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CONTENTS

1. Description
2. Operation of the Video-RAM
3. Programming
4. Installation
5. Block diagram
6. Jumpers
7. Technical data
8. Bus and I/O connectors
9. Character set tables
10. Component diagram

INNEHÅLL

1. Beskrivning
2. Funktionen hos Video-RAM
3. Programmering
4. Installation
5. Blockschema
6. Bygglingar
7. Tekniska data
8. Buss och I/O kontakter
9. Tabeller: Teckenuppsättningar
10. Komponentplacering

DESCRIPTION

- The 2006 Colour Video RAM controller provides direct interfacing to colour or monochrome TV-monitors.
- The controller provides the standard VIEWDATA characters for alphanumeric and graphic presentation. Special standardized control characters provide an efficient control of the colour and the high graphic capability.
- The character code conforms to the ASCII code, comprising 32 control characters, 96 alphanumerics and 64 graphic characters.

Different markets are catered for by the optional character generator chip, the TROM.
- Character video output is available both as a monochrome signal and RGB signals for colour receivers.
- This datasheet contains technical details and a description of the 2006. We refer to the 2006-H RGB-option datasheet for further details and programming advice.

BESKRIVNING

- 2006 Färg-Video-RAM kortet anslutes direkt till en TV-monitor i färg eller svart/vit.
- Kortet ger standard VIEWDATA teckenuppsättning med alfa-numeriska och grafiska tecken.

Särskilda standardiserade kontrolltecken ger effektiv kontroll över färgen och den mångsidiga grafiken.
- Teckenkoderna är anpassade till ASCII-koden, med 32 kontrolltecken, 96 alfanumeriska samt 64 grafiska tecken.

Kortet kan anpassas till olika marknader genom byte av den valfria karaktärs-generatorkretsen, TROM-et.
- Videoutgångar finns som både färg (Röd/Grön/Blå) signaler och som svart/vit utsignal.
- Detta datablad innehåller tekniska detaljer och en beskrivning av 2006. Vi hänvisar till 2006-H RGB-option datablad för ytterligare detaljer och programmeringstips.

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-The display memory:

In the display memory, the data for a displayed page with 24 lines with 40 characters/line is stored in two 2114 1K * 4 static RAM.

As the display only requires 960 bytes (40*24), 96 bytes remain unused. Each byte contains 8 bits. 7 bits is the character code and one bit, bit 7, indicates the CURSOR position. To indicate the cursor, bit 7 is set in the corresponding memory byte.

-Character generator:

7-bit data bytes from the video memory are input to the character generator ROM. Each character code defines a dot matrix pattern.

The character period is 1 microsec. and the character dot rate is 6 MHz. The timing is derived from the onboard 6MHz clock.

A character matrix is 6 dots wide and 10 TV-lines high. One dot space is left between adjacent characters on a line and one TV-line is left between each text-line. Alphanumeric characters are generated in a 5 * 9 matrix, allowing space for descending characters. All the 64 graphic characters are decoded to form a 2 * 3 block arrangement, which occupies the complete 6 * 10 character matrix.

Graphic characters can be either contiguous or separated. The alphanumeric characters are character rounded, i.e. a half dot is inserted before or after a whole dot in the presence of a diagonal in the matrix. This rounding gives the best result with interlace.

-Control characters:

The use of the 32 control characters provides information about the character colour, flashing, graphics, double height etc.

-Videominnet:

Data i videominnet för en visad sida med 24 rader med 40 tecken/rad lagras i två 2114 1K * 4 statiska RAM.

Eftersom bilden endast kräver 960 bytes (40*24) finns 96 bytes oanvända. Varje byte innehåller 8 bitar. 7 bitar är teckenkoden och en bit, bit 7, indikerar CURSORn. För att indikera cursorn, sätts bit 7 till "1" i motsvarande minnesbyte.

-Teckengenerator:

7-bitars data från video minnet styr teckengenerator ROMet. Varje teckenkod definierar ett punktmatrixmönster.

Ett tecken/mikrosekund skrivs vilket innebär en punktfrekvens på 6 MHz. Tidsstyrningen sker med en 6 MHz klocka på kortet.

En teckenmatrix är 6 punkter bred och 10 TV-linjer hög. En punktkolumn lämnas mellan tecknen på raden och en TV-linje lämnas mellan varje text-rad. Alfanumeriska tecken genereras i en 5 * 9 matrix, med plats för underslängar på tecknen. Alla 64 grafiska tecken kodas som en 2 * 3 matrix, som fyller hela 6 * 10 punktmatrixen.

Grafiska tecken kan antingen vara sammanhängande eller separerade. Alfanumeriska tecken är avrundade, dvs. en halv punkt inskjutes före eller efter en hel punkt i en diagonallinje i matrixen. Denna rundning ger bäst resultat med radsprång.

-Kontrolltecken:

De 32 kontrolltecknen används för att ställa in färg på tecken och bakgrund, välja blinkning, grafik, dubbel höjd m.m.

OPERATING THE COLOUR VIDEO RAM

- The colour video RAM is accessed as an ordinary RAM memory, connected to the DataBoard 4680 memory bus.
- The 2006 can be made WRITE-ONLY by a jumper (S8). When the write-only mode is set, the video RAM can be mapped on the same memory area as any EPROM program. The write-only can also prevent the operating system from considering the 2006 as a part of the available RAM memory for programs or data.
- The READY* strobe is used to avoid internal bus conflicts during access to the Video RAM from the CPU, while the internal display circuits are updating the screen. The READY* strobe holds the CPU waiting at any CPU-access to the 2006 during active updating periods.

CPU-access is only permitted during the line fly-back time, which is 10 microsec and occurs each 64 microsec. During the vertical field fly-back (2 millisek), the access permission signal is inverted, permitting access during 54 microsec. each 64 microsecond.

PROGRAMMING

- Software support is available for DataBoard 4680 EXTENDED BASIC and ABC80/ABC800 as an RGB-option, which simplifies the memory addressing and the writing of control characters.
- See the 2006-H RGB-option datasheet for further details about the 2006 and programming.

ANVÄNDNING AV FÄRGVIDEORAMET

- FärgvideoRAMet används som ett vanligt RAM-minne, anslutet till DataBoard 4680 minnesbuss.
- 2006 kan byglas för att förhindra läsning från kortet. (bygel S8). Om läs-skyddet byglats, kan 2006 placeras på samma minnesarea som ett PROM-program. Läs-skyddet kan även förhindra att operativsystemet behandlar 2006 som en del av tillgängligt RAM minne för program och data.
- READY* stroben används för att undvika interna bus-konflikter vid access till 2006 från CPU, medan de interna bildgenereringskretsarna uppdaterar skärmen. READY* stroben stoppar CPU vid en CPU-access till 2006 under perioder av aktiv bild-uppdatering.

CPU-access tillåts bara under linjesvepåtergången, vilken är 10 mikrosek och återkommer var 64:e mikrosekund. Under den vertikala svepåtergången (2 millisek.) inverteras access-signalen så att access tillåts under 54 mikrosekunder var 64:e mikrosekund.

PROGRAMMERING

- Programrutiner finns för DataBoard 4680 EXTENDED BASIC och ABC80/ABC800 som en RGB-option, vilken förklarar minnesadressering och kontrollteckengenerering.
- Se 2006-H RGB-option datablad för mer detaljer om 2006 och programmering.

INSTALLATION

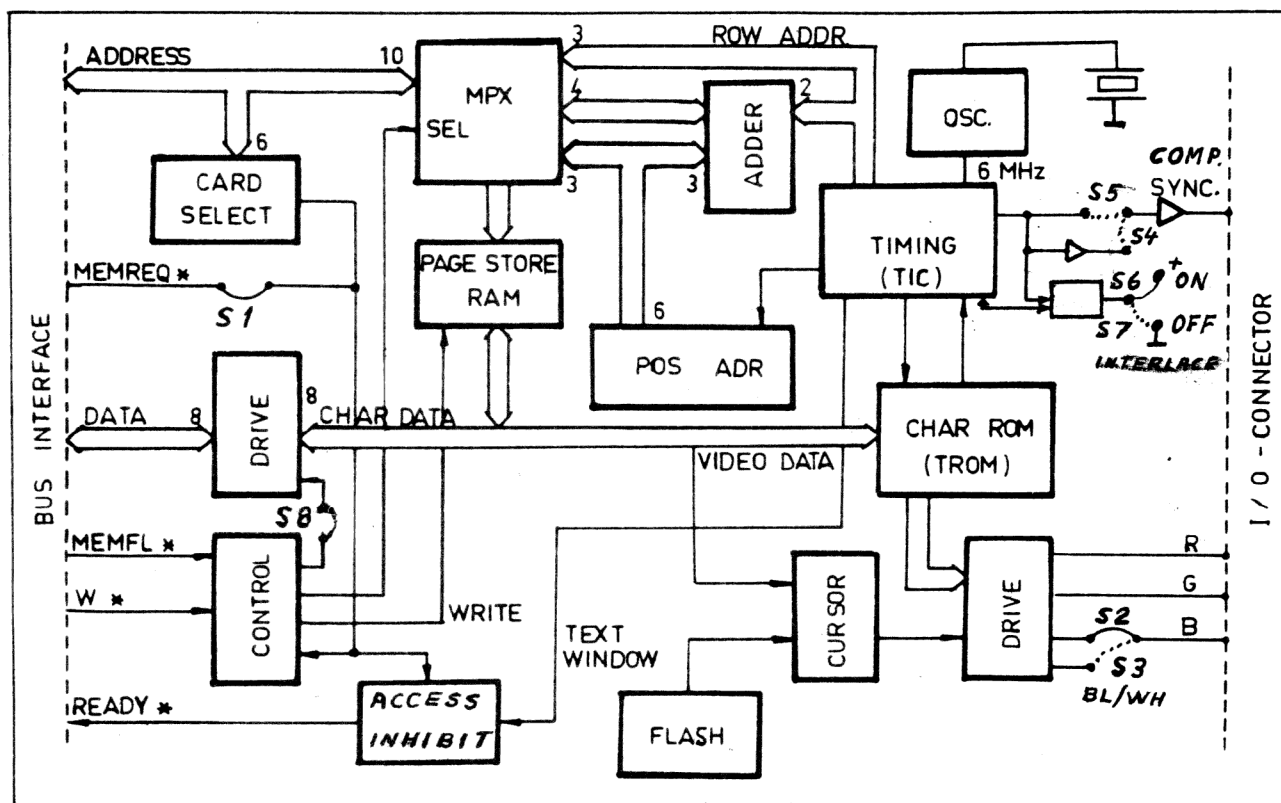
- Välj bygglingar enligt önskemål.
- Välj basadress för minneskortet på pluggen i pos. 3D.

Value: 2K 4K 8K 16K 32K 1K

Exempel: Öppna stift 1,3 och 6
för basadress 11K (=2+8+1).

- Installera 2006 på minnes-
sidan i en DataBoard buss med
spänningen avslagen.

BLOKSCHEMA



JUMPERS

BYGLINGAR

- S1 MEMREQ* Install S1 if the system uses dynamic RAM, to prevent the refresh cycles from disturbing the display. Remove the jumper in ABC80 applications.
- S2 COLOUR Install S2 and remove S3 for RGB output.
- S3 BLACK/WHITE Remove S2 and install S3 for monochrome output. The blue connector is used for the monochrome out-signal.
- S4 POSITIVE SYNC Install S4 and remove S5 for positive sync.
- S5 NEGATIVE SYNC Remove S5 and install S4 for negative sync.
- S6 INTERLACE Install S6 and remove S7 for interlace ON. Interlace-ON gives a stable picture on monitors with long persistent phosphorous.
- S7 NO-INTERLACE Remove S6 and install S7 for interlace-OFF.
- S8 WRITE-ONLY Remove S8 to select WRITE-ONLY.

BYGLINGAR

- S1 MEMREQ* Bygla S1 om systemet använder dynamiska RAM för att förhindra att refresh-signalerna stör bilden. Öppna S1 i ABC80 tillämpningar.
- S2 FÄRG Bygla S2 och öppna S3 för RGB utsignaler.
- S3 SVART/VIT Öppna S2 och bygla S3 för svart/vit utsignal. Den blå utgången används för den svart/vita utsignalen.
- S4 POSITIV SYNC Bygla S4 och öppna S5 för positiv sync.
- S5 NEGATIV SYNC Öppna S4 och bygla S5 för negativ sync.
- S6 RADSPRÅNG Bygla S6 och öppna S7 för radsprång. Radsprång (interlace) ger stabil bild på en monitor med lång efterlysningstid på bildröret.
- S7 EJ-RADSRÅNG Öppna S6 och bygla S7 för att koppla bort radsprånget.
- S8 LÄS-SKYDD Öppna S8 för att förhindra läsning från videominnet.

This datasheet information is subject to change without notice.

TECHNICAL DATA

TEKNISKA DATA

Power supply
Spänningsbehov

+5V +-5% mA

Peripheral interface -Red/Green/Blue video output or
monochrome output, jumper selectable.
-Positive or negative composite sync.
-Signal levels are TTL (low-power shottky).
-With or without interlace, selectable.
-WRITE-ONLY function selectable.

Videosignaler ut: -Röd/Grön/Blå video utgångar eller
svart/vit signal, valbar med bygling.
-Positive eller negativ sammansatt sync.
-Signalnivå: TTL (low-power shottky).
-Med eller utan radsprång (bygling).
-Läsning från VideoRAM kan förhindras.

Software support RGB-option for DataBoard 4680 EXTENDED
Programvara BASIC and for ABC80/ABC800.

Bus connection On the memory side of the DataBoard 4680
Bussanslutning bus.
På minnessidan av DataBoard 4680 bussen.

Bus connector B 64 pin Euroconnector plug (DIN 41612).
Busskontakt

I/O-connectors a) Four coaxial BNC connectors for
I/O-kontakter coaxial cables.
b) One 8-pin two-row UBC connector.
a) Fyra BNC koaxialkontakter för
koaxialkablar.
b) En 8-stifts tvåradig UBC kontakt.

Size Eurocard 100 * 220 mm, of which 60 mm is
Storlek an extension to the standard 100 * 160 mm.
This extension can be cut off if the
BNC connectors shall not be used.

Eurocard 100 * 220 mm, varav 60 mm är
en utökning av standard 100*160 mm.
Denna kan kapas av om BNC kontakterna
ej ska användas.

Character sets: The user can select optional character
Teckenuppsättning: sets, as defined by the character
generator ROM. See table 1 and 2.

Användaren kan välja teckenuppsättning
genom att byta teckengenerator-ROM.
Se tabell 1 och 2.

SAA 5050 Continental character set
SAA 5052 Swedish character set (SEN
850200)

BUS AND I/O SIGNALS

- The bus signals are:
 - 16 bit address
 - 8 bit tristate data
 - MEMFL* read strobe
 - W* write strobe
 - MEMREQ*, jumper selected.
Used when the system includes dynamic RAM.
 - READY* controls access to the video RAM.

For the pin numbering, see the system manual.

- The colour video output is through four BNC connectors in parallel with a two-row UBC connector. The jumper-selectable monochrome signal is output on the blue colour output connector.

- The BNC connectors are identified by the corresponding colour paint.

- The UBC connector pin numbering is:

1B	Composite sync
1A	Ground
2B	BLUE (or monochrome)
2A	Ground
3B	GREEN
3A	Ground
4B	RED
4A	Ground

BUSS OCH I/O SIGNALER

- Buss-signalerna är:
 - 16 bitars address
 - 8 bitars tri-state data
 - MEMFL* lässtrob
 - W* skrivstrob
 - MEMREQ* med bygling.
Används när systemet har dynamiska RAM.
 - READY* styr CPU access till video RAM.

Se systemmanualen för stift-numreringen.

- Färgvideoutsignalerna kommer i fyra BNC-kontakter parallellt med en tvåradars UBC-kontakt. Den valbara svart/vita signalen kommer på den blå färgutgången.

- BNC kontakterna är målade med färg, motsvarande utgångssignalerna.

- Stiftsnumreringen på UBC-kontakten är:

1B	Sammanfatt sync.
1A	Jord
2B	BLÅ (el.svart/vit)
2A	Jord
3B	GRÖN
3A	Jord
4B	RÖD
4A	Jord

CHARACTER SET TABLES

TABELLER: TECKENUPPSÄTTNINGAR

SAA 5052 CHARACTER SET

Bits	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0	Graphics Red	Graphics Green	Graphics Yellow	Graphics Blue	Graphics Magenta	Graphics Cyan	Graphics White	Conceal Display
1	Alpha ⁿ Red	Alpha ⁿ Green	Alpha ⁿ Yellow	Alpha ⁿ Blue	Alpha ⁿ Magenta	Alpha ⁿ Cyan	Alpha ⁿ White	Flash
2	Normal Height	Double Height						Steady
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Control characters shown in columns 0 and 1 are normally displayed as spaces.

Character rectangle

** These control characters are presumed before each row begins

Black represents display colour.

White represents background.

Table 2.

SAA 5050 CHARACTER SET

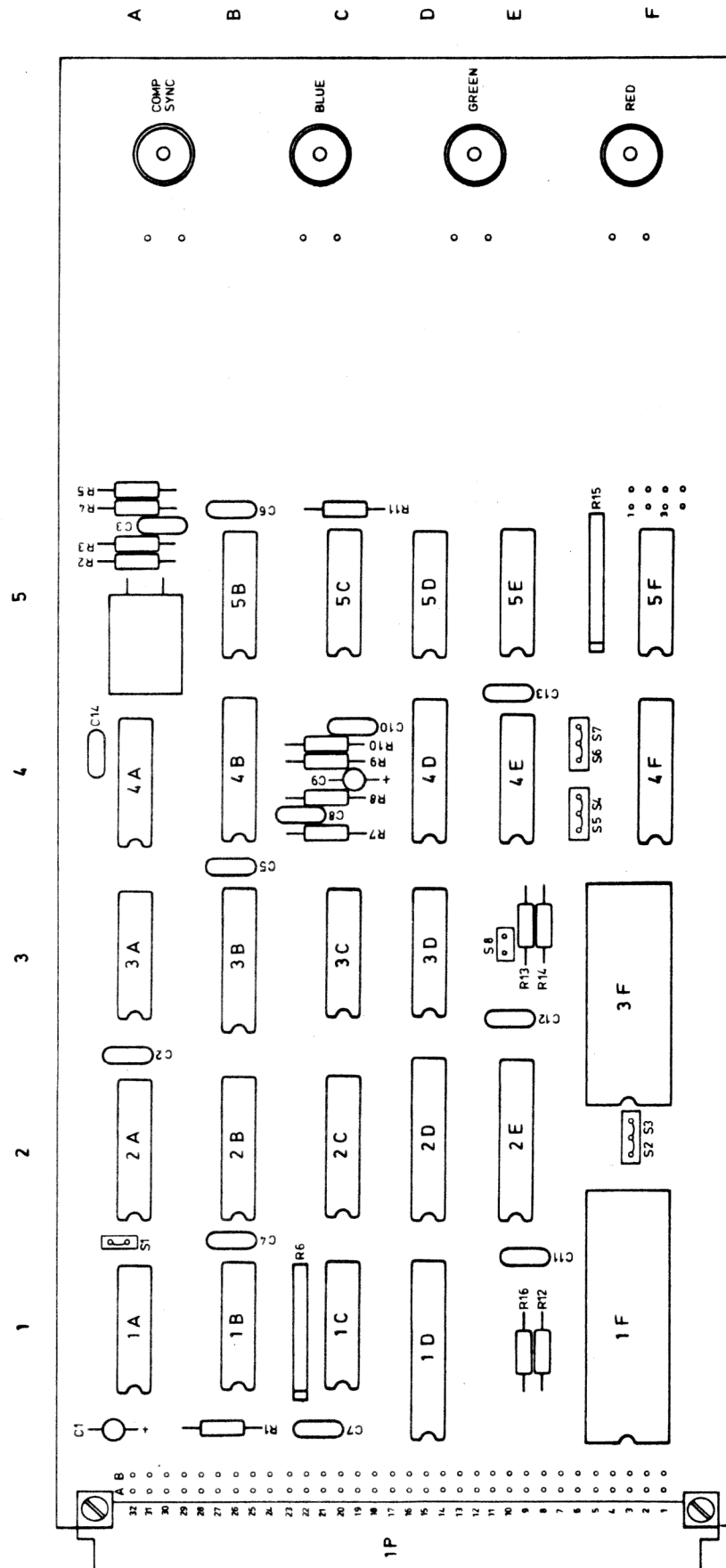
Bits	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0	Graphics Red	Graphics Green	Graphics Yellow	Graphics Blue	Graphics Magenta	Graphics Cyan	Graphics White	Conceal Display
1	Alpha ⁿ Red	Alpha ⁿ Green	Alpha ⁿ Yellow	Alpha ⁿ Blue	Alpha ⁿ Magenta	Alpha ⁿ Cyan	Alpha ⁿ White	Flash
2	Normal Height	Double Height						Steady
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Black represents display colour, and white represents background.

Table 1.

COMPONENT DIAGRAM

KOMPONENTPLACERING



Coloured display is becoming widely used with computer systems applied in studios, industrial process control etc. DataBoard 4680 provides through the FVRAM-module (coloured video RAM) a cost-effective and flexible coloured semi-graphic display system. The interface offers a considerable cost reduction achieved by FVRAM using IC's for television-based text display.

The RGB-packet comprises:

- FVRAM, product number 2081 or 2006.
- Colour TV-receiver adapted to RGB-video input, product number 8912
- Software support:
 - In DataBoard 4680 through Extended Basic
 - In ABC 80 through Datadisk 80 and the RGB-PROM, product No 9704
- Koax-cables for RGB and sync, length c:a 2 m, included when ordering 8912.

SPECIFICATION SOFTWARE SUPPORT

	<u>Extended Basic</u>	<u>ABC 80 Basic</u>
Volume	0.5 K	1.0 K ^{*)}
Base Address (FVRAM)	374Q:000Q(FC00H)	100Q:000Q(4000H)
Attributes	Yes	No, use CHR\$(128+code)
Program Driver	Inherent Ext. Basic	PROMed
D:o allocation	" " "	DOS PROM-module

^{*)}Includes printer drives.

INSTALLATION

- a) Select the appropriate Base Address for the FVRAM
- b) Check and install/remove optional functions by jumpers to fit your system.

This is not required when using the TV-receiver 8912. In ABC 80 applications the user must in all cases, however, remove the MEMREQ -jumper. See data sheets 2081 or 2006.

- c) Plug the FVRAM module into any spare slot on the Memory-side of the backplane
- d) Connect RGB and Sync of the FVRAM by koax-cables to the RGB input of the TV-receiver.

In ABC 80 applications the ABC 80 CRT and the RGB TV-receiver shall, to avoid disturbances, be placed as far as possible from each other.

- e) The RGB-option requires when working in Basic a program driver as follows:

It is delivered in Extended Basic as option which the user demands when ordering the Extended Basic.

The PROMed RGB-option is shipped as one 2708 PROM to be plugged as PROM 6 on DOS PROM-module (3032) (the third memory circuit location on the second row). The module base address is 24K.

THE FVRAM DISPLAY CONTROL

Control Characters

There are 32 control characters, which determine the nature (mode) of the display. These modes are listed in table 3 as complementary pairs, those on the left are assumed at the start of every row. The control character codes listed with each mode are used to initiate that mode. Some control characters have immediate effect ("set at") in that the new mode obtains for and from the corresponding character rectangle. Others have subsequent effect ("set after") when the new mode obtains for and from the next character rectangle. The later control character takes precedence over an earlier one.

A description of the effects produced by the control characters is given below.

Coloured characters

The alphanumeric characters can be displayed on the screen in any of seven colours, depending on the alphanumeric control character chosen. These colours are: red, green, yellow, blue, magenta, cyan and white.

Graphic characters

Each of the 64 graphic characters can be in any of the seven standard colours above. The use of these characters permits the construction of extra large letters and simple diagrams. Graphic characters are displayed on a 2-by-3 matrix as shown in Fig. 1. Six bits determine which cells on the matrix are illuminated, while the seventh bit (b_6) distinguishes between alphanumeric and graphic characters. If b_6 is a '0', then the code is always for an alphanumeric character; if it is a '1', then the code is either for an alphanumeric or a graphic character; the control characters determine which.

The control characters 'contiguous graphics' and 'separated graphics' allow different areas of graphics or outlines to be distinguished by either being contiguous (a continuous line, for instance) or being separated (a dotted line, for instance); see Fig 2.

The 'hold graphics' control character enables the blanks on the display produced by the control characters to be filled by a repeat of the preceding graphics character. The character is to be displayed in the Contiguous or Separated mode as when it was first displayed. In the absence of such a character the held graphics character is considered to be a space. Thus, for example, different coloured areas in graphics can be joined up without gaps between them. The command 'release graphics' cancels this command.

Coloured backgrounds

The background of a display is normally black, but a background of any of the seven standard colours can be selected by the control character 'new background'. The background then becomes the colour of the preceding colour control character. A black background is restored by the control character 'black background'.

Flashing characters

All characters following the control 'flash' flash repetively until the command 'steady' is given.

Double-height characters

The control 'double height' causes the characters following it to be displayed twice the normal height but with the same width, and thus selected characters can be displayed double-height. Note that the selection of a double-height character causes the information for the row below to be ignored and blanked out. The command 'normal height' cancels this command.

PROGRAMMING

The user program is designed by either using the RGB option which is available in:

- DataBoard 4680 Extended Basic
- ABC 80 Basic

or designs all required programs (-driver) by himself. The simplicity in programming by using the RGB-option will be clear when studying the following description. If RGB-option is not used then the user must write all characters (controls and display characters) as explicit memory-bytes and use the data structure as shown by table 4.

ASSIGNING IN EXTENDED BASIC

Format: <statement number> OPEN "RGB:" AS FILE <LU-number >

Example: 10 OPEN "RGB:" AS FILE 3
 300 PRINT #3 RED "4680"

Where: 4680 will be displayed in red.

ASSIGNING IN ABC 80 BASIC

Format: <statement number> OPEN <string expression> AS FILE <LU-number>

Where: <string expression> is written "PR:R"

Example: 10 OPEN "PR:R" AS FILE 3
300 PRINT #3 CHR\$(128+1); "DATADISK 80"

Where: DATADISK 80 will be displayed in red.

"CRT"-FACILITIES

The display can be handled as a normal CRT operator console by following special characters (given in decimal):

8	CTRL-H	Back-space
10	LF	Line Feed
12	FF	Form Feed, which erases the whole screen
13	CR	Carriage Return

Example: 100 PRINT #5 CHR\$(12)
a starting command which erases the screen.

POSITIONING

Use the function CUR(row, column)

Where: row = 0 - 23 column = 0 - 39

Example: 100 PRINT #5 CHR\$(12), CUR(0,0) which erases the screen and moves control to home-position.

CONTROL CHARACTERS

All teletext control characters as shown by tables 1 and 2 columns 0 and 1 can be ordered by the function

CHR\$(128 + <control character in Ascii-code> [...])

Example: 110 PRINT #5 CHR\$(128+1, 128+29) which if statement 100 above present, turns row 0 to red - the new background.

Note: As stated in table 3 the default controls will be in power if not complementary control characters are ordered. Thus the display mode for the exemplified row is:

- Alphanumeric Red (as ordered)
- Contiguous graphics (if graphics will be ordered)
- Steady
- Normal Height
- Released Graphics

Do not forget that the next row starts in the same way with the defaults in effect.

CONTROL CHARACTERS BY ATTRIBUTES

The RGB-option in Extended Basic (not provided in 9703) facilitates further the user programming by naming the control characters by attributes. The following attributes are:

RED	RED GRAPHICS
GREEN	GREEN GRAPHICS
YELLOW	YELLOW GRAPHICS
BLUE	
MAGENTA	
CYAN	
WHITE *)	WHITE GRAPHICS
FLASH	STEADY *)
BLACKBG *)	NEWBG
DOUBH	SINGH *)
HOLDG	RELG

Note: *) These attributes are in effect at row start.

Example: 110 PRINT #5 RED, NEWBG which is the same as the former statement 110.

GRAPHICS

If graphic mode is in effect then the Ascii-codes in tables 1 and 2 columns 2, 3, 6 and 7 are interpreted where found as graphic characters.

The graphics are displayed using 2 * 3 fields as shown by figures 1 and 2. The RGB-option facilitates handling the whole screen as dots. If the graphic mode is in effect at a specific position then the following statements may be used to set or clear a dot:

SETDOT row,column sets dot
CLRDOT row,column clears dot

Where: row = 0 - 72
 column = 2 - 79 (0 and 1 are occupied by control characters)

The user may check if a dot is turned ON or OFF by function:

DOT(row,column)
- 1 is given if ON
- 0 is given for OFF

Example: IF DOT(y,x) THEN CLRDOT y,x ELSE SETDOT y,x
 The dot (y,x) is complemented.

* Only available in Extended BASIC DataBoard 4680.

FURTHER FACILITIES IN PROMed RGB OPTION FOR ABC 80

The PROMed RGB option contains also printer program drivers. These are made available to the user program by assigning with the OPEN-statement as is done for the RGB-display. The drivers are used with a finishing CLOSE-statement before the other is OPENed.

General format: <statement number>OPEN<string expr.> AS FILE
 <logical unit number>

Where: The<string expression>is as follows:

"PR:U" printer output via the UART interface, 4117 or 4017(/1)
 Card address 74Q(03CH).
"PR:C" printer output via the Centronics interface, product number
 4038 or 4001.
 Card address 74Q(03CH).
"PR:P" SP1 sender, product number 4015.
 Card address 74Q(03CH).
"PR:V" printer output via the modem connector on ABC 80.
"PR:R" RGB output on the FVRAM, product number 2006

Example: 10 OPEN "PR:" AS FILE 5
 200 PRINT#5 "UART"

Where: The output is assumed to come on a printer connected to the
 UART-interface in Datadisk 80.

SAA 5050 CHARACTER SET

Date	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
00 00	0	0	0	0	0	0	0	0
00 01	0	0	0	0	0	0	0	0
00 10	0	0	0	0	0	0	0	0
00 11	0	0	0	0	0	0	0	0
01 00	0	0	0	0	0	0	0	0
01 01	0	0	0	0	0	0	0	0
01 10	0	0	0	0	0	0	0	0
01 11	0	0	0	0	0	0	0	0
10 00	0	0	0	0	0	0	0	0
10 01	0	0	0	0	0	0	0	0
10 10	0	0	0	0	0	0	0	0
10 11	0	0	0	0	0	0	0	0
11 00	0	0	0	0	0	0	0	0
11 01	0	0	0	0	0	0	0	0
11 10	0	0	0	0	0	0	0	0
11 11	0	0	0	0	0	0	0	0

Black represents display colour, and white represents background.

SAA 5052 CHARACTER SET

Bits	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
00 00	0	0	0	0	0	0	0	0
00 01	0	0	0	0	0	0	0	0
00 10	0	0	0	0	0	0	0	0
00 11	0	0	0	0	0	0	0	0
01 00	0	0	0	0	0	0	0	0
01 01	0	0	0	0	0	0	0	0
01 10	0	0	0	0	0	0	0	0
01 11	0	0	0	0	0	0	0	0
10 00	0	0	0	0	0	0	0	0
10 01	0	0	0	0	0	0	0	0
10 10	0	0	0	0	0	0	0	0
10 11	0	0	0	0	0	0	0	0
11 00	0	0	0	0	0	0	0	0
11 01	0	0	0	0	0	0	0	0
11 10	0	0	0	0	0	0	0	0
11 11	0	0	0	0	0	0	0	0

Control characters shown in columns 0 and 1 are normally displayed as space.

Character rectangle

** These control characters are presumed before each row begin

Table 2.

Black represents display colour.
White represents background.

Table 1.

DISPLAY MODE	SET AT	SET AFTER	COMPLEMENTARY DISPLAY MODE	SET AT	SET AFTER
ALPHANUMERICS ***	Row Start	0/1 0/2 0/3 0/4 0/5 0/6 0/7	GRAPHICS	-	1/1 1/2 1/3 1/4 1/5 1/6 1/7
CONTIGUOUS ***	Row Start 1/9*	1/9*	SEPARATED	1/10*	1/10*
DISPLAY COLOUR *** <div> <div>includes</div> <div>RED</div> <div>includes</div> <div>GREEN</div> <div>includes</div> <div>BLUE</div> </div>	Row Start	0/1 0/3 0/5 0/7 1/1 1/3 1/5 1/7	DISPLAY COLOUR *** <div> <div>excludes</div> <div>RED</div> <div>excludes</div> <div>GREEN</div> <div>excludes</div> <div>BLUE</div> </div>	-	0/2 0/4 0/6 1/2 1/4 1/6
	Row Start	0/2 0/3 0/6 0/7 1/2 1/3 1/6 1/7		-	0/1 0/4 0/5 1/1 1/4 1/5
	Row Start	0/4 0/5 0/6 0/7 1/4 1/5 1/6 1/7		-	0/1 0/2 0/3 1/1 1/2 1/3
	Row Start	-		1/13**	-
BLACK BACKGROUND ***	Row Start 1/12	-	NEW BACKGROUND		
STEADY ***	Row Start 0/9	-	FLASH	-	0/8
NORMAL HEIGHT ***	Row Start 0/12	-	DOUBLE HEIGHT	-	0/13
RELEASE ***	Row Start	1/15	HOLD	1/14	-

* these codes may take effect "at" or "after" their occurrence.
 ** whenever this code occurs the Display Colour is adopted as the New Background colour.
 *** These controls, including alphanumeric white, are known as 'defaults'. They apply to a normal display and are assumed before each row begins.

Table 3. Display Modes and Control Characters

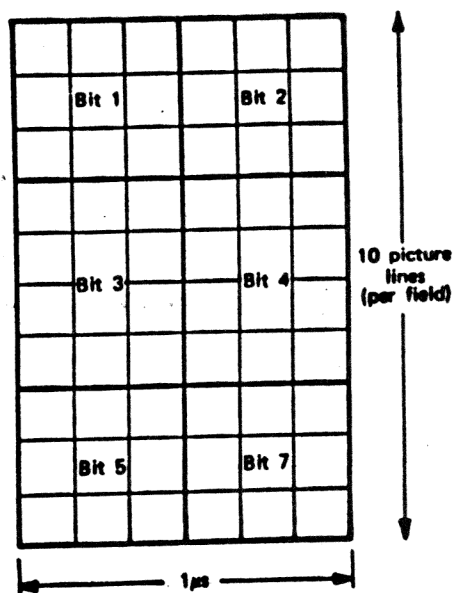


Fig. 1 -Size of the character rectangle and allocation of data bits to a graphics character.

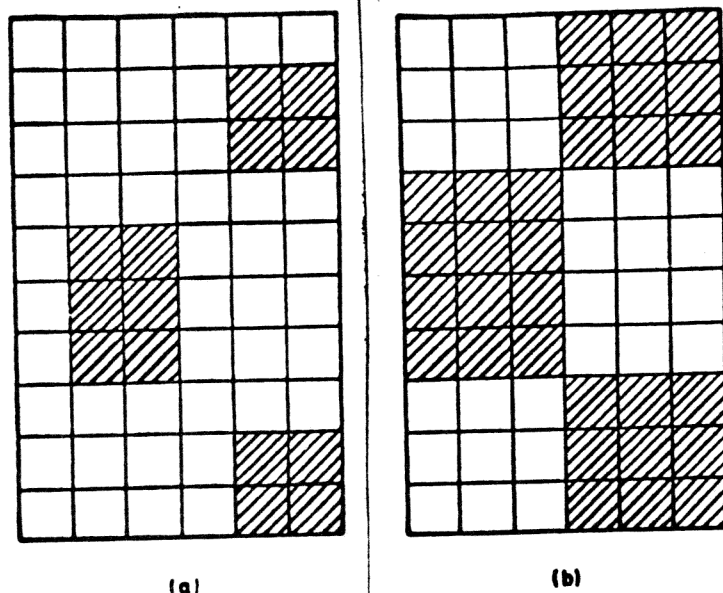


Fig. 2 -Graphics character 11001 10
(a) separate mode (b) contiguous mode

Table 4 FVRAM data structure (written: Assembler)

FVRAM	STRUC	ORG	<expression>
*			; 8 GROUPS OF 128 BYTES
ROW0	DS	40	
ROW8	DS	40	
ROW16	DS	40	
	DS	8	FILLER
ROW1	DS	40	
ROW9	DS	40	
ROW17	DS	40	
	DS	8	FILLER
⋮	⋮	⋮	
ROW7	DS	40	
ROW15	DS	40	
ROW23	DS	40	
	DS	8	FILLER
	ENDS		