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

purple binder, tab 6

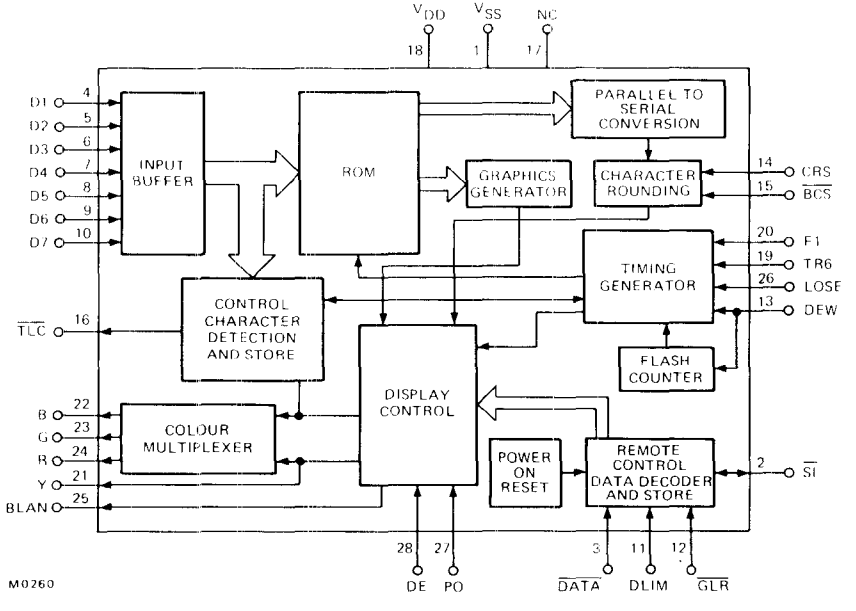


Fig.1 Block diagram

PACKAGE OUTLINE

28-lead DIL; plastic (SOT-117)

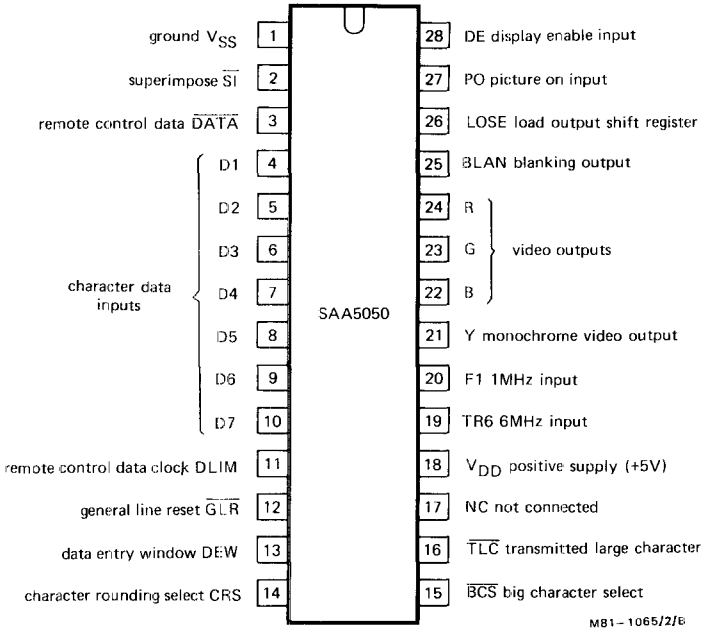


Fig.2 Pinning diagram

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 μs 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.	
Voltages (with respect to pin 1)					
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 °C and V_{DD} = 5 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					
$\overline{\text{DATA}}$ (pin 3) DEW (pin 13) LOSE (pin 26)					
DLIM (pin 11) CRS (pin 14) PO (pin 27)					
$\overline{\text{GLR}}$ (pin 12) $\overline{\text{BCS}}$ (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 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 mA)		V_{OL}	–	–	0.5	V
Output voltage; LOW (I_{OL} = 4 mA)		V_{OL}	–	–	1.0	V
Output voltage; LOW (I_{OL} = 6 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	note 1	Δt_f	0	–	20	ns
$\overline{\text{TLC}}$ (pin 16)						
Output voltage; LOW (I_{OL} = 100 μA)		V_{OL}	0	–	0.5	V
Output voltage; HIGH ($-I_{OH}$ = 100 μA)		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	μs
Output fall time	Measured between 0.8 V and 2.0 V levels	t_f	–	–	1.0	μs
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 V)		I_{IR}	–	–	10	μA
Input capacitance		C_I	–	–	7	pF
Output voltage; LOW (I_{OL} = 0.4 mA)		V_{OL}	0	–	0.5	V
Output voltage; LOW (I_{OL} = 1.3 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 μs. 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	–	μs
	Alphanumerics	t_{CDA}	–	2.767	–	μs

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	–	μs
LOSE falling edge to 'Display off'	t_{DOFF}	–	2.6	–	μs
'Display period'	t_{DP}	–	40	–	μs

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	–	μs
Line start* to GLR falling edge	t_{GLR}	–	5	–	μs
Line start* to LOSE rising edge	t_{LSL}	–	14.5	–	μs
LOSE falling edge to Line start*	t_{LLS}	–	9.5	–	μs
Line period	t_{LNP}	–	64	–	μs
LOSE HIGH time	t_{LHP}	–	40	–	μs

Remote data input timing (Fig.8)

Assuming F1 period = 1 μs and GLR period = 64 μs

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

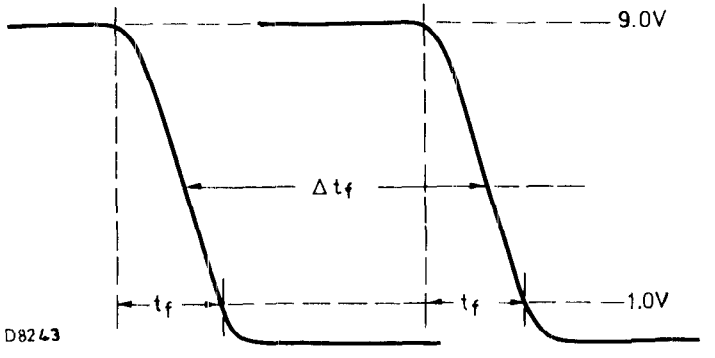
*Taken as falling edge of 'line sync' pulse.

Notes

1. Fall time, t_f and Δt_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.

   Δt_f is the maximum time difference between outputs.



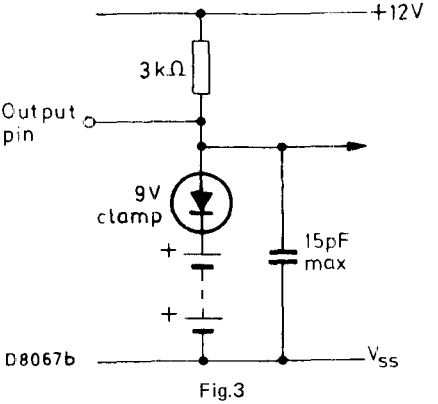


Fig.3

2. Recommended pull-up resistor for $\overline{SI}$ is 18 kΩ.
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 μs. 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_{SS} 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_{SS}), 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. **$\overline{DATA}$ 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 μs/bit. The command codes used in the SAA5050 are shown in Table 2.

4,5,6 7,8,9, 10 **D1 to D7 Character data**

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. **$\overline{BCS}$ Big character select**

This input from the SAA5040 Teletext Acquisition and Control device allows selection of large characters by remote control.

16. **$\overline{TLC}$ 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_{DD} + 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_{SS}

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_{SS}.

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_{SS}. 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.

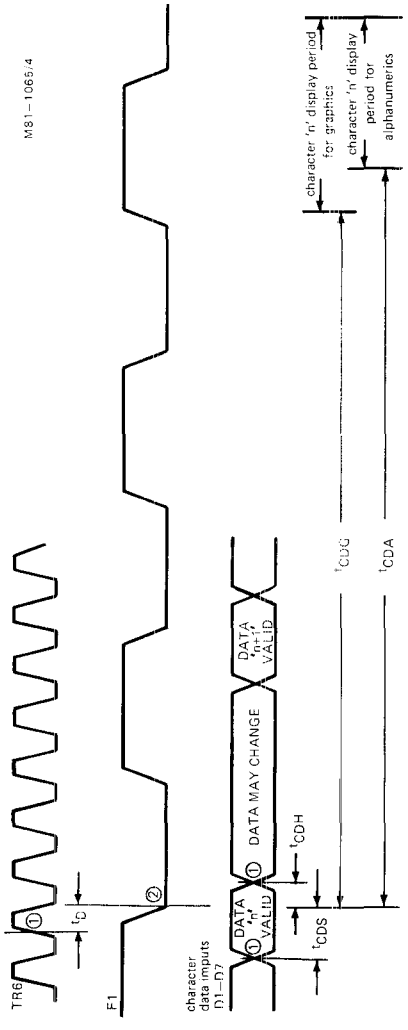


Fig.4 Character data timing (for typical 40 character display)

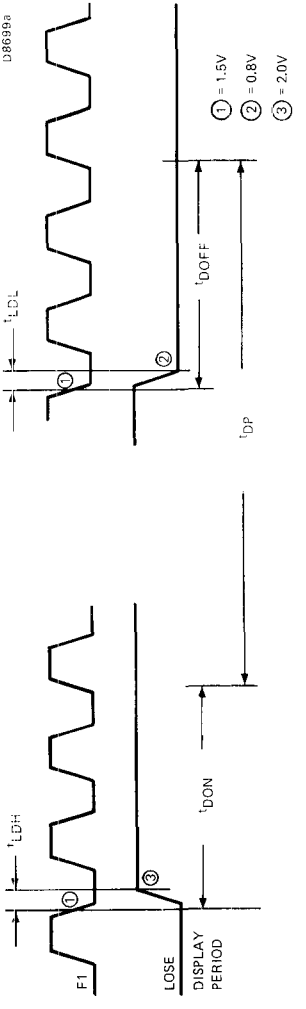


Fig.5 Display period timing (for typical 40 character display)

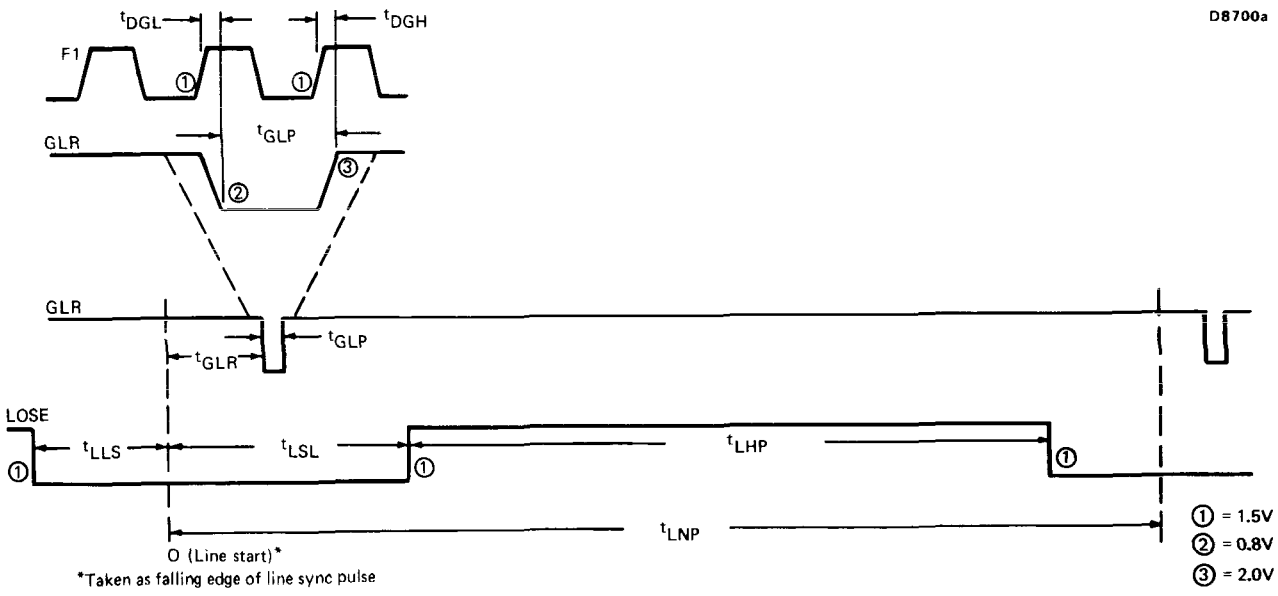


Fig.6 Line rate clocks (for line period of 64 μs)

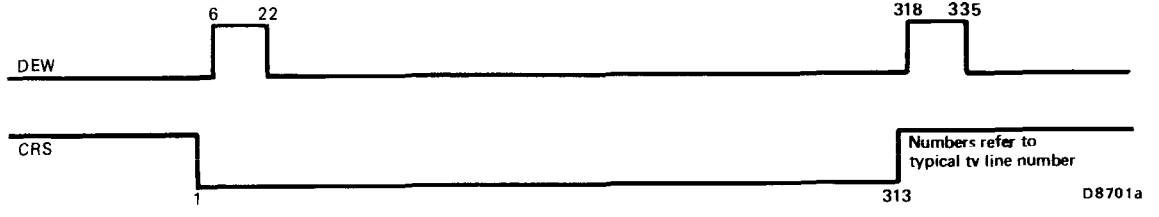


Fig.7 Field rate clocks (for field period of 20 ms, 312½ lines per field)

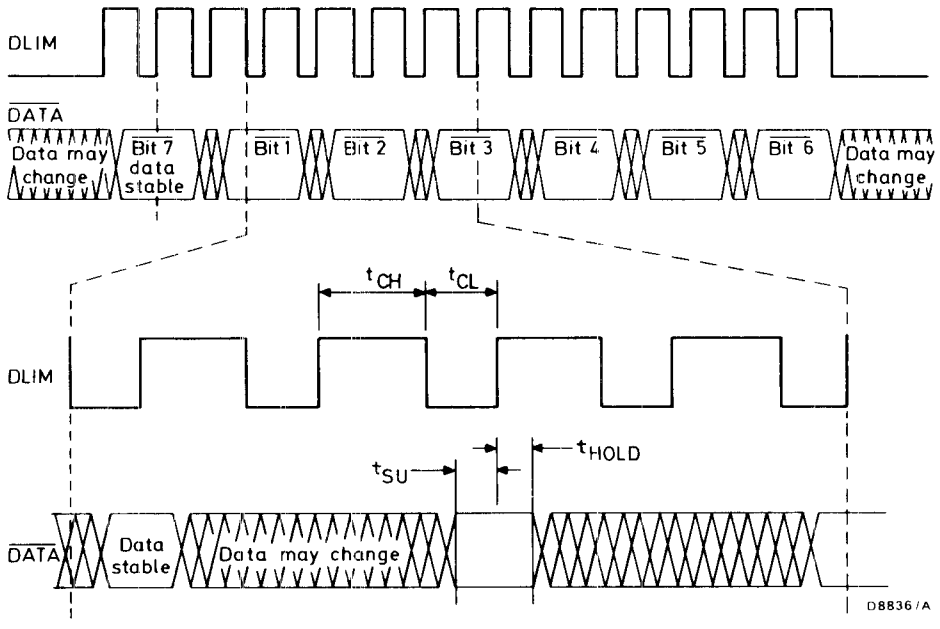
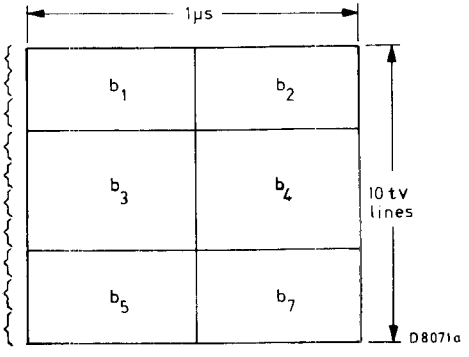


Fig.8 Remote control input timing



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

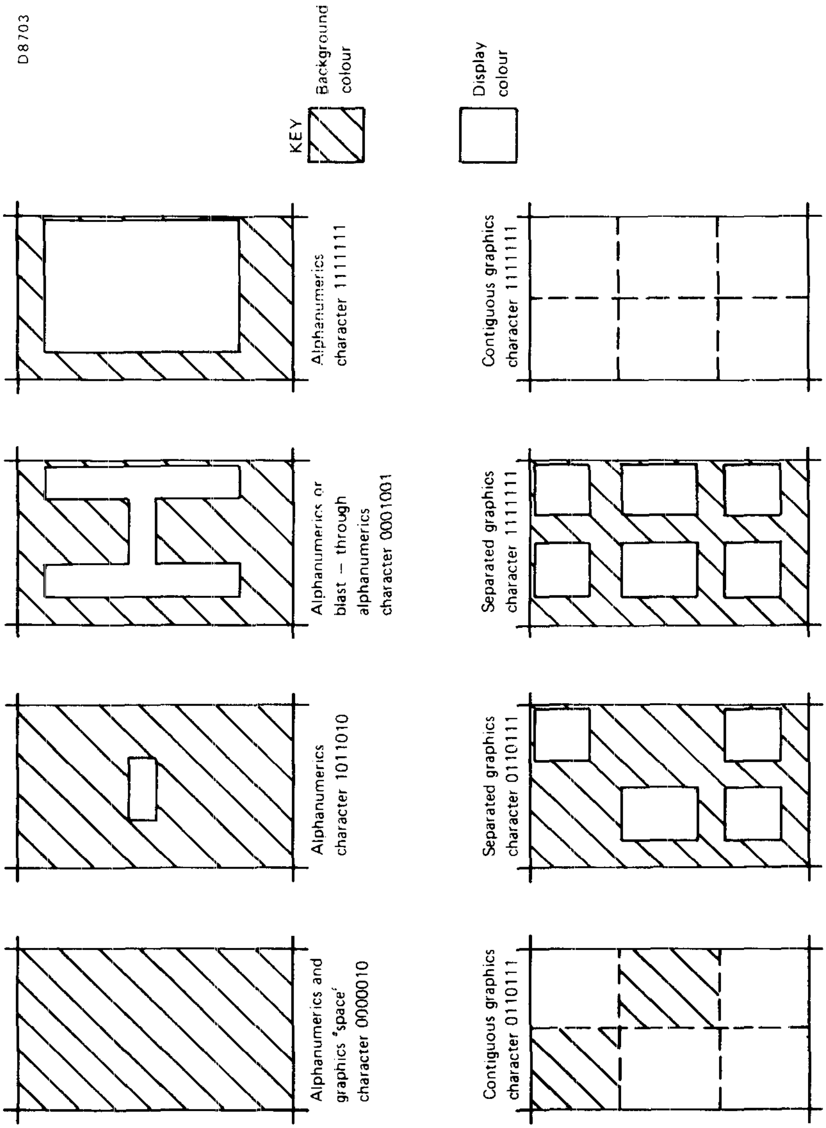


Fig.10 Character format

TABLE 1

Character data input decoding

D8068a

Bits b_4 b_3 b_2 b_1	Row	b_7 b_6 b_5 = 0 0 0	0 0 1	0 1 0	2	0 1 0	2a	0 1 1	3	0 1 1	3a	1 0 0	4	1 0 1	5	1 1 0	6	1 1 0	6a	1 1 1	7	1 1 1	7a
0 0 0 0	0	NUL*	DLE*					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	10	End Box**	Separated Graphics	*				:				J		Z		j				z			
1 0 1 1	11	Start Box**	ESC*	+				;				K		[		k				¼			
1 1 0 0	12	Normal Height**	Black Background**	,				<				L		\		l				‖			
1 1 0 1	13	Double Height	New Background	-				=				M		]		m				¾			
1 1 1 0	14	SO*	Hold Graphics	.				>				N		↑		n				÷			
1 1 1 1	15	SI*	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 compatability with other data codes.

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

Codes may be refered 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 b_7	b_6	b_5	b_4	b_3	b_2	b_1	COMMAND	FUNCTION
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

1. When the power is applied the SAA5050 is set into the 'tv' mode and reset out of Superimpose and Reveal modes.
2. 'Text' mode is selected when $\overline{SI}$ (pin 2) is held LOW
3. Reveal mode allows display of text previously concealed by 'conceal display' control characters.
4. 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.
5. The Superimpose output is LOW only if Superimpose mode is set and the DE (display enable) input is HIGH.
6. 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').

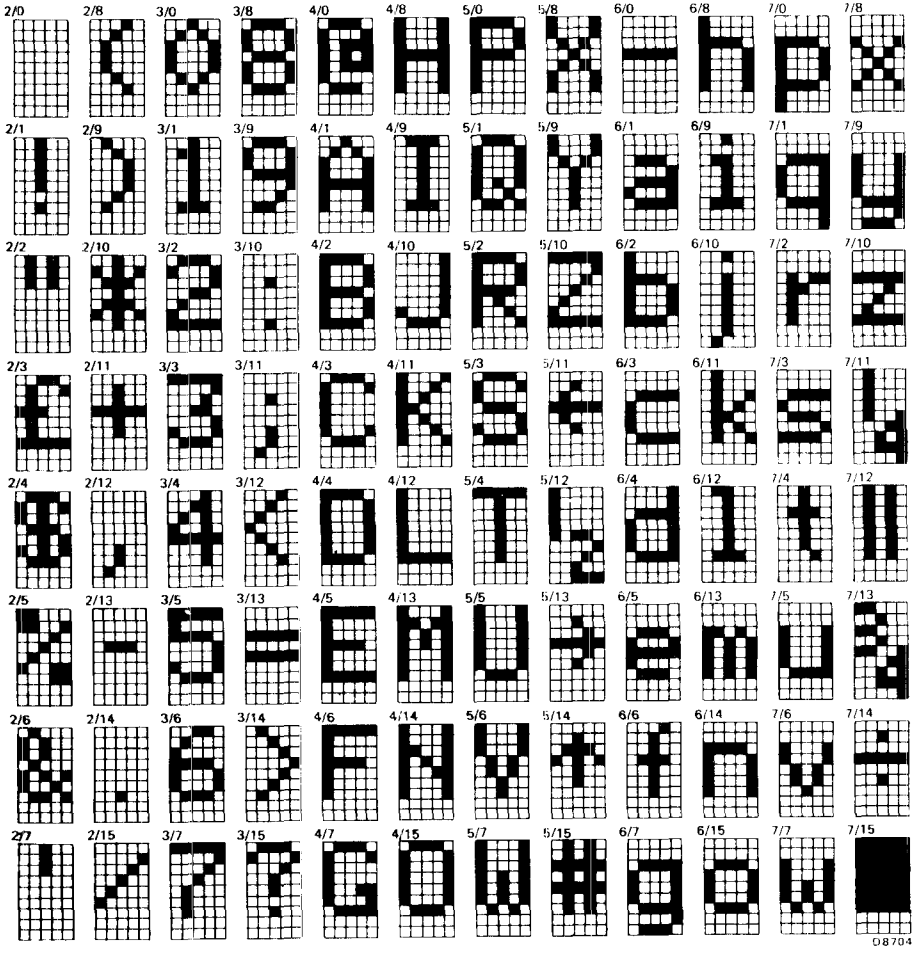


Fig. 11 SAA5050 character set (English).

Fig.12 SAA5051 character set (German).

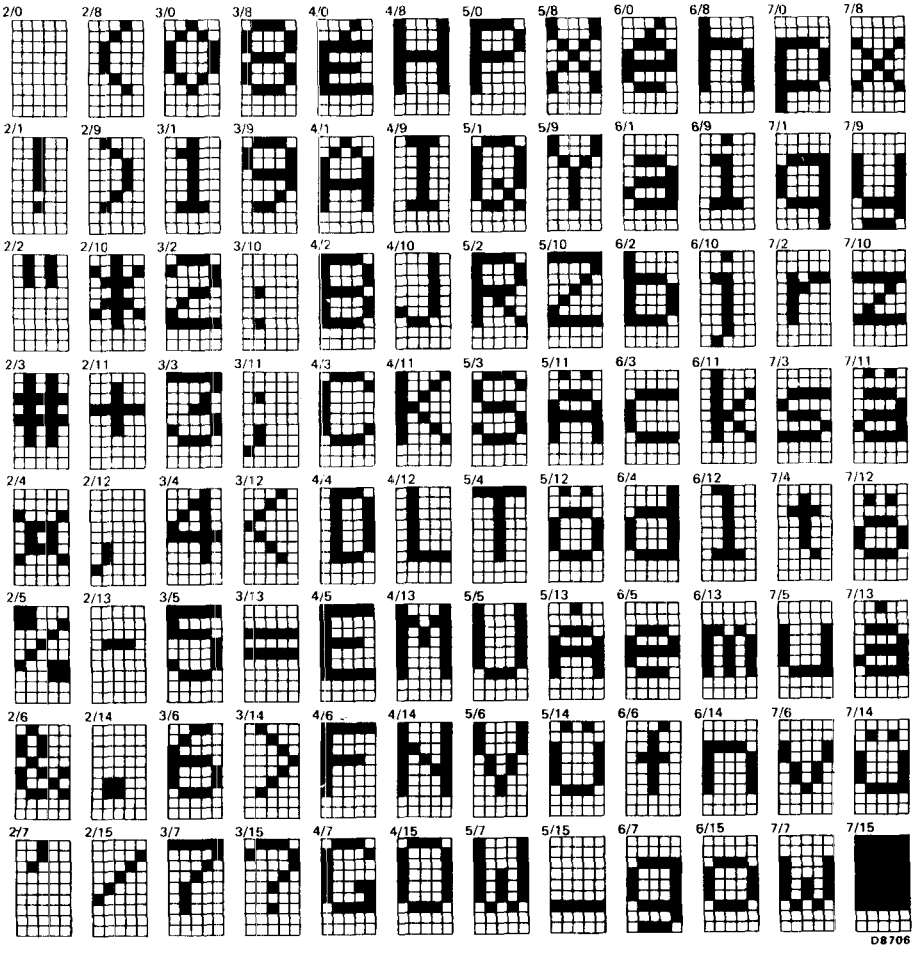


Fig.13 SAA5052 character set (Swedish).

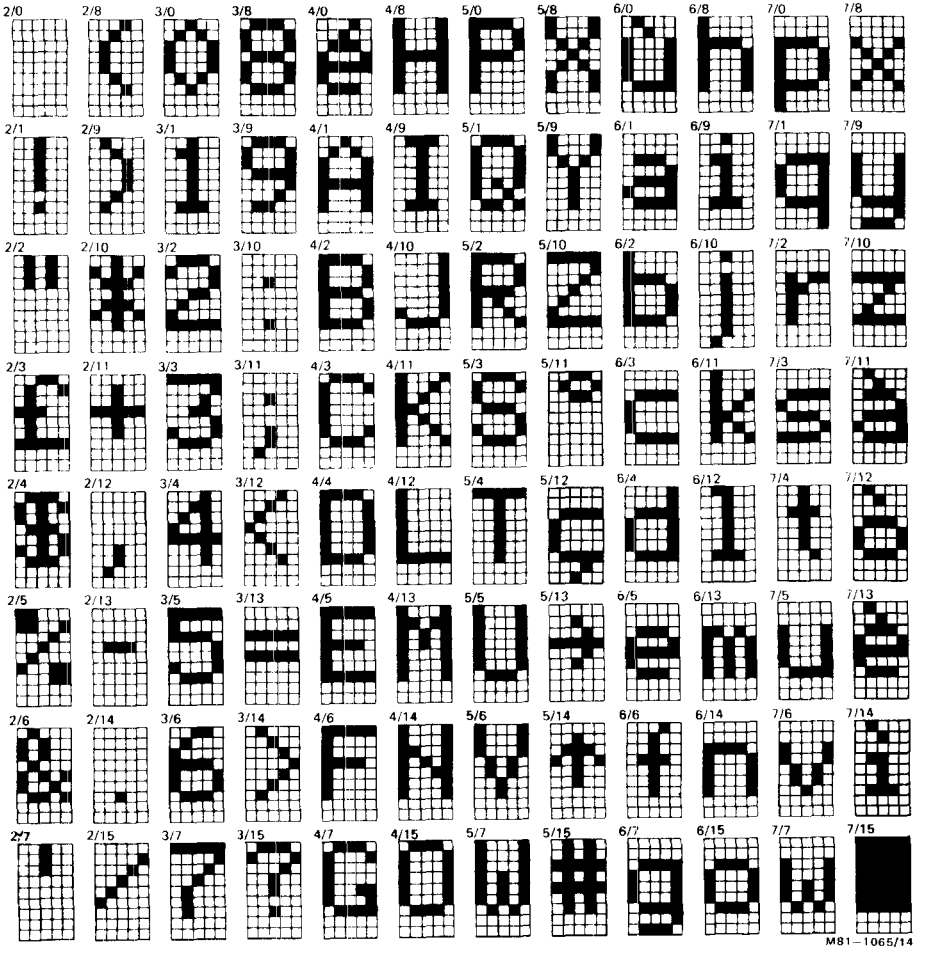


Fig.14 SAA5053 character set (Italian).

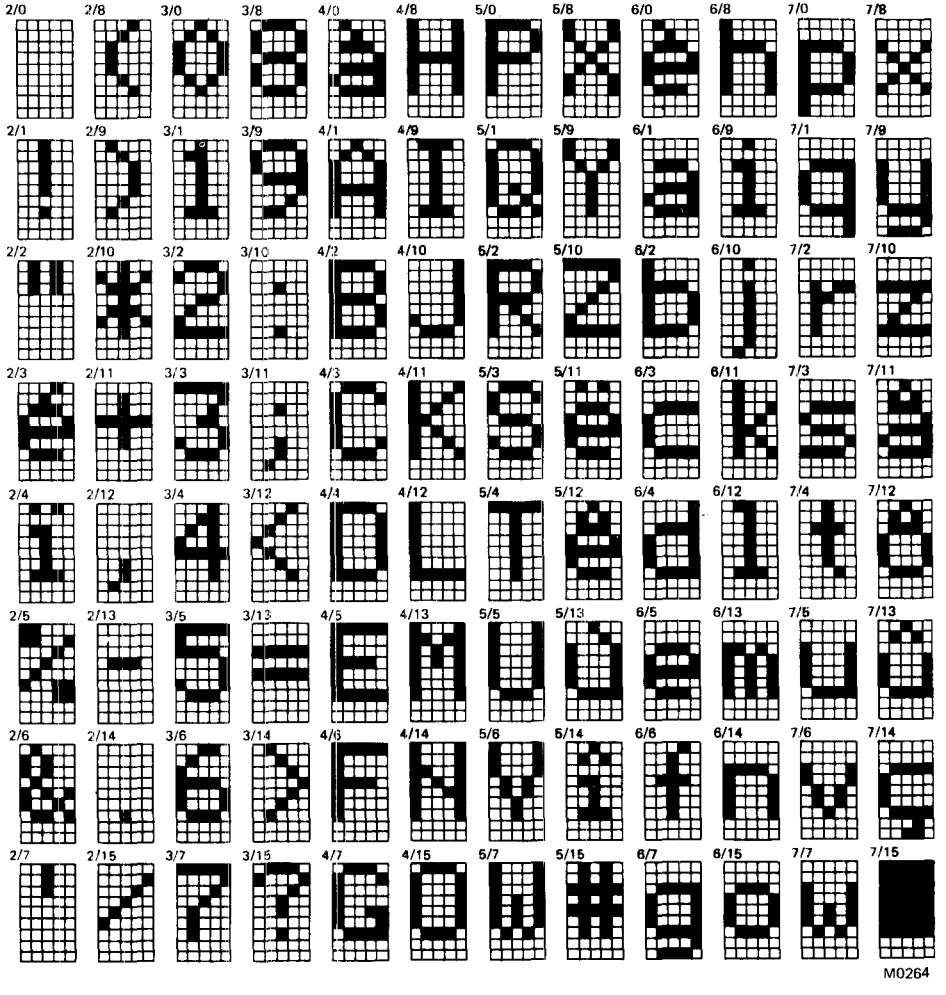


Fig.15 SAA5054 character set (Belgian)

Fig.16 SAA5055 character set (US ASCII).

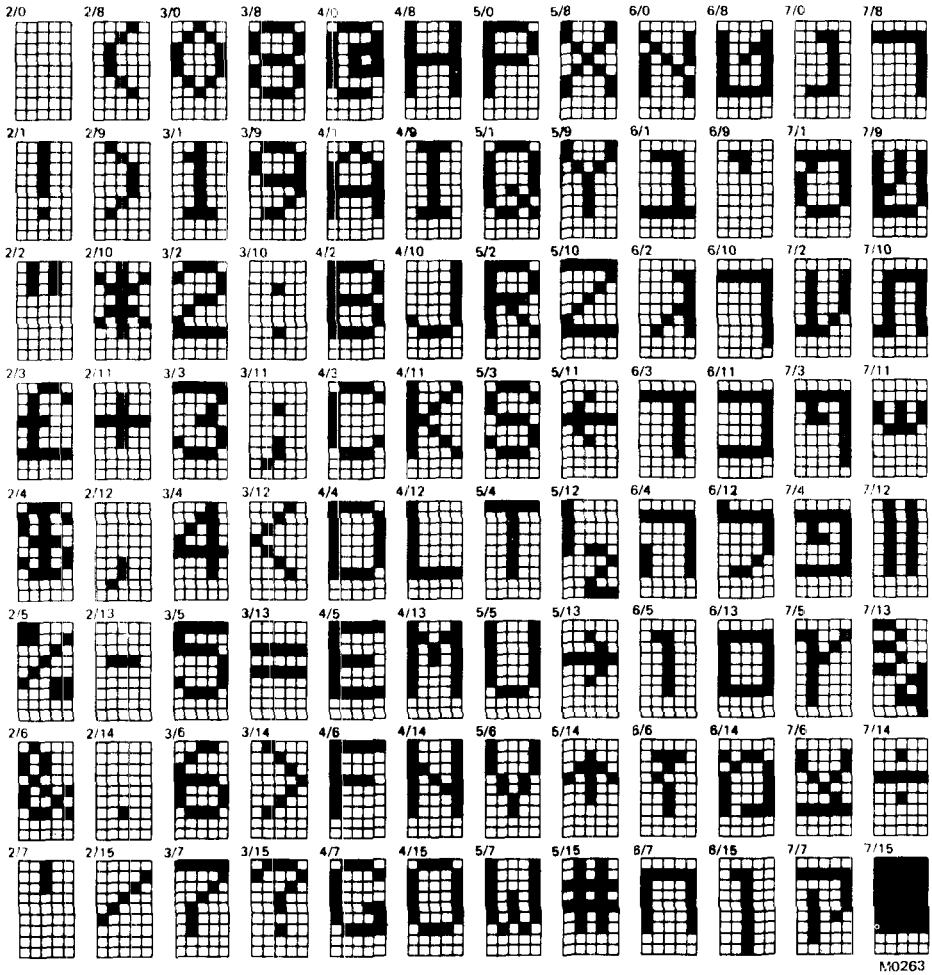


Fig.17 SAA5056 character set (Hebrew).

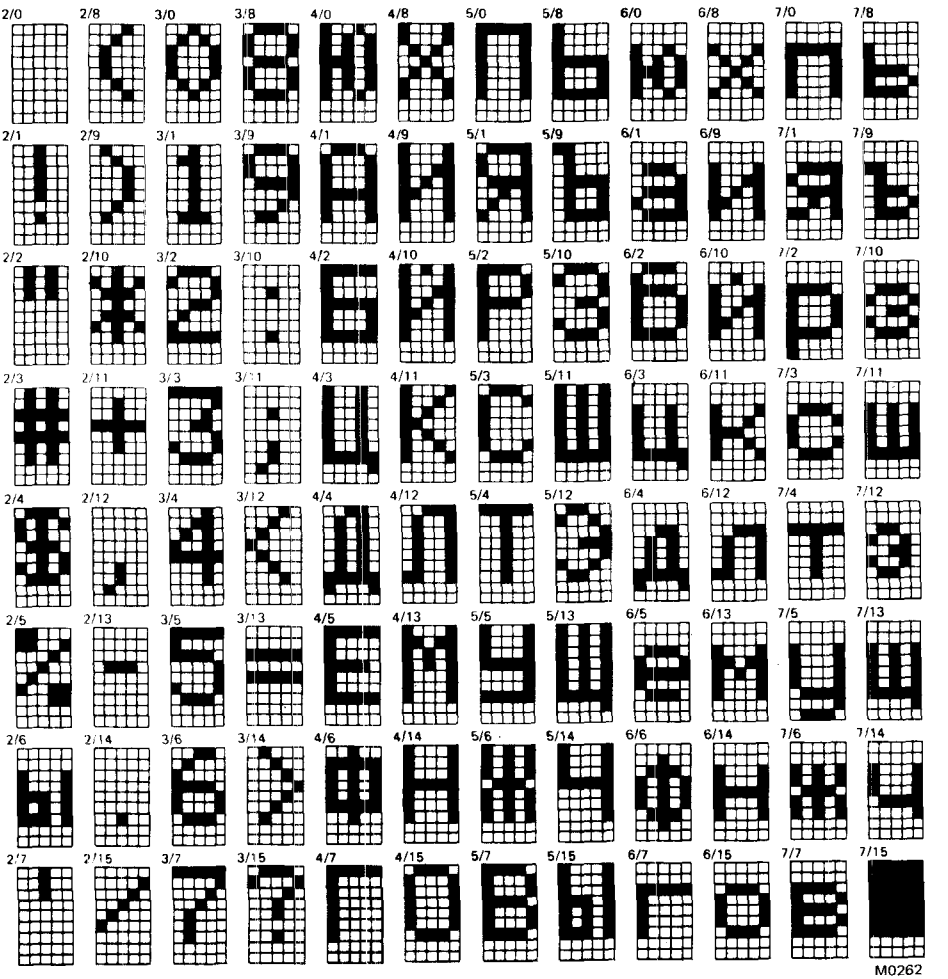
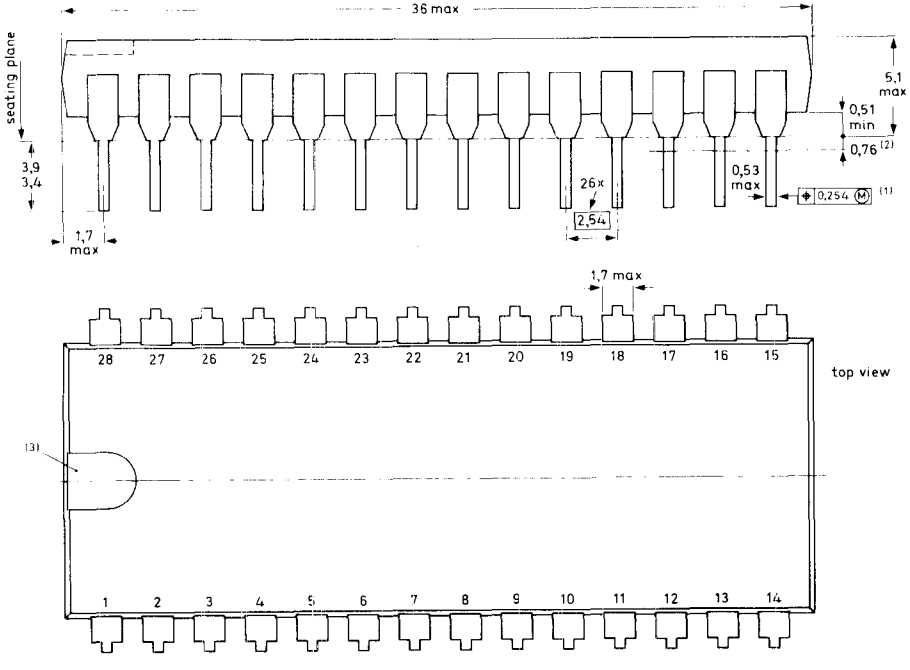
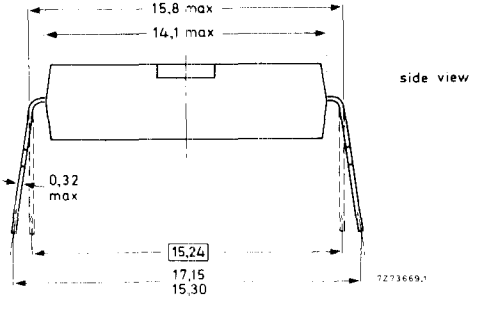


Fig.18 SAA5057 character set (Cyrillic).

28-LEAD DUAL IN-LINE; PLASTIC (SOT- 117)





Dimensions in mm

⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

(1) Centre-lines of all leads are within ±0,127 mm of the nominal position shown; in the worst case, the spacing between any two leads may deviate from nominal by ±0,254 mm.

(2) Lead spacing tolerances apply from seating plane to the line indicated.

(3) Index may be horizontal as shown, or vertical.