WT625 Teletext Colour Graphics Board.

CONTENTS.

1. INTRODUCTION.

The WT625 Teletext Colour Graphics VDU board plugs directly into the NASBUS expansion interface of a Nascom 1 or 2 microcomputer and provides a UHF output for connection to the aerial socket of a standard 625 line PAL colour television.

The board uses the standard Teletext/viewdata display format and character codes. It interprets the Teletext control characters that are relevant to stand-alone VDU applications, these being described in detail in Section 2. Other functions, in addition to those required by Teletext are provided such as a programmable cursor, optional display formats, and a programme controlled electronic switch to route either the Nascom or Teletext video output to the TV.

Section 2 explains the aspects of the Teletext specifications which are relevant to the WT625. Later sections describe the hardware operation of the board and provide information on programming. Installation and setting up instructions are given in Section 5. Reference data such as code charts and circuit diagrams etc. are listed in Section 8 and for convenience the more commonly used data is repeated on the back cover of this document.

2. TELETEXT SPECIFICATIONS.

In order to appreciate the operation of the WT625 it is necessary to understand aspects of the Teletext display specifications.

2.1. SCREEN FORMAT.

The standard Teletext format is 24 rows of 40 characters each. This is the basic format of the WT625 but under programme control the board can be made to display 12 rows of 40 characters where each character is twice its normal height.

2.2. CHARACTER CODES.

Teletext uses 7 data bits to define each character giving 128 possible character codes. These codes are divided into 32 control codes and 96 displayable characters. Certain of the control codes are used to define whether the displayable characters actually display as text or graphic symbols. In total there are 96 different alphanumeric (Text) characters plus 126 graphic symbols.

In practice the video buffer is 8 bits wide with only the 7 low order bits (bits 0 to 6) being used to store the Teletext character. The extra bit is either used to define the position of a cursor (as required for Viewdata applications), or to gain access to an extra 6 colours which are not directly accessible by the Teletext control characters. (In the following description the control codes are defined in hexadecimal notation e.g. '17'H is equivalent to binary 0010111.)

2.3. CONTROL CHARACTERS.

The concept of control characters is fundamental to all Teletext based displays. They define the attributes, such as colour and height of the displayable text and graphic characters.

Placing a control character in the video buffer affects the characteristics of the following alphanumeric or graphic characters up to the end of the current row (or until a later control character overrides the action of the first).
Control characters are provided to:-

a) Determine whether the following characters will display as alphanumeric or graphics.
b) Select the colour of alpha and graphic characters (Foreground).
c) Select the background colour.
d) Cause characters to be displayed in flashing or steady mode.
3) Select between contiguous and separated graphic modes.
f) Cause characters to be displayed as twice normal height.
g) Cause characters to be 'concealed'.

At the end of each display row the action of all control characters is reset so that all rows start as white, single height, non flashing alphanumerics characters on a black background. To cause characters to be displayed in any other format requires one or more control characters to be stored in the video buffer.

Normally control characters will display as spaces but the use of 'Hold Graphics Mode' (which is described in Section 2.12) permits any of the graphic symbols to be substituted for the usual space. This feature is particularly useful when control characters are required within a graphic image.

The specific action of all control characters is described in detail in Sections 2.6. through 2.12.

2.4. ALPHANUMERIC CHARACTERS.

The WT625 can display the 96 alphanumeric (text) characters defined in the Teletext specification. These characters are listed in columns 2 through 7 of the WT625 code chart. The majority of character codes correspond to the ASCII character set used by the Nascom VDU.

2.5. GRAPHIC CHARACTERS.

These are the building blocks for generating drawings, bar charts and the like. Each character is composed of six segments (usually called picture elements or pels) arranged in a 3 high by 2 wide matrix. Columns 2g, 3g, 6g and 7g of the WT625 code chart show the graphic symbols that are available.

There is a direct relationship between the pels of a graphic character that are illuminated and binary code of the character. Figure 1 shows this.

b0	b1
b2	b3
b4	b6

Figure 1.

3 x 2 Pel Matrix
of graphic characters
(b0 = least significant)

For instance, if bit 2 of the character is a '1' the middle left hand pel will be lit. Note that bit 5 does not control a pel.

The total graphics resolution is 80 x 72 = 5760 pels which is adequate for most applications.

Graphics characters are normally displayed so that adjacent, illuminated pels touch each other so that blocks of colour can be created. This is called 'Contiguous Graphics Mode'. An alternative mode is 'Separated Graphics' in which only the centre of pels are lit. This leaves a distinct gap between adjacent pels to produce a shading effect. The difference between the two modes for the character '37'H is shown below.

Separated graphics mode is invoked by the control code '1A'H.

Contiguous Graphics   Separated Graphics

Fig 2 Contiguous and separated graphics.

2.6. FOREGROUND COLOUR.

Teletext permits graphic and alphanumeric characters to be displayed in seven colours i.e. white, yellow, cyan, green, magenta, red and blue. A character's colour is defined by a preceeding colour setting control character. Seven control characters ('01'H to '07'H) are provided to define the colour of alphanumeric characters and a further seven control characters to define the colour of graphics ('11'H to '17'H). It should be remembered that the colour setting control characters also determine whether the following characters will display as alphanumeric or graphic symbols.

In addition to the seven Teletext colours the WT625 can produce an additional six colours. (The programming section describes how to invoke these colours.)

2.7. BACKGROUND COLOUR.

The background colour of the screen is normally black but a 'New Background' character can be used to change this. The action of this character is to set the background colour to the current foreground colour. In general 'New Background' is followed by a colour setting control character to establish a new foreground colour. So, for example, to write green characters on a yellow background the following sequence could be used:-

a) Set foreground to yellow ('03'H)
b) New Background ('1D'H)
c) Set foreground to green ('02'H)

As it is not possible to set the foreground colour to black the 'New Background' technique cannot be used to reset the background to black, therefore a special 'Black Background' character ('1C'H) is provided.

2.8. DOUBLE HEIGHT CHARACTERS.

Characters following a 'Double Height' control character ('OD'H) are displayed at twice their normal height. Any codes which are stored in the video buffer that would normally be displayed on the row following the Double Height control character are ignored. Double height display continues until a 'Normal Height' character ('OC'H) or the end of the row is detected.

It is possible to use the WT625's control register to define the whole screen as double height as explained in Section 4 but this is an additional function of the WT625 and is not required by the Teletext specification.

2.9. FLASHING CHARACTERS.

The 'Flash' control character ('08'H) causes the displayable characters following it to flash approximately once per second. All displayable characters up to the end of the current row or up to a 'Steady' control character ('09'H) are flashed.

2.10. BLAST THROUGH.

Codes following a graphic colour setting control character will normally display as their graphic form. However, a subset of the alphanumeric characters can still be used thus permitting text to be embedded in graphic images without unnecessary alpha setting control characters. The subset consists of the characters in columns 4 and 5 of the code chart and includes all the upper case alpha characters.

2.11 CONCEALED CHARACTERS.

Characters following the 'Conceal' control character ('18') will display as if they are spaces. This enables 'blanked' areas to be defined on the screen for the entry of confidential information. The concealed display mode is reset by the next colour setting control character or the end of the row.

2.12 HOLD GRAPHICS.

As control characters will normally display as spaces this would seem to imply that it is not possible to have abrupt changes of colour in graphic images as a control character is always needed to change colours. To overcome this Teletext defines a 'Hold Graphics' character ('1E'H). Detection of this sets 'Hold Graphics Mode' and subsequently control characters will display as a graphic character instead of a space. The actual character that replaces the space is the last graphic encountered before the control character that is to be replaced.

Hold graphics mode only applies to control characters encountered during graphic mode and is reset by either the 'Release Graphics' control character ('1F'H) or at the end of the row.

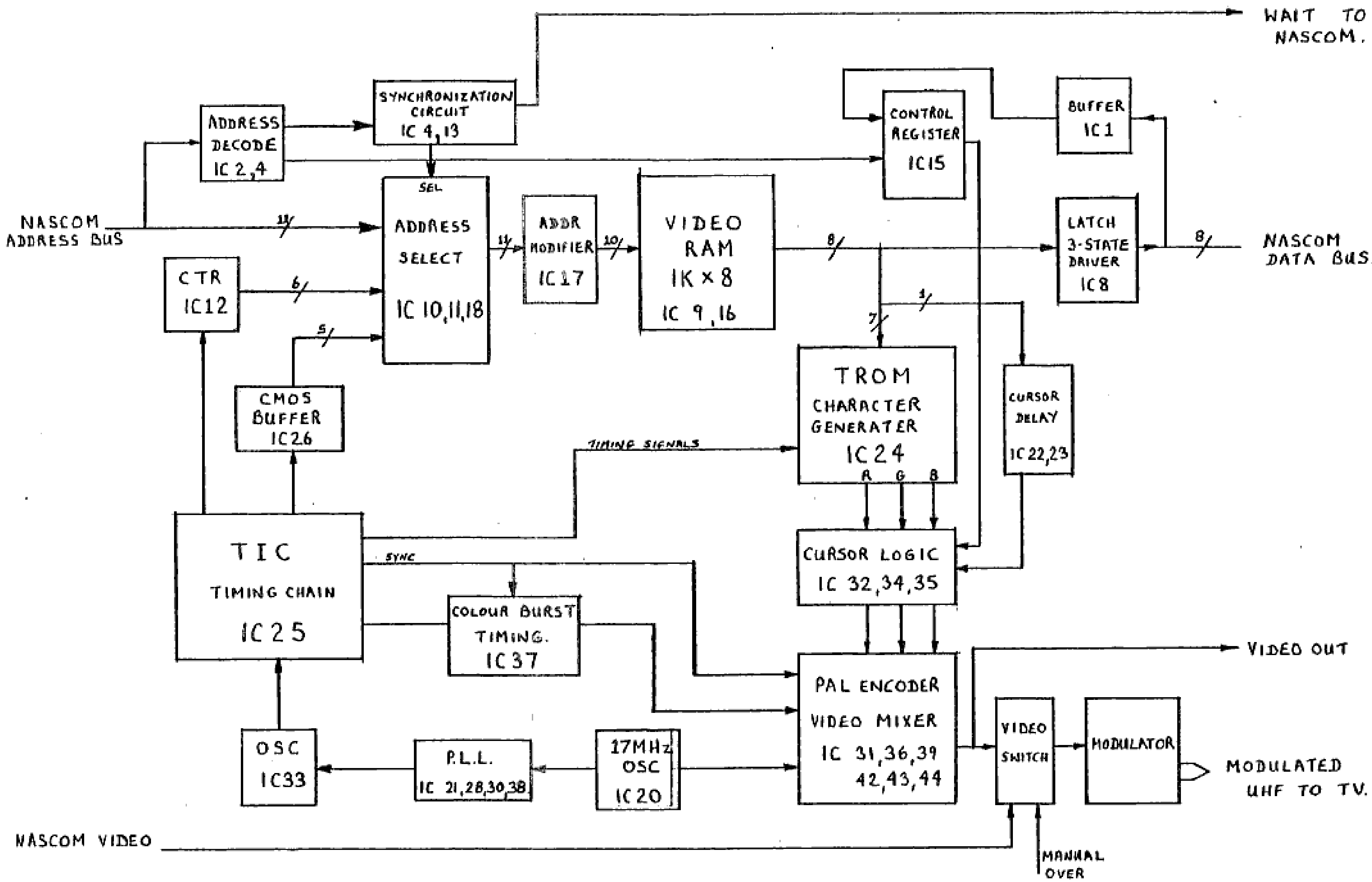


Fig 3. Data Flow.

3. HARDWARE OPERATION.

A simplified block diagram of the WT625 is shown opposite with detailed circuit diagrams being given in Section 8. The principal elements of the board are described below.

3.1. CLOCK GENERATION.

The basic timing reference for the board is a 17.734 MHz crystal controlled oscillator. This frequency, which is four times the PAL sub-carrier frequency, is fed to the PAL encoder circuits. The video timing circuits require a 6 MHz signal which is derived from the 17 MHz clock by a phase locked loop.

3.2. VIDEO BUFFER.

The board has 1K of static RAM which acts primarily as the Video Buffer for the display data which is written to or read from the buffer in the same way as any other block of RAM. As the screen format is usually 24 rows of 40 characters only 960 of the 1024 bytes are needed for the video buffer which leaves 64 bytes spare. 48 of these are available to the user while the other 16 occupy the same memory addresses as the Display Control Register, but more about this later. Each byte in the buffer is 8 bits wide. The seven low order bits (b0 to b6) store the Teletext character while the eighth bit (b7) controls additional non-Teletext functions such as the generation of a reverse image cursor and/or the generation of six extra colours.

The address lines to the video buffer are only controlled by the Nascom during a read or write operation to the buffer. At all other times the address is generated by the video timing circuits which read out each character in sequence for presentation to the video character generation circuits. ICs 10, 11 & 18 gate either the Nascom address bus or the video address to the RAMS under the control of the memory access synchronisation circuit.

The video buffer addressing is organised so that 5 address lines define the required row with another 6 bits defining the character on that row. This gives a total of 11 address bits to define each character location. The RAMS have only 10 address lines so IC17 is used to fold the 11 lines into 10.

3.3. SYNCHRONISATION OF VIDEO BUFFER ACCESS.

To give a flicker free display the character generator circuits must be presented with a continuous stream of data from the video buffer. To maintain this stream without interruption requires that all CPU accesses of the buffer are interleaved with the normal character generator accesses which occur once per micro-second. To achieve this the micro-second interval has been divided into two 500 nano-second timeslots, one of which is reserved for the character generator access while the other is available for CPU update of the buffer.

When the address decoder IC4 detects that a video buffer address is present on the Nascom address bus the synchronisation circuit (ICs 13 & 14) comes into action. The WAIT signal to the Nascom is activated which causes the microprocessor to stretch its read or write cycle timings and the data transfer is delayed until the CPU access timeslot occurs. At the end of this timeslot the transfer complete latch is set and the WAIT signal de-activated so that the Nascom can complete it's memory cycle. If the cycle is a read then the WT625 output buffer (IC8) is enabled at this time.

3.4. VIDEO TIMING CIRCUITS.

The heart of this circuit is the SAA5020 Timing Chain (TIC) which uses a 6 MHz signal to generate most of the timings required by the board.

The input signal is divided by 6 to produce a 1 MHz character clock (F1) which in turn is divided by 64 to generate the TV line rate and further division by 312/313 gives the TV field rate of

50 Hz. The outputs of these dividers are combined within the SAA5020 to produce an interlaced composite sync signal.

A signal at one tenth the TV line rate is used to clock a divide by 24 Row address Counter whose 5 outputs (TIC A0 - A4) form part of the 11 bit address to the Video Buffer. The other 6 bits are supplied by a TTL counter (IC12) which is incremented by the Read Address Clock (RACK) signal from the TIC. The counter is reset to zero by the General Line Reset (GLR) at the start of each line.

The SAA5020 also has two inputs that allow large characters to be displayed. When the Big Character Select (BCS) input is low all characters will be displayed at twice their normal height thus changing the screen format from 24 rows of 40 characters to 12 rows of 40. A second input Top/Bottom Select (T/B) determines whether the top or bottom 12 rows are displayed. The levels of these two signals are set by bits 5 & 6 of the Control Register. Bit 5 being a zero causes large characters to be displayed, while bit 6 being zero selects the top 12 rows and a one selects the bottom 12 rows.

The PAL encoder needs two timing signals that are not directly generated by the SAA5020. One half of IC37 divides the TV line rate by two to control the phase switching of the colour signal which is the basis of PAL colour TV and the second half produces a 2.5 micro-second pulse to gate the colour burst signal. (The colour burst is a pulse of colour signal that occurs shortly after the line sync pulse and is used to synchronise the colour detection circuits of the TV to the transmitted signal.)

3.5. CHARACTER GENERATION CIRCUITS.

The character generator basically consists of a single SAA5050 integrated circuit (IC24). This circuit is known as a Teletext Read Only Memory (TROM) although in practice it is much more sophisticated than a standard Read Only Memory.

The main function of the TROM is to convert the 7 bit display character codes from the Video Buffer into a dot matrix pattern. It also provides the decode for the Teletext control characters.

Alpha characters are displayed on a 7 x 5 matrix but a character rounding facility effectively doubles this to 14 x 10 giving much improved legibility. Character rounding is a technique in which a half dot is inserted before or after a full dot in the presence of a character diagonal.

A number of other input signals are provided by the SAA5020 such as the 6 MHz dot rate clock (TR6), the 1 MHz character clock (F1) and the Load Output Shift Register Enable signal (LOSE) which resets internal latches at the start of each line. The General Line Reset (GLR) and Data Entry Window (DEW) are used for internal synchronisation of the TROM and to reset the ROM line address counter prior to the display period. The latter is also used to derive the 'flash' interval.

The main outputs of the TROM are the red, green and blue video signals which contain both character and background colour information. These signals then pass to the cursor and video blanking circuits.

3.6. CURSOR AND VIDEO BLANKING.

The WT625 can generate a reverse image cursor of programmable colour. For black and white VDU's this function is normally performed by inverting the video signal of the character at the cursor location. This causes the normal white on black display to change to black on white. The WT625 has three video signals, i.e. red, green and blue, and under programme control can invert any combination of these to produce the reverse image. Bits 0, 1 & 2 of the control register determine which colours are inverted. (Bit 0 being a one enables the red signal to be inverted, bit 1 enables green and bit 2 enables blue.) The character(s) to be reversed are defined by setting bit 7 of the location in the video buffer to a one. When such locations are read from the buffer the 7 low order bits are passed to the TROM as normal, however bit 7 is delayed by ICs 22 & 23 to take account of the internal delays of the TROM. The delayed cursor bit is gated by IC32 with the colour enable signals from the control register and then used to control exclusive-or gates (IC34) which invert the appropriate colour signals. Finally the three video signals are gated by IC 35 which enables the entire screen to be blanked by setting bit 4 of the control register to a zero.

3.7. COMPOSITE VIDEO.

The output of the character generation and cursor circuits are separate video signals for the three primary colours. These signals must be mixed with each other and then combined with the sync output of the Timing Chain to produce a composite video signal.

The final video signal consists of three components, i.e. luminance (brightness), chrominance (colour), and sync. The separate video signals are buffered by IC 36 and then mixed by the resistor network R26, 27, 28 & 31 to produce the luminance component. The chrominance signal of the PAL system consists of two 4.43 MHz sub-carrier signals which are 90 degrees out of phase. The amplitude of one of these sub-carriers is primarily modulated by the red component of the colour signal while the second sub-carrier is modulated by the blue component. Colour TV receivers deduce the green signal by subtracting the red and blue components from the total amplitude of the video signal.) The red sub-carrier must be shifted by 180 degrees after each line so that it alternately lags and leads the blue sub-carrier by 90 degrees. (PAL actually stands for Phase Alternate Line which describes this process.)

The WT625 uses digital techniques to synthesize and modulate the two sub-carriers. IC 31 is a ring counter which divides a 17.7 MHz signal to produce two 4.43 MHz clocks which are 90 out of phase. IC 39 inverts one of these sub-carrier signals on alternate

Lines to give the 180 degree phase shift. IC 43 & 44 with their resistor networks modulate the basic sub-carriers by an amount that is dependant on the video colour components. The total chrominance signal is coupled by C5 to the luminance resistor network and the combined luminance/chrominance signal, buffered by TR1, is mixed with the sync signal from the Timing Chain (buffered by IC 42) to give composite video and sync at the junction of D1 and R29.

3.8. VIDEO SWITCH.

When the WT625 is installed you will have two video sources, i.e. the standard Nascom output and that of the WT625. While it is perfectly reasonable to connect the Nascom UHF output to a black and white TV and the WT625 output to a colour TV provision has been made to use a single TV.

The Nascom has a video output (i.e. the video signal prior to UHF modulation) which can be connected to pin 12 of the WT625's I/O socket. The board has an analogue switch which can route either the Nascom video signal or the colour signal to the UHF modulator. This switch can be controlled by bit 7 of the control register or by external switches connected to the I/O socket. A 3 position switch can be connected so that in one position it grounds pin 5 of the I/O socket to force display of the Nascom video signal, in the second position it grounds pin 10 to force display of the WT625 output and in the third position both pins 5 & 10 are left 'floating' which leaves the video switch under programme control. When under programme control bit 7 of the control register being a Ø displays the Nascom signal, bit 7 = 1 displays the WT625 signal.

3.9. EXTRA COLOURS.

The seven basic Teletext colours can be modified under programme control to produce 6 extra colours (actually 7 if you count grey as a colour). This function is enabled by setting bit 3 of the control register to '1' and flagging the characters to be displayed in the alternative colours by setting bit 7 of those characters to '1'. When the WT625 detects this combination of bits it inverts the phase of blue sub-carrier from the PAL encoder and reduces the amplitude of the video luminance signal. This causes the basic Teletext colours to be changed as follows:-

Teletext Colour.	Extra Colour.
Red	Maroon
Yellow	Purple
Blue	Dark Green
Green	Light Blue
Magenta	Brown
Cyan	Light Green
White	Grey

As the extra colours are produced by modifying the action of the PAL encoder these colours are not available when driving a monitor from the separate RGB outputs of the I/O socket. (N.B. A monitor connected to the mixed video output of I/O socket will display the extra colours).

3.10. CONTROL REGISTER.

This is an 8 bit hardware register (IC 15) that is loaded by writing to memory location 'C7C0'H (this address being decoded by IC 5).

The outputs of the register control various functions of the WT625 which have already been described.

In practice the control register overlays 16 of the unused memory locations, i.e. addresses 'C6C0' to C6C7'H and 'C7C0' to 'C7C7'H, but by considering the control register as a single address it is possible to read back its contents. This happens because data written to 'C7C0'H is loaded into both the control register and the overlaid memory location. Reading from 'C7C0'H will fetch data from the memory location which is the same as the register contents. This facility enables the Z80 set/reset bit instructions to be used to define individual bits of the control register.

3.11. I/O SOCKET.

The board has a 14 pin socket (labelled IC40) for the connection of external signals.

The socket connections are:-

PIN.	SIGNAL.
1	Ground
2	Ground
3	No connection
4	Blue video output
5	$\overline{\text{Force Nascom video}}$
6	Green video output
7	Ground
8	Ground
9	Red video output
10	$\overline{\text{Force Teletext video}}$
11	Sync output
12	Nascom video input
13	+5 volts output
14	Mixed video + sync output.

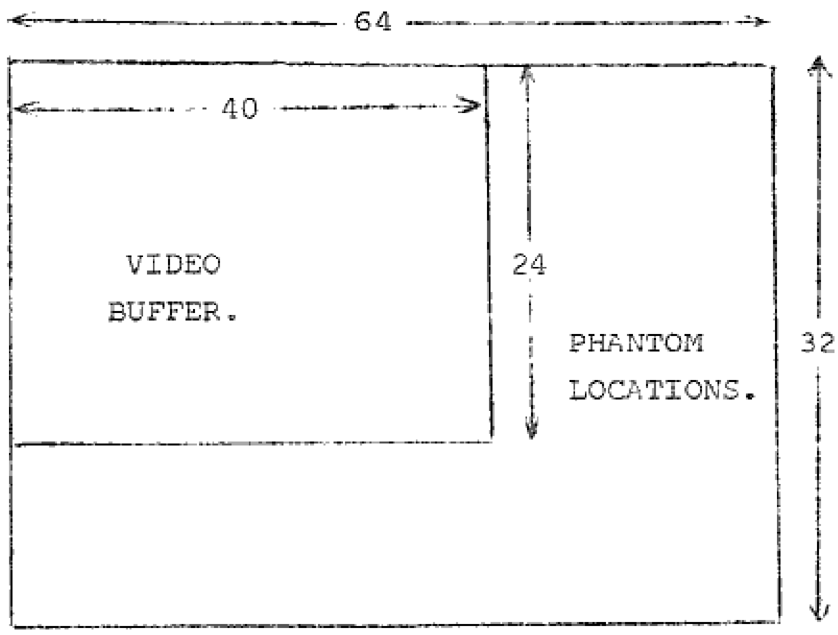
IMPORTANT NOTE: The separate Red, green, blue and sync outputs are provided to drive commercial colour monitors. DO NOT ATTEMPT TO MODIFY A COLOUR TV FOR USE AS A MONITOR. SUCH MODIFICATIONS CAN BE VERY DANGEROUS.

3.12. NASBUS CONTROL SIGNALS.

The WT625 generates four signals that are necessary for orderly transfer of data over NASBUS. $\overline{\text{NASCOM MEM}}$ (PIN 11) is taken low when an address in the range '0000'H to '0FFF'H is present on the NASBUS address lines. This enables the on-board memory devices of Nascom 1. (Nascom 2 does not use $\overline{\text{NASCOM MEM}}$).

During data transfers to the video buffer $\overline{\text{WAIT}}$ (PIN 23) is activated as part of the synchronisation process. $\overline{\text{DBDR}}$ (PIN 13) is taken low to enable the input data buffers of the Nascom 1 Buffer Board. (This signal is not used by Nascom 2).

When the WT625 places data on the NASBUS data line, it takes $\overline{\text{DISABLE RAM}}$ (PIN 9) low to prevent other boards attempting to drive the bus simultaneously.



ROW.	first char. address(Hex (decimal)).	last char.
1	C000 (-16,384)	C027 (-16,345)
2	C040 (-16,320)	C067 (-16,281)
3	C080 (-16,256)	C0A7 (-16,217)
4	C0C0 (-16,192)	C0E7 (-16,153)
5	C100 (-16,128)	C127 (-16,089)
6	C140 (-16,064)	C167 (-16,025)
7	C180 (-16,000)	C1A7 (-15,961)
8	C1C0 (-15,936)	C1E7 (-15,897)
9	C200 (-15,872)	C227 (-15,833)
10	C240 (-15,808)	C267 (-15,769)
11	C280 (-15,744)	C2A7 (-15,705)
12	C2C0 (-15,680)	C2E7 (-15,641)
13	C300 (-15,616)	C327 (-15,577)
14	C340 (-15,552)	C367 (-15,513)
15	C380 (-15,488)	C3A7 (-15,449)
16	C3C0 (-15,424)	C3E7 (-15,385)
17	C400 (-15,360)	C427 (-15,321)
18	C440 (-15,296)	C467 (-15,257)
19	C480 (-15,232)	C4A7 (-15,193)
20	C4C0 (-15,168)	C4E7 (-15,129)
21	C500 (-15,104)	C527 (-15,065)
22	C540 (-15,040)	C567 (-15,001)
23	C580 (-14,976)	C5A7 (-14,937)
24	C5C0 (-14,912)	C5E7 (-14,873)

Fig. 4. Screen Addressing.

4. PROGRAMMING.

4.1. SCREEN ADDRESSING.

The Video buffer is mapped into addresses 'C000'H to 'C7FF'H, which is a total of 2048 bytes. Screen addressing is organised as if the actual screen format is 32 rows of 64 characters each. However, only the first 40 characters of the first 24 rows are actually displayable on the TV screen. This arrangement is illustrated in Fig. 4, which shows the addresses of the first and last character of each row. E.g. the first character of row 1 is at address 'C000'H and the last character of row 5 is at location 'C127'H and so on. The numbers in brackets represent the decimal equivalents and should be used for BASIC 'Peek' and 'Poke' instructions.

This arrangement was chosen so that the first character of each row is on a 64 byte boundary. It allows an eleven bit address to be used where the 5 high order bits define the row number and the 6 low order bits define the character position on the row. This addressing scheme allows easy implementation of 'Carriage Return' 'Line Feed' and 'Cursor Tab' operations. It also is ideal for graphic programming as it allows easy checking of a given position on the row.

Attempts to read or write to phantom character locations 41 to 64 on each row are suppressed by hardware and the data read from these locations will be random.

4.2. SPARE MEMORY LOCATIONS.

The video buffer contains 48 bytes of RAM which are not used by the video generation circuits. The bytes are available for use as data areas.

The spare locations are:-

'C600'H to 'C607'H	'C640'H to 'C647'H
'C680'H to 'C687'H	'C700'H to 'C707'H
'C740'H to 'C747'H	'C780'H to 'C787'H

4.3. CLEARING THE SCREEN.

After switching on, the video buffer is filled with random data. Normally the screen has to be erased before it can be used properly for your application. This is achieved by filling it with ASCII space characters, '20'H. The example below shows how this might be done.

```
                        ;
                        ;  store a space character in the
                        ;  first position of the first line.
                        ;
0000    3E20            CLEAR LD A,20H
0002    3200C0                LD (0C000H),A
                        ;
                        ;  copy space characters into remainder
                        ;  of line.
                        ;
0005    2100C0                LD HL,0C000H
0008    1101C0                LD DE,0C001H
000B    012700                LD BC,39
000E    EDB0                  LDIR
                        ;
                        ;  copy first line into remainder of screen
                        ;
0010    2100C0                LD HL,0C000H
0013    1140C0                LD DE,0C040H
0016    01C005                LD BC,23*64
0019    EDB0                  LDIR
                        ;
                        ;  return to caller
                        ;
001B    C9                    RET
                              END
```

4.4. CONTROL REGISTER.

As described earlier this is an 8 bit hardware register that controls certain functions of the VDU. In particular it is used in conjunction with the high order bit (b7) of characters to provide a cursor facility and/or the generation of six extra colours.

When the system is reset all bits of the register are set to zero and it is necessary to initialise the register before using the VDU. If this is not done the TV picture will be blank. The register is loaded by writing data to location 'C7C0'H.

N.B. After applying power to the WT625 the first 'write' to the control register should load all eight bits in one operation. Subsequently, either the Z80's memory load or set/reset bit instructions can be used to define the contents of the register.

The definitions of the control register bits are shown on the back cover of this document and are defined below :-

BIT 7 VIDEO SWITCH CONTROL. This bit determines whether the WT625 or Nascom video signal is routed to the UHF modulator for display on the TV screen.

B7 = 0 displays Nascom (External) Video.
    = 1 displays Teletext video.

N.B. The action of B7 can be overriden by external switches. (See Section 5 on Installation).

BITS 6 & 5 DISPLAY FORMAT. These bits select one of three possible formats.

The settings are:-

B6	B5		
0	0	-	12 x 40 format ('TOP' 12 rows)
1	0	-	12 x 40 format ('BOTTOM' 12 rows)
0	1	)	24 x 40 format
1	1	)	

Usually bit 5 is set to a one to select the Teletext format of 24 rows of 40 characters each.

BIT 4. BLANKING. Setting this bit to 0 blanks the WT625 output and for normal operations it should be set to 1. A typical use of the blanking facility is to flash the entire screen as an error indication.

BIT 3. EXTRA COLOURS. If this bit is a 0 then the WT625 will only generate the seven basic Teletext colours. If this bit is a 1 then any characters which have bit 7 = 1 will display in the alternative colour set. See Section 3. for definition of the colours.

BITS 2, 1, 0. CURSOR COLOUR ENABLES. These bits determine which colours are inverted to produce a reverse image cursor. The appropriate colour inversion will occur for any characters that have b7 = 1. ie C to E

4.5. DISPLAYING A CURSOR.

This is done by setting the control register bit 3 to '0' and setting one or more of bits 0, 1 & 2 to '1' depending on which colours are to be inverted to produce the cursor.

It is normal to have only one cursor on the screen at any one time, but as the cursor facility is really just a 'reverse video' function it can be put to other uses. For instance, to set the entire screen to a green background it is only necessary to set bit 7 of every location to 1 and then programme bits 0, 1, 2 & 3 of the control register to 0100.

4.6. DISPLAYING THE EXTRA COLOURS.

To display characters in the extra colours set bit 3 of the control register to '1' and bits 0, 1 & 2 to '0'. This causes characters with bit '7' on to display in the extra colours and suppresses the generation of a cursor.

Note: While it is normal to have either bit 3 on, or a combination of bits 0, 1 & 2 on, but not both, this is not a programming restriction. The effect of enabling both the extra colours and cursor simultaneously is rather complex and best understood by actual experiment.

4.7. CALLING ASSEMBLER PROGRAMS FROM BASIC.

You may well be writing programmes for the WT625 in high level languages such as BASIC, however, many functions such as clearing the screen are more quickly and efficiently performed by Assembly Language routines. Nascom's BASIC provides a USR (X) function which enables such routines to be called from BASIC programmes. This function is described in the Nascom BASIC manual. We recommend that you make full use of this facility as Assembly Language subroutines execute many times faster than equivalent routines in BASIC.

5. INSTALLATION.

5.1. GENERAL.

The WT625 should be installed in your system so that it is not subjected to vibration or high temperatures, this will ensure maximum reliability. To minimise the pick up of electrical noise the power supply connections to the Nasbus motherboard should be made using short lengths of thick wire. (The WT625 draws power from the +5 and +12 volt supplies.) Use the coaxial cable supplied with the board for connection to the TV.

5.2. NASBUS CONTROL SIGNALS.

The control signals implemented by the board have been described in Section 3. The only signal of concern when installing the board is $\overline{\text{NASMEM}}$ which appears on pin 11 of the edge connector. This signal enables the memory devices on the Nascom 1 board and must be generated by one of the expansion boards in the system. For most installations $\overline{\text{NASMEM}}$ will already be generated by an expansion RAM board and in these cases the $\overline{\text{NASMEM}}$ of the WT625 should be disabled. The easiest way to do this is to unplug IC7 from it's socket, bend pin 4 outwards and then replug IC7 in it's socket so that pin 4 does not make contact. (The diagrams below illustrate this.) As Nascom 2 does not use the signal it should always be disabled to prevent possible conflict with other boards which generate the signal.

If the WT625 is used with a Nascom 1 ensure that link 5 on the micro-computer board is set to 'external' memory select.

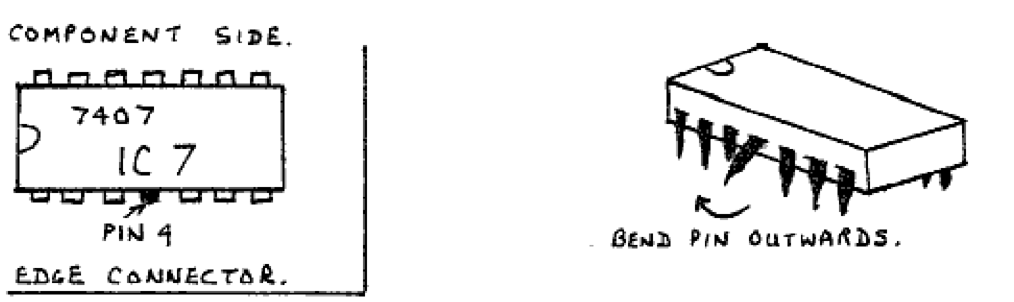


Fig 5. $\overline{\text{NASMEM}}$ Disable.

5.3. MEMORY ADDRESSING.

The WT625 as shipped will occupy memory locations 'COOO'H to 'C7FF' and it is important that other memory devices do not share these addresses. It is especially important to check that the PROM sockets on any memory expansion boards have not been inadvertantly set to these addresses.

5.4. I/O SOCKET CONNECTIONS.

These will depend on whether a single or separate TVs are to be used to display the WT625 and Nascom video outputs. If separate TVs are used then it is only necessary to connect pins ~~5~~ 7 and ~~7~~ 10 of the I/O socket together. This will force the analogue video switch on the WT625 to route its own video signal to the UHF modulator.

If a single TV is to be used then wire the socket so that the Nascom video signal is connected to pin 12 and a three position switch connected as below.

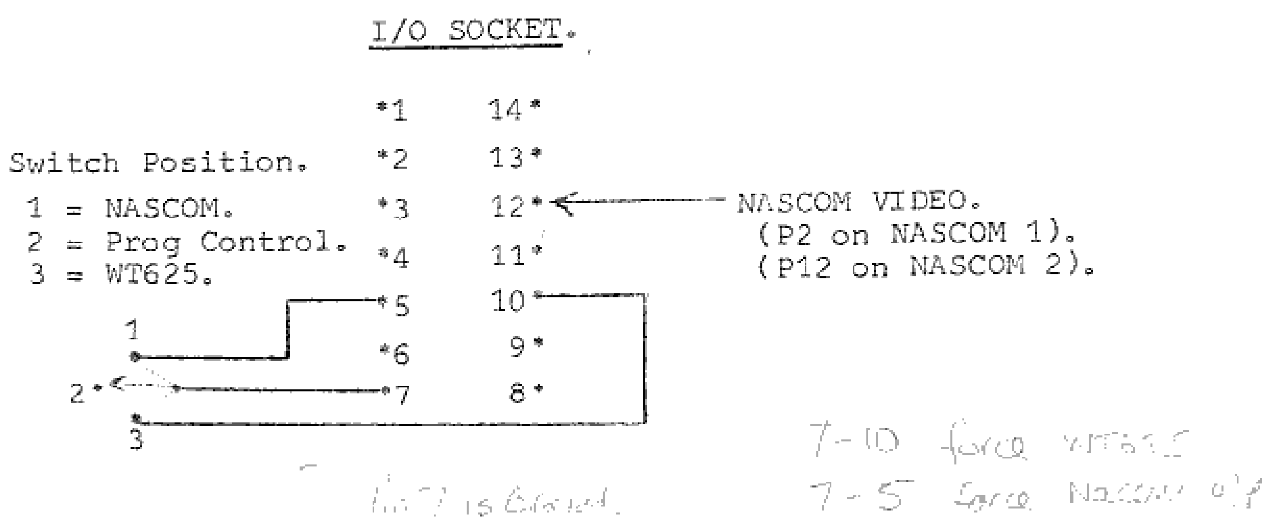


Fig. 6. 3 Position Switch - Video Source Selector.

Setting the switch to position 1 will display the Nascom output, position 3 displays the WT625 signal and position 2 leaves the analogue switch under programme control (See description of control register bit 7.)

Alternative switch arrangements are possible, for instance, a two position switch could be used to select either the Nascom or WT625 signals without the programme control option. To do this, wire the switch as above but omit connection 2. If no external switch is connected the video switch will always be under programme control.

5.5. ADJUSTING THE TV.

The output of the UHF modulator is set to channel 36. However, it is sometimes possible to tune into a harmonic which will give poorer results. Be sure to tune to the best signal. Some experimentation will be needed to find the best settings of the brightness, contrast and colour controls of the TV. The brightness should be turned up so that blue characters are clearly visible and the colour control should be adjusted to give the best compromise between colour intensity and character definition. (N.B. After resetting the Nascom computer it is necessary to write to the control register before the WT625 will display a signal.)

5.6. WT625 ADJUSTMENTS.

It is very unlikely that you will need to adjust the preset capacitors on the board but if it does prove necessary due to loss of colour or sync then follow the procedure described in Section 6.2.

6. FAULT FINDING.

6.1. BASIC PRINCIPLES.

This section gives some basic hints on fault finding. Although primarily intended for use with the WT625 the principles described apply equally to other boards in your system.

It is essential to adopt a systematic approach when fault finding on any electronic equipment. A suitable procedure is:-

1) Study the fault symptoms carefully to gather as much information on the failure as possible.
2) Carry out a thorough visual check of the board.
3) Carry out simple tests (module swapping etc.)
4) More complex testing (i.e. 'true' de-bugging)
5) If necessary return board for repair.

Following these steps will achieve a repair, hopefully without having to return the board, but if this does become necessary we provide a repair service at reasonable cost.

6.2. ADJUSTMENTS.

The board has two preset trimmer capacitors which occasionally may need re-adjustment. C7 adjusts the PAL sub-carrier frequency and is set for best colour. Serious mis-adjustment of C7 may cause loss of colour. The second trimmer, C6, sets the centre frequency of the phase locked 6 MHz oscillator. If this is out of adjustment the TV will not lock into synchronization producing a zig-zag or rolling picture. This trimmer should be adjusted to find the limits at which lock can be achieved and then reset to the middle of this range.

As touching the adjustment slot of the trimmers with metal objects upsets the capacitance of the device, a plastic trimmer tool should be used whenever possible. If one is not available then use a small metal screwdriver making very small adjustments and removing the screwdriver bit from the trimmer after each attempt. C6 & 7 are both single turn devices. i.e. rotating the adjuster once, sweeps through the entire adjustment range.

6.3. SIMPLE CHECKS.

When a fault becomes apparent study it carefully to determine:-

1) Is it a true fault? (Many 'faults' actually turn out to be software errors.)
2) Is the fault solid or intermittent?
3) Does the fault cause other parts of the system to fail?

The most likely sources of faults are the cables that connect the board to other system components, Check these carefully for damage and only if you are satisfied that these are OK should you go on to fault find on the board itself. The approach adopted for tracing faults on the WT625 assumes that you do not have access to sophisticated test equipment. (If you do have access to such equipment then you probably do not need advice on fault finding.)

The first step is to carry out a very thorough visual check of the board. Look for fragments of wire or solder that may be shorting out PCB tracks, suspect soldered joints, damaged tracks, bent IC pins and any components that show signs of overheating. Secondly unplug and reseat all ICs in their sockets. It is possible for the IC sockets to give trouble, especially if the board has been roughly handled or stored in places prone to condensation. If this does not cure the fault then the next step is to interchange similar part number ICs to see if the fault varies. Swap one type of IC at a time, keeping a note of those changed, and retest the board after each change. If the fault does vary then use a third IC of the same type to determine which of the last interchanged ICs is bad.

These simple tests will find the majority of faults but in some cases more testing will be required.

6.4. ADVANCED TESTING.

The following tests are recommended only for users who understand digital electronics. Those who have a purely software background are recommended to return boards with difficult faults for repair.

The WT625 has a UHF modulator and provision to display an external video signal. This allows a TV to be used as a crude form of oscilloscope to give a visual check of certain signals. Using the technique to be described it is possible to determine whether signals are up, down, or pulsing. An estimate of the frequency of pulsing signals can also be made. Assuming that the modulator is working and a TV signal can be 'tuned in' the I/O socket should be wired as below. (If the TV cannot be tuned then suspect either the modulator itself or the zener diode and resistor that form the regulated 9 volt supply to the modulator.)

		PINS.		
	[illegible] 1	14	comp video	
	2	13	5v	
	3	12	Resistor	Probe
	Blue 4	11	sync 470	
This link forces	5	10	OHMS	
display of the	green 6	9	Red	
external video	7	8		
signal.				

Fig. 7. I/O Socket Connections for Testing.

Touching the probe on a signal will modulate the TV image with high voltages displaying as white and low voltages as black. Having installed the probe, touch it onto a ground connection (I/O socket pin 8) and then on a 5 volt source (I/O socket pin 13). This shows how signals at the two logic levels will display. Now place the probe on pin 10 of IC33 which is a high frequency oscillator and displays as a grey background with a feint 'shimmer' superimposed. Finally place the probe on pin 8 of IC38 to show how lower frequencies display. Bearing in mind that it takes 48 micro-seconds for the TV to scan from side to side and 20 millisecs to scan vertically the approximate duration of signals can be found by counting (or estimating) the number of vertical or horizontal bars displayed. Having seen how the various signals display it is now necessary to make an intelligent guess as to which part of the circuit is failing and then check that each point in the circuit is pulsing or tied to a logic level as expected. To test certain sections of the circuit it will be necessary to write simple programmes. For instance to check out the video buffer read/write circuits a programme that repetively stores then reads a single byte from a known memory location is ideal.

6.5. FAULTS THAT DISABLE THE NASCOM.

These may be caused by two main reasons:-

1) An overload or short circuit of the power supply
2) Interference with Nasbus signals.

Power supply problems should be detectable using a resistance meter. If a short does occur look carefully for electrolytic decoupling capacitors that are inserted the wrong way around as these may run for a considerable time before failing. Logic faults that cause the Nascom to fail can be isolated by removing the ICs which connect to Nasbus and testing for correct operation of the basic Nascom. (Obviously the WT625 will not operate correctly with ICs removed.)

Remove the following ICs in order:-

ICs 8, 7, 10, 11, 18, 5, 1, 15, 3, 19, 4, 2 & 6.

If removing IC8 (the data bus driver) cures the fault it is possible that the circuits controlling pin 1 of IC8 are faulty.

Similarly if IC7 appears to be faulty but replacement does not fix the problem then suspect ICs 13 & 14.

6.6. INTERMITTENT FAULTS.

These may be cuased by one of several reasons and by their nature are difficult to track down. Things to look for are:-

1) Loose connectors, poor soldering, dirty IC sockets etc.
2) Power supply problems. e.g. poor ground connection between boards, inadequate smoothing capacitors or low voltages.
3) Overheating problems.

Finally always beware of programming errors that are mistaken for hardware faults.

7. REPAIR SERVICE.

Should your WT625 develop a fault, we can offer a prompt and efficient repair service. The charge for this is £10 plus the cost of any replacement parts. This includes return postage but not VAT.

If the total cost of replacement parts is less than £5 the board will be repaired and returned with an invoice for these parts. (Parts totalling less than £1.50 are supplied at no charge.) If the cost is greater than £5 you will be contacted by letter or telephone and supplied with an estimate of the cost. We would normally expect to receive payment prior to despatching the repaired board.

When returning a board please ensure that it is adequately packed to prevent damage in transit. (We suggest that you consider insuring the parcel). Be sure to enclose a return address and telephone number if possible. Providing a full description of the fault will help us carry out a speedy repair.

Boards should be sent to:-

WINCHESTER TECHNOLOGY LTD.,
P.O. Box 26,
Eastleigh,
Hampshire SO5 5YY.

(The above charges are correct at the time of printing but are subject to change.)

WT625 CHARACTER CODES

b6 b5 b4 →					0 0 0	0 0 1	0 1 0		0 1 1		1 0 0	1 0 1	1 1 0		1 1 1	
Bits b_3	b_2	b_1	b_0		0	1	2	2G	3	3G	4	5	6	6G	7	7G
0	0	0	0	0					0		@	P	—		p	
0	0	0	1	1	Alpha Red	Graphics Red	!		1		A	Q	a		q	
0	0	1	0	2	Alpha Green	Graphics Green	"		2		B	R	b		r	
0	0	1	1	3	Alpha Yellow	Graphics Yellow	£		3		C	S	c		s	
0	1	0	0	4	Alpha Blue	Graphics Blue	$		4		D	T	d		t	
0	1	0	1	5	Alpha Magenta	Graphics Magenta	%		5		E	U	e		u	
0	1	1	0	6	Alpha Cyan	Graphics Cyan	&		6		F	V	f		v	
0	1	1	1	7	Alpha White ●	Graphics White	'		7		G	W	g		w	
1	0	0	0	8	Flash	Conceal Display	(		8		H	X	h		x	
1	0	0	1	9	Steady ●	Contiguous Graphics ●	)		9		I	Y	i		y	
1	0	1	0	A		Separated Graphics	*		:		J	Z	j		z	
1	0	1	1	B			+		;		K	←	k		¼	
1	1	0	0	C	Normal Height ●	Black Background ●	,		<		L	½	l		‖	
1	1	0	1	D	Double Height	New Background	-		=		M	→	m		¾	
1	1	1	0	E		Hold Graphics	.		>		N	↑	n		÷	
1	1	1	1	F		Release Graphics ●	/		?		O	#	o		■	

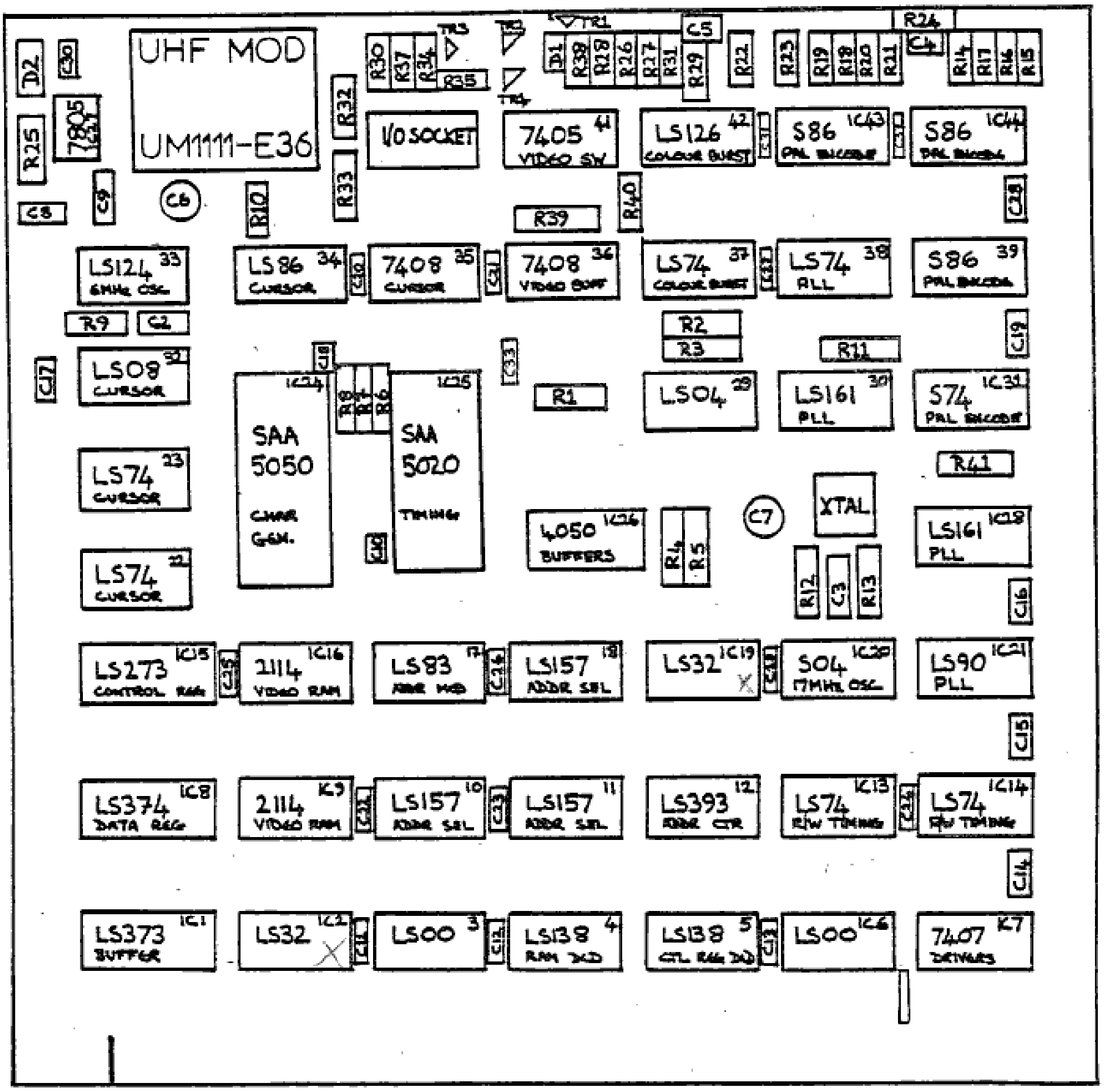
● These control characters are presumed before each row begins

Character rectangle

Black represents display colour

White represents background

Title	WT625 CHARACTER CODES			
PN WT625	Sheet 1 of 1	Issue	1 8/1/80	2 3/3/80
Drawn SW	Checked CF	3	4	5



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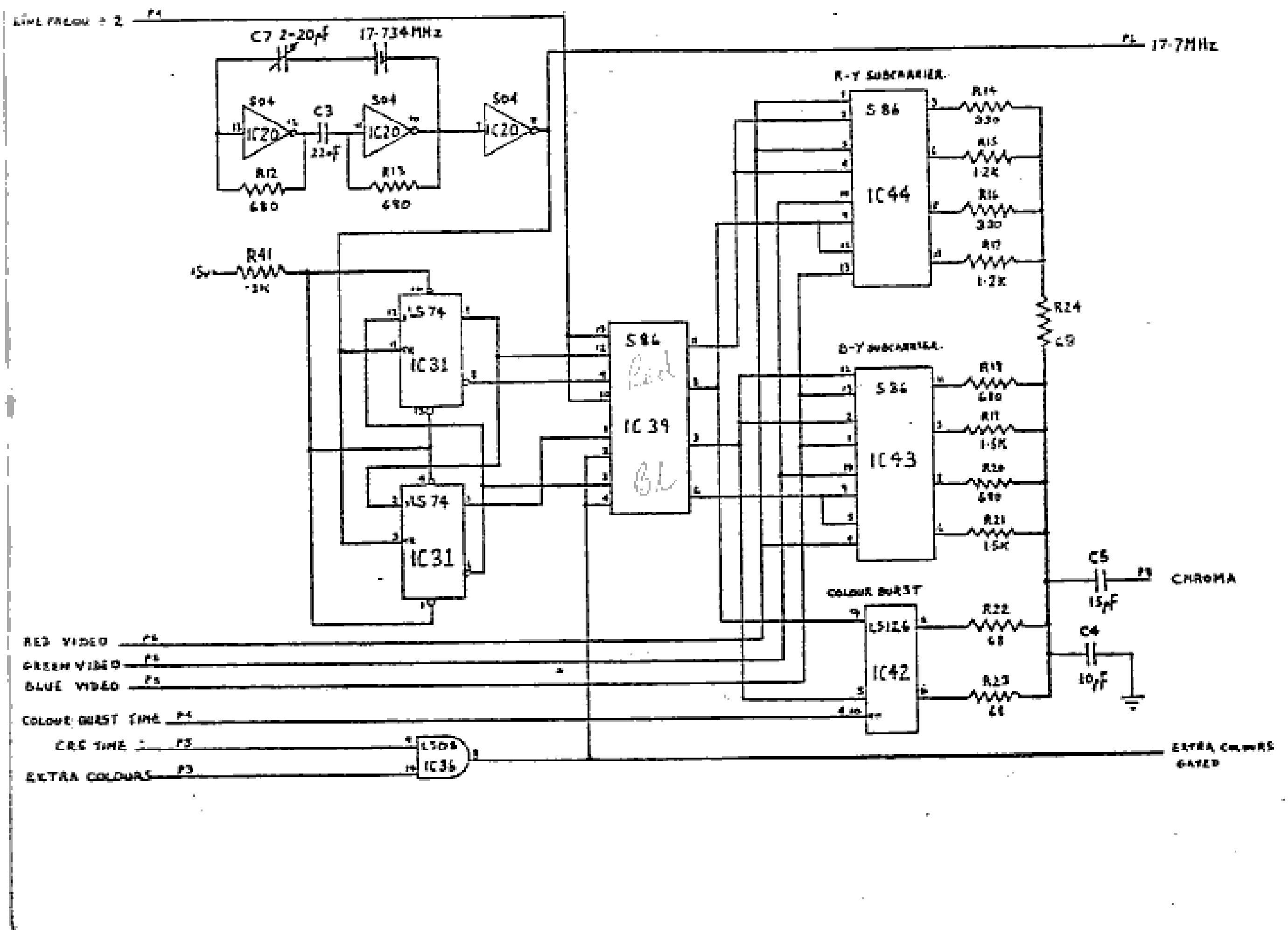

Title TELETEXT COLOUR GRAPHICS BOARD

PN WT 625	Sheet 7 of 8	Issue	1 16.03.80	2
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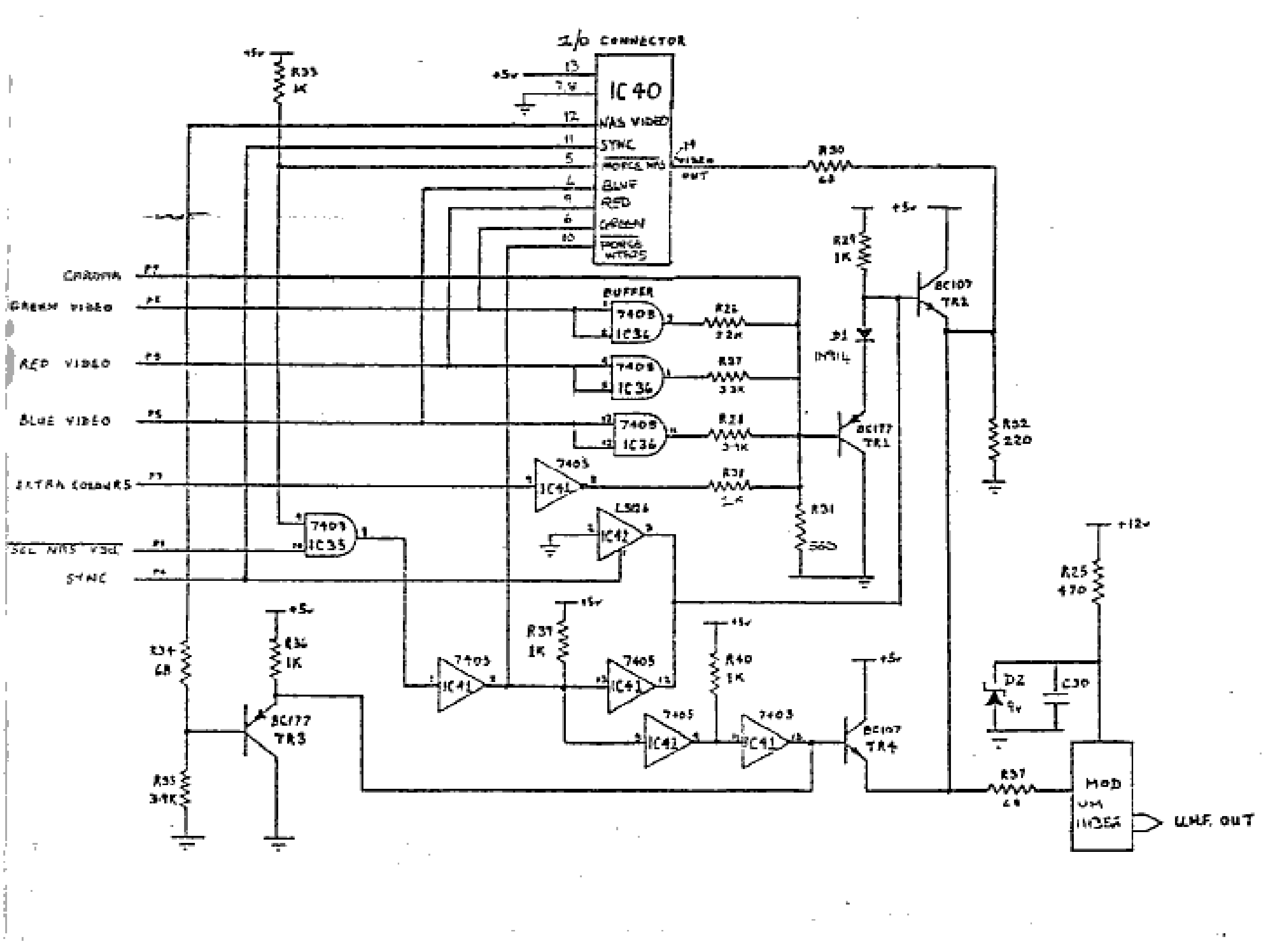

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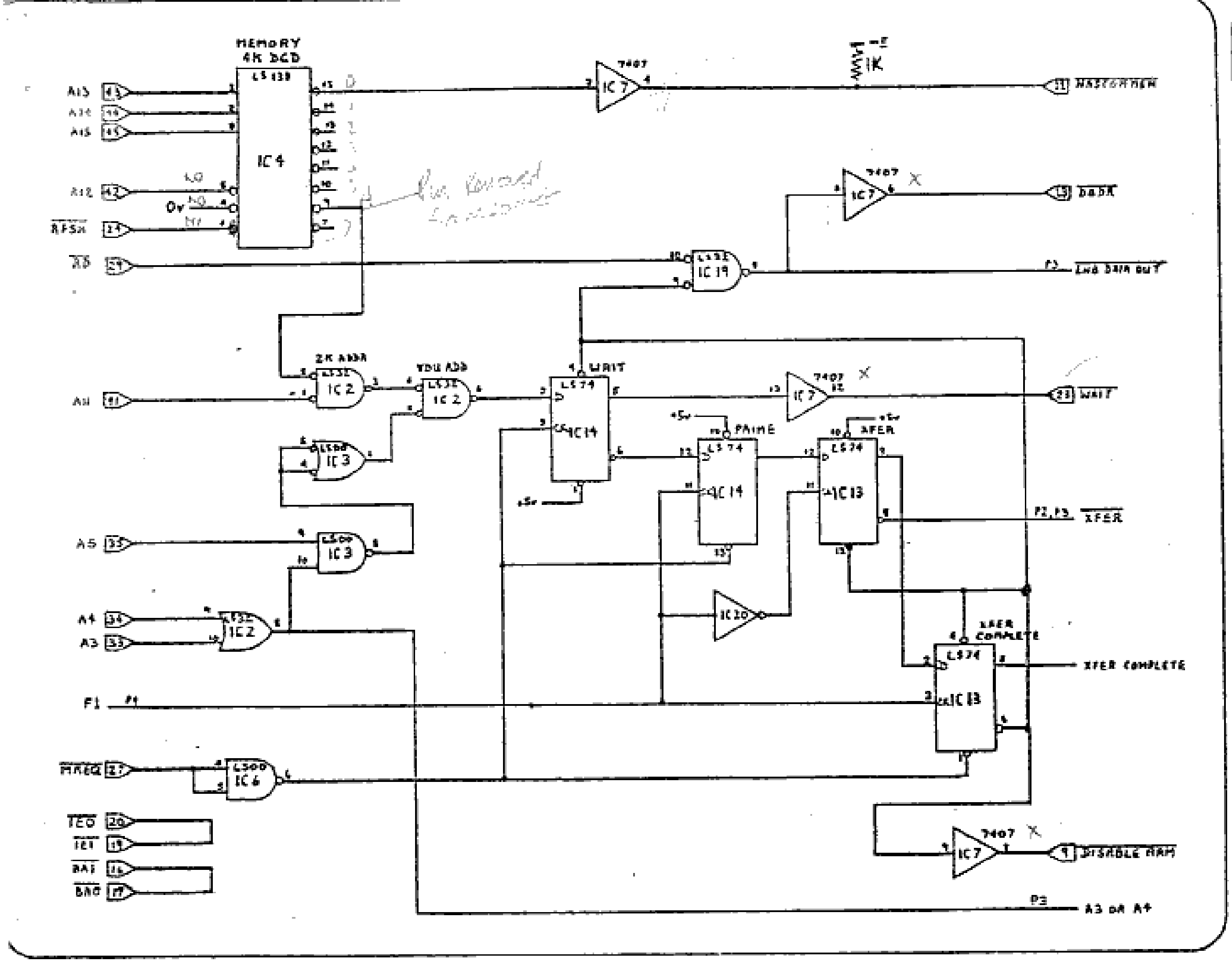

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Drawn CF | Checked SW | 3 | 4 | 5
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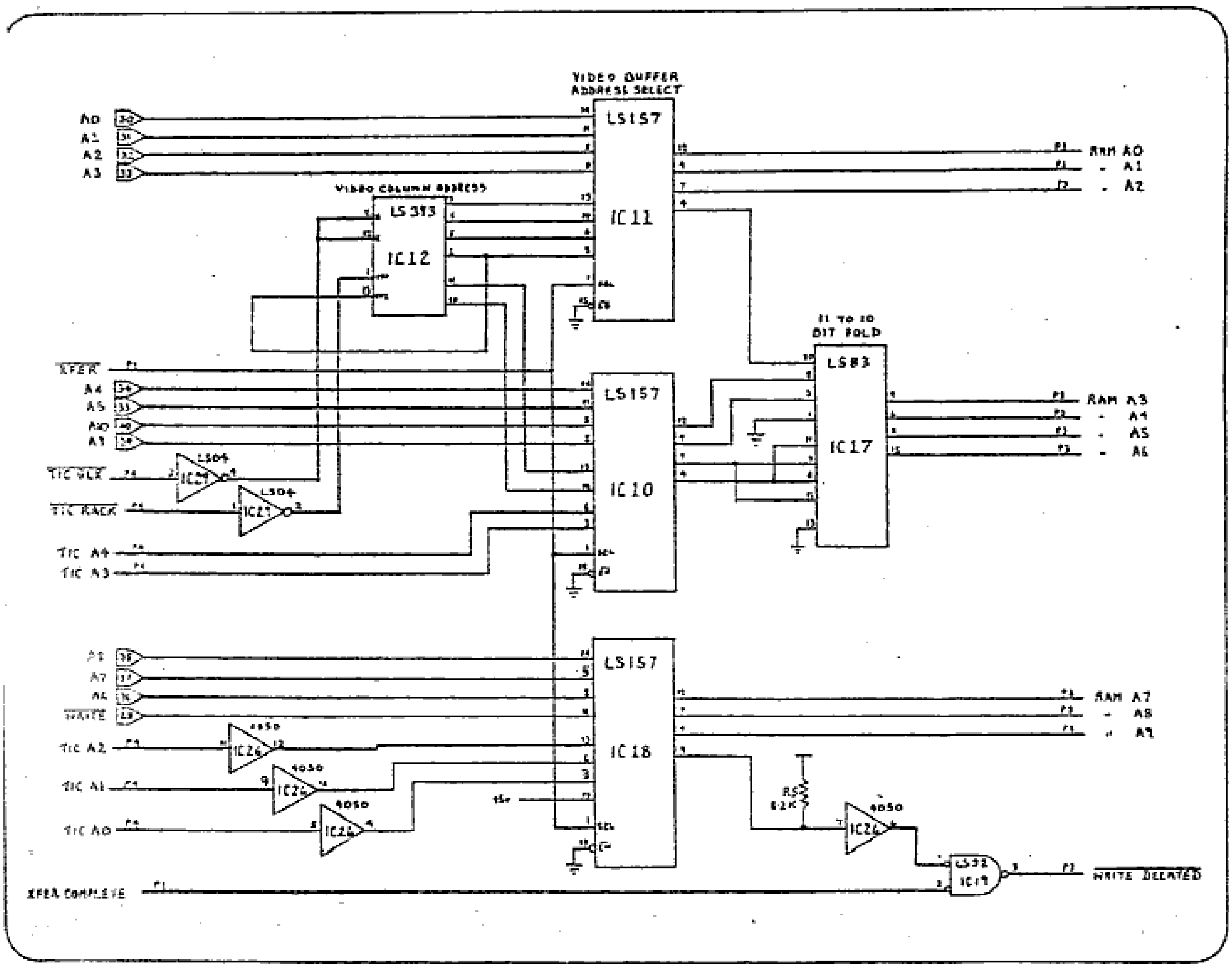

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Drawn CF | Checked SW | 3 | 4 | 5
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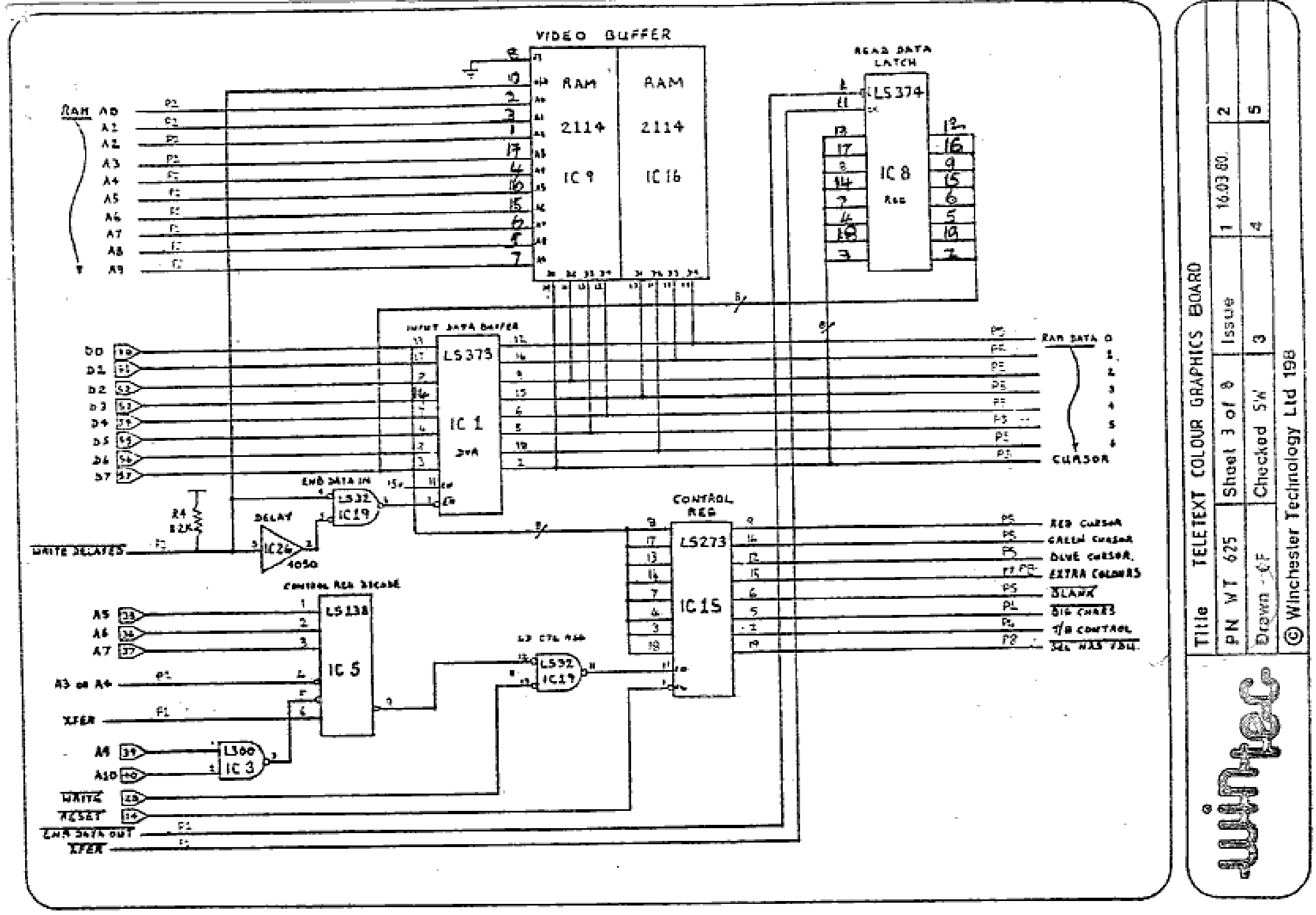
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PN WT 625
Sheet 3 of 8
Issue 1 16.03.80.
Drawn CF
Checked SW
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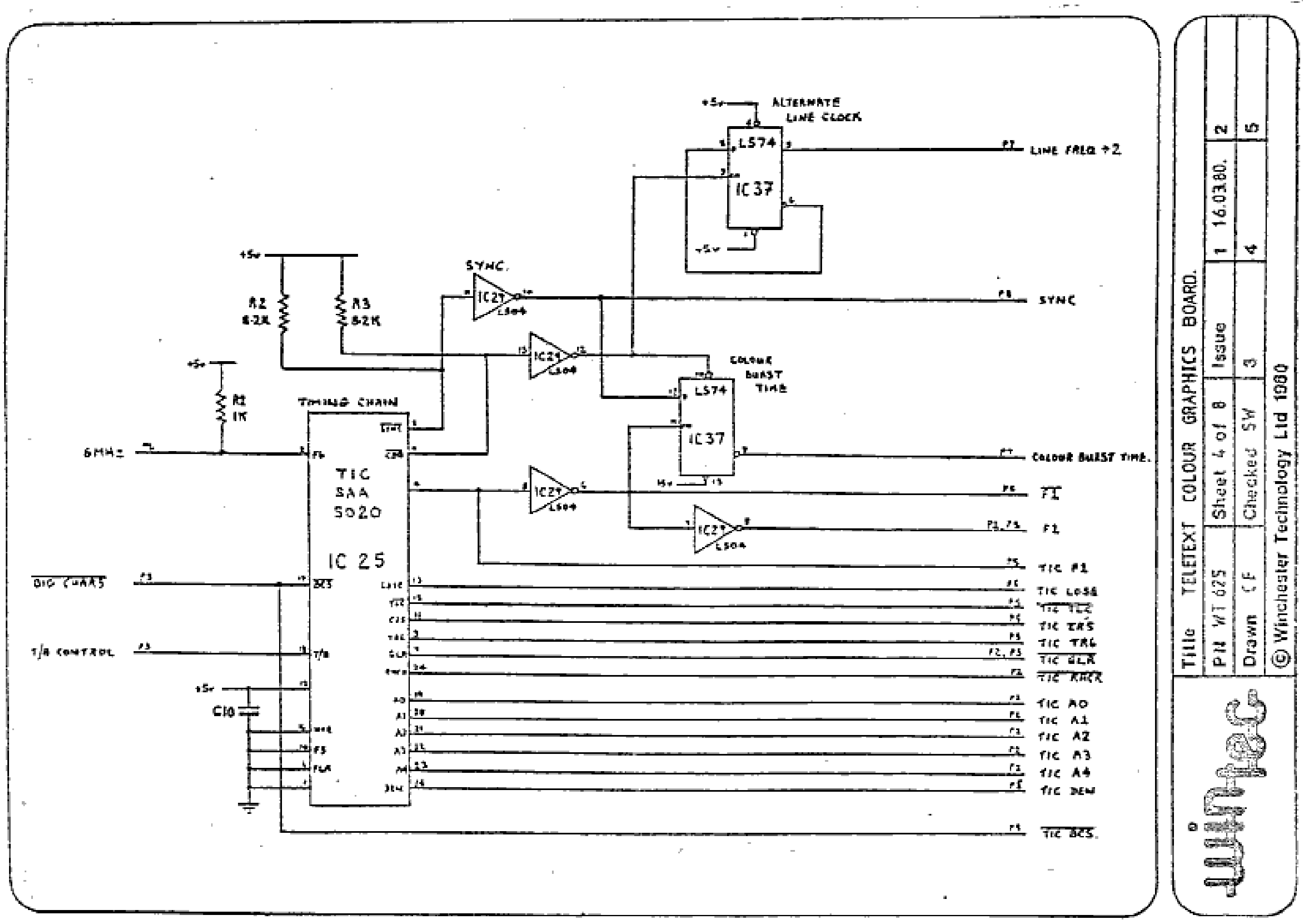
VIDEO BUFFER
RAM 2114 IC 9
RAM 2114 IC 16
READ DATA LATCH
LS374
IC 8
INPUT DATA BUFFER
LS375
IC 1
CONTROL REG
LS273
IC15
CONTROL REG DECODE
LS138
IC 5
DELAY
IC26
4050
LS32
IC19
LS32
IC19
LS00
IC 3
RAM A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
D0
D1
D2
D3
D4
D5
D6
D7
R4 82K
WRITE DELAYED
A5
A6
A7
A3 or A4
XFER
A4
A10
WRITE
RESET
XFER
RAM DATA 0
1
2
3
4
5
6
CURSOR
RED CURSOR
GREEN CURSOR
BLUE CURSOR
EXTRA COLOURS
BLANK
DIG CHARS
T/B CONTROL
SEL MAS FSU


Title TELETEXT COLOUR GRAPHICS BOARD.
PN WT 625
Sheet 4 of 8
Issue 1 16.03.80.
Drawn CF
Checked SW
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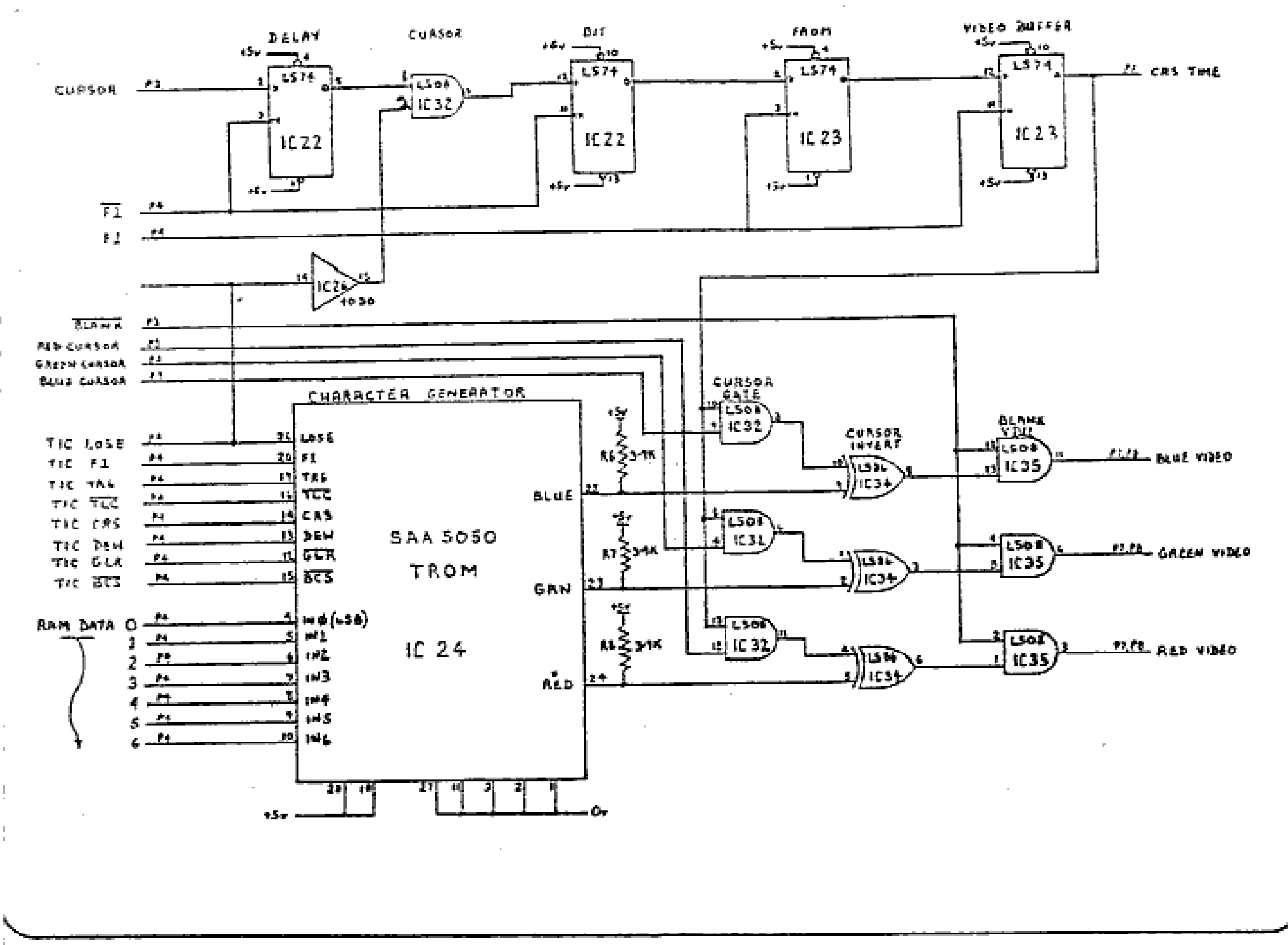
ALTERNATE LINE CLOCK
LS74
IC 37
LINE FREQ ÷2
SYNC.
IC27
LS04
SYNC
R2 8.2K
R3 82K
R1 1K
IC24
LS04
COLOUR BURST TIME
LS74
IC 37
COLOUR BURST TIME.
TIMING CHAIN
TIC SAA 5020
IC 25
6MHz
IC27
LS04
F1
F1
TIC F1
TIC LOSE
TIC TRS
TIC TRG
TIC GLR
TIC RACK
TIC A0
TIC A1
TIC A2
TIC A3
TIC A4
TIC DEW
TIC BCS.
DIG CHARS
T/B CONTROL
C10



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PN WT625	Sheet 5 of 8	Issue	1	16.03.80	2
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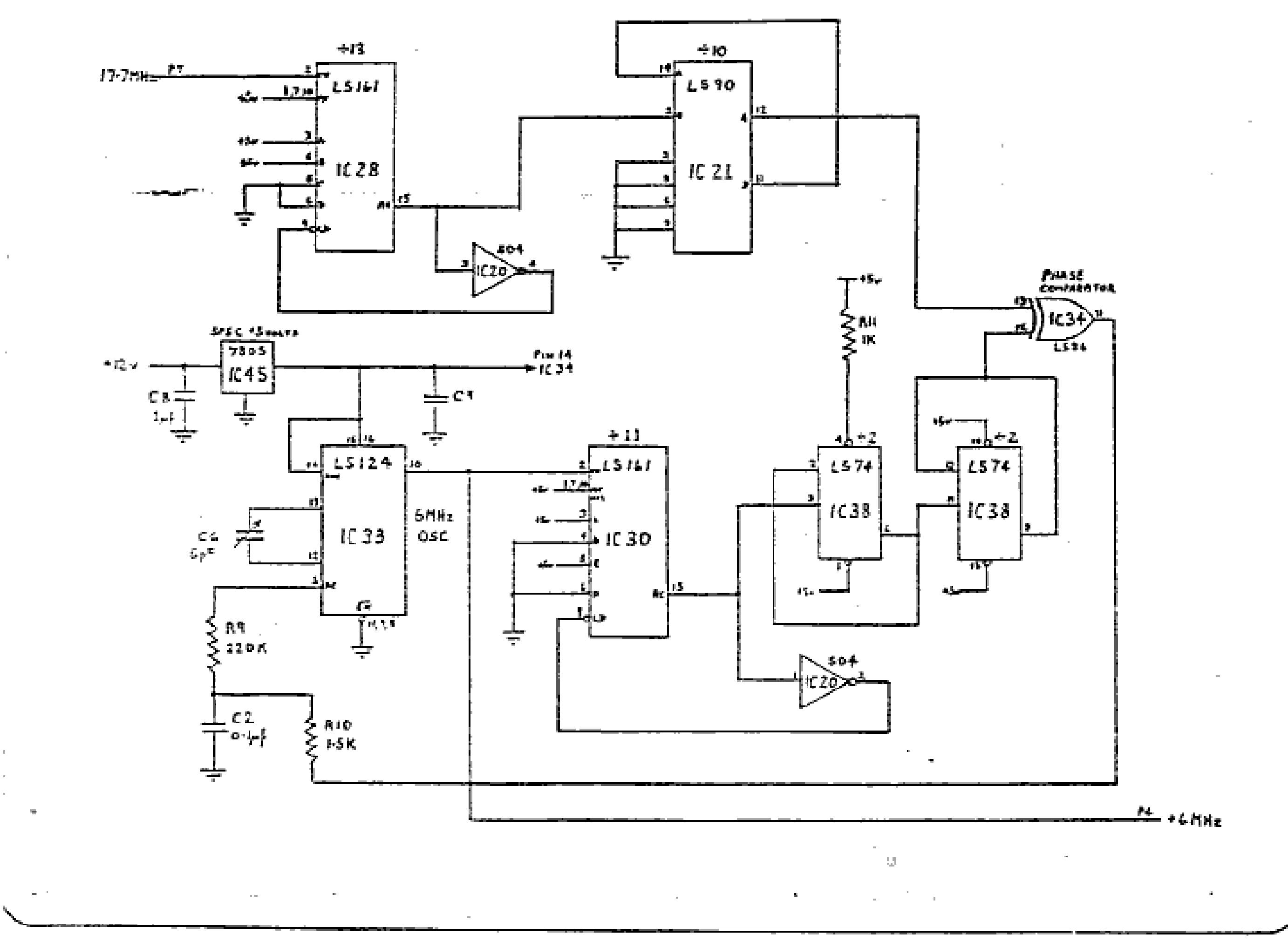

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PN WT 625	Sheet 6 of 8	Issue	1	16.03.80.	2
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