ESSELTE

LabelWriter ® EL Technical Manual

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Important:
There is no standard or general solution to print to the LabelWriter from any other application than Windows.
People who want/need to communicate with the labelwriter without using the Windows printer driver; e.g. those who want to print from an IBM mainframe, DOS, UNIX, Linux, ... to the labelwriter will need to built their own printer driver.
This document should provide the necessary technical information.

1.0 General

The LabelWriter EL (LWEL) is a high performance, low cost printer used for printing mailing labels, disk labels, bar code labels, etc. Label sizes can be up to 40mm wide with the EL 40 and 56mm wide with the EL 60; label length can be any length greater than 36mm.

Printing is handled by a thermal print head that contains a single row of dots covering the entire width of the label.

The LWEL is connected to a host computer that 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 LWEL.

2.0 Theory of Operation

The electronics of the LWEL consists of the thermal print head, a stepper motor, and a microprocessor based controller board. Connection to the host computer is via an RS-232 serial communications port. Internal power accepts wide input voltage 100-240 Vac via an IEC 320 C7 plug.

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 .125 mm square; the 40mm model contains 320 elements, and the 56mm model contains 448 elements. When a line is to be printed, the control electronics loads the desired data into a serial shift register which has 1 location for each print element. A "1" in any given location will cause the corresponding dot to be printed, a "0" 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 LabelWriter EL 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 LabelWriter EL only when changes are required.

The data rate of the LW EL40 and EL60's serial port is fixed at 19200 baud. For the LW Turbo at 115200.

2.2.1 Print Data

Print data is encoded in strings of 8-bit bytes preceded by a single synchronization character <syn> (16H). The number of bytes in each string is controlled by the bytes per line variable. The default values are 40 for the EL40 and 56 for the EL60. 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 39 is the last byte in the EL60). 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 Xon/Xoff

The data transfer from the host computer to the LWEL is controlled with Xon/Xoff (dcl/dc3) 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 sent by the LabelWriter EL to signal that the buffer is nearly full. After the host receives an Xon request from the LWEL, transmission resumes at the point it was interrupted. When the LWEL RAM buffer has only twenty (20) bytes remaining it issues an Xoff request to stop the data flow. When the RAM buffer has at least forty (40) bytes available it issues an Xon command.

2.2.3 Buffer overflow

If the host computer does not suspend data transmission quickly enough following an Xoff request, the LabelWriter EL will overrun its data buffer and the oldest data in the buffer is overwritten. The Label Writer EL sets an error bit (data overrun) in the status byte and sends a cancel <can> character to the host to inform it of the problem.

2.2.4 Data synchronization

After the LabelWriter EL 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 LWEL 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 LabelWriter XL sets an error bit (invalid sequence) in the status byte and sends a <can> character to the host to inform it of the synchronization problem. 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 fifty seven (57) <esc> characters followed by either a Q to reset the printer or by an A to request the printer to return the status byte.

Note: A minimum of fifty seven <esc>'s are required as this would be 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 EL will 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 1424 which corresponds to approximately 7.0 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 LWEL 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 32 lines command.

The LWEL 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 LWEL, the paper jam indicator may be set erroneously. In addition, the LWEL 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 LW EL: 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 LWEL 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 take 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 LWEL 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)

The data is sent to the print head by the control electronics in eight bit (1 byte) groups. The EL40 model has 40 bytes per print line and the EL60 model has 56 bytes per line.

2.5 Status Byte

The LWEL control electronics maintains two status bytes, the normal status and a hardware status byte. The results of power on self-test and ongoing communication error conditions are reported in the hardware status byte. 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 status byte is read by the host computer. If the error condition persists the error will be set again.

2.5.1 Status (normal)

The host computer requests the LWEL to transmit the status byte by issuing an <esc> A. The ready bit (bit 0) 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).

2.5.1 Hardware Status

The host computer requests the LWEL to transmit the status byte by issuing an <esc> a. The hardware status byte is primarily used for diagnosing faults occurring within the LabelWriter EL.

2.6 Optimization of throughput

The print speed for the EL40 is nominally 1" per second, 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. Under normal conditions the data transfer from host to printer is the limiting factor. As the number of bytes per line decreases, the motor step time is the determining factor.

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 LWEL 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 ON.
4. Release the form feed button.

The test patterns are advanced by pressing the form feed button. 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).

4.0 Plug and Play

The LabelWriter ELs are all Plug and Play printers. They return the following Plug and Play messages when prompted by the host computer:

Printer	Product ID	Description
EL40	DYM002	Dymo LabelWriter EL40
EL60	DYM004	Dymo LabelWriter EL60

5.0 Barcode and Text Printing modes

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

Command/Data Sequences

Host to LabelWriter EL

```
     <esc>  B   n                   Set Dot Tab
        1B  42  ?                    n = starting byte # per line
(binary)
                                        where    0 =< n =< 39
EL40
                                                 0 =< n =< 55
EL60
                       default value = 0

     <esc>  Q  n1  n2               Set Line Tab
        1B  51  ?   ?                n1, n2 = # lines from start line
                       where    n1 = 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 =< 40
EL40
                                        1 =< n =< 56
EL60
                        default value = maximum

     <esc>  L   nl  n2      Set Label Length
        lB  4C  ?   ?        nl, n2 = # dot lines from sense
hole
                              to sense hole
                        default value = 7.0" 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>  a               Return Hardware Status
        lB  61               printer return current status
byte

                         $01 = ROM checksum error
                         $02 = RAM self-test error
                         $04 = serial port - framing error
                         $08 = serial port - overrun
                         $10 - print head data error
                         $20 = protection one shot error
                         $40 = +24 volt power supply error
                         $80 = timer error

     <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
        1B  2A                   resets all parameters to
                        default values
                        Note: this command is acted upon in
                        sync with received commands/data

     <esc>  R   n               Set Baud Rate
        1B  52  ?                no operation

     <esc>  W   nl  n2          Wrap Data
        1B  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

                    bit     7            6 5 4 3 2 1 0
                         |             \___    ___/
                         |                 \  /
                         |                  \/
                         |           number of bits + 1
                         |
                         0 = white space
                         1 = black
```

LabelWriter to Host

<dcl> 11	XON	(resume transfer) informs host computer that at least 40 bytes available in buffer
<dc3> 13	XOFF	(suspend transfer) informs host computer that only 20 bytes remain in buffer
<can> 18	Cancel Label	informs host computer that an unrecoverable error occurred and printing suspended; host action required (e.g. send status then form feed)
@ 40	Power Up/Reset/Abort	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 LWEL 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 compressed line for a EL40 would be:

```
        17   0F   8F   20   A0   20   A0   0F   8F FF
```

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
Total          320 pixels = 40 bytes x 8
```