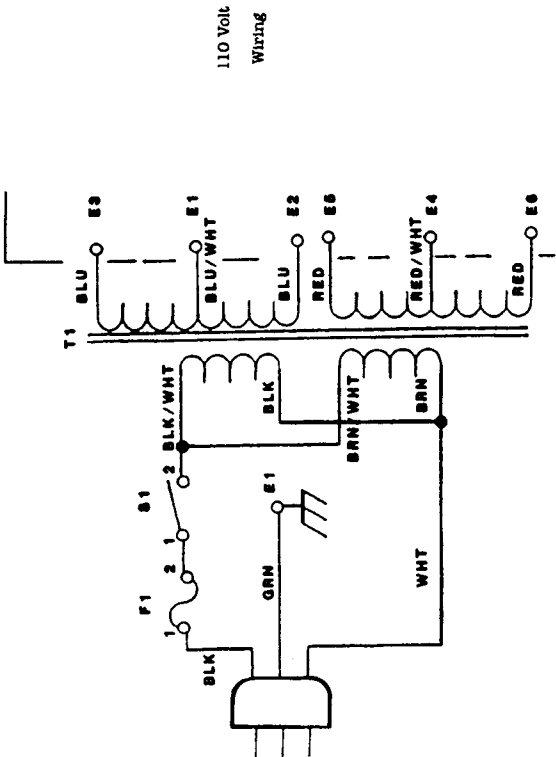


Figure 2-1. 110 Vac Wiring

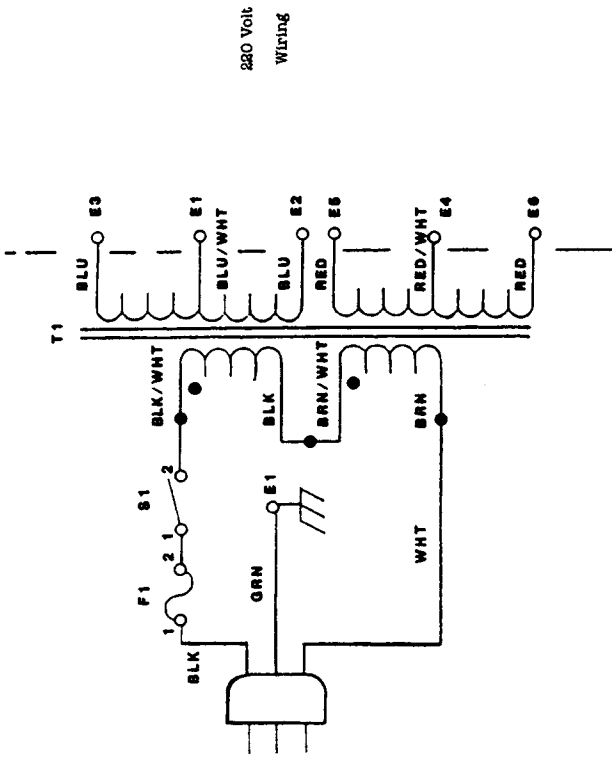


Figure 2-2. 220 Vac Wiring

3.1.2

Switch 2

Switch 2, position 1 determines the power on mode of operation. Two modes are possible and apply only to the power up condition in the Command Mode. Mode 1 will require several commands to begin conversions. Mode 2 causes conversions to commence immediately and data to be transmitted continuously; one conversion per line.

Switch 2, position 1:

ON — Serial Command Mode
*OFF — Continuous

Switch 2, position 2 enables a self-test program at power-on. Refer to paragraph 3.4, "Self-Test Mode".

Position 2

ON — Enable self-test
*OFF — Disable self-test

Switch positions 3 and 4 are not used.

Switch position 5 determines the initial power-on state of the four digital outputs. A high state indicates the transistor is OFF.

Position 5

ON — Power-on with all outputs high (OFF)
*OFF — Power-on with all outputs low (ON)

Switch 2, position 6 enables or disables the DSR and CTS requirements. Refer to Paragraph 3.2 for pin assignments to these signals. DTR and RTS will be asserted by the WB-31/31B regardless of this switch position.

Position 6

OFF — The DSR and CTS pins at the serial interface must be asserted (pulled to a high RS-232 level).

*ON — It is not necessary to do anything with DSR or CTS.

Switch 2, position 7 enables or disables the Echo Mode. When a character is sent to the WB-31/31B, it is sometimes necessary for the host to receive confirmation that the character was accepted. If the Echo Mode is selected, the interface will reflect all characters received. Also, if the Echo Mode is enabled, the prompt character ">" will be transmitted each time the WB-31/31B executes a command or is awaiting commands.

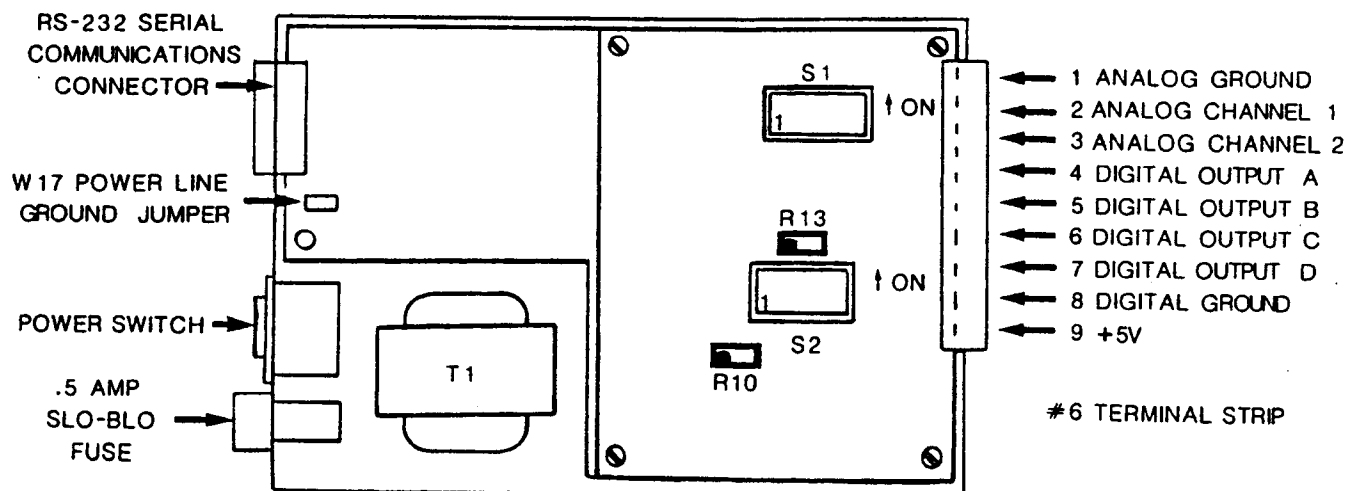


Figure 3-1. WB-31/31B Component Layout

Position 7

ON — Echo is turned off
*OFF — Echo is turned on

Switch 2, position 8 determines whether a decimal point is to be included in the data stream while in the Command Mode. Suppressing the decimal point saves transmission time and space on the display device.

Position 8

ON — Decimal point off
*OFF — Decimal point on

3.2 SERIAL COMMUNICATION LINK

A 25-pin female sub-D connector is provided for both the RS-232 and current loop interfaces. The RS-323 port is set up as Data Terminal Equipment (DTE) in the standard unit. Table 3-1 describes the pin assignments and data direction for the serial interface connector. Figure 3-2 shows the location of these pins as viewed facing the connector mounted on the WB-31/31B.

In cases where it is desirable to connect the WB-31/31B to another DTE device, the connecting cable must be wired according to Figure 3-3. Notice that RTS/CTS handshaking can not be used in this configuration. DTR/DSR handshaking may still be implemented, however, by turning dipswitch 2 position 6 OFF.

TABLE 3-1
PIN ASSIGNMENTS

PIN	DESIGNATION	DTE	DCE
1	Chassis Ground	This line is connected through W17 to the metal frame of the WB-31/31B and subsequently to the earth ground pin of the power line. W17 is inserted in the standard unit.	Same.
2	Transmitted Data	Serial data will be output from the WB-31/31B on this pin.	The WB-31/31B will accept serial commands on this pin.
3	Received Data	The WB-31/31B will accept serial commands on this pin.	Serial data will be output from the WB-31/31B on this pin.

TABLE 3-1 (Con't.)
PIN DESIGNATION DTE

DCE

4	Request to Send	The WB-31/31B will assert this pin high.	If the DSR-CTS option is selected, then this pin must be pulled high before the WB-31/31B will output data.
5	Clear To Send	If the DSR-CTS option is selected then this pin must be pulled high before the WB-31/31B will output data.	The WB-31/31B will assert this pin high.
6	Data Set Ready	If the DSR-CTS option is selected then this pin must be pulled high before the WB-31/31B will output data.	The WB-31/31B will assert this pin high.
7	Circuit Ground	This is the ground return for all RS-232 signals.	Same.
8	Carrier Detect	The WB-31/31B will assert this pin high. Jumper W12 is not supplied by the factory and must be installed if pin 8 is to be used. Refer to WB-31/31B schematic.	Same.
13	TTYTX +	Positive transmitter terminal for the current loop (see paragraph 3.3).	Same.
18	TTYRX -	Negative receiver terminal for the current loop (see paragraph 3.3).	Same.
20	Data Terminal Ready	The WB-31/31B will assert this pin high.	If the DSR-CTS option is selected, then this pin must be pulled high before the WB-31/31B will output data.
24	TTYRX +	Positive receiver terminal for the current loop (see paragraph 3.3).	Same.
25	TTYTX -	Negative transmitter terminal for the current loop (see paragraph 3.3).	Same.

CURRENT LOOP OPERATION

The serial current loop uses several pins in the sub-D connector that are not used by the RS-232 interface. It is not meant to interface directly with standard 20 mA current loops, although in some cases it will. It is best to understand the circuit if trying to connect to a particular current link. Refer to WB-31/31B schematic.

To use the current loop, place jumper W7 in the A-B position. Install jumpers W8, W9, and W11. Install W10 in either the A-B or B-C position according to the current loop being connected to. Position B-C grounds TTYTX+ and position A-B places +12 V on TTYTX+. Be sure that switch 2, position 6 (DSR-CTS) is ON (disabled). Also, the pins used for RS-232 serial communications should be left unconnected. These are pins 2, 3, 4, 5, 6, 8, and 20. If problems still persist, then call the OMEGA Customer Service Department at (203) 359-1660.

The Receiver—The receiver is optically coupled, isolated and passive. This means that the host device must supply the current to operate the LED portion of the coupler. This element, however, is not referenced to common, therefore, either side can be grounded.

The Transmitter—The transmitter is an active bipolar driver; however, it is capable of driving active or passive receivers. It can supply the current for the LED side of an optocoupler.

SELF-TEST MODE

The WB-31/31B is equipped with a Self-Test Mode which automatically tests the RAM and dipswitches 1 and 2. This mode sets the serial port to 9600 Baud, 7-Bit, 1 stop bit, and no parity regardless of switch positions.

To use the Self-Test Mode, set dipswitch 2 position 2 ON before the power switch is turned on. Then follow the instructions given by the program. Since the Self-Test routine blanks the entire memory (RAM), it will erase any BASIC program stored in memory.

RAM Test

The message "TESTING RAM" should appear on the screen when the WB-31/31B is turned on in the Self-Test Mode. If this message does not appear, the unit is probably not wired correctly to the terminal being used, or the terminal is not configured properly (baud rate and word format). The entire RAM will be exercised and either "RAM OK" or "BAD RAM" will be printed. If the unit does not print either of these messages, but does print "TESTING RAM", then the RAM is bad. If the RAM is bad the test routine will skip the rest of the tests until it is replaced.

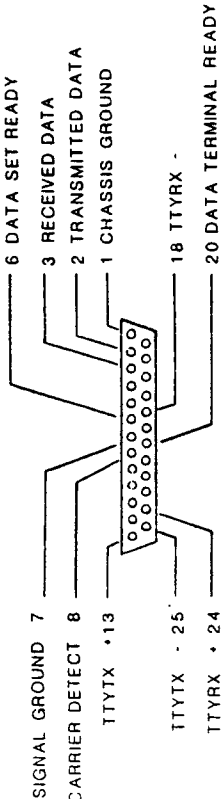


Figure 3-2. Serial Connector

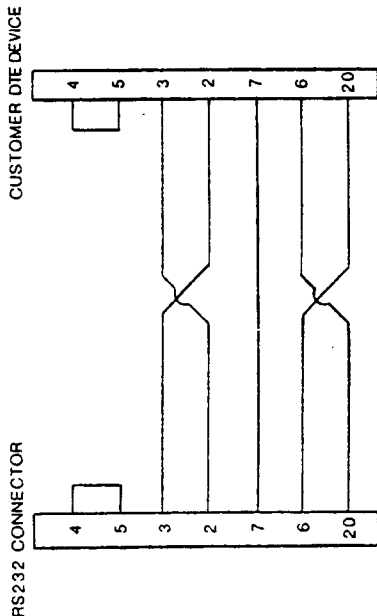


Figure 3-3. DTE to DTE Wiring

3.4.2 Dipswitch Test

A message will be printed stating which dipswitch is being tested followed by a series of 1's and 0's. These digits represent the status of the dipswitch under test. A "1" indicates the switch is closed (ON) and a "0" indicates the switch is open (OFF). The display will be constantly updated at this point, so a flashing or flickering on the terminal screen is normal. Turning the switches on and off during this test will determine if any are bad. The far left digit corresponds to switch position 1. Typing any character will continue the test routine.

3.5 ANALOG INPUTS

The WB-31/31B has two single-ended analog inputs (refer to Figure 3-1). Both are referenced to the same ground point. The standard full scale input is 0 to ± 4.999 V with selectable resolution of 1 mV or 250 μ V. The inputs are protected against over-voltages; however, voltages greater than 15 V should be avoided. Input impedance for each channel is greater than 100 kohms even under overrange conditions. Figure 3-4 shows a general block diagram for the analog input circuitry. A single A/D converter is used along with a two channel multiplexer. This means that only one analog signal can be sampled at any given time. The conversion time for the A/D converter is about 140 ms.

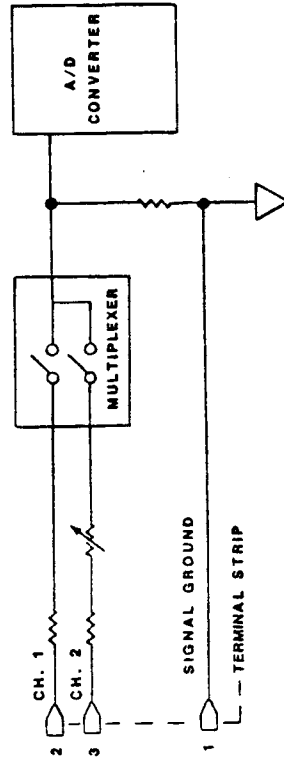


Figure 3-4. Analog Input Configuration

3.6 DIGITAL OUTPUTS

Four open collector digital outputs are provided. Each output can be controlled individually. If an external power supply is not available, +5 V and digital ground are available via the terminal strip on the rear of the WB-31/31B. The total power supply drain from the +5 V output should be limited to 100 mA. Figure 3-5 shows some typical load connections. Each digital output is capable of sinking 40 mA and can accept positive voltages up to +30 V.

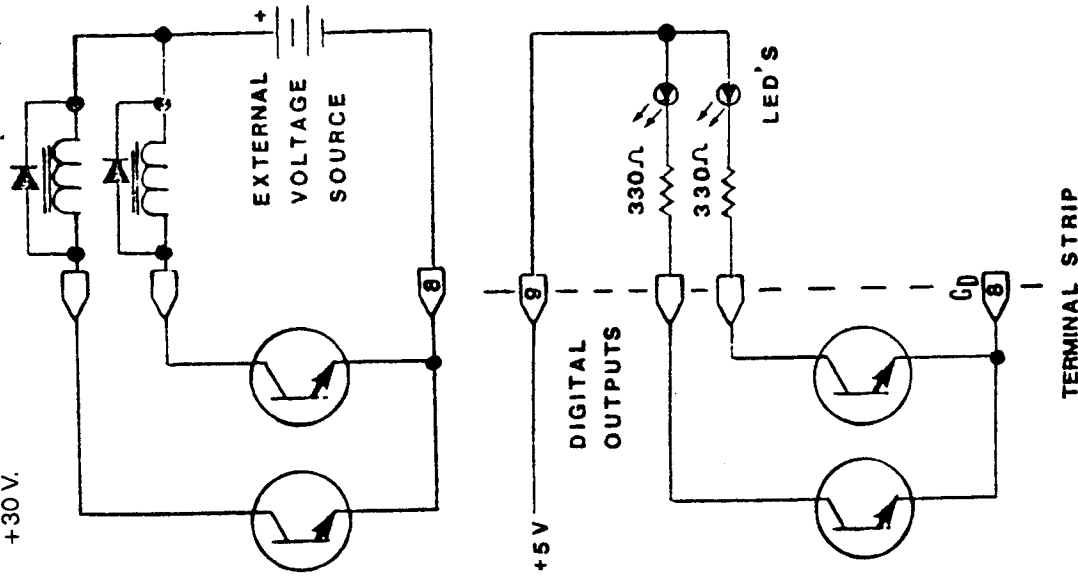


Figure 3-5. Digital Output Configurations

SECTION 4 COMMANDING THE WB-31/31B

There are two modes of operation available; the Command Mode and the BASIC Mode. The WB-31 can only use the Command Mode, while the WB-31B can use either the Command Mode or the BASIC Mode. When power is turned on, the WB-31 will be in the Command Mode, and the WB-31B will return to the mode which was being used when power was turned off.

4.1 COMMAND MODE

The Command Mode is the only mode available in the WB-31. In this mode, the WB-31 will respond to commands received from the host computer or terminal. This section will define the use and structure of the available commands in this mode. Some terms need to be defined at this point:

Record — This is the result of a single analog to digital conversion cycle. It is a single voltage reading. If the A/D converter is overranged then the record would be OVRNG. The number of characters in the overrange message is adjusted to the selected data format. Note: One space is sent before each record to separate them.

String — This is a group of records. A string is composed of X number of records where X is a number between 1 and 18 and is defined as part of a command. A string of records is terminated with a carriage return and line feed.

The WB-31/31B can transmit information faster than it can collect it when using baud rates over 600 (refer to paragraph 4.8). Because of this, there seems to be a pause after a string is transmitted. If a continuous conversion command is received, data will be collected and stored until a complete string is assembled. All of the commands are ASCII characters. Each command must be followed by a carriage return. Table 4-1 lists the available commands. Characters other than the defined command letters and carriage return are ignored by the WB-31/31B, but will be echoed if the Echo Mode is selected (refer to paragraph 3.1.2). ALL COMMANDS MUST USE CAPITAL LETTERS.

TABLE 4-1
AVAILABLE COMMANDS IN COMMAND MODE

ASCII CHARACTER	COMMAND	COMMAND DESCRIPTION
B	Basic	This command causes the WB-31/31B to go into the BASIC Monitor Mode. See paragraph 4.4 for use of this mode. This command is available in the Model WB-31/31B ONLY.
C	Convert	Start conversions and collect records. This would normally follow an "S" command. However, it can be used to collect one record strings when used alone on power-up.
D	Divide	Divide data by 4. At power on or after reception of the "D" command, the output data of the WB-31/31B is scaled for 0.000 to 4.999 volts (1 mV resolution).
E	End	This command is used to stop conversions. Data collection will continue until a complete string is available for transmission. After the string is transmitted, the WB-31/31B will go into a halt state awaiting another command.
In	Input	Select one of the input channels. On power-up, channel one is selected. n is an integer 1 to 2 corresponding to the respective input channel. All other numbers will default to channel 1.
N	No divide	The "N" command configures the WB-31/31B to scale the output for 00.000 to 19.999 corresponding to an input signal of 4.999 volts full scale to provide a resolution of 1 part in 20000 (.25 mV).
Onnnn D A	Output	This command is used to control the four bit digital output port. 0 (zero) — causes the output to sink current (ON) 1 (one) — causes the output to open (OFF) X — causes no change in the output The output command allows outputs to change simultaneously. The "O" is followed by a four digit code of 1's, 0's or X's that correspond to the desired output. The first number to follow the "O" controls channel D, the second, channel C, etc. All four channels must be specified.

TABLE 4-1 (Con't.)

ASCII CHARACTER	COMMAND	COMMAND DESCRIPTION
Q	Quit	This command is similar to "E" except that data collection is terminated immediately on receipt of this command. A partial string would be transmitted on reception of 'Q'.
P	Poll	The status of the output ports is returned in the same format as in the "Q" command. A space is sent, then the status (output D first), then a carriage return.
R	Run once	When a single conversion is needed, 'R' would be used. This would be appropriate when the time between samples is relatively long.
Snn	String	This command is used to set the string length where nn is a number between 01 and 18. This command can be used at any time during the data collection process to change the length of the string. Two digits must be specified.
Tn	Time	Note 'S' and 'C' would be used to format the output display. In the case of printed output they would be used to save paper by printing records across the full length of the paper. The WB-31/31B will send a ^ G (Control G) every n seconds where n is a number from 0 to 32767 and may contain 1 to 5 digits. The command may be cancelled by letting n=0. This command could be used with the "R" command to gather data at specific time intervals. Note: The ASCII hex value of a ^ G is 07. This is a bell on most terminals.

Examples:

T25 Prompt every 25 seconds.
T500 Prompt every 500 seconds.
T0 Stop prompting.

4.2 COMMAND MODE SUMMARY

Command	Description
B	Selects BASIC monitor mode (Model WB-31B only).
C	Start conversions.
D	Divide by 4 resolution (set output scale to 0 to ± 4.999).
E	End—stop conversions at end of record.
In	Select input channel n, where n is an ASCII character from 1 to 8.
N	No divide; sets scale to 0 to ± 19.999 .
Onnnn	Set digital outputs DCBA. 0 = sink current (ON) 1 = open (OFF) X = no change
Q	Quit—stop conversions as soon as command is received.
P	Poll status of outputs.
R	Run 1 conversion.
Snn	Set string length, where nn = number of records per string. nn is a 2-digit string of numbers from 01 to 18.
Tn	Send prompt (^ G) every n seconds, where n is a 1 to 5 digit number from 0 to 32767.

4.3 COMMAND MODE EXAMPLES

In the examples below, the small letters "cr" mean Carriage Return. Also, for the following examples, the WB-31/31B should be connected to a terminal. Remember, the terminal and the WB-31/31B are both DTE devices. Therefore, wire the connecting cable accordingly. (See Figure 3-3.)

Example 1:

Continuously convert and transmit 9 records per line. The terminal is displaying a ">"

Type:

S09 cr
C cr
The interface will respond in about 1.5 seconds with the first line of data.

Example 2:

Perform one conversion.

Type:

R cr
First, send the "R" character. Then, when the conversion is desired, send the "cr" character. The device will respond in less than 200 ms to the "cr".

Mathematical Operators:

/ divide. Note that only integers are available, therefore remainders are truncated. EXAMPLE: $7/3=2$
* multiply
+ add
- subtract

Relation Operators:

The following operators are available for use in comparison functions:

= equal to
not equal to
> greater than
> = greater than or equal to
< less than
< = less than or equal to

NOTE

All comparison operations result in a "1" if true and a "0" if false.

Operations Hierarchy: Expressions will be evaluated from left to right except that *, / are done first, then +, -, then the relation operators.

Program Line: A program line consists of a line number from 1 to 32767 followed by one or more commands. A semi-colon separates commands on the same line.

Editing: To change a line, retype the line number and the corrected line. BASIC will replace the old line with the new line. If the line number is followed with a carriage return, the line will be deleted. The Rub-Out or Delete keys may be used to delete the last character typed. The Backspace key will NOT delete the last character.

Errors: The following messages will be sent when an error occurs:

WHAT?—BASIC does not understand you. Usually means a typing error or wrong format for a command.

HOW?—BASIC understands you, but does not know how. Usually means a number is out of range or a line reference does not exist.

SORRY—Means there is not enough memory to do it.

ANALOG INPUT OVERRANGE—Input to analog channel is too high or too low if negative.

INVALID MEMORY LOCATION—Cannot Poke into this address. See POKE command.

Example 3:

Read channel 2 every 30 seconds.

Type:

I2 cr

T30 cr

Each time the terminal beeps (i.e., a ^ G is received) then type:

R cr

4.4 BASIC Mode (WB-31B only)

The second mode of operation is the BASIC Mode. Note that Command characters apply only to the Command Mode. This section applies to the WB-31B only.

4.4.1 Terminology and Specifications

Range of Values: BASIC will allow integers from -32767 to +32767. Only integer values may be used.

var.—Variable: A variable may be any single capitalized alphabetic character (A-Z).

(expr)—Expression: An expression is a combination of one or more variables and/or constants. Example: (A*25-3).

stmtnt—Statement: A statement is any valid BASIC command or statement, except where otherwise noted.

'string': A 'string' is any combination of ASCII characters enclosed in single or double quotes. If it is desired to include single quotes within a string, then use double quotes to enclose the string and vice-versa.

Arrays: A one dimensional array is available. It is specified by @(expr) where @ is the array name and (expr) represents the subscript. @ is the only valid array name. EXAMPLE: @(3) represents the third value in the array.

NOTE

The range, or dimension, of the array is set automatically by BASIC to make use of all unused memory space, (i.e. 0 to SIZE/2 since each value requires two bytes of storage. See SIZE function below).

Monitor Mode: When BASIC is not executing a program we say that the WB-31B is in the Monitor Mode, i.e., BASIC is monitoring the terminal for instructions.

4.4.2

Available Commands

All commands may be abbreviated by typing at least the first letter of the command followed by a period. Be careful to include enough letters to avoid ambiguity. ALL COMMANDS MUST USE CAPITAL LETTERS.

4.4.3

Monitor Commands

The Monitor Commands are used in the Monitor Mode only. They may not be used inside a BASIC program.

LIST n—List the program in memory starting with line number n. If n is not specified, 1 is assumed.

NEW—Erase BASIC program in memory.

NOBASIC—Return to the Command Mode. Execution of this statement will erase the BASIC program currently in memory.

RUN—Execute BASIC program in memory starting with lowest number line.

PRUN—Execute current program upon power-up of WB-31B. Power must be turned off while still in the BASIC mode, otherwise the program will be lost. This command will remain in effect until the PROFF command is issued.

PROFF—Cancel PRUN command.

^C—A control C (hold the control key and press "C") will halt the execution of a BASIC program or LIST command and return to the monitor mode.

^O—A control O (hold the control key and press "O") will cause the WB-31B to stop sending data to the serial port. This does not halt the execution of the program. A second ^O must be issued to cancel this command. Note that a ^C will not cancel this command.

^S—mA control S (hold the control key and press "S") will halt the execution of a BASIC program or a LIST command. Execution may be continued by issuing a ^Q or ended by a ^C. This command is sometimes called "XOFF".

^Q—A control Q (hold the control key and press "Q") will cause the continuation of the BASIC program or LIST command which was halted using the ^S command. This command is sometimes called "XON".

4.4.4

Direct Commands

The Direct Commands may be used in Monitor Mode or in a BASIC program.

DOUT (klmn)—Turn on or off digital outputs D, C, B, A according to values of k, l, m, n may be single digit values or variables. A 1 corresponds to a high impedance state (OFF) and a 0 to a low impedance state (ON). Any other value will cause no change in that output. See example #2 in paragraph 4.6.

INPUT 'string' n—Print 'string' on terminal, wait for (expr) to be entered, and set variable n equal to value of (expr). n may be any variable. If 'string' is not present, the variable name will be printed. Note that there is no comma between 'string' and n. See example #4 in paragraph 4.6.

LET var. = (expr)—Sets variable equal to value of (expr). The word LET is optional.

POKE (expr)—The value of variable P will be stored in the memory location determined by (expr). P must be defined prior to execution of POKE command. POKEable RAM is located between 16485 and 18278; however, BASIC will not allow the user to POKE into the area being used for program storage. This means that as the size of the BASIC program increases, the lower limit of POKEable RAM also increases. The lower limit of POKEable RAM may be found by the equation:

$$\text{Lower Limit} = 18278 - \text{SIZE}$$

See SIZE function below. (expr) must be enclosed in parenthesis.

PRINT—This command has several formats:

PRINT (expr)—Print value of (expr)

PRINT 'string'—Print 'string'

PRINT 'string', (expr)—Print 'string' followed by value of (expr) on same line.

Formatting—The following format characters are available:

Comma—A comma after a PRINT statement suppresses the usual carriage return and line feed.

n—A pound sign ('#') followed by a number ('n') determines the field size. The default field size is 6. If the expression to be PRINTed has less than n characters, it will be right justified (example #1). If the expression has more than n characters, it will be left justified (example #2).

Underline—An underline character will cause a carriage return to be sent without a line feed.

Examples: Let I = 2, and N = 545. Notice that both single and double quotes may be used, provided they are used as a matched pair.

```
1) PRINT 'CHAN #',I;" = "N
```

Result:

```
CHAN #      2 =      545
```

```
2) PRINT #1,'CHAN #',I;" = "N
```

Result:

```
CHAN #2=545
```

RESET—Cancel SET command.

SET((expr1):(expr2):(expr3)) stmnt—Causes stmnt to be executed at the time specified where (expr1) is hours, (expr2) is minutes, and (expr3) is seconds, and stmnt may be either GOTO or GOSUB. Remember, the WB-31/31B uses a 24-hour clock.

Example:

```
SET(15:30:0) GOTO 1000
```

Result:

Jump to line 1000 at 15:30:00, i.e. 3:30 P.M.

Notes on GOSUB—When GOSUB is used in the SET command, there are two possible returns. RETURN returns execution to line following the SET command. RETI returns execution to line which was about to be executed when the SET time was reached.

TIME = (expr1):(expr2):(expr3)—Sets clock time where (expr1) is the hours, (expr2) is the minutes, and (expr3) is the seconds. All three must be specified and separated by colons. There can be no space between the word TIME and the equal sign. Note that the clock is a 24-hour clock and that the clock does not count time while power is turned off.

Example: TIME = 10:25:00

TIME?—Prints the present time in the form

```
HOUR:MINUTE:SECOND
```

4.4.5

Statements

These commands may only be used in a BASIC program. They have no meaning in the Monitor Mode.

FOR var. = (expr1) TO (expr2) STEP (expr3)

program

NEXT var.

Establishes a loop which sets the value of var. equal to (expr1) and adds the value of (expr3) to it each time through the loop. The loop runs from the FOR statement to the NEXT statement until the value of var. is equal to (expr2).

Example:

```
10 FOR I=1 TO 10 STEP 2
20 PRINT I
30 NEXT I
```

Result:

Print the odd numbers from 1 to 10.

GOTO (expr)—Go to subroutine at line number determined by (expr). This may be used in the Monitor Mode to start execution of a program at a specific line number instead of the RUN command.

GOSUB (expr)—Go to subroutine. Same as GOTO except that upon execution of RETURN command execution continues at statement following GOSUB.

IF (expr1) condition (expr2) stmnt—If condition is met then stmnt will be executed. If not, the program continues to the next line. The condition may be any of the relation operators.

Example:

```
IF X < 25 GOTO 10
```

Result:

As long as X is less than 25, program will jump to line 10. Note that there is no THEN statement.

REM—Remark. BASIC will ignore anything on this line.

RETURN—Return from subroutine. See GOSUB.

RETI—Return from interrupt subroutine to line where interrupt occurred. See SET.

STOP—Stop execution of BASIC program at this point.

4.4.6

Functions

The following functions may be used within an (expr).

ABS((expr))—Evaluates absolute value of (expr). (expr) must be enclosed in parenthesis.

AIN((expr))—Returns value of the analog input channel determined by (expr). Converts input voltage of 0 to ± 4.999 volts to a value of 0 to ± 19999 . To read this value in mV, divide the value by 4. If the value of (expr) is anything other than 1 or 2, then channel 1 will be selected. (expr) must be enclosed in parenthesis.

HOUR—Returns the current hour.

MINUTE—Returns the current minutes.

PEEK(expr)—Returns contents of memory location determined by (expr). (expr) must be enclosed in parenthesis.

RND((expr)) — returns random number between 1 and (expr) inclusive. (expr) must be enclosed in parenthesis.

SECOND—Returns the current seconds.

SIZE—Returns the number of bytes left unused by the program.

4.5

BASIC SUMMARY

Command	Shortest Abbreviation	Description
Monitor Command		
^ C	^ C	Used only in Monitor Mode.
LIST n	L.	List program starting at line n.
NEW	N.	Erase BASIC program in memory.
NOBASIC	NO.	Go to Command Mode. Erases BASIC program in memory.
^ O	^ O	Turn serial output OFF and ON.
PROFF	PRO.	Cancel PRUN.
PRUN	P.	Run BASIC program on power-up.
^ Q	^ Q	Continue execution after ^ S.
RUN	R.	Run BASIC program..
^ S	^ S	Stop execution.
Direct Commands		Used in Monitor Mode or within a BASIC program.
DOUT(klmn)	D.(klmn)	Turn on/off digital outputs.
INPUT	IN. n	Input variable n.
LET var.= (expr)	var.= (expr)	Sets value of var. equal to value of (expr).
POKE(expr)	PO. (expr)	Put value of variable P in memory location (expr).
PRINT	PRI.	Print 'string' and, or (expr).
RESET	RES.	Cancel SET.
SET(h:m:s) stmt	S.(h:m:s) stmt	Execute stmt at h:m:s.
TIME=h:m:s	TIME= h:m:s	Set clock time to h:m:s
TIME?	T.	Prints time in format h:m:s

Command	Shortest Abbreviation	Description
Statements		
FOR	F.	Used only in a BASIC program. Establishes a FOR loop. TO and STEP may not be abbreviated.
GOSUB (expr)	GOS. (expr)	Jump to subroutine at line # (expr).
GOTO (expr)	GO. (expr)	Jump to line # (expr).
IF cond. stmt	I. cond. stmt	If cond. is met do statement.
NEXT var.	NEX.var.	Ends a FOR loop.
REM	REM	Remark.
RETI	RETI	Return from GOSUB in a SET command to line where time occurred.
RETURN	RETU.	Return from GOSUB.
STOP	ST.	Stop execution.
Functions		Used within an (expr).
ABS(expr)	A.(expr)	Absolute value of (expr).
AIN(expr)	AI.(expr)	Value of Analog input #(expr).
HOURL	H.	Hours.
MINUTE	M.	Minutes.
PEEK(expr)	P.(expr)	Value of memory location (expr).
RND(expr)	R.(expr)	Random number between 1 and (expr) inclusive.
SECOND	SE.	Seconds.
SIZE	S.	Amount of unused RAM area.

4.6

BASIC EXAMPLES

Example 1:

Print out the value of both analog input channels.

```
10 FOR I=1 TO 2
20 X=AIN(I)
30 PRINT 'CHANNEL #',I,'=',X
40 NEXT I
```

Example 2:
Keep checking Analog input #2. When it reaches a value of 15000 or higher cause Digital output B to go to a low impedance state without affecting the other outputs.

```
10 T=AIN(2)
20 IF T15000 GOTO 10
30 DOUT(2202)
40 STOP
```

Note that the value "2" in the DOUT command leaves the output unchanged because it is not a "1" or a "0".

Example 3:
Print value of Analog channel #1 in mV every hour.

```
10 H=HOUR
20 IF H=HOUR GOTO 20
30 PRINT AIN(1)/4
40 GOTO 10
```

Example 4:
At 5:00 PM, prompt operator for desired Analog input channel to be converted and print its value.

```
10 SET(17:0:0) GOTO 100
20 GOTO 20
100 INPUT 'DESIRED CHANNEL?' I
110 PRINT AIN(I)
```

NON-VOLATILE RAM (Model WB-31B Only)

The WB-31B has non-volatile RAM. When the power is turned on, the WB-31B will return to the mode being used when power was turned off (either the Command Mode or BASIC Mode). This allows BASIC programs to be saved in memory when power is turned off. All variables, including the array, are also saved. Power must be turned off while in the BASIC Mode or the program will be lost.

If the WB-31B does not respond or does not respond correctly, it may be due to an improper value stored in RAM. This problem may be corrected by running the self-test routine. Note that this will completely blank the RAM. Therefore, any program stored in the RAM will be destroyed. Refer to paragraph 3.4 for instructions on using the self-test routine.

Baud rate is a number used in data communications circles to define data transmission speed. It is really a measure of the number of bits of data transferred per second. Several bits are required to make up a single character; characters being letters, numbers, and punctuation marks. Transmitting a character requires a start bit, data bits, parity (if used) and stop bits. The table below lists the function and variability of the various bits necessary to transmit data.

Start bit—This is necessary to indicate to the receiver the beginning of a data word.

Data bits—These bits contain the actual data being transmitted. There can be 7 or 8 data bits per word.

Parity bit—This bit is used as a mechanism for error detection.

Stop bits—Stop bits are used to indicate the end of a data word. There can be 1 or 2 stop bits per data word.

There can be up to 12 bits used to transmit a single data character or as few as 9. Data word length is computed by adding 1 start bit plus # data bits plus the parity bit if enabled plus # stop bits. Dividing the baud rate by the number of bits per word will yield the number of characters transmitted per second.

In the Command Mode, using divide by 4 resolution, if the decimal point is included when a record is transmitted, then it will require 6 characters to relate a complete record (polarity, MSD, decimal point and 3 more digits). At low baud rates, a problem could arise since it would take longer to transmit the data than it did to perform the A/D conversion.

For Example:

Assume: —Baud rate = 300
—Bits per character = 7
—No parity
—1 stop bit
Bits per character = 9

From Table 4-2, it takes 30 ms to transmit 1 character.

$$\frac{30 \text{ ms.}}{\text{character}} \times \frac{6 \text{ characters}}{\text{record}} = 180 \text{ ms.}$$

Note: A single A/D conversion takes 140 ms.

Result: It takes longer to transmit a record than it did to acquire it. This problem can be overcome by using the single convert command.

TABLE 4-2
SERIAL TRANSMISSION SPEED

	7 bits /word	8 bits /word	9 bits /word	10 bits /word	11 bits /word	12 bits /word
110 BAUD	15.7 64 ms	13.8 73 ms	12.7 82 ms	11.0 91 ms	10.0 100 ms	9.2 109 ms
134	19.1 52 ms	16.8 60 ms	14.9 67 ms	13.4 75 ms	12.2 82 ms	11.2 90 ms
300	42.9 23 ms	37.5 27 ms	33.3 30 ms	30.0 33 ms	27.3 37 ms	25 40 ms
600	85.7 12 ms	75.0 13 ms	66.7 15 ms	60.0 17 ms	54.5 18 ms	50.0 20 ms
1200	171 6 ms	150 6.7 ms	133 7.5 ms	120 8.3 ms	109 9.2 ms	100 10 ms
2400	343 2.9 ms	300 3.3 ms	267 3.8 ms	240 4.2 ms	218 4.6 ms	200 5 ms
4800	686 1.5 ms	600 1.7 ms	533 1.9 ms	480 2.1 ms	463 2.3 ms	400 2.5 ms
9600	1371 730 μ s	1200 830 μ s	1067 940 μ s	960 1040 μ s	873 1.2 ms	800 1.3 ms

Characters per second = $\frac{\text{BAUD RATE}}{\text{Bits per word}}$

Time per character = $\frac{1}{\text{Characters per second}}$

The top number in the table is the number of characters transmitted per second for a given baud rate and word size.

The bottom number in each box is the time required to transmit a character.

SECTION 5 CALIBRATION AND TROUBLESHOOTING

5.1 CALIBRATION

If it becomes necessary to adjust the calibration of the A/D converter, follow the procedure below.

1. Remove the cover from the unit and turn the power on.
2. Put the WB-31/31B in the Command Mode and set for continuous conversions ("C" command) and no divide resolution ("N" command).
3. Apply a known voltage standard to the channel 2 input terminals. Set the voltage source for +4.000 volts.

4. Select analog input channel 2 ("I2" command).
5. Adjust the reference voltage potentiometer R10 so that the serial output of data from channel 2 reads +16.000 $\pm$.001.
6. Apply the input signal to the channel 1 input terminals and select analog input channel 1 ("I1" command).
7. Adjust potentiometer R13 for the correct serial output data (+16.000 $\pm$.001).

5.2 TROUBLESHOOTING

Refer to Table 5-1 for troubleshooting information. Please note that this is a guide only.

TABLE 5-1
TROUBLESHOOTING CHART

SYMPTOM	CHECK
1. Unit does not appear to work	— Power line — Fuse — RS-232 connector — Baud rate, word format — Port configuration (DTE/DCE)
2. Unit blows fuse	— Serial tag for correct line voltage — +5 volt output can supply maximum of 100 mA
3. Unit has power but still does not appear to work	— Baud rate, word format — Serial connections (unit is standard DTE) — Display device — DSR-CTS option — Port configuration — Be sure all capitol letters are being used — Echo mode
4. Unit does not respond correctly (i.e., wrong number of records per string, missing characters)	— Baud rate, word format — Re-check the command structure
5. Data is random	— Analog grounds
6. Unit does not respond when in BASIC mode	— Was ^ O issued — Was ^ S issued
7. In units with non-volatile RAM (WB-31B), unit does not respond on power-up	— Run Self-Test routine to blank memory. Try unit again

If the WB-31/31B still does not function properly, contact the OMEGA Customer Service Department at (203) 359-1660.

SECTION 6 SPECIFICATIONS

ANALOG SIGNAL INPUT

STANDARD INPUT VOLTAGE RANGE: 0 to ± 4.999 Vdc

MAX. INPUT RANGE: ± 20 Vdc

INPUT IMPEDANCE: 100k minimum

INPUT CONFIGURATION: Single-ended, 2-channels

RESOLUTION: 1 part in 5000 (1 mV). May be changed to 1 part in 20000 (0.25 mV)

RECALIBRATION: 12 months

SERIAL I/O

ELECTRICAL:

RS-232 or current loop (not simultaneous)

WORD FORMAT:

7 or 8 bits per character, 1 or 2 stop bits, odd, even or no parity

BAUD RATES:

9600, 4800, 2400, 1200, 600, 300, 134.5, 110

PROTOCOL:

Uses DSR/DTR and RTS/CTS (when selected) on the RS-232 interface and nothing on the current loop interface

RS-232 CONFIGURATION:

DTE (standard) jumper select for DCE if desired

CURRENT LOOP:

Active output, passive input

CONNECTOR:

25-pin sub-D female

DIGITAL OUTPUT

CONFIGURATION:

Four open collector drivers

VOLTAGE:

+30 Vdc max.

CURRENT (SINK):

40 mA max.

A/D CONVERTER

TYPE:

Dual slope integration

CONVERSION RATE:

7.5 per second (133 ms)

SPECIFICATIONS (con't.)

CONTROL COMMANDS

FORMAT:

Serial input ASCII characters

COMMANDS:

- Select analog channel
- Start/stop conversions
- Set digital numbers
- Set number of conversions per string
- Select resolution
- Poll digital outputs
- Prompt after time
- Select BASIC mode (Model WB-31B only)

POWER

INPUT:

110 Vac (105-125) 50/60Hz

ISOLATION:

220 Vac (200-240) 50/60Hz

CONSUMPTION:

20 watts max.

ENVIRONMENTAL

TEMPERATURE:

0° to 50°C operating; -25° to 70°C storage

WEIGHT:

3.5 lbs.

SIZE:

9.0" x 5.8" x 2.25"

INPUT CONNECTIONS:

#6 terminal strip



WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC) used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

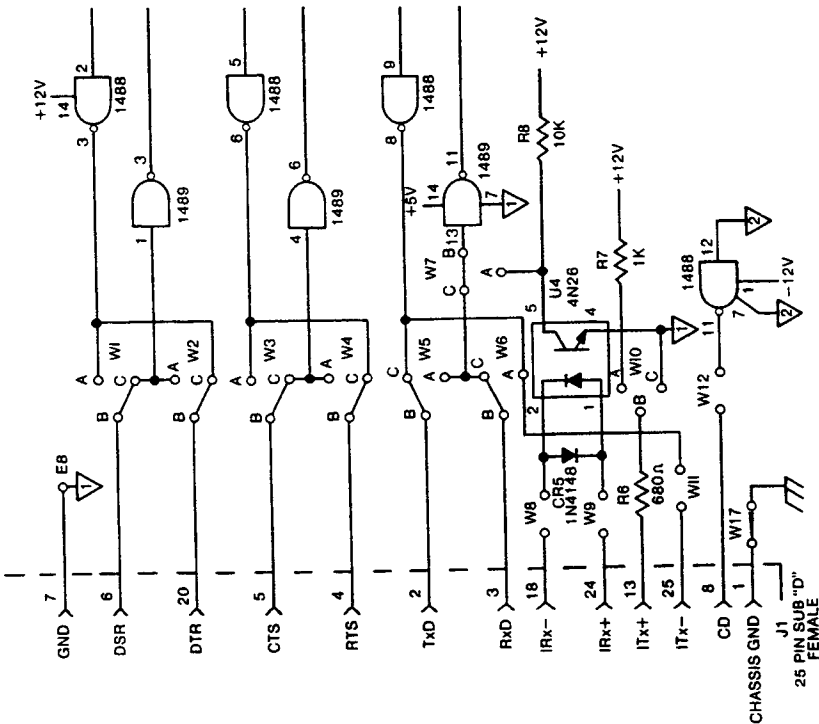
FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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WB-31/31B SERIAL INTERFACE SCHEMATIC