

PROGRAMMING THE NICK CHIP  
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In contrast to the majority of video display devices which allow the user various modes for the whole display, NICK allows many different modes in the same display frame.

Principal features of NICK are:-

- \* Mixed mode displays
- \* User definable characters from fonts of 64, 128 and 256
- \* 8-bit colour output (256 colours)
- \* 2,4,16, and 256 colours per line chosen from 256
- \* Maximum resolution (using interlace) 672 \* 512
- \* Cell based graphics, bitmap and characters
- \* Characters any height from 1 to 256 scanlines
- \* Choice of 256 border colours
- \* User defined screen width and height
- \* External colour input (unlimited sprites or TV camera)
- \* Efficient use of RAM (can work with < 1K of RAM)
- \* 4 colour-pairs in 84 column tet mode
- \* Special use of bits to increase colour options
- \* Pointer-based memory mapping, for flexibility and speed



## CONTROL REGISTERS

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Input-output addresses 080H to 08FH are reserved for NICK registers although only 080H to 083H are used at present. These registers are write-only.

080H	/FIXBIAS d7	VC1 output used to kill external colour
	(d6,d5)	(PRIOR1,PRIOR0) external colour priority, working in conjunction with an external 4-bit (16 colour-value) input on ECO-EC3.
	=00	ECO-EC3 select corresponding palette colour whenever the display is active and /EXTC is low.
	=01	The external colour on ECO-EC3 selects the corresponding palette colour if /EXTC is low and the internal display is generating a palette colour in the range COL8-COL15.
	=10	The external colour on ECO-EC3 selects the corresponding palette colour if /EXTC is low and the internal display is generating a palette colour in the range COL8-COL15 OR the external colour is in the range COL0-COL7 (EC3 low).
	=11	The external colour on ECO-EC3 selects the corresponding palette colour if /EXTC is low and the internal display is generating a palette colour in the range COL8-COL15 OR the external colour is in the ranges COL0-COL3 or COL8 - COL11 (EC2 low).
	(d4..d0)	colour bias for palette colours 8-15.
081H	/BORDER (d7..d0)	8 bit border colour
082H	/LPL (d7..d0)	a11 ↓ (a11..a4) of pointer to line parameter table in video RAM. The index into an entry of 16 bytes, (a3..a0) is generated by the hardware.
083H	/LPH d7 d6 (d3..d0)	/(load line parameter base) normally 1 /(clock in line parameter base) (a15..a12) or pointer to the line parameter table in video RAM.



The video display is controlled by values loaded into the video RAM segments (up to 64K at the top of the 4M space) by the Z80. Once this 'line parameter table' has been loaded in and the line parameter base register has been loaded the display requires no more action on the part of the Z80.

The visible display is split up into 'video mode lines'. These 'modelines' are made up of 1 to 256 scanlines. (A scanline is one scan of the electron beam across the CRT and takes about 64 microseconds.)

The following 16 registers are loaded from the line parameter table before each modeline:

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SC	scanlines in this modeline (two's complement)
MB	the MODEBYTE (defines video display mode)
LM	left display margin etc.
RM	right margin etc.
LD1L	(a7..a0) of line data pointer LD1
LD1H	(a8..a15) of line data pointer LD1
LD2L	(a7..a0) of line data pointer LD2
LD2H	(a8..a15) of line data pointer LD2
COL0	8 bit value of palette colour £0
COL1	" £1
COL2	" £2
COL3	" £3
COL4	" £4
COL5	" £5
COL6	" £6
COL7	" £7

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23872 = status line

47000 = 1st line

-16 = 2nd line

*2. 2nd line: 47000*



BUS ACTIVITY FOR THE VARIOUS MODES  
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The possible video modes are:

- VSNC no border colour and use margin information to control positioning of the vertical sync pulse. This gives considerable interlace flexibility.
- PIXEL use information pointed to by LD1 as a bit mapped display.
- ATTR use information pointed to by LD2 as a 2-C bitmap display and information pointed to by LD1 as cell-based graphics attributes (ie: to define paper and ink colours in the cell).
- CH256 use information pointed to by LD1 as indices of characters pointed to by LD2. These characters can be any number of lines deep (up to 256).  
NB: offsets in the font pointer define which line of the character to start on.
- CH128 As above but assumes a font of 128 characters.
- CH64 As above but assumes a font of 64 characters.
- LPIXEL As for pixel mode but with half the horizontal resolution.

Note that all these modes may be mixed on the same screen and that one has the choice of 2-C, 4-C, 16-C and 256-C colour modes for the PIXEL, LPIXEL, CH256, CH128 and CH64 modes. Also note the special interpretation of certain bits of display data described below.



Details of bus use during a memory cycle in the various modes:

PIXEL	/VDC1	/VDC2
Address	LD1(15....0)	LD1(15....0)
Data into	BUF1(7....0)	BUF2(7....0)

BUF1 and BUF2 are loaded sequentially into the shift register and clocked out MSB first, ie. both are display bytes. The line data pointer LD1 is incremented twice in each memory cycle. Screen data is fetched from memory and the LD1 counter is incremented only in the active part of the display, ie. between the left and right margins of a scanline. The scanline count loaded at the beginning of the PIXEL modeline determines how many scanlines in this scanline.

~~MODE~~

	/VDC1	/VDC2
Address	LD1(15....0)	LD2(15....0)
Data into	BUF1(7....0)	BUF2(7....0)

Cell based (parallel attribute) graphics. LD1 is used as a pointer to the colour array (paper and ink colours) and LD2 points at 2-C pixel data, ie. the display bytes. LD2 is incremented once every memory cycle while the display is active and keeps incrementing up for all scanlines in the modeline. LD1 restarts from the same address for each scanline so attribute data in BUF1 applies to cells which are 8 bits wide and have a depth of the number of scanlines in the modeline.

The character modes involve indirection through the character font. A different font may be defined for each modeline and line by line vertical scrolling is obtained by offsetting the original index.

	/VDC1	/VDC2
Address	LD1(15....0)	LD2(7....0), BUF1(7....0)
Data into	BUF1(7....0)	BUF2(7....0)

LD1 is reloaded at the start of each scanline and acts as a pointer into a section of RAM containing the indices of the characters to be displayed. It is incremented once in each memory cycle. LD2 is a pointer into the character font to be used and is incremented at the start of each scanline (it points to a row of a character in the font). Thus the font consists of 256 bytes defining the first row of each character and then another 256 bytes for the next row of each character etc. If the characters are 9 lines deep this requires 2304 bytes of character font (256\*9). The data in BUF2 is loaded into the shift register.



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	/VDC1	/VDC2
CH128	LD1(15....0)	LD2(8....0)
Address	BUF1(7....0)	BUF1(6....0)
Data into		BUF2(7....0)

This is basically the same as the 256 character font mode but note that the font for 64 9 line deep characters only requires 1152 bytes of memory.

	/VDC1	/VDC2
CH164	LD1(15....0)	LD2(9....0)
Address	BUF1(7....0)	BUF1(5....0)
Data into		BUF2(7....0)

This is basically the same as the 256 character font mode but note that the font for 64 9 line deep characters only requires 576 bytes of memory.

	/VDC1	/VDC2
LPIXEL	LD1(15....0)	LD1(15....0)
Address	BUF1(7....0)	BUF2(7....0)
Data into		

This is much the same as the PIXEL mode except that the LD1 pointer is only incremented once in each memory cycle and the BUF2 data is not used. This gives half the horizontal resolution of the PIXEL mode.

## VSYNC

No use is made of the information loaded from memory. It is equivalent to the LPIXEL mode.



# THE LINE PARAMETER REGISTERS

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SC This is a two's complemented count of the number of scanlines in the modeline, ie: OFFH for one scanline in modeline.

MB d7 If set this takes the VIRQ interrupt line low for the duration of the modeline. In conjunction with the DAVE chip this causes an interrupt to be generated at the beginning of the modeline.

(d6,d5) Defines the colour mode:

00 2-C Two colour mode. If a bit in the byte of display data is 1 a pixel of palette colour £ 1 is output and if 0 a pixel of palette colour £0. The bits are output to the screen in the following order:

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: d7 : d6 : d5 : d4 : d3 : d2 : d1 : d0 :
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01 4-C Four colour mode. Pairs of bits in the byte of display data define the colour of the pixel displayed. 00 for palette colour £0, 01 for palette colour £1, 10 for palette colour £2, and 11 for palette colour £3. The pixels are displayed in the following order:-

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:(d7,d3) : (d6,d2) : (d5,d1) : (d4,d0):
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10 16-C Sixteen colour mode. Groups of 4 bits in the byte of display data define the colour of the pixel displayed. 0000 for palette colour £0 up to 1111 for palette colour £15. The pixels are displayed in the following order:-

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: (d7,d3,d5,d1) : (d6,d2,d4,d0) :
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```



Note that palette colours £0 to £7 have 8-bit values loaded from the line parameter table at the start of each scanline but that palette colours £8 to £15 have 8-bit values defined as follows:-

palette colour £8 = (f4,f3,f2,f1,f0,0,0,0)  
 palette colour £9 = (f4,f3,f2,f1,f0,0,0,1)  
 .....  
 palette colour £15 = (f4,f3,f2,f1,f0,1,1,1)

where (f4,f3,f2,f1,f0) are the low 5 bits of the FIXBIAS register.

- 11 256-C Two hundred and fifty six colour mode. In this mode the byte of display data defines the colour of a single display pixel.

The actual colour produced is as follows:-

RED = [b0]\*(4/7) + [b3]\*(2/7) + [b6]\*(1/7)  
 GREEN = [b1]\*(4/7) + [b4]\*(2/7) + [b7]\*(1/7)  
 BLUE = [b2]\*(2/3) + [b5]\*(1/3)

(Note that this specification of red, green and blue also occurs when allocating a colour to the palette.)

- d4 =0 for /VRES. The VRES mode the LD1 and LD2 data pointers are reloaded at the start of each scanline and so the same display pattern is repeated for each scanline of the modeline.

(d3,d2,d1) defines the video display mode (see above):

000 VSYNC mode  
 001 PIXEL mode  
 010 ATTR mode  
 011 CH256 mode  
 100 CH128 mode  
 101 CH64 mode  
 110 unused at present  
 111 LPIXEL mode

- d0 If 1 this forces a reload of the line parameter base register. This will normally be programmed to occur at the end of each video frame.



LM d7

=1 for MSBALT, ie: if the top bit of the display byte is 1 this causes palette colours £2 and £3 to be selected instead of £0 and £1 in the 2-C display mode. If the top bit is 0 palette colours £0 and £1 are used as usual. In both cases the top bit seen by the shift register is forced to 0. This mode is useful in simulating an 80 column VDU in the PIXEL mode. Since the msb or LHS of any character is 0 for character spacing it can be used to highlight areas of text.

d6

=1 for LSBALT ie: if the bottom bit of the display byte is 1 this causes palette colours £4 and £5 to be selected instead of £0 and £1 in the 2-C display mode. If the top bit is 0 palette colours £0 and £1 are used as usual. In both cases the top bit seen by the shift register is forced to 0. This mode is useful in simulating an 80 column VDU in the PIXEL mode, Since the lsb or RHS of any character is 0 for character spacing it can be used to highlight areas of text.

(d5...d)

define the left hand margin of the active display. In practice this value will not be below 10 for the left hand edge of the CRT. The display changes from being border colour at the left hand margin and the display data counters start being incremented. The left hand margin defines the start of the vertical sync pulse in the VSYNC video mode.

RM d7

ALTIND1 If a 2-C character mode is selected this will cause characters with an index above 080H to have a paper of palette colour £2 and an ink of palette colour £3 instead of £0 and £1.

d6

ALTIND0 If a 2-C character mode is selected this will cause characters which have their next to most significant bit set to swap palette colours as follows:-

£0 - > £4  
£1 - > £5  
£2 - > £6  
£3 - > £7



(d5...d0) These bits define the right hand side of the active display. The maximum value is normally 54 for the right hand edge of the CRT. The display returns to the border colour at the right hand margin and the line data pointers are not incremented until the next left hand margin. In the VSYNC video mode the right hand margin defines the end of the vertical sync pulse.

LD1L This 8-bit value defines the starting value of (a7..a0) of the line data pointer LD1.

LD1H This 8-bit value defines the starting value of (a8..a15) of the line data pointer LD1.

LD1 is used as a pointer to the next byte of display data in the PIXEL and LPIXEL modes. In the CH256, CH128 and CH64 modes it is the index of a character in the character font. In the ATTR mode it points to attribute information.

LD2L This 8-bit value defines the starting value of (a7..a0) of the line data pointer LD2.

LD2H This 8-bit value defines the starting value of (a8..a15) of the line data pointer LD2.

LD2 is used as a pointer for pixel information in the ATTR display mode and as a pointer to the character font in the CG256, CH128 and CH64 modes. It is not used in the PIXEL and LPIXEL modes.

COL0 Palette colour £0. This is the paper colour in 2C modes though note the exceptions above.

COL1 Palette colour £1. This is the ink colour in 2C modes though note the exceptions above.

COL2 Palette colour £2 (Alternate paper)

COL3 Palette colour £3 (Alternate ink)

COL4 Palette colour £4

COL5 Palette colour £5

COL6 Palette colour £6

COL7 Palette colour £7

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