

## TELETEXT CHARACTER GENERATOR

The SAA5050 series of MOS N-channel integrated circuits provides the video drive signals to the television receiver necessary to produce the teletext/viewdata display. The variants are described in the Quick Reference Data and full details of the characters sets are given in Figs. 11 to 18.

## QUICK REFERENCE DATA

Supply voltage	$V_{DD}$	nom.	5	V
Supply current	$I_{DD}$	typ.	85	mA
Operating ambient temperature range	$T_{amb}$		-20 to +70	°C
Variant	Character set	Variant	Character set	
5050	English	5054	Belgian	
5051	German	5055	US ASCII	
5052	Swedish	5056	Hebrew	
5053	Italian	5057	Cyrillic	

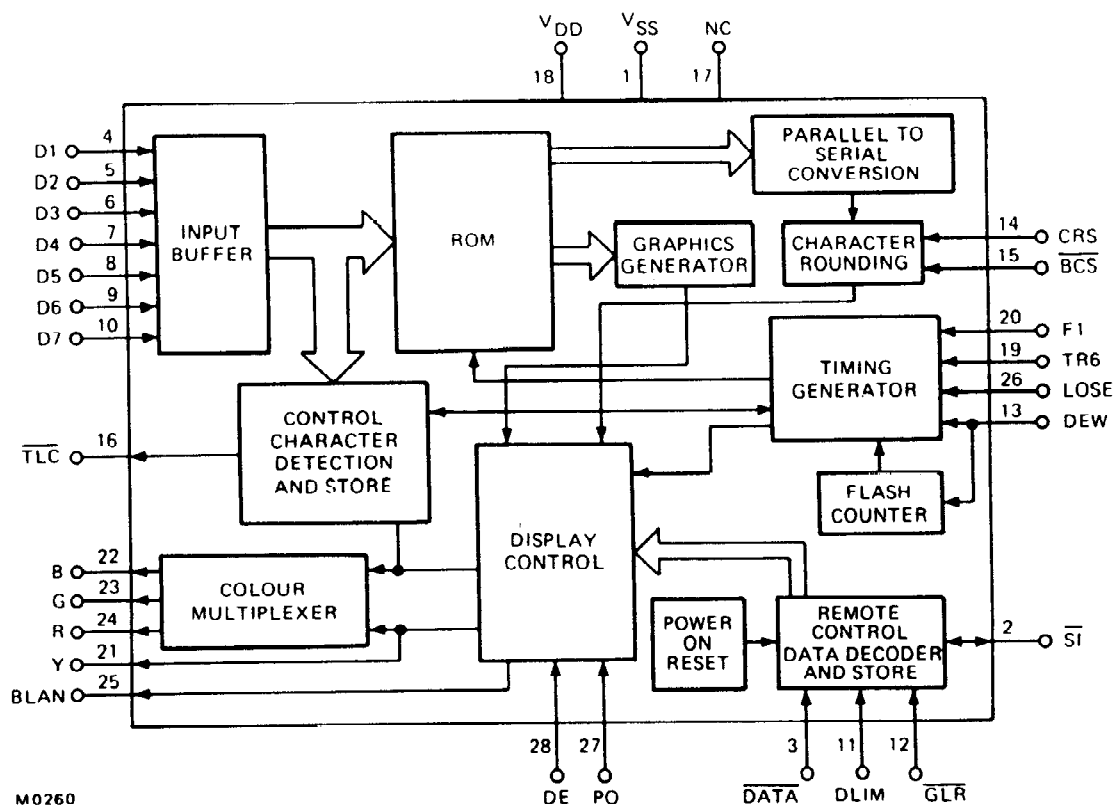


Fig.1 Block diagram

## PACKAGE OUTLINE

28-lead DIL; plastic (SOT-117)



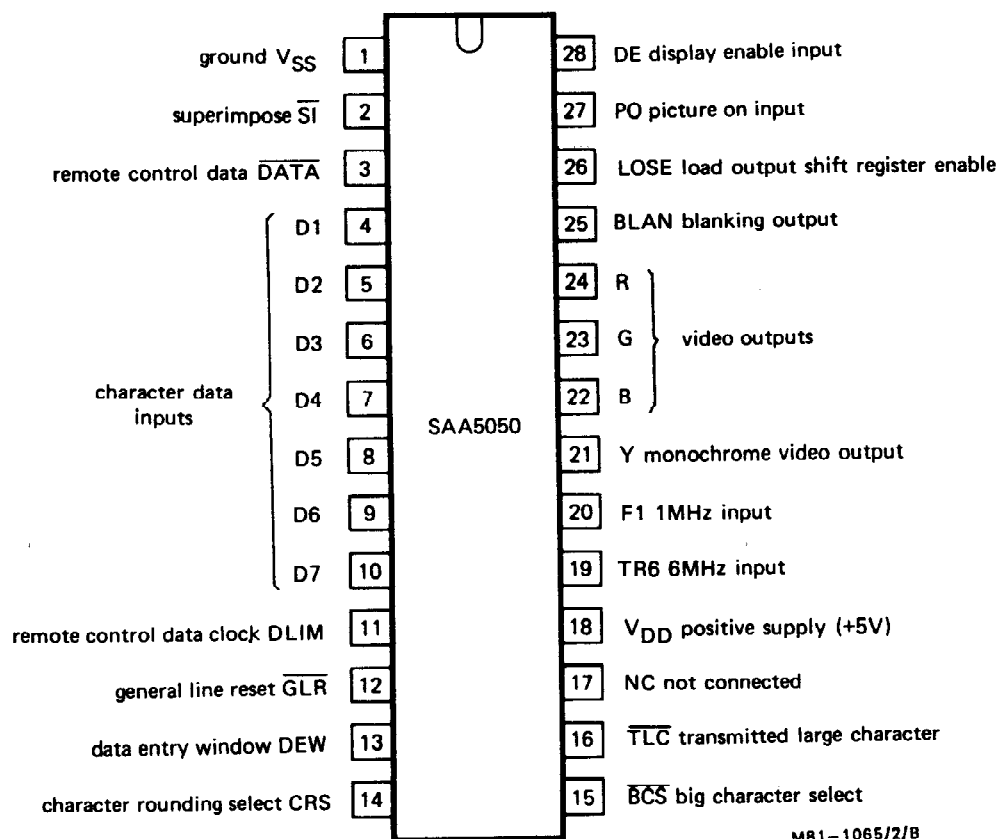


Fig.2 Pinning diagram

## DESCRIPTION

The SAA5050 is a 28 pin device which incorporates a fast access character generator ROM (4.3 k bits), the logic decoding for all the teletext control characters and decoding for some of the remote control functions. The circuit generates 96 alphanumeric and 64 graphic characters. In addition there are 32 control characters which determine the nature of the display.

The SAA5050 is suitable for direct connection to the SAA5010, SAA5012, SAA5020 and SAA5040 Series integrated circuits.

The basic input to the SAA5050 is the character data from the teletext page memory. This is a 7 bit code. Each character code defines a dot matrix pattern. The character period is 1  $\mu$ s and the character dot rate is 6 MHz. The timings are derived from the two external input clocks F1 (1 MHz) and TR6 (6 MHz) which are amplified and re-synchronised internally. Each character rectangle is 6 dots wide by 10 TV lines high. One dot space is left between adjacent characters, and there is one line space left between rows. Alphanumeric characters are generated on a 5 x 9 matrix, allowing space for descending characters. Each of the 64 graphic characters is decoded to form a 2 x 3 block arrangement which occupies the complete 6 x 10 dot matrix (Fig.9). Graphics characters may be either contiguous or separated (Fig.10). 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 a character matrix.

The character video output signals comprise a monochrome signal and RGB signals for a colour receiver. A blanking output signal is provided to blank out the television video signal under the control of the PO and DE inputs and the box control characters (see Table 3).

The monochrome data signal can be used to inlay characters into the television video. The use of the 32 control characters provides information on the nature of the display, e.g. colour. These are also used to provide other facilities such as 'concealed display' and flashing words etc. The full character set is given in Table 1.



**HANDLING**

Inputs and outputs are protected against electrostatic charge in normal handling. However, to be totally safe, it is desirable to take normal precautions appropriate to handling MOS devices (See 'Handling MOS Devices').

**RATINGS** Limiting values in accordance with the Absolute Maximum System, (IEC134)

		min.	typ.	max.	
<b>Voltages (with respect to pin 1)</b>					
Supply voltage (pin 18)	$V_{DD}$	-0.3	—	7.5	V
Input voltages (all inputs + input/output)	$V_I$	-0.3	—	7.5	V
Output voltage (pin 16)	$V_{O16}$	-0.3	—	7.5	V
(all other outputs)	$V_O$	-0.3	—	14.0	V

**Temperature**

Storage temperature range	$T_{stg}$		-20 to +125	°C
Operating ambient temperature range	$T_{amb}$		-20 to +70	°C

**CHARACTERISTICS**

		min.	typ.	max.	
Supply voltage (pin 18)	$V_{DD}$	4.5	—	5.5	V
The following parameters apply at $T_{amb} = 25\text{ °C}$ and $V_{DD} = 5\text{ V}$ unless otherwise stated.					
Supply current	$I_{DD}$	—	85	160	mA

**Inputs****Character data D1 to D7 (pins 4 to 10)**

Input voltage; HIGH	$V_{IH}$	2.65	—	$V_{DD}$	V
Input voltage; LOW	$V_{IL}$	0	—	0.6	V

**Clock inputs F1 (pin 20) TR6 (pin 19)**

Input voltage; HIGH	$V_{IH}$	2.65	—	$V_{DD}$	V
Input voltage; LOW	$V_{IL}$	0	—	0.6	V

**Logic inputs**

DATA (pin 3)	DEW (pin 13)	LOSE (pin 26)
DLIM (pin 11)	CRS (pin 14)	PO (pin 27)
GLR (pin 12)	BCS (pin 15)	DE (pin 28)

Input voltage; HIGH	$V_{IH}$	2.0	—	$V_{DD}$	V
Input voltage; LOW	$V_{IL}$	0	—	0.8	V

**All inputs**

Input leakage current ( $V_I = 5.5\text{ V}$ )	$I_{IR}$	—	—	10	μA
Input capacitance	$C_I$	—	—	7	pF



## CHARACTERISTICS (continued)

min.      typ.      max.

*Outputs*

Character video outputs + Blanking output (open drain) (note 3)

B — (pin 22), G — (pin 23), R — (pin 24), Y — (pin 21),  
Blanking (pin 25)

Output voltage; LOW ( $I_{OL} = 2 \text{ mA}$ )	$V_{OL}$	—	—	0.5	V
Output voltage; LOW ( $I_{OL} = 4 \text{ mA}$ )	$V_{OL}$	—	—	1.0	V
Output voltage; LOW ( $I_{OL} = 6 \text{ mA}$ )	$V_{OL}$	—	—	2.0	V
Output voltage; HIGH	$V_{OH}$	$V_{DD}$	—	13.2	V
Output load capacitance	$C_L$	—	—	15	pF
Output fall time	note 1 $t_f$	—	—	30	ns
Variation of fall time between any outputs		0	—	20	ns

 $\overline{\text{TLC}}$  (pin 16)

Output voltage; LOW ( $I_{OL} = 100 \mu\text{A}$ )	$V_{OL}$	0	—	0.5	V
Output voltage; HIGH ( $-I_{OH} = 100 \mu\text{A}$ )	$V_{OH}$	2.4	—	$V_{DD}$	V
Output load capacitance	$C_L$	—	—	30	pF
Output rise time	Measured between 0.8 V and 2.0 V levels	$t_r$	—	1.0	$\mu\text{s}$
Output fall time					

*Input/output* $\overline{\text{SI}}$  (pin 2) (open drain)

Input voltage; HIGH	$V_{IH}$	2.0	—	6.5	V
Input voltage; LOW	$V_{IL}$	0	—	0.8	V
Input leakage current ( $V_I = 5.5 \text{ V}$ )	$I_{IR}$	—	—	10	$\mu\text{A}$
Input capacitance	$C_I$	—	—	7	pF
Output voltage; LOW ( $I_{OL} = 0.4 \text{ mA}$ )	$V_{OL}$	0	—	0.5	V
Output voltage; LOW ( $I_{OL} = 1.3 \text{ mA}$ )	$V_{OL}$	0	—	1.0	V
Output load capacitance	$C_L$	—	—	45	pF
Output voltage; HIGH state (note 2)	$V_{OH}$	—	—	6.5	V



*Timing characteristics*

For typical display of 40 characters per line.

Line rate = 64  $\mu$ s.

Field rate = 20 ms.

**Character data timing (Fig.4)**

		min.	typ.	max.	
TR6 rising edge to F1 falling edge	$t_D$	6	—	60	ns
TR6 frequency	$f_{TR6}$	—	6	—	MHz
TR6 mark/space ratio		40:60	—	60:40	
F1 frequency	$f_{F1}$	—	1	—	MHz
F1 mark/space ratio		40:60	—	60:40	
Data set-up time	$t_{CDS}$	80	—	—	ns
Data hold time	$t_{CDH}$	100	—	—	ns
Delay time — character in/ character data at outputs	Graphics $t_{CDG}$	—	2.6	—	$\mu$ s
	Alphanumerics $t_{CDA}$	—	2.767	—	$\mu$ s

**Display period timing (Fig.5)**

F1 falling edge to LOSE rising edge	$t_{LDH}$	0	—	250	ns
F1 falling edge to LOSE falling edge	$t_{LDL}$	0	—	250	ns
LOSE rising edge to 'Display on'	$t_{DON}$	—	2.6	—	$\mu$ s
LOSE falling edge to 'Display off'	$t_{DOFF}$	—	2.6	—	$\mu$ s
'Display period'	$t_{DP}$	—	40	—	$\mu$ s

**Line rate timing (Fig.6)**

F1 rising edge to GLR falling edge	$t_{DGL}$	0	—	200	ns
F1 rising edge to GLR rising edge	$t_{DGH}$	0	—	200	ns
GLR LOW time	$t_{GLP}$	—	1	—	$\mu$ s
Line start* to GLR falling edge	$t_{GLR}$	—	5	—	$\mu$ s
Line start* to LOSE rising edge	$t_{LSL}$	—	14.5	—	$\mu$ s
LOSE falling edge to Line start*	$t_{LLS}$	—	9.5	—	$\mu$ s
Line period	$t_{LNP}$	—	64	—	$\mu$ s
LOSE HIGH time	$t_{LHP}$	—	40	—	$\mu$ s

**Remote data input timing (Fig.8)**Assuming F1 period = 1  $\mu$ s and GLR period = 64  $\mu$ s

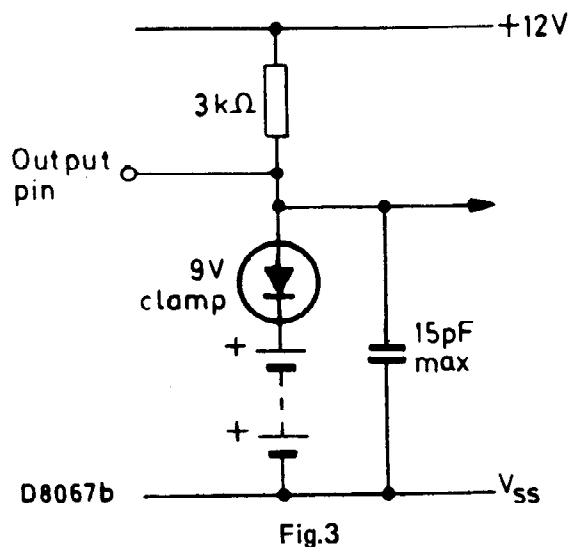
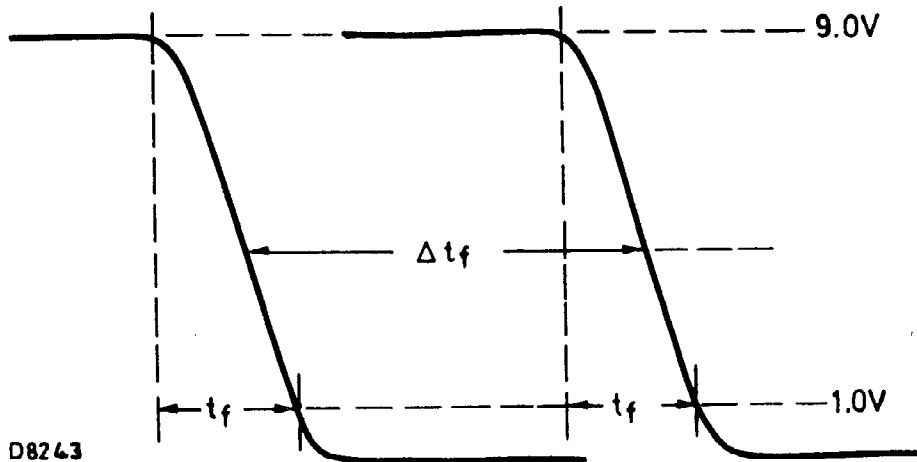
DLIM clock HIGH time	$t_{CH}$	6.5	8	(note 4)	$\mu$ s
DLIM clock LOW time	$t_{CL}$	3.5	8	60	$\mu$ s
DATA to DLIM set-up time	$t_{DS}$	0	14	—	$\mu$ s
DLIM to DATA hold time	$t_{DH}$	8	14	—	$\mu$ s

\*Taken as falling edge of 'line sync' pulse.



## Notes

1. Fall time,  $t_f$  and  $\Delta t_f$ , are defined as shown and are measured using the circuit shown below:  
 $t_f$  is measured between the 9 V and 1 V levels.  
 $\Delta t_f$  is the maximum time difference between outputs.



2. Recommended pull-up resistor for  $\overline{SI}$  is 18 k $\Omega$ .
3. The R, G, B, Y and blanking outputs are protected against short circuit to supply rails.
4. There is no maximum DLIM cycle time, provided the DLIM duty cycle is such that the  $t_{CL}$  max requirement is not exceeded.

## SPECIAL FEATURES

## Flash oscillator

The circuit generates a 0.75 Hz signal with a 3:1 ON/OFF ratio to provide the flashing character facility.

## Power-on-reset

When the supply voltage is switched on, the character generator will reset to tv, conceal, and not superimpose modes.



**Character rounding**

The character rounding function is different for the small and double height characters. In both cases the ROM is accessed twice during the character period of 1  $\mu$ s. The dot information of two rows is then compared to detect the presence of any diagonal in the character matrix and to determine the positioning of the character rounding half dots.

For small characters rounding is always referenced in the same direction (i.e. row before in even fields and row after in odd fields as determined by the CRS signal).

For double height characters rounding is always referenced alternately up and down changing every line using an internally generated signal. (The CRS signal is '0' for the odd field and '1' for the even field of an interlaced tv picture).

**Graphics decoder**

The 64 graphics characters are decoded directly from the character data inputs and they appear on a 2 x 3 matrix. Figure 9 gives details of the graphics decoding.

**APPLICATION DATA**

The function is quoted against the corresponding pin numbers

Pin No.

1. **V<sub>SS</sub> Ground - 0 V**
2.  **$\overline{SI}$  Superimpose**  
This is a dual purpose input/output pin. The output is an open drain transistor (capable of sinking current to V<sub>SS</sub>), which is in the conducting state when superimpose mode is selected. This allows contrast reduction of the tv picture in superimpose mode if required. If the pin is held LOW, the internal 'tv mode' flip-flop is held in the 'text' state. This is for VDU applications when the remote control is not used.
3. **DATA Remote control data**  
This input accepts a 7-bit serial data stream from the remote control decoder. This data contains the teletext and viewdata remote control functions. The nominal data rate is 32  $\mu$ s/bit. The command codes used in the SAA5050 are shown in Table 2.
- 4,5,6 **D1 to D7 Character data**  
7,8,9, 10 These inputs accept a 7-bit parallel data code from the page memory. This data selects the alphanumeric characters, the graphics characters and the control characters. The alphanumeric addresses are ROM column addresses, the graphics and control data are decoded internally.
11. **DLIM**  
This input receives a clock signal from the remote control decoder and this signal is used to clock remote control data into the SAA5050. The positive-going edge of every second clock pulse is nominally in the centre of each remote control data bit (Fig.8).
- 12 **GLR General line reset**  
This input signal from the SAA5020 Timing Chain is required for internal synchronisation of remote control data signals.
13. **DEW Data entry window**  
This input signal from the SAA5020 Timing Chain is required to reset the internal ROM row address counter prior to the display period. It is also used internally to derive the 'flash' period.



## APPLICATION DATA (continued)

14. **CRS Character rounding select**  
This input signal from the SAA5020 Timing Chain is required for correct character rounding of displayed characters. (Normal height characters only).
15. **BCS Big character select**  
This input from the SAA5040 Teletext Acquisition and Control device allows selection of large characters by remote control.
16. **TLC Transmitted large characters**  
This output to the SAA5020 Timing Chain enables double height characters to be displayed as a result of control characters stored in the page memory.
18. **V<sub>DD</sub> + 5 V supply**  
This is the power supply input to the circuit.
19. **TR6**  
This input is a 6 MHz signal from the SAA5020 Timing Chain used as a character dot rate clock.
20. **F1**  
This input is a 1 MHz equal mark/space ratio signal from the SAA5020 Timing Chain. It is used to latch the 7-bit parallel character data into the input latches. It is also used to synchronise an internal divide-by 6 counter. The F1 signal is internally synchronised with TR6.
21. **Y Output**  
This is a video output signal which is active in the HIGH state containing character dot information for tv display.  
The output is an open drain transistor capable of sinking current to V<sub>SS</sub>
- 22,23, 24. **B,G,R outputs**  
These are the Blue, Green and Red Character video outputs to the tv display circuits. They are active HIGH and contain both character and background colour information.  
The outputs are open drain transistors capable of sinking current to V<sub>SS</sub>.
25. **BLAN Blanking**  
This active HIGH output signal provides tv picture video blanking. It is active for the duration of a box when Picture On and Display Enable are HIGH. It is also activated permanently for normal teletext display when no tv picture is required (PO LOW). The output is an open drain transistor capable of sinking current to V<sub>SS</sub>. Full details given in Table 3.
26. **LOSE Load output shift register enable**  
This input signal from the SAA5020 Timing Chain resets the internal control character flip-flops prior to the start of each display line.  
This signal also defines the character display period.
27. **PO Picture On**  
This input signal from the SAA5040 Teletext Acquisition and Control device is used to control the character video and blanking outputs. When PO is HIGH, only text in boxes is displayed unless in superimpose mode. The input is HIGH for tv picture video on, LOW for picture off. See Table 3.
28. **DE Display enable**  
This input signal from the SAA5040 Teletext Acquisition and Control device is used to enable the teletext display. The input is HIGH for teletext display enabled. LOW for display cancelled. See Table 3.





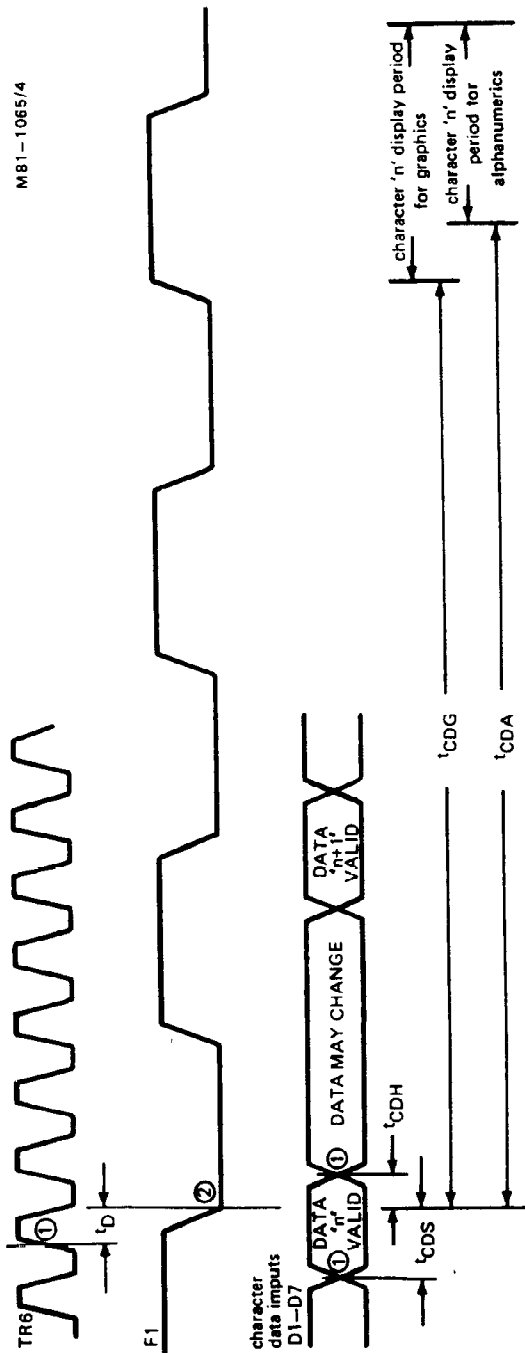


Fig.4 Character data timing (for typical 40 character display)

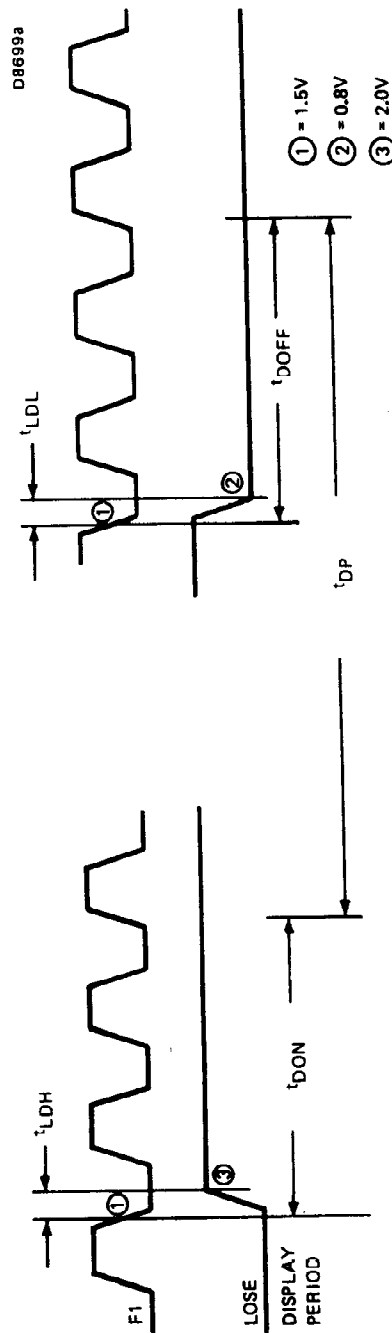


Fig.5 Display period timing (for typical 40 character display)

D8700a

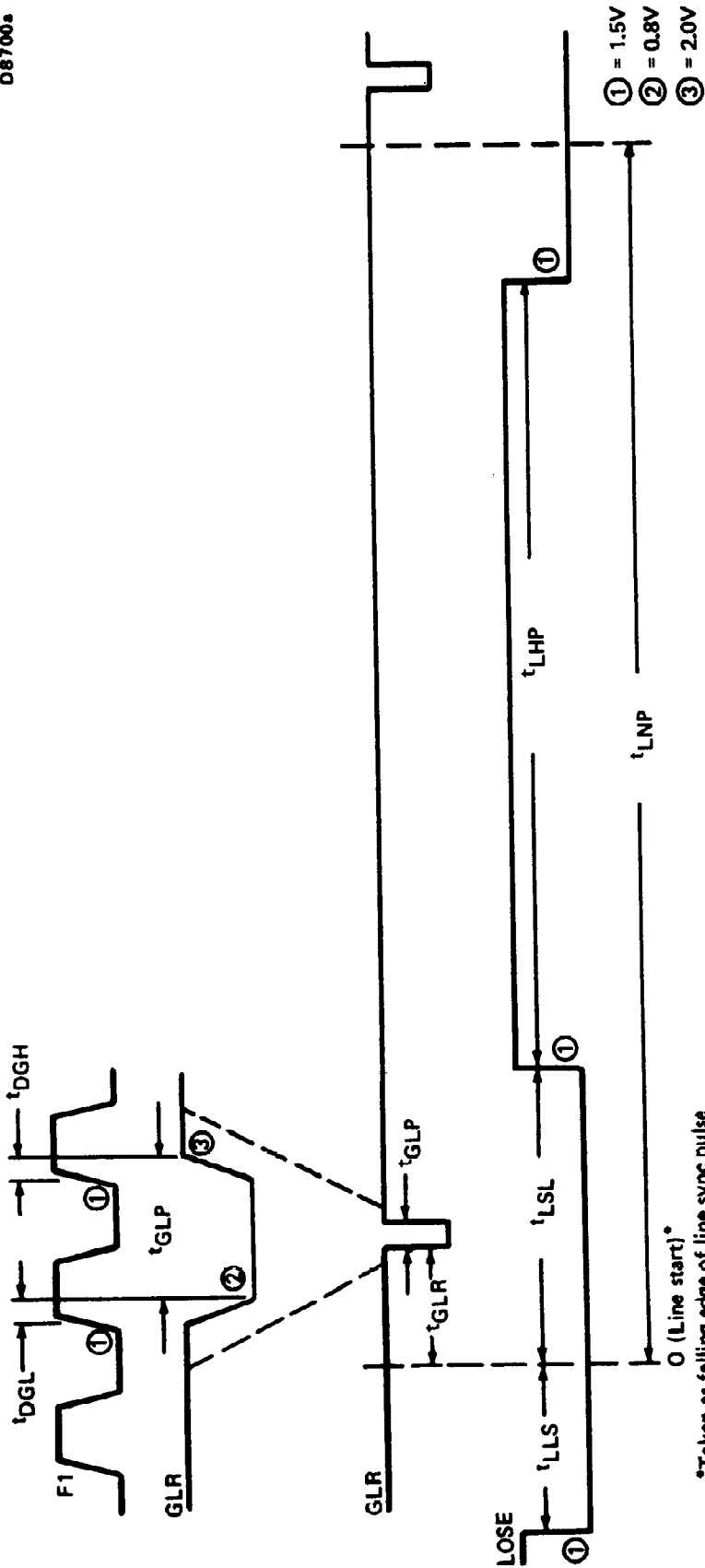


Fig.6 Line rate clocks (for line period of 64  $\mu$ s)

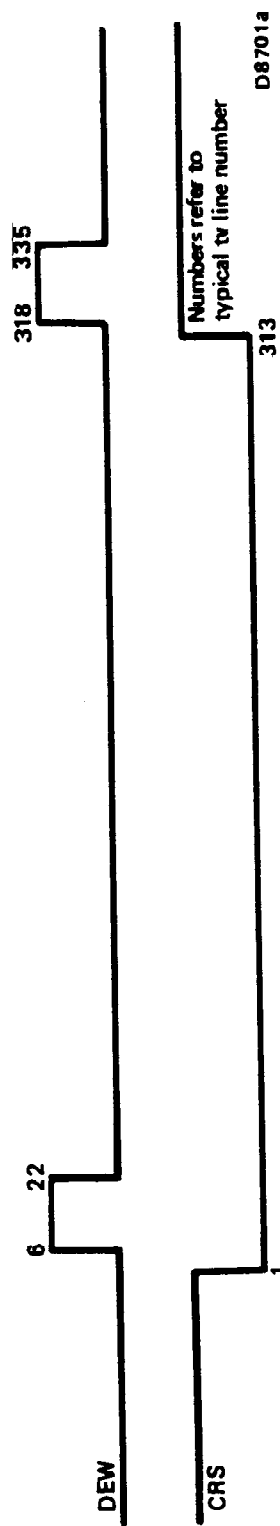


Fig.7 Field rate clocks (for field period of 20 ms, 312½ lines per field)

D8701a



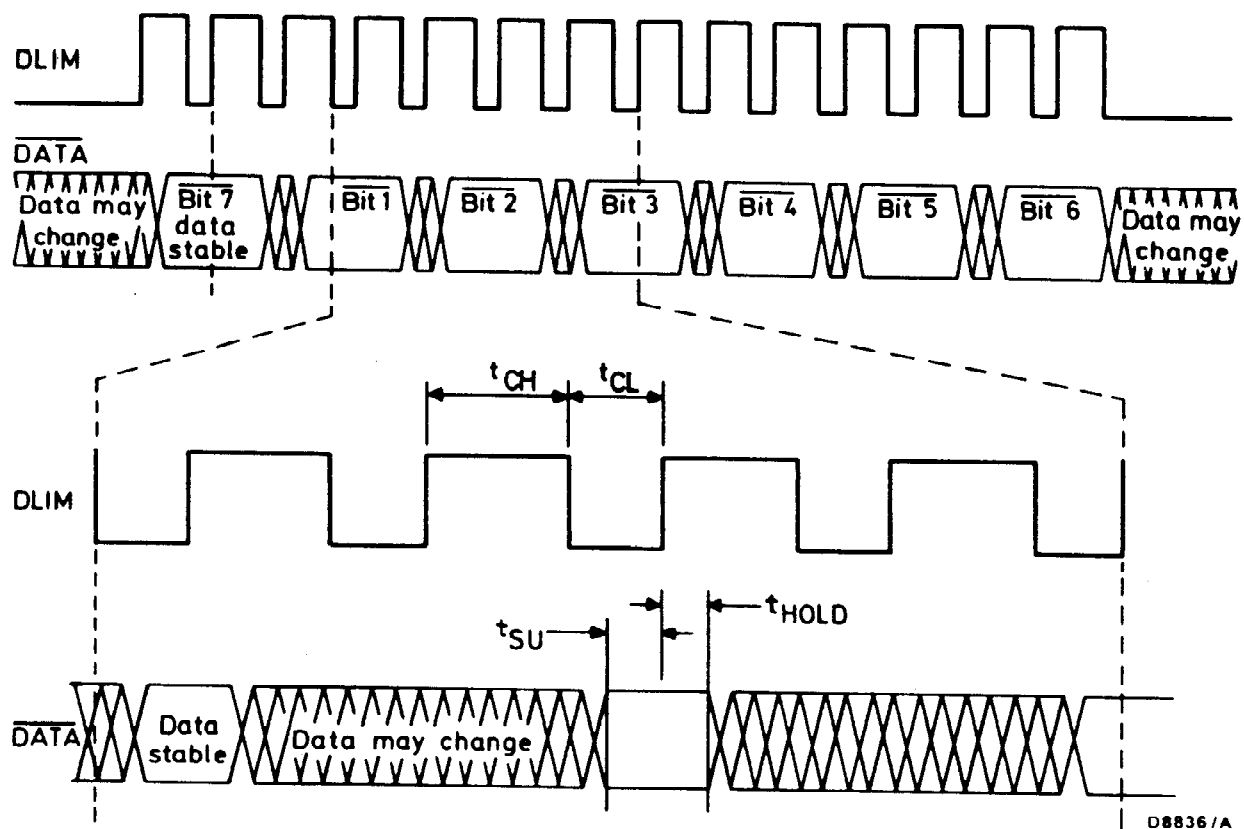
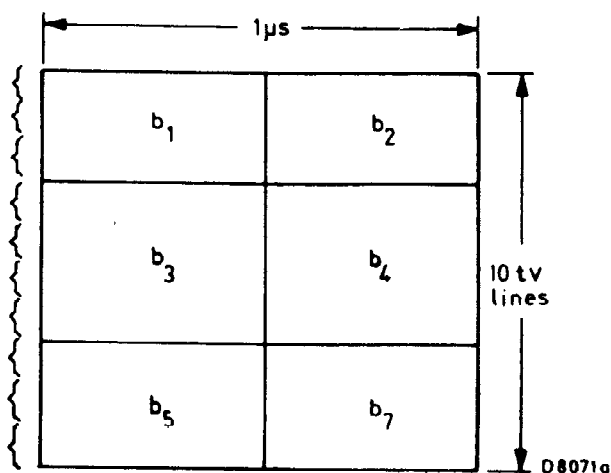


Fig.8 Remote control input timing



Each cell is illuminated if particular 'bit' ( $b_1$ ,  $b_2$ ,  $b_3$ ,  $b_4$ ,  $b_5$ , or  $b_7$ ) is a '1'.  
For graphics characters  $b_6$  is always a '1' — See Table 1.

Fig.9 Graphics Character



D8703

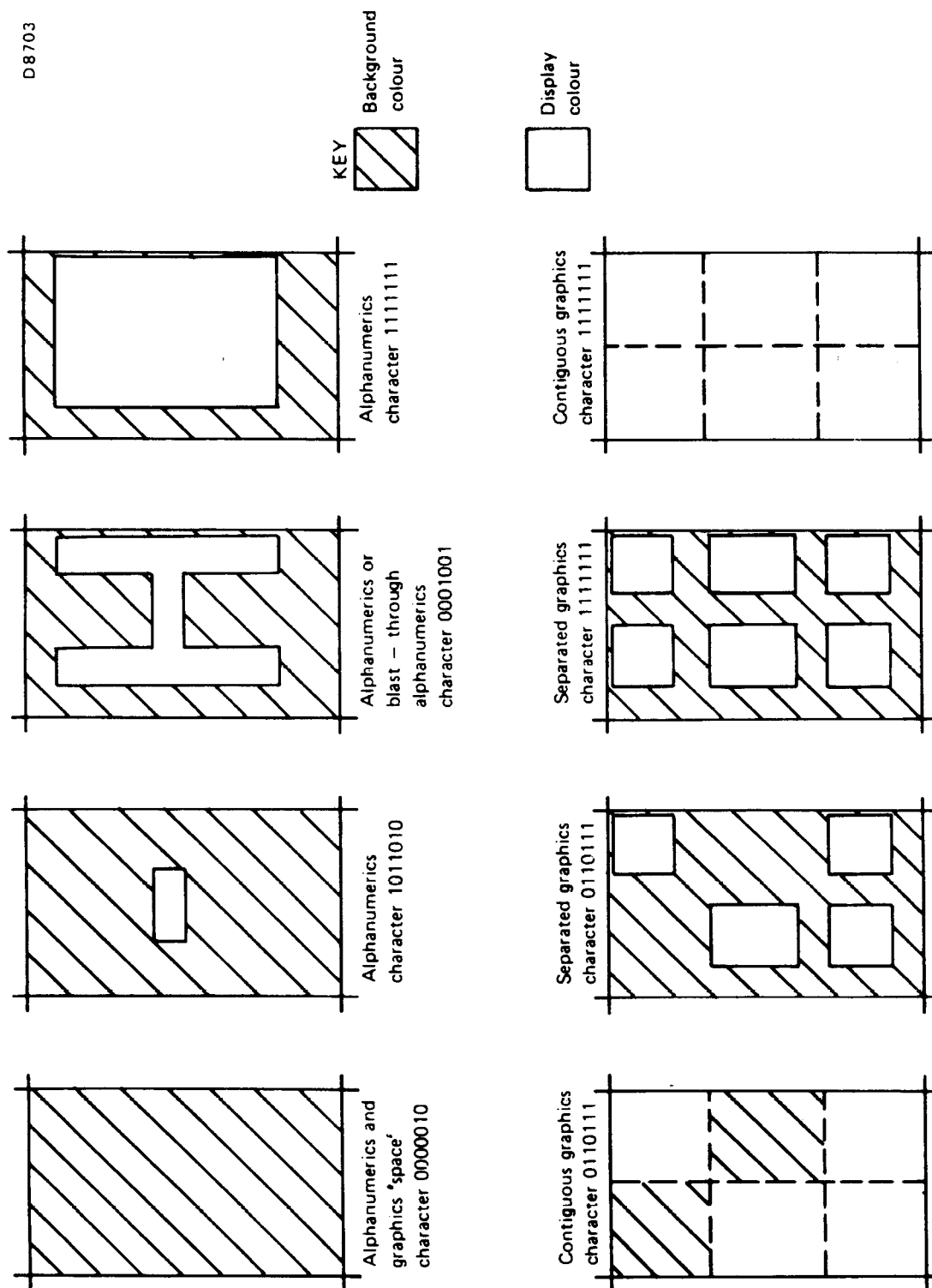


Fig.10 Character format



TABLE 1

Character data input decoding

D8058a

<div style="display: flex; align-items: center;"> <div style="transform: rotate(-45deg); padding: 5px;">           Bits            b7 b6 b5 b4 b3 b2 b1 b0         </div> <div style="margin-left: 10px;"> </div> </div>					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	1	2	2a	3	3a	4	5	6	6a	7	7a
0	0	0	0	0	0	<u>NUL</u> *	<u>DLE</u> *			0		@ P	-		p	
0	0	0	1	1	1	Alpha <sup>n</sup> Red	Graphics Red	!		1		A Q	a		q	
0	0	1	0	0	2	Alpha <sup>n</sup> Green	Graphics Green	"		2		B R	b		r	
0	0	1	1	1	3	Alpha <sup>n</sup> Yellow	Graphics Yellow	£		3		C S	c		s	
0	1	0	0	0	4	Alpha <sup>n</sup> Blue	Graphics Blue	\$		4		D T	d		t	
0	1	0	1	1	5	Alpha <sup>n</sup> Magenta	Graphics Magenta	%		5		E U	e		u	
0	1	1	0	0	6	Alpha <sup>n</sup> Cyan	Graphics Cyan	&		6		F V	f		v	
0	1	1	1	1	7	Alpha <sup>n</sup> White	Graphics White	.		7		G W	g		w	
1	0	0	0	0	8	Flash	Conceal Display	(		8		H X	h		x	
1	0	0	1	1	9	** Steady	** Contiguous Graphics	)		9		I Y	i		y	
1	0	1	0	0	10	** End Box	** Separated Graphics	*		:		J Z	j		z	
1	0	1	1	1	11	Start Box	* <u>ESC</u>	+		;		K -	k		1/2	
1	1	0	0	0	12	** Normal Height	** Black Background	,		<		L 1/2	1			
1	1	0	1	1	13	Double Height	New Background	-		=		M -	m		3/4	
1	1	1	0	0	14	* <u>SO</u>	Hold Graphics	.		>		N ↑	n		-	
1	1	1	1	1	15	* <u>SI</u>	** Release Graphics	/		?		O #	o		□	

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

The SAA5050 character set is shown as example. Details of character sets are given in Figs. 11 to 18.

\* These control characters are reserved for compatibility with other data codes.

\*\* These control characters are presumed before each row begins.

Codes may be referred to by their column and row e.g. 2/5 refers to %

Character rectangle

Black represents display colour.

White represents background.



TABLE 2

Remote control command codes used in the SAA5050

CODE							COMMAND	FUNCTION
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>		
0	X	X	X	X	X	X	'tv' mode	Allows text on top row of display only.
1	X	X	X	X	X	X	'Text' mode	Allows text throughout display period.
1	0	1	1	1	1	0	Superimpose	Sets Superimpose mode.
1	0	1	1	1	1	1	teletext	Resets Superimpose mode.
0	X	X	X	X	X	X	'tv' mode	Resets Superimpose mode.
1	1	X	X	X	X	X	viewdata mode	Resets Superimpose mode;
1	X	0	0	1	1	0	Reveal	Reveals for time-out (notes 3, 4).
1	X	0	1	0	1	1	Reveal set	Sets Reveal mode (note 3).
Any command apart from reveal set.								Resets Reveal mode (note 3)

X = Don't care.

## Notes

- When the power is applied the SAA5050 is set into the 'tv' mode and reset out of Superimpose and Reveal modes.
- 'Text' mode is selected when  $\overline{SI}$  (pin 2) is held LOW
- Reveal mode allows display of text previously concealed by 'conceal display' control characters.
- This code is sent from the SAA5010 or the SAA5012 Series as a repeated command. Thus Reveal mode is set for as long as the Reveal key is depressed. The SAA5050 reverts to normal 'not Reveal' mode 160 ms after the last Reveal command.
- The Superimpose output is LOW only if Superimpose mode is set and the DE (display enable) input is HIGH.
- The above table shows code required for functions specified.  
The SAA5010 or the SAA5012 Series transmits and the SAA5050 requires the inverse of these codes i.e.  $\overline{b_7}$  to  $\overline{b_1}$ . The code is transmitted serially in the following order:  $\overline{b_7}$   $\overline{b_1}$   $\overline{b_2}$   $\overline{b_3}$   $\overline{b_4}$   $\overline{b_5}$   $\overline{b_6}$ .  
For full details of remote control data coding see the SAA5010 or the SAA5012 data sheets.



TABLE 3

Conditions affecting display (see note 3)

Inputs		Control data		Outputs	
Picture On (PO)	Display Enable (DE)	Superimpose Mode	Box	Text Display Enabled (i.e. R,G,B,Y outputs)	Blanking
(a) 1	0	1 or 0	1 or 0	0	0
(b) 0	1	1 or 0	1 or 0	1	1
(c) 0	0	1 or 0	1 or 0	0 (note 2)	1
(d) 1	1	0	0	0	0
(e) 1	1	1	0	1	0
(f) 1	1	1	1	1	1
(g) 1	1	0	1	1	1

## Notes

1. For tv mode (Picture On = '1', Superimpose mode not allowed) rows (a), (d) and (g) of Table 3 refer to display row 0 only. For all other rows text display is disabled and Blanking = '0'.
2. The R, G, B outputs may contain character and background colour information. The only exception is that background colours are inhibited when Blanking = '0'.
3. Valid during display period only (see Fig.5) otherwise no character or background information is displayed as blanking is determined by the Picture On. (No blanking if PO = '1').



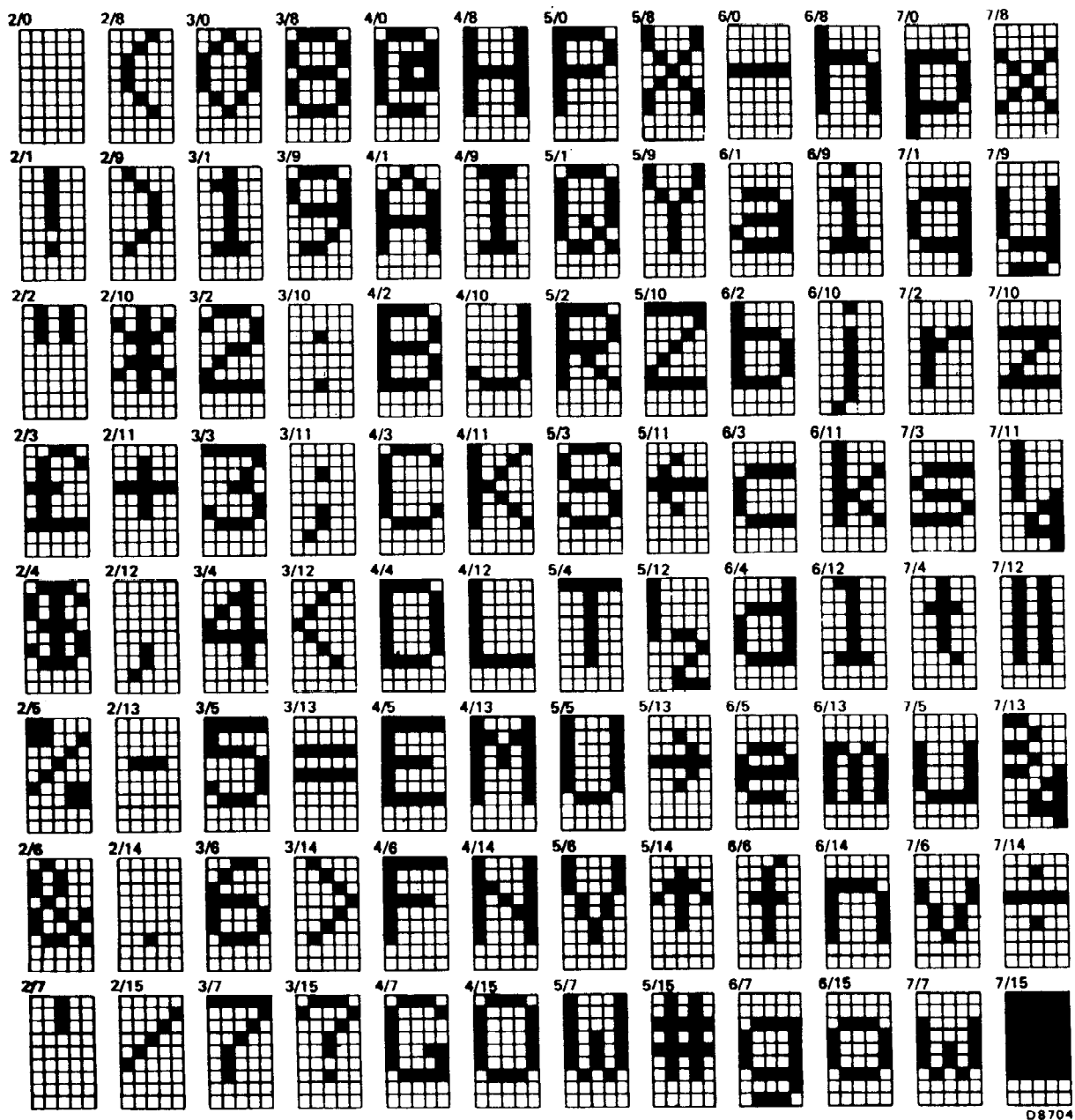


Fig. 11 SAA5050 character set (English).