Signetics

SAA5050/55
Teletext Character Generator

Product Specification

Linear Products

DESCRIPTION
The SAA5050 series of MOS N-channel integrated circuits provides the video drive signals to the television receiver necessary to produce the teletext/view-data display.

The SAA5050 is a 28-pin device which incorporates a fast access character generator ROM (4.3kbits), 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 1μs and the character dot rate is 6MHz. The timings are derived from the two external input clocks F1 (1MHz) and TR6 (6MHz) which are amplified and re-synchronized 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 $\times$ 9 matrix, allowing space for descending characters. Each of the 64 graphic characters is decoded to form a 2 $\times$ 3 block arrangement which occupies the complete 6 $\times$ 10 dot matrix (Figure 7). Graphics characters may be either contiguous or separated (Figure 8). 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 color 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., color. 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.

FEATURES
- **On-chip character ROM**
- **Contains 'character rounding' facility**
- **Interprets remote control commands**
- **Video output consists of R, G, B and Y open-collector**
- **Provides a 'Blanking' output**
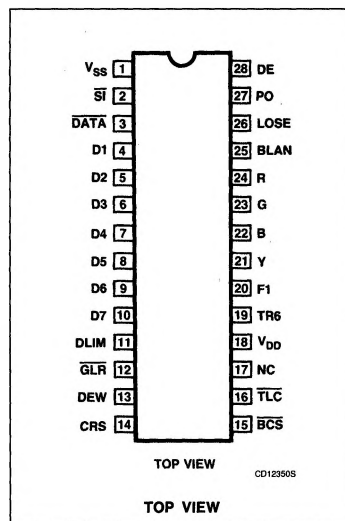- **Provides a 'Superimpose' output for use in 'Mix-mode' type displays**

APPLICATIONS
- **Teletext**
- **Videotex**
- **Low cost character generator**
- **Display systems with windowing, boxing, and text overlay capabilities**
- **Telecaptioning**

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
28-Pin Plastic DIP (SOT-117)	−20°C to +70°C	SAA5050N
28-Pin Plastic DIP (SOT-117)	−20°C to +70°C	SAA5055N

PIN CONFIGURATION

V$_{SS}$	1	28	DE
SI	2	27	PO
DATA	3	26	LOSE
D1	4	25	BLAN
D2	5	24	R
D3	6	23	G
D4	7	22	B
D5	8	21	Y
D6	9	20	F1
D7	10	19	TR6
DLIM	11	18	V$_{DD}$
GLR	12	17	NC
DEW	13	16	TLC
CRS	14	15	BCS

TOP VIEW

CD12350S

TOP VIEW

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BLOCK DIAGRAM
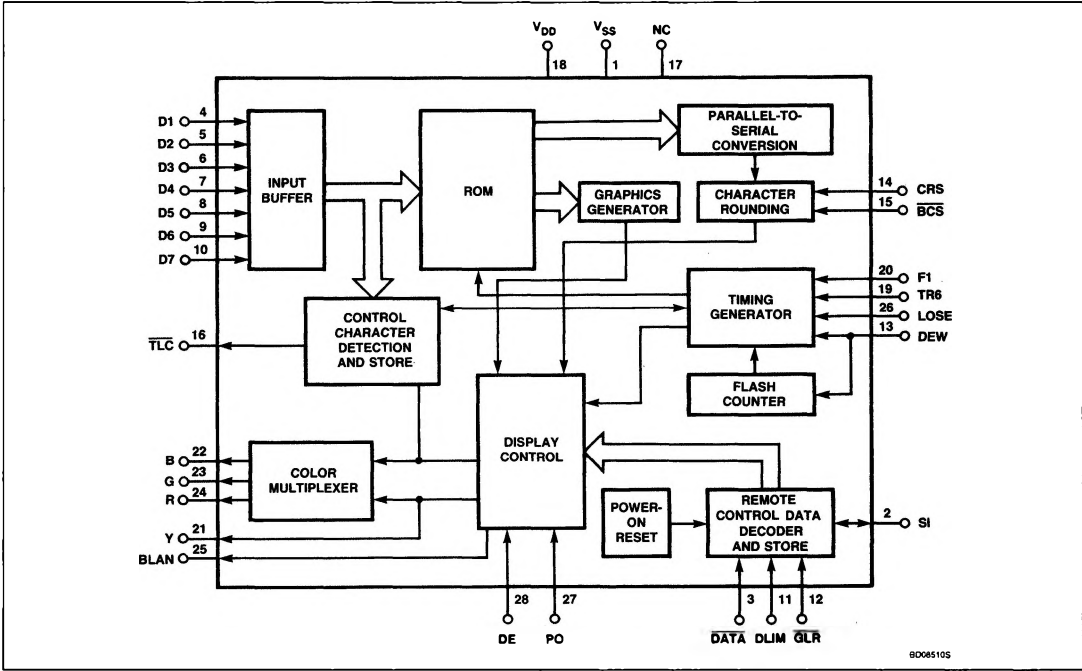
ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
Voltages (with respect to Pin 1)			
V_{DD}	Supply voltage (Pin 18)	−0.3 to 7.5	V
V_I	Input voltages (all inputs + input/output)	−0.3 to 7.5	V
V_{O16} V_O	Output voltage (Pin 16) (all other output s)	−0.3 to 75 −0.3 to 14.0	V V
Temperature			
T_{STG}	Storage temperature range	−20 to +125	°C
T_A	Operating ambient temperature range	−20 to +70	°C

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SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
V_{DD}	Supply voltage (Pin 18)	4.5		5.5	V
I_{DD}	Supply current		85	160	mA
Inputs					
Character data D1 to D7 (Pins 4 to 10)					
V_{IH}	Input voltage; High	2.65		V_{DD}	V
V_{IL}	Input voltage; Low	0		0.6	V
Clock inputs F1 (Pin 20) TR6 (Pin 19)					
V_{IH}	Input voltage; High	2.65		V_{DD}	V
V_{IL}	Input voltage; Low	0		0.6	V
Logic inputs DATA (Pin 3), DLIM (Pin 11), GLR (Pin 12) DEW (Pin 13), CRS (Pin 14), BCS (Pin 15), LOSE (Pin 26), PO (Pin 27), DE (Pin 28)					
V_{IH}	Input voltage; High	2		V_{DD}	V
V_{IL}	Input voltage; Low	0		0.8	V
All inputs					
I_{IR}	Input leakage current ($V_I = 5.5V$)			10	μA
C_I	Input capacitance			7	pF
Outputs					
Character video outputs + blanking output (open-drain)[3] B– (Pin 22), G– (Pin 23), R– (Pin 24), Y– (Pin 21), blanking (Pin 25)					
V_{OL}	Output voltage; Low ($I_{OL} = 2mA$)			0.5	V
V_{OL}	Output voltage; Low ($I_{OL} = 4mA$)			1.0	V
V_{OL}	Output voltage; Low ($I_{OL} = 6mA$)			2.0	V
V_{OH}	Output voltage; High[5]	V_{DD}		13.2	V
C_L	Output load capacitance			15	pF
t_F	Output fall time[1]			30	ns
Δt_F	Variation of fall time between any outputs[1]	0		20	ns
TLC (Pin 16)					
V_{OL}	Output voltage; Low ($I_{OL} = 100\mu A$)	0		0.5	V
V_{OH}	Output voltage; High ($-I_{OH} = 100\mu A$)	2.4		V_{DD}	V
C_L	Output load capacitance			30	pF
t_R	Output rise time Measured between 0.8V and 2.0V levels			1.0	μs
t_F	Output fall time Measured between 0.8V and 2.0V levels			1.0	μs

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DC AND AC ELECTRICAL CHARACTERISTICS (Continued) $T_A = 25°C$ and $V_{DD} = 5V$, unless otherwise stated.

| SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
Input/output					
SI (Pin 2) (open-drain)					
V_{IH}	Input voltage; High	2.0		6.5	V
V_{IL}	Input voltage; Low	0		0.8	V
I_{IR}	Input leakage current (V_I = 5.5V)			10	μA
C_I	Input capacitance			7	pF
V_{OL}	Output voltage; Low (I_{OL} = 0.4mA)	0		0.5	V
V_{OL}	Output voltage; Low (I_{OL} = 1.3mA)	0		1.0	V
C_L	Output load capacitance			45	pF
V_{OH}	Output voltage; High state[2]			6.5	V
Character data timing (Figure 2)					
t_D	TR6 rising edge to F1 falling edge	6		60	ns
f_{TR6}	TR6 frequency		6		MHz
	TR6 mark/space ratio	40:60		60:40	
f_{F1}	F1 frequency		1		MHz
	F1 mark/space ratio	40:60		60:40	
t_{CDS}	Data setup time	80			ns
t_{CDH}	Data hold time	100			ns
t_{CDG} t_{CDA}	Delay time — character in/ character data at outputs } Graphics / Alphanumerics		2.6 2.767		μs μs
Display period timing (Figure 3)					
t_{LDH}	F1 falling edge to LOSE rising edge	0		250	ns
t_{LDL}	F1 falling edge to LOSE falling edge	0		250	ns
t_{DON}	LOSE rising edge to 'Display on'		2.6		μs
t_{DOFF}	LOSE falling edge to 'Display off'		2.6		μs
t_{DP}	'Display period'		40		μs
Line rate timing (Figure 4)					
t_{DGL}	F1 rising edge to GLR falling edge	0		200	ns
t_{DGH}	F1 rising edge to GLR rising edge	0		200	ns
t_{GLP}	GLR Low time		1		μs
t_{GLR}	Line start* to GLR falling edge		5		μs
t_{LSL}	Line start* to LOSE rising edge		14.5		μs
t_{LLS}	LOSE falling edge to Line start*		9.5		μs
t_{LNP}	Line period		64		μs
t_{LHP}	LOSE High time		40		μs

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DC AND AC ELECTRICAL CHARACTERISTICS (Continued) $T_A = 25°C$ and $V_{DD} = 5V$, unless otherwise stated.

| SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
Remote data input timing (Figure 6) Assuming F1 period = 1μs and GLR period = 64μs					
t_{CH}	DLIM clock High time[4]	6.5	8		μs
t_{CL}	DLIM clock Low time	3.5	8	60	μs
t_{DS}	DATA to DLIM setup time	0	14		μs
t_{DH}	DLIM to $\overline{DATA}$ hold time	8	14		μs

NOTES:

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

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 9V and 1V levels.
   Δt_F is the maximum time difference between outputs.
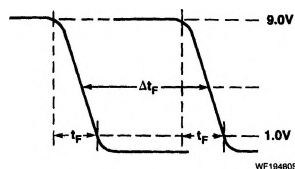
2. Recommended pull-up resister for $\overline{SI}$ is 18kΩ.
3. The R, G, B, Y, and blanking outputs are protected against short circuit to supply rails.
4. There is no maximum DLIM cycle time, provided the DLIM duty cycle is such that the t_{CL} max requirement is not exceeded.
5. With maximum pull-up voltage applied to R, G, B, and BLAN outputs the leakage current will not exceed 20μA with the outputs in the off state.
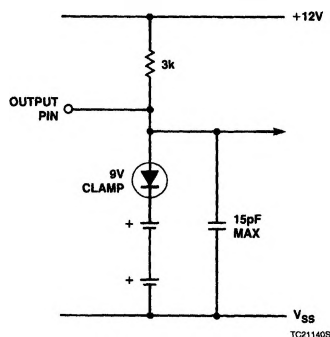
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SPECIAL FEATURES

Flash Oscillator

The circuit generates a 0.75Hz 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 graphic characters are decoded directly from the character data inputs and appear on a 2×3 matrix. Figure 7 gives details of the graphics decoding.

APPLICATION DATA

The function is quoted against the corresponding pin numbers.

1 V_{SS} Ground — 0V.

2 Sī 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 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, 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 center of each remote control data bit (Figure 6).

12 GLR General Line Reset — This input signal from the SAA5020 Timing Chain is required for internal synchronization 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.

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_{DD} +5V Supply — This is the power supply input to the circuit.

19 TR6 — This input is a 6MHz signal from the SAA5020 Timing Chain used as a character dot rate clock.

20 F1 — This input is a 1MHz 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 synchronize an internal divide-by-6 counter. The F1 signal is internally synchronized 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 color 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 are given in Table 3.
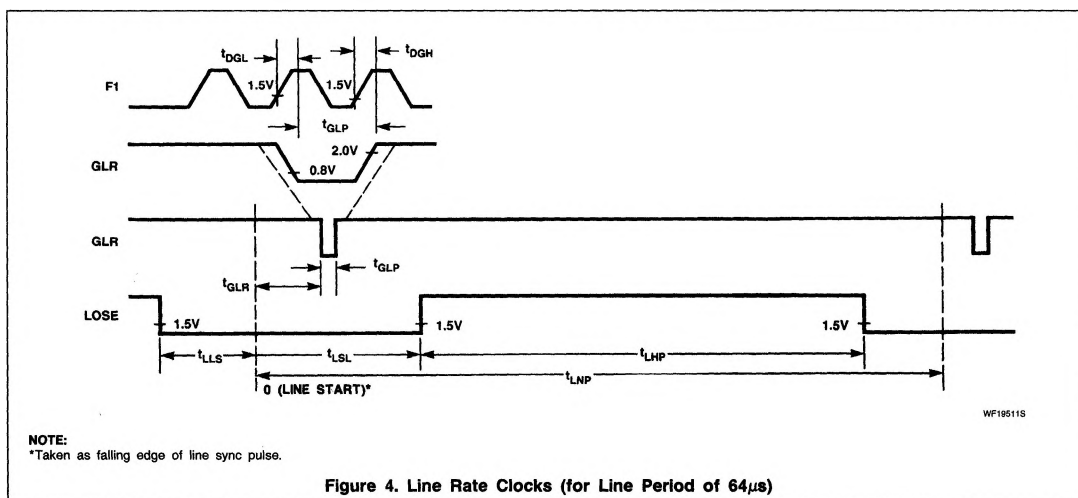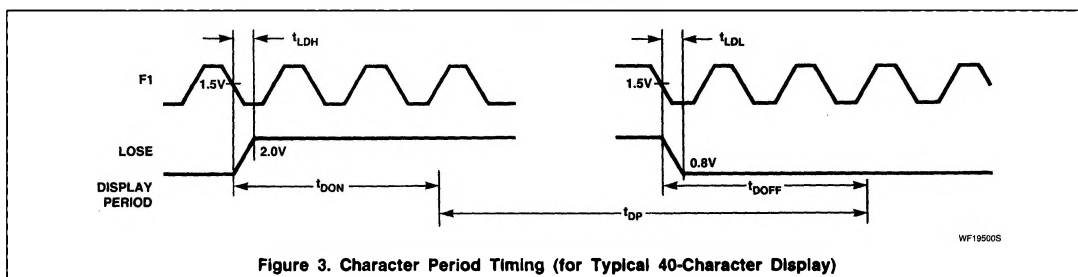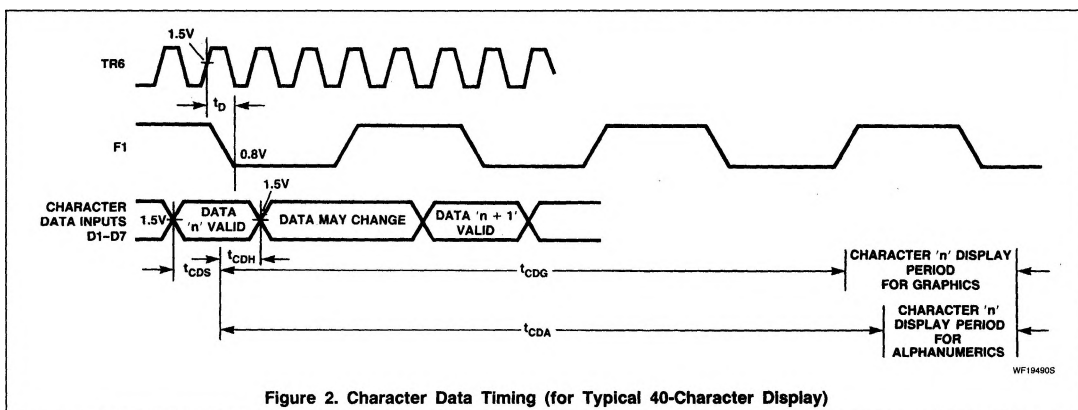
26 LOSE Load Output Shift Register Enable — This input signal from the SAA5020 Timing Chain resets the internal control character flip-flops prior to the start of each display line. It also defines the character display period.

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).
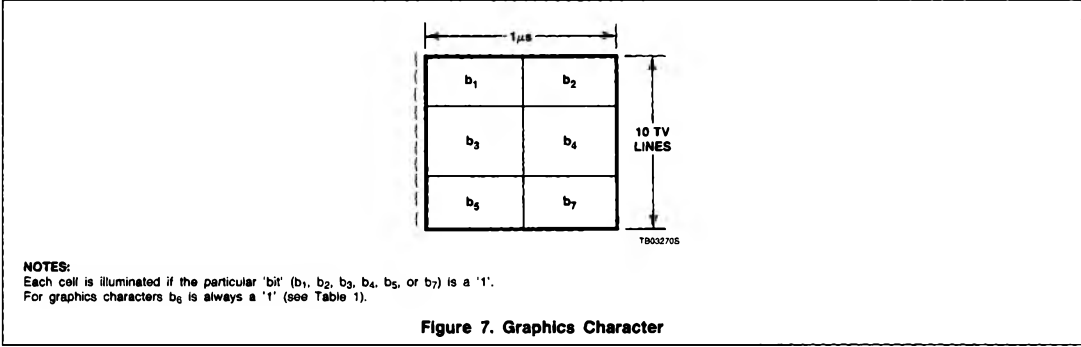
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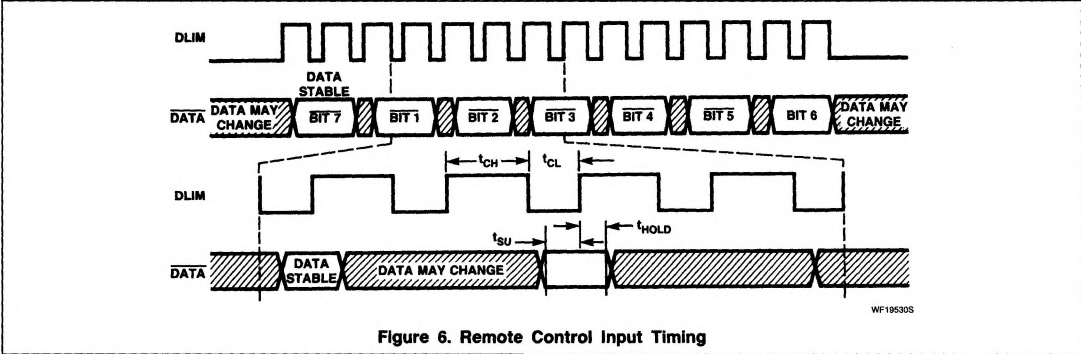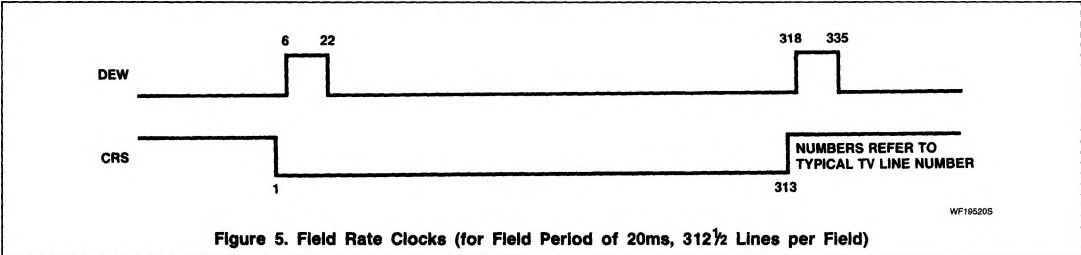
Figure 2. Character Data Timing (for Typical 40-Character Display)

Figure 3. Character Period Timing (for Typical 40-Character Display)

NOTE:
*Taken as falling edge of line sync pulse.

Figure 4. Line Rate Clocks (for Line Period of 64μs)

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Figure 5. Field Rate Clocks (for Field Period of 20ms, 312½ Lines per Field)

Figure 6. Remote Control Input Timing

NOTES:
Each cell is illuminated if the 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).

Figure 7. Graphics Character

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Figure 8. Character Format

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Table 1. Character Data Input Decoding

The table shows Character Data Input Decoding. Columns are labeled by bits b7 b6 b5 (0 0 0 through 1 1 1) giving columns 0, 1, 2/2a, 3/3a, 4, 5, 6/6a, 7/7a. Rows are labeled by bits b4 b3 b2 b1 giving rows 0–15.

| Row	b4 b3 b2 b1	0	1	2	3	4	5	6	7
0	0 0 0 0	NUL*	DLE*		0	@	P		p
1	0 0 0 1	Alpha^n Red	Graphics Red	!	1	A	Q	a	q
2	0 0 1 0	Alpha^n Green	Graphics Green	"	2	B	R	b	r
3	0 0 1 1	Alpha^n Yellow	Graphics Yellow	£	3	C	S	c	s
4	0 1 0 0	Alpha^n Blue	Graphics Blue	$	4	D	T	d	t
5	0 1 0 1	Alpha^n Magenta	Graphics Magenta	%	5	E	U	e	u
6	0 1 1 0	Alpha^n Cyan	Graphics Cyan	&	6	F	V	f	v
7	0 1 1 1	Alpha^n White **	Graphics White	'	7	G	W	g	w
8	1 0 0 0	Flash	Conceal Display	(	8	H	X	h	x
9	1 0 0 1	Steady **	Contiguous Graphics **	)	9	I	Y	i	y
10	1 0 1 0	End Box **	Separated Graphics	*	:	J	Z	j	z
11	1 0 1 1	Start Box	ESC *	+	;	K	←	k	¼
12	1 1 0 0	Normal Height **	Black Background **	,	<	L	½	l	‖
13	1 1 0 1	Double Height	New Background	–	=	M	→	m	¾
14	1 1 1 0	SO *	Hold Graphics	.	>	N	↑	n	÷
15	1 1 1 1	S1 *	Release Graphics **	/	?	O	#	o	▮

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NOTES:
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 Figures 9 and 10.
* These control characters are reserved for compatability 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 color.
White represents background.

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Table 2. Remote Control Command Codes Used in the SAA5050

CODE							COMMAND	FUNCTION
b_7	b_6	b_5	b_4	b_3	b_2	b_1		
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[3]
1	X	0	1	0	1	1	Reveal set	Sets Reveal mode[3]
Any command apart from reveal set								Resets Reveal mode[3]

NOTES:
X = Don't care.
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.

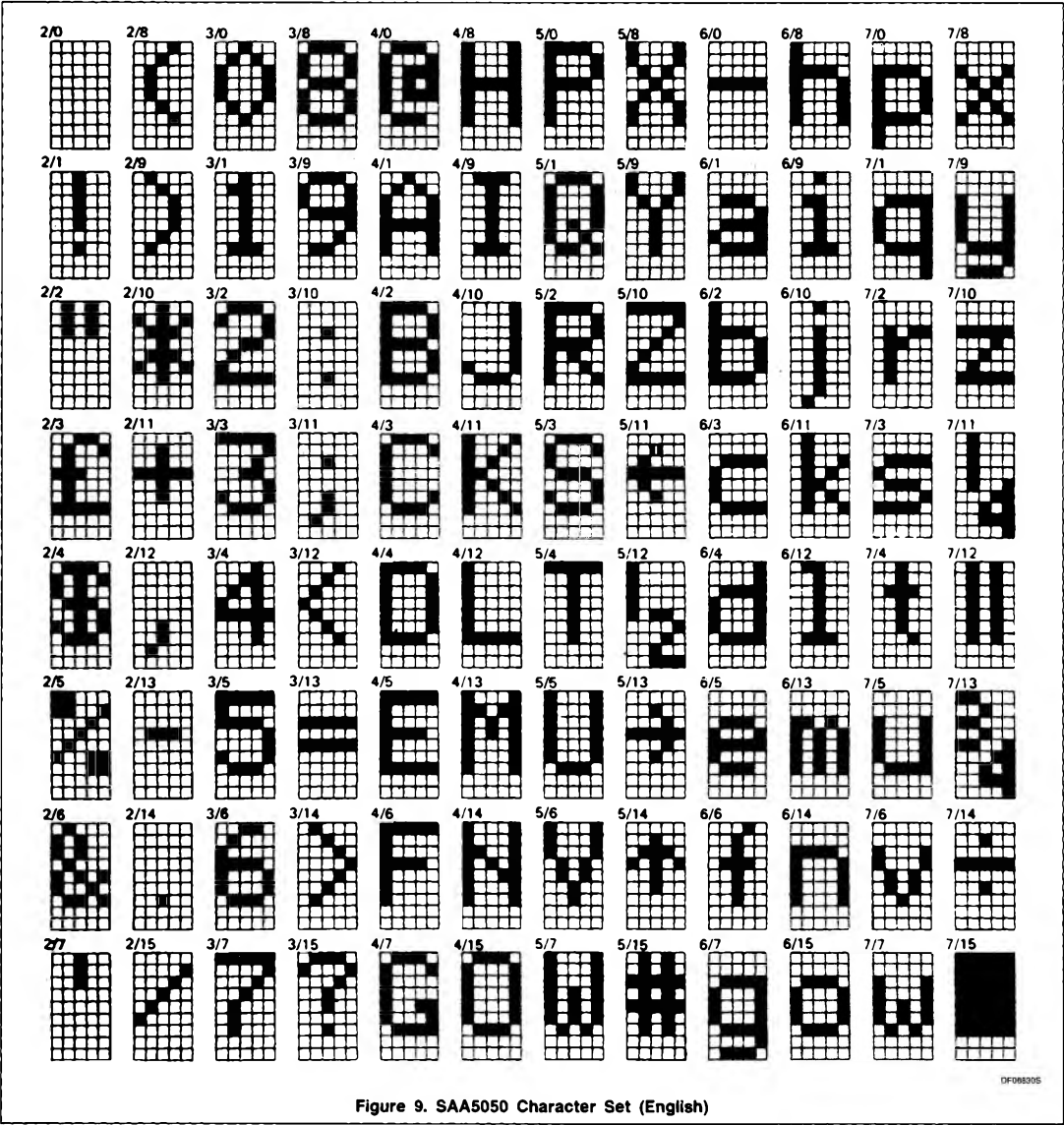### Table 3. Conditions Affecting Display[3]

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[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 color information. The only exception is that background colors are inhibited when Blanking = '0'.
3. Valid during display period only (see Figure 5); otherwise no character or background information is displayed as blanking is determined by the Picture On. (No blanking if PO = '1').

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Figure 9. SAA5050 Character Set (English)

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Figure 10. SAA5050 Character Set (US ASCII)