



PRINTER TECHNICAL MANUAL

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This booklet covers the technical requirements for both serial and parallel printers linked to a Lynx. But first some words of advice on using Lynx expansion packs, which are relevant to the parallel printer interface.

LYNX EXPANSION PACKS

Lynx expansion packs use the special Lynx expansion connector at the rear of the unit. This 40 way connector is very useful because it gives direct access to the Lynx internally.

Expansion packs can be joined together, one into the back of another, so that you can use more than one at once. We recommend that you do not have more than three in use together, because each one consumes power and the Lynx power supply is only rated to provide power for three packs.

The Lynx must be turned off before you plug in or unplug a pack. If you don't follow this rule you will very likely crash the machine. It is normal practice to follow this procedure with computers; failure to do so can cause permanent damage. Similar problems might occur if the connector isn't fully engaged, or 'walks off' due to vibration, although that is unlikely to happen.

The 40 way Expansion Connector is a very powerful facility. It will allow you to add a Centronics printer, joystick, disk drives, and more, to your Lynx. Stay tuned for further developments from Computers.

USING A SERIAL PRINTER WITH THE LYNX

The Lynx serial printer lead can be used with the majority of serial printers available today. The recommended printer for the Lynx is the Seikosha GP-250X, but modifications can be made to the serial printer software to enable other printers to be used without too much difficulty. Full details of how this may be done are given in the section of the manual entitled 'Technical Details'. Users of the Seikosha will probably never need to refer to these.

The 96K Lynx has serial printer commands in the ROM; the 48K Lynx needs a special program on cassette to be loaded before using a serial printer.

When the 96K Lynx starts up it is ready to drive a parallel printer.

If you wish to use a serial printer, make sure you use the following command:

Type EXT SPRINT and press (RETURN).

For users who wish to know exactly what this command does, the following will explain:

1. It places the address of the serial printer into 6202.
2. It copies the parameters from ROM to RAM.

Loading The Serial Printer Driver Program

The Lynx serial printer program is supplied in cassette form for the 48K Lynx. This has the file name "SPRINT.48K", and is suitable for the standard 48K Lynx. The 96K Lynx has the printer program in the extra ROM on board.

The program is in two parts:

A program loader, written in *BASIC*, and called "SPRINT.48K".

The actual printer driver, called *CODE*. This is written in machine code and loaded automatically by the *SPRINT* program.

The program is loaded from the cassette tape in the standard way, that is, enter:

LOAD "SPRINT.48K"

from the keyboard. With the volume on the correct setting, press the 'play' key on the cassette player and then press the (RETURN) key on the LYNX.

The *SPRINT* program will load and run automatically. Its first action is to load in turn the printer driver software which is called "*CODE*" (so that the word "*CODE*" will appear on the screen next). The *SPRINT* program then sets the correct initial values for *CODE*, before printing a title and copyright message and clearing itself from RAM—leaving only the initialised printer driver "*CODE*" in memory. The Lynx is now ready to print.

LYNX PARALLEL PRINTER PACK

The Lynx printer pack provides the hardware to drive printers equipped with a standard 'Centronics' interface (the vast majority of printers commonly available are equipped with this type of inter-

face). You should read the general notes about Lynx expansion packs above.

The printer interface has other uses: it provides you with an 8 bit digital output port and also a 4 bit digital input port. Hobbyists can, therefore, base their own control projects around the interface; for instance, controlling a model railway or driving disco lights. If you are connecting the pack to your own circuitry, take care not to exceed the electrical specification of our pack. See page 10 for further details.

Connecting a printer to the interface is very simple; just ensure that all the connectors are fully engaged and that the ribbon cable to the printer is not strained at all. The pack itself must only be plugged into or unplugged from the Lynx whilst the Lynx is switched off. It is advisable to treat the ribbon cable in the same way. Software to drive the printer must be read in from tape for a 48K Lynx: the 96K Lynx already includes this software within its system ROMs.

When the 96K Lynx starts up it is ready to drive a parallel printer. However, if you have been using a serial printer you need to tell the 96K Lynx to return to using a parallel printer. To execute the parallel printer command:

Type EXT PPRINT and press (RETURN).

For users who wish to know exactly what this command does, the following will explain:

1. It places the address of the parallel printer into 6202.
2. It copies parameters from ROM to RAM.
3. It sends an "initialise" signal to the printer.

Loading The Parallel Printer Driver Program

The Lynx parallel printer program is supplied in cassette form for the 48K Lynx. This has the file name "PPRINT.48K", and is suitable for the standard 48K Lynx. The 96K Lynx has the printer program in the extra ROM on board.

The program is in two parts:

A program loader, written in BASIC, and called "PPRINT.48K".

The actual printer driver, called "CODE". This is written in machine code and is loaded automatically by the PPRINT program.

The program is loaded from the cassette tape in the standard way, that is, enter:

LOAD "PPRINT.48K"

from the keyboard. With the volume in the correct setting, press the 'play' key on the cassette player and then press the (RETURN) key on the Lynx.

The PPRINT program will load and run automatically. Its first action is to load in turn the printer driver software, which is called "CODE" (so the word "CODE" will appear on the screen next). The PPRINT program then sets the initial values for CODE, before printing a title and copyright message and clearing itself from RAM—leaving only the initialised printer driver "CODE" in memory. The Lynx is now ready to print.

Some sections of the Manual do not apply for some configurations of the Lynx machine and printer.

The following chart summarises the machines, printer drivers and appropriate sections of the Manual.

		PRINTER DRIVER	HANDSHAKE ?	RELEVANT SECTIONS IN THIS PRINTER TECHNICAL MANUAL
48K	SERIAL	ON CASSETTE (SPRINT.48K)	NO	(ALL SECTIONS APPLY)
	PARALLEL	ON CASSETTE (PPRINT.48K)	YES	ALL SECTIONS EXCEPT:- —TIME DELAY PARAMETERS
96K	SERIAL	IN MEMORY	NO	ALL SECTIONS EXCEPT:- —TAPE LOADING INSTRUCTIONS
	PARALLEL	IN MEMORY	YES	ALL SECTIONS EXCEPT:- TIME DELAY PARAMETERS— TAPE LOADING INSTRUCTIONS

PRINTER COMMANDS

The Lynx has three printer commands from Basic: LLIST, LPRINT and LINK (which is switched on and off by LINK ON and LINK OFF respectively). The use of the printer from within machine code programs is given in the final 'Technical Information' section, page 8.

It can be very useful to have a 'hard copy' of your program. It enables you to see the entire program at once, to trace the flow of the program or to note down any changes which need to be made.

LLIST

In the same way that LIST will print all or part of a user's Basic program currently in memory to the screen, LLIST will direct this output to the printer. Any sequence of line numbers can be sent to the printer by specifying start and end line numbers separated by a comma. For example:

LLIST 100,530

will print line numbers 100 to 530 inclusive.

LPRINT

This command directs output to the printer in precisely the way that PRINT directs output to the screen.

Control characters can be used to instruct the printer from within Basic by using the CHR\$ command. For example: CHR\$(13) will perform a carriage return. For full details see the Lynx User Manual.

Note: Be careful to use spaces instead of TAB with LPRINT since the Basic ROM does not pass its value to the printer. A TAB instruction will generally result in double the spaces required. For full details of how to overcome this, see the section on 'Troubleshooting'.

LINK ON

This command links screen and printer displays, giving the user a simultaneous hard copy of text which is displayed on the screen.

Note: The LINK instruction responds to the cursor as a character to be printed so if you wish to avoid cursor characters being printed use LINK ON only from within a Basic program.

LINK OFF

This command frees the display screen and keyboard for INPUT statements or for loading programs. Be sure to execute LINK OFF when printout is no longer required.

TROUBLESHOOTING

The Printer Is Not Activated

First check that switches and connections to the printer are correct. If they are, then the printer driver program is probably at fault. This may be because it was unsuccessfully loaded from cassette tape or because the Lynx was switched off after loading. A CALL to memory location 0 will also 'lose' the driver program. Corruption of the printer driver can also happen if you use machine code programs which occupy the addresses in memory required to store the printer driver.

Given that the printer is otherwise functioning correctly, the remedy is to remove or correct any machine code program which is co-resident with the printer driver and reload the SPRINT program from power up.

Serial Printer "HANGS UP" After Printing One Or More Lines

The Lynx does not have a 'handshake' line on the serial port, so various delay parameters are used to control the amount of time allowed to print characters, clear buffers and issue formfeeds. These issues are covered under the heading of 'Time delay parameters' in the 'Technical Information' section, below.

Tabs Overshoot When Link On Is Used

The horizontal tabulation character (HT, ASCII 9) can produce unwanted results when used in conjunction with the LINK ON command. This is because the screen driver routine converts TAB into spaces, which are sent to the printer. The original TAB is also converted into spaces and sent directly to the printer, causing an effect equal to two TAB characters.

To avoid this, set the HT flag (bit 1 of byte 61 BD) when LINK ON is in use. On printers such as the Seikosha GP-250X, which do not interpret horizontal tabulation (HT), the printout will be correct without changing the HT flag.

Graphics Are Not Displayed

Although the screen can display both graphics characters (CHR\$(224) to (249)) and bit-pattern graphics, these will not be transmitted to the printer when LINK ON is used. Only the standard ASCII character set (CHR\$(32) to (127)) may be printed with this method.

Graphics can be produced on a printer with graphics capability for which a suitable program has been written. Such a program will send the special characters needed to produce the pattern of 'dots' required. Each model of printer will have its own sequences of special characters and corresponding dot patterns, so refer to your printer manual for further details.

LLIST Doesn't Issue A Carriage Return

This is a simple test for the integrity of the printer driver and a failure probably indicates corruption of the printer driver program. Other symptoms can occur depending on the severity of the corruption. Apart from hardware failures (which are quite unlikely), the most probable causes are a machine code program which is using memory locations needed by the printer driver. Another possible cause of corruption is by re-setting 'HIMEM' and confusing a Basic program.

TECHNICAL INFORMATION

Lynx Parallel Printer Interface

A total of three I/O ports are assigned to the printer interface: a read only, four bit port to gather status information, a read or write port simply used to trigger an initialise signal, and a write only port to output a data byte to an external device.

Port Allocation

	DIRECTION	I/O ADDRESS							
		A7	A6	A5	A4	A3	A2	A1	A0
PRINTER STATUS	READ	*	1	1	1	1	1	0	0
INITIALISE	R/W	*	1	1	1	1	1	0	1
ASCII DATA	WRITE	*	1	1	1	1	1	1	0

Data Bit Assignment

	DATA							
	D7	D6	D5	D4	D3	D2	D1	D0
PRINTER STATUS					PIN 8	PIN 2	PIN 4	PIN 6
INITIALISE					SPARE	SEL	PE	BUSY
ASCII DATA	PIN 10	PIN 12	PIN 14	PIN 16	PIN 18	PIN 20	PIN 22	PIN 24
	DATA 8	DATA 7	DATA 6	DATA 5	DATA 4	DATA 3	DATA 2	DATA 1

N.B. Pin numbers above are for 26 way connector on printer pack and also for the ribbon cable.

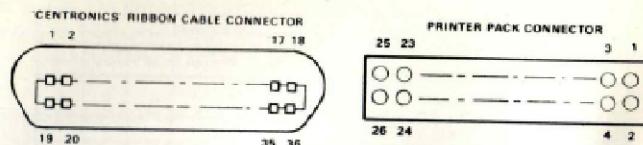
See below for correspondence to 36 way 'CENTRONICS' connector:-

CENTRONICS PIN No	1	2	3	4	5	6	7	8	9	10	11	12
RIBBON CABLE PIN No	26	24	22	20	18	16	14	12	10	8	6	4
SIGNAL NAME	STROBE	D1	D2	D3	D4	D5	D6	D7	D8	SPARE	BUSY	PE

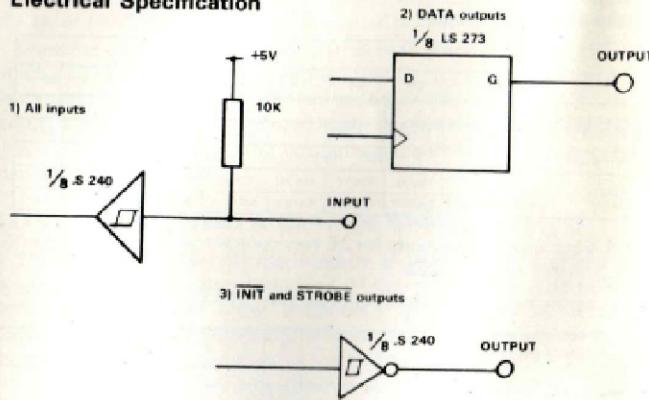
CENTRONICS PIN No	13	14	15	16	17	18	19	20	21	22	23
RIBBON CABLE PIN No	2						25	23	21	19	17
SIGNAL NAME	SEL	N/C	N/C	N/C	N/C	N/C	GND	GND	GND	GND	GND

CENTRONICS PIN No	24	25	26	27	28	29	30	31	32	33	34	35	36
RIBBON CABLE PIN No	15	13	11	9	7	5	3	1					
SIGNAL NAME	GND	INIT	N/C	N/C	N/C	N/C	N/C						

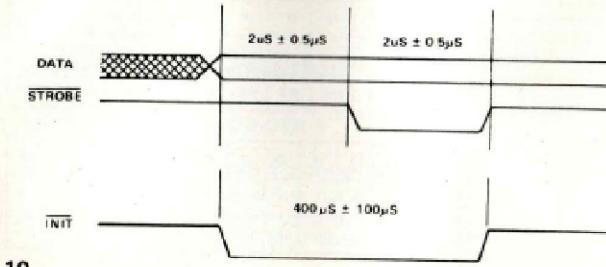
Shown below are pinouts for the two connectors:-



Electrical Specification



Signal Timing



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Printer Configuration

The recommended serial printer for the Lynx is the Seikosha GP-250X. The printer routine may be easily adapted to suit other serial printers, since many of the characteristics which govern their behaviour are held in fixed locations in RAM.

The Lynx has 50 (decimal) bytes of RAM reserved for additional system programs, starting at location 61BC. The serial printer uses the first 10 of these bytes, from 61BC to 61C5. In detail, these locations and default settings are:

61BC (4 bytes) Initialised to: 00 22 08 C8 hex

These four bytes contain 32 flag bits which affect the treatment of control characters. When the flag bit is '0', the character is sent to the printer buffer unchanged. If the bit is '1', special action is taken, as detailed in the table below.

SPECIAL TREATMENT OF CONTROL CHARACTERS

The table shows the action taken with control characters when the flag bit of each of these four bytes is 'set' (i.e. the bit has a value '1'). Note that bit 0 of each byte is the Least Significant Bit. These apply to both serial and parallel printer drivers.

Address Flag Bit ASCII Hex Action if bit = '1'

61BC	0	NUL	00	Not sent
	1	SOH	01	Not sent
	2	STX	02	Not sent
	3	ETX	03	Not sent
	4	EOT	04	Converted to formfeed (cf Lynx VDU 4)
	5	ENQ	05	Not sent
	6	ACK	06	Not sent
	7	BEL	07	Not sent
61BD	0	BS	08	Not sent
	1	HT	09	Converted to spaces (See Note 1)
	2	LF	0A	Not sent (See Note 2)
	3	VT	0B	Not sent

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	4	FF	OC	Converted to linefeed (See Note 3)
	5	CR	OD	Converted to linefeed (See Note 2)
	6	SO	OE	Not sent
	7	SI	OF	Not sent
61BE	0	DLE	10	Converted to formfeed (cf Lynx VDU 16)
	1	DC1	11	Not sent
	2	DC2	12	Not sent
	3	DC3	13	Not sent/Converted to linefeed (cf Lynx VDU 19)
	4	DC4	14	Not sent
	5	NAK	15	Not sent
	6	SYN	16	Converted to backspace (cf Lynx VDU 22)
	7	ETB	17	Not sent
61BF	0	CAN	18	Not sent
	1	EM	19	Not sent
	2	SUB	1A	Not sent
	3	ESC	1B	Not sent
	4	FS	1C	Not sent
	5	GS	1D	Not sent
	6	RS	1E	Not sent
	7	US	1F	Converted to linefeed (cf Lynx VDU 31)

Note 1:

From 1 to 8 spaces are sent to bring the print head to the next Tab position. Tab positions are fixed at intervals of eight characters at 1, 9, 17, etc. The current head position is assumed to be the same as the number of characters left in the printer line buffer.

Note 2:

Printers tend to differ in their interpretations of when a 'newline' is required. On the Lynx, the carriage return character (CR, ASCII 13) is used for 'newline' (carriage return followed by linefeed). On

some printers 'newline' is generated not from receipt of CR, but from the linefeed character instead (LF, ASCII 10). In this case, set the CR flag (bit 5 of byte 61 BD) to produce the required linefeed. Some programs, for example, the ZEN assembler, may transmit the CR + LF combination for newline. This will result in an extra linefeed on most printers which may be suppressed by setting the LF flag (bit 2 of byte 61BD).

Note 3:

The formfeed character (FF, ASCII 12) has been converted to a linefeed character on the Lynx, since sending FF not preceded by a print command results in incorrect printout.

61C0 (1 byte) Initialised to: 1F hex

This byte contains the print command flags. The values are used to tell the driver whether certain control characters act as print commands on the actual printer being used. A set bit (with a value of '1') indicates that the corresponding character is a print command.

bit ASCII

0	CR
1	LF
2	DC4
3	FF
4	VT
5	BS
6	spare
7	spare

61C1 (1 byte) Initialised to: 80 decimal

The value entered in this byte gives the size of the printer buffer (in decimal bytes).

61C2 (1 byte) Initialised to: 00

This byte holds the number of characters presently in the printer buffer. This location is continuously updated during printing, so the contents of 61C2 should not be altered by the user.

TIME DELAY PARAMETERS (SERIAL PRINTER ONLY)

The following three bytes (61C3 to 61C5) are all concerned with periods of time which are needed for tasks to be satisfactorily completed. The values are highly specific to the printer used and are initialised with values which suit the Seikosha GP250-X. Suitable values for other printers may be found either from their technical manuals or by trial and error.

Some delay will be necessary because the Lynx serial line does not use a handshake' line or software protocol. When the printer buffer is full the driver program will automatically indicate a BUSY status and activate a delay to allow the buffer time to discharge before continuing.

61C3 (1 byte) Initialised to: 65 decimal

The value in this byte determines the delay time between individual characters being sent by the printer driver to the printer buffer. The unit is about 0.2 milliseconds.

61C4 (1 byte) Initialised to: 135 decimal

The value in this location determines the time allowed for the printer to print out one character from its buffer. The unit is approximately 0.2 milliseconds.

61C5 (1 byte) Initialised to: 135 decimal

The value in this location determines the time allowed for the printer to execute a formfeed. The unit is 0.1 second.

PRINTING FROM WITHIN A MACHINE CODE PROGRAM

The printer driver occupies the following locations in memory in 48K Lynx:

Start address	End address
48K 9EFA	9FF7

However, the preferred method of invoking the printer driver from within a machine code program is to jump to the address held at 6202, since this location holds the start address of the printer routine in every case.

The character to be printed must be in the accumulator (Register A). A subsequent jump will place this character in the printer buffer. Remember that a carriage return (CR, ASCII 13) must be the last character in the buffer.