Programmer's Manual
LabelWriter LW 300 Series

May 2002

1.0 General

The LabelWriter 300 Series (LW 300/310/315/320/330/330 Turbo) are high performance, low cost printers used for printing mailing labels, disk labels, bar code labels, etc. Label sizes can be up to 40mm wide with the LW 300 and LW 310 and 56mm wide with the LW 315/320/330/330 Turbo; label length can be any length greater than 36mm.

Printing is done with a thermal print head, which contains a single row of dots covering the entire width of the label.

The LW 300 Series is connected to a host computer, which is responsible for supplying the data to be printed and to control label movement. Software in the host computer is used to convert the dot image of the label to be printed into the data stream required by the LW 300 Series.

2.0 Theory of Operation

The electronics of the LW 300 Series consists of the thermal print head, a stepper motor, and a microprocessor based controller board. Connection to the host computer is via either an RS-232 serial communications port or a Universal Serial Bus (USB) communications port on the LW 300/330/330 Turbo. On the LW 310/315/320, connection to the host computer is only via the Universal Serial Bus (USB) communications port. Internal power for the LW 300/330/330 Turbo accepts wide input voltage 100-240 Vac via IEC 320 C7 plug. External power for the LW 310/315 accepts wide input voltage 120 Vac; 100-240 Vac via IEC 320 C7 plug for the LW 320.

2.1 Print Head

The print head forms the image by heating a row of resistive elements which blacken the thermally sensitive label material. The resistive elements are .085 mm square. The 40mm models (LW 300/310) contain 480 elements, and the 56mm models (LW 315/320/330/330 Turbo) contain 672 elements. When a line is printed, the control electronics loads the desired data into a serial shift register, which has 1 location for each print element. A "1" in a location will cause the corresponding dot to be printed, a "O" will leave the dot un-printed. There is no clear for the shift register therefore the entire register must be loaded for each print line in order to flush out the old data.

The darkness or density of the image is dependent upon the heat applied to the label material. The heat is dependent upon both the temperature of the head and the amount of energy put into the resistive elements. The energy is dependent upon the voltage applied and the length of time

that it is applied. In order to maintain a constant density the control electronics measures the print voltage and the head temperature before each print cycle and calculates the required print strobe time.

The power supply was designed to handle an average of 37% of the dots on per line at full speed. Depending upon the average number of dots printed and AC voltage at the input, the power supply output voltage will drop and require longer print strobe times thereby slowing the overall print speed. If the voltage goes below 20 volts at the print head, printing is suspended until the power supply recovers to 22 volts.

In order to protect the head from excessive heat, the control electronics inhibits printing if the head temperature exceeds 55 C. In addition, if the voltage at the print head exceeds 36 VDC printing is inhibited until it falls below 34 VDC.

2.2 Communication Protocol

The LW 300 Series printer supports two kinds of transfers via the serial port: command/status and print data. The command/status transfers are accomplished via escape sequences. All control parameters are set to specific default values by power on reset, PWR ON switch or from a reset command (software reset) from the host computer. Control parameters can be modified by the host computer at any time and will take effect at the appropriate time. In order to maximize data throughput, control parameters should be sent to the LW 300 Series printer only when changes are required.

The data rate of the LW 300 Series printer's serial port is fixed at 115,200 baud.

2.2.1 Print Data

Print data is encoded in strings of 8-bit bytes preceded by a single synchronization character (<syn> (16H) for uncompressed data, <etb> (17H) for compressed data). The number of bytes in each string is controlled by the bytes per line variable. **The default values are 60 for the LW 300/310 and 84 for the LW 315/320/330/330 Turbo.** The host computer can send fewer bytes than the maximum via the Set Bytes Per Line command (<esc> D n), where n is the number of bytes. The control electronics do not check the validity of the new value therefore it is the responsibility of the host software to send only numbers which are valid for the width of print head in use.

In addition to sending fewer bytes per line, the host computer also has the ability to adjust the starting point on a line via the Set Dot Tab (<esc> B n), where n is the starting byte number (note: byte 0 is the first byte, byte 59 is the last byte in the LW 300/310). If the host computer does modify starting byte, the number of bytes per line must be adjusted downward by a corresponding amount. The control electronics do not check the validity of the dot tab vs. bytes per line therefore it is the responsibility of the host software to send correct combinations of these two variables.

Both the dot tab variable and the bytes per line variable are held by the control electronics until changed by a new command sequence or reset to default values by power on or by a software reset command.

2.2.2 Serial Handshaking

The serial data transfer from the host computer to the LW 300 Series printer is controlled with Hardware Handshaking (RTS/CTS) protocol. The host computer keeps transmitting the data strings or command sequences until all of the label data is transmitted or until requested to pause via an Xoff request or a signal on the RTS line sent by the LW 300 Series printer to signal that the buffer is nearly full. After the host receives an Xon or RTS request from the LW 300 Series printer, transmission resumes at the point it was interrupted.

2.2.3 Buffer overflow

If the host computer does not suspend data transmission quickly enough, the LabelWriter will overrun its data buffer and the oldest data in the buffer is overwritten. The Label Writer sets an error bit (data overrun) in the status byte.

2.2.4 Data synchronization

After the LabelWriter receives a <syn> or <etb> character, it takes the following n characters and put them into the RAM buffer. The value for n is determined by the number of characters required to specify a full line of data. This value is affected by the setting for Bytes per Line and (in the case of <etb>) the data compression of the bit pattern.

The character received by the LW after the last data character should be either an <esc> denoting a command sequence or a <syn> or <etb> denoting another data string. If any other character is received, the LW 300 Series printer sets an error bit (invalid sequence) in the status byte. The LabelWriter will then accept only a valid escape sequence.

In order to reset the LabelWriter after a synchronization error or to recover from an unknown state, the host computer should send at least eighty five (85) <esc> characters.

Note: A minimum of eighty five <esc>'s are required as this is one more than the longest possible string of data bytes that the LabelWriter EL could be expecting.

Also, the re-sync characters sent by the host must be <esc> otherwise the LabelWriter may assume it is still out of sync.

2.3 Positioning

Label movement within the LWEL is controlled by a stepper motor driven platen which acts as a pinch roller. The control electronics keeps track of the logical position on a label by counting motor steps. The top of form sense hole located between labels is detected with an infrared LED photocell and is used to re-sync the logical counter to a known value which corresponds to the number of motor steps between the sensor and the cutter bar. Top of form position (i.e. inter label gap under the cutter bar) is reached when the logical counter decrements to zero. The first motor step after top of form reloads the
down counter with a value representing the hole to hole length of the current label stock.

2.3.1 Top of form sync

The logical position counter is not initialized at power up. Label position is always assumed to be correct since it is self re-syncing as described above. If an out of paper condition is detected at power up, an "advance to top of form" command is issued and the stepper motor will advance until either a top of form sense hole is detected causing a re-sync or until the counter has advanced the equivalent of 1 full label. This "load paper" condition also causes the stepper motor to step at a slower rate to help overcome the frictional drag caused by the print head rubbing directly on the rubber platen.

2.3.2 Label Length

At power up the label length variable is set to a default value of 3058, which corresponds to approximately 10.0 inches. The "load label length" command sequence (<esc> L nl n2) allows the host software to change the label length variable to accommodate longer lengths. If longer length labels are used it is the responsibility of the host computer to load (and/or re-load) the required label length variable every time the LW is reset by power-on conditions or by software resets.

When the label length variable is set to value of -1 (FFFF16), it allows for the use of continuous form paper. In the continuous form mode, the form feed command (<esc> E) is changed to a skip 45 lines command.

The LW 300 Series printer does not do any checking for the validity of label length variables sent by the host computer, it merely uses the information as
provided in order to maintain the logical position counter. If incorrect information is loaded into the LW 300 Series printer, the paper jam indicator may be
set erroneously. In addition, the LW 300 Series printer does not check for inter-label gap when printing. Again, it is the responsibility of the host computer
not to overrun the label area.

2.3.3 Label Movement Commands

There are three label movement commands implemented in the LabelWriter: form feed, skip lines and set line (vertical) tab. The form feed command (<esc> E) causes the control electronics to keep skipping lines until the logical position counter has decremented to zero indicating top of form.

The skip lines command (<esc> f 1 nl) is used to force the LabelWriter to advance line(s) corresponding to the variable nl (O to 255 lines). This command is put into the data buffer along with the print data in order that it takes effect at the appropriate point in the data stream. The skip line command has a one time effect and must be re-issued each time a skip is desired.

The set line tab command (<esc> Q nl n2) is used to force all subsequent labels to start some number of line after the first printable line. The starting line corresponds to the variable nl, n2 used as a 16-bit number (0-65,536 lines).

Note: It is the responsibility of the host computer to assure that this variable does not exceed the length of a label

At power up and after software reset, the line tab variable is set to zero by the control electronics. If the host computer changes this variable it stays in effect until reset or changed via a new set line tab command.

In order to prevent inadvertent line tabs, the control electronics only checks the line tab variable when the first byte of data is sent to the print head when the top of form status bit is set. If the line tab variable is changed when the LabelWriter is not at top of form, the line tab will not occur until the next label is printed.

2.4 Byte Ordering of Print Data (Raster Data) (LW 300/330/330 Turbo)

The data is sent to the printer (via serial communication only) by the control electronics in eight bit (1 byte) groups.

2.4.1 Byte Ordering of Print Data (Raster Data) (LW 300 Series)

The data is sent to the print head (via USB communication only) according to the USB 1.1 specification and the USB printer class specification. The LW 300/330/330 Turbo operate as full speed devices while the LW 310/315/320 operate as low speed devices.

2.5 Status Byte

The LW 300 Series printer control electronics maintains one status byte - the normal status. The normal status byte has several bits (3-6) dedicated to various error conditions. Any of the error bits also sets bit 7 (the sign bit) to facilitate error handlers in the host driver software. The error bits are cleared by the control electronics after the host computer reads the status byte. If the error condition persists the error will be set again.

2.5.1 Status (normal)

The host computer requests the LabelWriter to transmit the status byte by issuing an <esc> A. The ready bit (bit O) is intended as a busy indicator. Ready is true (1) when there are no errors, a top of form is not in progress and the data buffer is empty. The TOF (bit 1) is set when the control electronics thinks the inter label gap is under the cutter bar. Bits 3-6 (invalid sequence, data overrun, no paper, and paper jam are self explanatory.

2.6 Optimization of throughput

The print speed for the LW 310/315 is 8 labels per minute (lpm), the 300/320/330 is 16 lpm, and the 330 Turbo is 32 lpm, (these speeds are based on a 3 line address with text only on the address (no barcode)) however a variety of factors can affect the print speed. For example a low voltage condition will cause the printer to pause between lines occasionally. In general, the print speed is determined by the input data rate, the head load time, and the print strobe pulse width required.

To achieve optimal performance the data transfer from the host to the printer should be kept as short as possible. The communication protocol was designed to allow the data to be transferred with only one overhead byte per dot line. Command sequences, such as set dot tabs or set bytes per line, should be sent only when a change is desired. Use of the dot tab and bytes per line commands should be used to reduce the number of null bytes transmitted. Form feed should be used after transmitting the last dot line to be printed.

Note: Multiple form feed commands will result in blank labels being issued. The ready status bit may be monitored to detect when the data buffer is empty and the form feed command completed.

3.0 Self-test Capability

The LW 300/330/330 Turbo contains a self-test capability in the form of canned print patterns. Eight patterns are currently implemented. The patterns are accessed as follows:

1. Starting with AC power applied, the green LED off and Power set to OFF.
2. Depress the form feed button.
3. Switch the Power button to ON.
4. Release the form feed button.

Pressing the form feed button advances the test patterns. The test patterns will continue to print until power is removed.

During test mode the control electronics send a stream of data to the host computer via the serial port. The data consists of the test number, data pattern, line number a/d reading of the voltage, a/d reading of the head temperature thermistor, and the calculated pulse width (in hexadecimal).

The LW 310/315/320 contains a self-test capability in the from of canned print patterns. Eight patterns are currently implemented. The patterns are accessed as follows:

1. Starting with AC power applied.
2. Press and hold the form feed button for ten seconds.
3. An alternating Red/Green light will appear.
4. Press the form feed button again to stop the self-test.

4.0 Plug and Play

The LW 300 Series printers are all plug and play compatible. They return the following Plug and Play messages when prompted by the host computer:

Printer	Product ID	Description
LW300	DYM0006	Dymo LabelWriter 300
LW330	DYM0007	Dymo LabelWriter 330
LW330 Turbo	DYM0008	Dymo LabelWriter 330 Turbo
LW310	DYM0009	Dymo LabelWriter 310
LW320	DYM0010	Dymo LabelWriter 320
LW315	DYM0012	Dymo LabelWriter 315

5.0 Barcode and Text Printing modes

For better accuracy of dot placement and sizing the LW 300 Series printers incorporate a feature which allows the host computer to specify the print speed appropriate for the current label. In text mode an LW 300 Series printer will print as fast as the data stream, power and it's internal acceleration table will allow. In barcode mode an LW will print at a reduced speed to provide greater dot clarity.

Command/Data Sequences

Host to LabelWriter

<esc> B n — Set Dot Tab
lB 42 ? — n = starting byte # per line (binary)
where 0 =< n =< 59 LW 300/310
0 =< n =< 83 LW 310/315/320/330/330 Turbo
default value = 0

<esc> Q nl n2 — Set Line Tab
lB 51 ? ? — nl, n2 = # lines from start line
where nl = msb (binary),
n2 = lsb (binary)
default value = 0

<esc> D n — Set Bytes per Line from Dot Tab
lB 44 ? — n = # bytes per line
where 1 =< n =< 60 LW 300/310
1 =< n =< 84 LW 310/315/320/330/330 Turbo
default value = maximum

<esc> L nl n2 — Set Label Length
lB 4C ? ? — nl, n2 = # dot lines from sense hole to sense hole
default value = 10.0" label

Note: a value of -1 (hex FFFF). All bits set denotes continuous form stock and inhibits paper jam checks

<esc> E — Form Feed
lB 45 — advance to first printable line of next label (TOF)

<esc> A — Return Status
printer return current status byte
$01 = ready (i.e. paper in, no jam)
$02 = TOF
$04 = size (0=1", 1=2")
$08 = invalid sequence
$10 = data overrun
$20 = no paper
$40 = paper jam
$80 = error
(jam, invalid sequence, etc.)

<esc> @ Reset Printer
lB 40 resets all parameters to default
values and advances to TOF.
Note: this command is acted upon immediately; any data still in print buffer will be lost

<esc> * Restore Default Settings
lB 2A resets all parameters to
default values
Note: this command is acted upon in sync with received commands/data

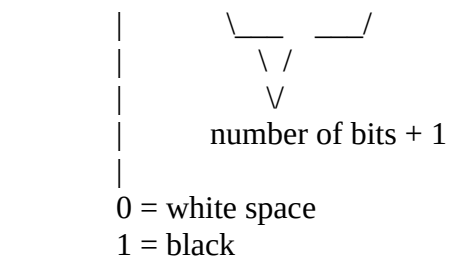
<esc> W nl n2 Wrap Data
lB 57 ? ? nl, n2 data bytes sent back to host
(binary)

<esc> f 1 n Skip "n" Lines (one time effect)
1B 66 1 ?

<esc> V Return Revision Letter/Number
1B 56 printer returns ASCII string containing firmware revision.

<syn> nl..nx Transfer data
16 ? ? where: nl = lst 8 data bits
nx = last 8 data bits

<etb> nl..nx Transfer compressed data
17 ? ? (run length encoded)
where: n1 = 1st compressed character
nx = last compressed character



LabelWriter to Host

<dcl> XON (resume transfer)
11 informs host computer that at least 40 bytes available in buffer

<dc3> XOFF (suspend transfer)
13 informs host computer that only 20 bytes remain in buffer

<can> Cancel Label
18 informs host computer that an unrecoverable error occurred and printing suspended; host action required (e.g. send status then form feed)

@ Power Up/Reset/Abort
40 power up reset occurred, reset switch on front panel pushed by operator, executed reset command sent by host computer

Data Compression

Data compression is done via a form of run length encoding. Bit seven (sign bit) of a compressed character represents the value to be printed; 0 = white space, 1 = printed pixel. Bits 6 through 0 represent the number of consecutive bits of the selected value plus 1.

examples: 00 = 1 white pixel
80 = 1 printed pixel
0F = 16 white pixels
FF = 128 printed pixels

The data is handled by the LW 300 Series printer on a line-by-line basis so compressed lines may be intermixed with normal lines. In addition, compressed mode also uses the bytes per line variable to determine how much data to expect from the host for each line. However, the sum of

the pixels MUST be equal to the bytes per line variable multiplied by 8. No error checking is done on the incoming data and unexpected results will occur if the above caution is not observed. An example of a compressed line for a EL40 would be:

17 0F 8F 1F 9F 1F 9F 0F 8F FF 7F 1F

which would translate to:

16 white pixels
16 printed pixels
32 white pixels
32 printed pixels
32 white pixels
32 printed pixels
16 white pixels
16 printed pixels
128 printed pixels
128 white pixels
32 white pixels

Total 480 pixels = 60 bytes x 8