REMOTE CONTROL RECEIVER DECODER

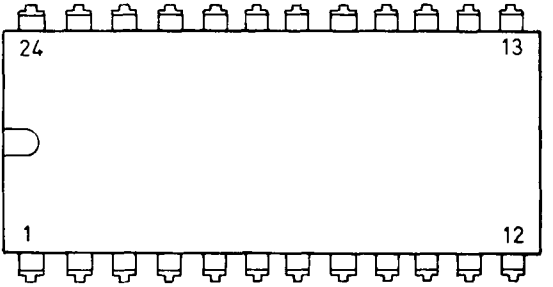
The SAA5010 is a MOS N-channel integrated circuit which provides the receiver decoding function for the remote control of television receivers.
The SAA5010 is a 24-lead device for the control of television receivers incorporating stepable tuning selector systems and including those equipped with teletext and viewdata facilities. It is suitable for use either in ultrasonic or infra-red transmission systems and is intended for use with the SAA5000 transmitter encoder integrated circuit. The SAA5010 is also suitable for direct connection to the SAA5040 and the SAA5050 teletext decoder circuits. Operation with the digital channel selection system (DICS) is also possible.

QUICK REFERENCE DATA

Supply voltage				
Digital	V_{DD1}	nom.	5	V
Analogue	V_{DD2}	nom.	12	V
Supply current				
Digital	I_{DD1}	typ.	20	mA
Analogue	I_{DD2}	typ.	10	mA
Operating temperature range	T_{amb}		−20 to +70	°C

PACKAGE OUTLINE

24-lead dual-in-line



Viewed from top

PINNING

1 - V_{SS}
2 - Local reset
3 - Step
4 - Clear
5 - $\overline{\text{Data}}$ out
6 - On/standby
7 - DLIM
8 - $\overline{\text{DLEN}}$
9 - Mute
10 - Analogue 1
11 - Analogue 2
12 - Analogue rate of change control
13 - V_{DD2}
14 - Analogue 3
15 - Analogue 4
16 - Message received indicator
17 - Picture on sense
18 - Oscillator (R connection)
19 - Oscillator (C and R common connection)
20 - Teledata modes inhibit
21 - Clock out
22 - Data input
23 - Data input type selector
24 - V_{DD1}

DESCRIPTION

The data input is in the form of a 7-bit framing code and a 5-bit message followed by an identical but complemented sequence making a complete 24-bit message sequence. Error checking is effected within the device to ensure a high degree of corrupted signal immunity. The SAA5010 allows for 16 channel selections, 4 analogue functions (e.g. volume, contrast, brightness and saturation), sound muting, and 'set in standby' to be controlled remotely. An output is provided to drive visual and/or audible indication of a received code. Logic outputs are available to provide control data and clocks for use in teletext, viewdata and DICS systems. No adjustments or critical components are required in the peripheral circuitry.

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 MOS Handling Notes).

RATINGS

Limiting values of operation in accordance with the Absolute Maximum System.

			min.	max.	
Voltages (with respect to pin 1)					
Supply voltage	(pin 24)	V_{DD1}	−0.3	7.5	V
	(pin 13)	V_{DD2}	−0.3	14	V
Input voltages	All inputs except Data in and Picture on sense (pins 2, 12, 18, 19, 20, 23)		−0.3	7.5	V
	Data in and Picture on sense (pins 22, 17)		−0.3	14	V
Output voltage	All outputs to TV functions (pins 3, 4, 6, 9, 10, 11, 14, 15, 16)		−0.3	14	V
	Logic outputs (pins 5, 7, 8, 21)		−0.3	7.5	V
Temperatures					
Storage temperature		T_{stg}	−20 to +125		°C
Operating ambient temperature		T_{amb}	−20 to +70		°C

CHARACTERISTICS

Supply voltages		min.	typ.	max.	
V_{DD1} (pin 24)		4.5	–	5.5	V
V_{DD2} (pin 13)		10.8	–	13.2	V

The following characteristics apply at T_{amb} = 25 °C, V_{DD1} = 5 V, V_{DD2} = 12 V unless otherwise stated.

Supply current					
I_{DD1}	Average current with analogues at reset	–	20	40	mA
I_{DD2}		–	10	20	mA
Analogue rate of change control (pin 12)					
Time for any analogue output to change from reset position (mid-point) to end stop with pin 12 connected to V_{SS}		–	3.2	–	s

		min.	typ.	max.	
Oscillator					
Resistor between pins 18 and 19, capacitor between pin 19 and V_{SS}, R = 27 kΩ, C = 27 pF					
Operating frequency		0.8	1.0	1.2	MHz
Used as an amplifier (pin 18 open-circuit)					
Operating frequency		0.8	–	1.2	MHz
Input voltage; HIGH	V_{IH}	3.6	–	V_{DD1}	V
Input voltage; LOW	V_{IL}	0	–	1.6	V
Inputs					
Data input (pin 22, Schmitt Trigger)					
Input voltage; HIGH	V_{IH}	3.8	–	V_{DD1}	V
Input voltage; LOW	V_{IL}	0	–	1.7	V
Applied voltage (R_{source} = 2 kΩ)		0	–	13.5	V
Input leakage (V_{in} = 5.5 V)		–	–	50	μA
Local reset (pin 2)					
Input voltage; HIGH	V_{IH}	2.5	–	V_{DD1}	V
Input voltage; LOW	V_{IL}	0	–	0.7	V
Input leakage (V_{in} = 5.5 V)		–	–	10	μA
Picture on sense (pin 17)					
Input voltage; HIGH	V_{IH}	2.0	–	V_{DD1}	V
Input voltage; LOW	V_{IL}	0	–	0.8	V
Applied voltage (R_{source} = 2 kΩ)		0	–	13.5	V
Input leakage (V_{in} = 5.5 V)		–	–	10	μA
Analogue change inhibit (V_{DD2} pin 13)					
Input level for analogues; inhibited		–	–	0.8	V
Input level for analogues; enabled		4.0	–	–	V
Outputs					
Step, Clear and Mute (pins 3, 4 and 9)					
Output voltage; LOW (I_{OL} = 2 mA)	V_{OL}	–	–	0.5	V
Output current in 'off' state (V_{OH} = 13.5 V)		–	–	50	μA
Data output, DLIM and Clock output (pins 5, 7 and 21)					
Output voltage; HIGH (I_{OH} = −100 μA)	V_{OH}	2.4	–	–	V
Output voltage; LOW (I_{OL} = 1 mA)	V_{OL}	–	–	0.5	V
Data output only					
Leakage current in 'off' state (V_{out} = 0 to 5.5 V)		–	–	10	μA

DEVELOPMENT SAMPLE DATA

CHARACTERISTICS (continued)

		min.	typ.	max.	
On/standby (pin 6)					
Output voltage; LOW (I_{OL} = 15 mA)	V_{OL}	–	–	0.25	V
Output current in 'off' state (V_{OH} = 13.5 V)		–	–	100	μA
$\overline{\text{DLEN}}$ (pin 8)					
Output voltage; HIGH (I_{OH} = −100 μA)	V_{OH}	2.4	–	–	V
Output voltage; LOW (I_{OL} = 1 mA)	V_{OL}	–	–	0.5	V
When used as input;					
Input voltage; HIGH	V_{IH}	2.0	–	V_{DD1}	V
Input voltage; LOW	V_{IL}	–	–	0.8	V
Analogue outputs (pins 10, 11, 14 and 15)					
Output voltage; LOW (I_{OL} = 2 mA) (see Fig.3)	V_{OL}	–	–	0.7	V
Output voltage; HIGH (I_{OH} = −2 mA) (see Fig.3)	V_{OH}	8	–	–	V
Output current; HIGH (V_{OH} = 11.0 V) (see Fig.3)	I_{OH}	−200	–	–	μA
Message received indicator (pin 16)					
Output voltage; LOW (I_{OL} = 10 mA)	V_{OL}	–	–	1.0	V
Output current in 'off' state (V_{OH} = 13.5 V)		–	–	50	μA

APPLICATION DATA

The function is quoted against the corresponding pin number.

This device has 3 basic modes of operation. These are:

TV mode Viewdata mode Teletext mode

The response of the device to an input code will vary according to which mode the device is in at that time. Certain input codes will cause the device to change mode, other codes perform different functions depending on the level of the Picture on sense input. See table 1 for full details.

Pin No.

1. V_{SS} Ground – 0 V

2. **Local reset**

   When this input is connected to 0 V, all four analogue outputs revert to their mid-range position, the 'mute' output switches to the 'unmute' state and the 'on/standby' output switches to the 'on' state, and the mode is set to 'TV'. During the normal operation this input should be connected to V_{DD1} through a suitable resistor.

3. **Step output**

   For the purpose of selection of one out of sixteen TV stations, a clear pulse is generated at pin 4 to set a tuning selection system to station 1. This is followed by an appropriate number of stepping pulses at pin 3 to step the tuning system. See Fig.2 for clear and step pulse details.
   These outputs may be connected together if single wire operation is required.

4. **Clear output**

Output to clear station tuning system. See pin 3 details.

5. **$\overline{\text{Data}}$ output**

This 3-state output provides 7-bit inverted serial data, 5 bits of which is identical to the input command message code, the other two bits control 3 modes (i.e. TV, teletext and viewdata This data contains all the teletext and viewdata control functions and interfaces directly with each system. See Fig.5 for details of the data output waveform and Table 2 for details of the output codes. When the data output is not in use the output switches to high impedance to allow the data line to be used by other circuits.

6. **On/standby output**

This output provides control for TV receiver power supply switching. (HIGH = On; LOW = Standby).
The 'standby' state occurs either on receiving the standby input code (Code 3) or with the application of the V_{DD1} supply.
The 'on' state occurs either by operation of the local reset (See pin 2 details) or on receipt of any of the following codes:

Code 1	- Reset
Code 4	- Transfer to TV mode/on
Codes 18 to 28	- Station select
Code 30	- Transfer to viewdata mode
Code 32	- Transfer to teletext mode

On using a station select code to revert from 'standby' to the 'on' state a delay of nominally 2 seconds occurs before the channel selection signals are produced at the step and clear outputs. This is to allow for slow start TV power supplies.

7. **DLIM**

This is a clocking pulse signal that occurs only during serial data output and is used to clock the data externally. Direct interface to the SAA5040 and SAA5050 teletext circuits is possible. See Fig.5 for timing details.

8. **$\overline{\text{DLEN}}$**

This is a 3-state input/output signal that occurs only during the serial data output and it is used in conjunction with the 'clock output' (pin 21) to clock the data output into the DICS system. See Fig.5 for timing details. Holding the DLEN input low inhibits the sending of a data output code. Whilst an output code is being held no further input codes will be accepted.

9. **Mute output**

This is a bistable output intended for instant sound muting. It is an open-drain output capable of sinking current to V_{SS}.
On receipt of the mute code (Code 2) the output is taken to V_{SS} and a time period of nominally 750 ms is initiated during which no further response is possible at this output. After this time period the reception of the same code will cause the output to return to the HIGH state and a similar immunity time period initiated.
The mute output also goes LOW whilst a programme selection command is being executed and whilst the two second delay after the standby state is in operation.

Pin No. (continued)

10. **Analogue 1 output**

This output provides a variable mark-space ratio waveform, adjustable over 62 values (see Fig.3). When integrated this output provides a d.c. voltage level controllable from approximately 0 to 12 volts which may be used for controlling any of the TV analogue functions. Reception of the AN1+(Code 9) command causes the mark-space ratio to increase, and the AN1−(Code 10) causes the ratio to decrease. The reset function (local or remote) sets the output to approximately a 50% duty cycle.

11. **Analogue 2 output**

This provides a similar output to analogue 1 (pin 10). It is controlled by the AN2+ and AN2− commands (Codes 11 and 12).

12. **Analogue rate of change control**

When this pin is connected to V_{SS} the internal timing chain operating from the oscillator dictates the analogue rate of change, (all four analogues have the same rate of change). The rate under these circumstances is nominally 107 ms/step. By connecting one capacitor and one resistor to this pin as shown on Fig.1 the analogue rate of change is variable from nominally 250 ms/step to 50 ms/step by using a 100 nF capacitor and a resistor in the range 2.2 MΩ to 470 kΩ.

13. V_{DD2} +12 V Supply

This supply feeds the analogue output stages only and does not affect the logic section of the circuit and therefore it may be removed at any time. The analogue outputs will cease but will restart with the same mark-space ratio when the supply is re-applied provided that the V_{DD1} supply has been maintained. Whilst the V_{DD2} supply is removed all commands that change analogue mark-space ratios are ignored.

14. **Analogue 3 output**

This provides a similar output to analogue 1 (pin 10). It is controlled by the AN3+ and AN3− (Codes 13 and 14). If the SAA5010 is in the teletext or viewdata modes the codes will control the mark-space ratio only if the Picture on sense input (pin 17) is high.

15. **Analogue 4 output**

See description of analogue 3 output (pin 14). This output is controlled by codes 15 and 16.

16. **Message received indicator**

This is an open drain output and is capable of sinking current to V_{SS} when a correct input data sequence has been received. The output remains low while the input signal is present and will revert to the high state after a period of silence of about 64 ms at the input. This output is capable of driving a LED display directly.

17. **Picture on sense**

When in teletext or viewdata modes, analogues 3 and 4 will be controlled by commands 13 to 16 only if this input is high (see tables 1 and 2).

18, 19. **Oscillator timing components**

A resistor and capacitor are required to time the oscillator which controls the timing of all the internal functions of the circuit. The capacitor is connected between pins 19 and 1 and the resistor between pins 18 and 19.

20. **Teledata modes inhibit**

This input when connected to V_{DD1} inhibits both the teletext and viewdata modes, thus permitting sets not equipped with these features to specifically exclude these modes. If these modes are required this input should be connected to V_{SS}.

21. **Clock output**

This is a 1:1 mark-space ratio clocking pulse of nominal frequency 62.5 kHz, and is intended for control to the DICS system. For phase locking purposes a divide by four must be used between the DICS system 4 MHz oscillator and pin 19.

22. **Data input**

The 24-bit message code must be applied to this input either from a pulse retrieving circuit driven by a transmission system or from the output of a local keyboard system. The SAA5000 generates the required data sequence. (See Fig 4 for details of data input format).

23. **Data input type selector**

By connecting this input to V_{SS} the input data is expected to be from an ultrasonic transmission system, and with this input connected to V_{DD1} the data is expected to be from an infra-red transmission system. For details of the expected pulse format see the SAA5000 data sheet.

24. V_{DD1} +5 V supply

This is the power supply input for the logic section of the circuit and must remain supplied during the standby condition.

PERIPHERAL CIRCUITRY

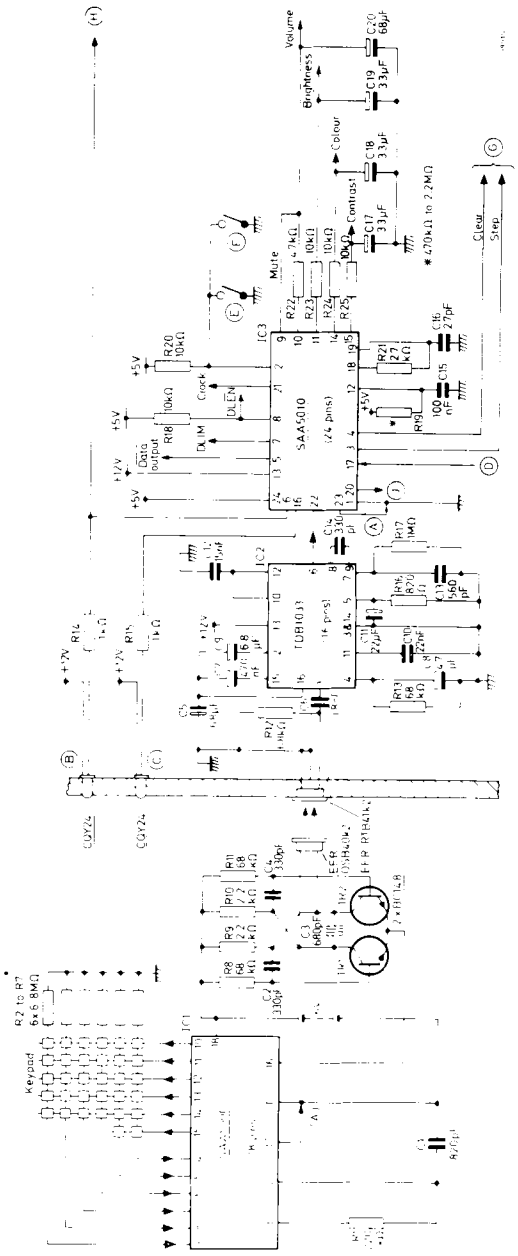


Fig.1 Ultrasonic System

A. Ultrasonic/infrared selection
B. On/standby indicator
C. Message received indicator
D. 'Picture on' input
E. Local reset switch
F. Third mains switch contact pair
G. To touch tuner
H. On/standby control
J. Mode selection

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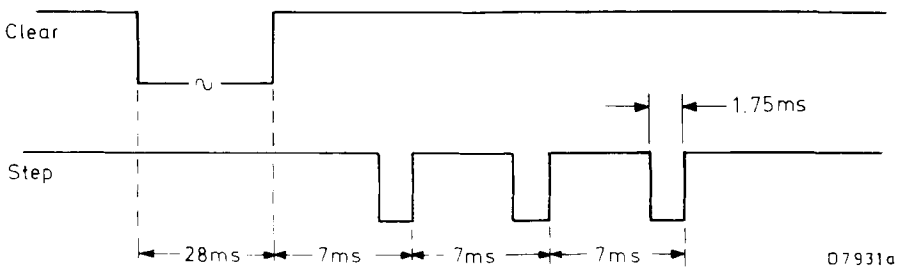


Fig.2

Outputs to channel selector to select CHANNEL 4

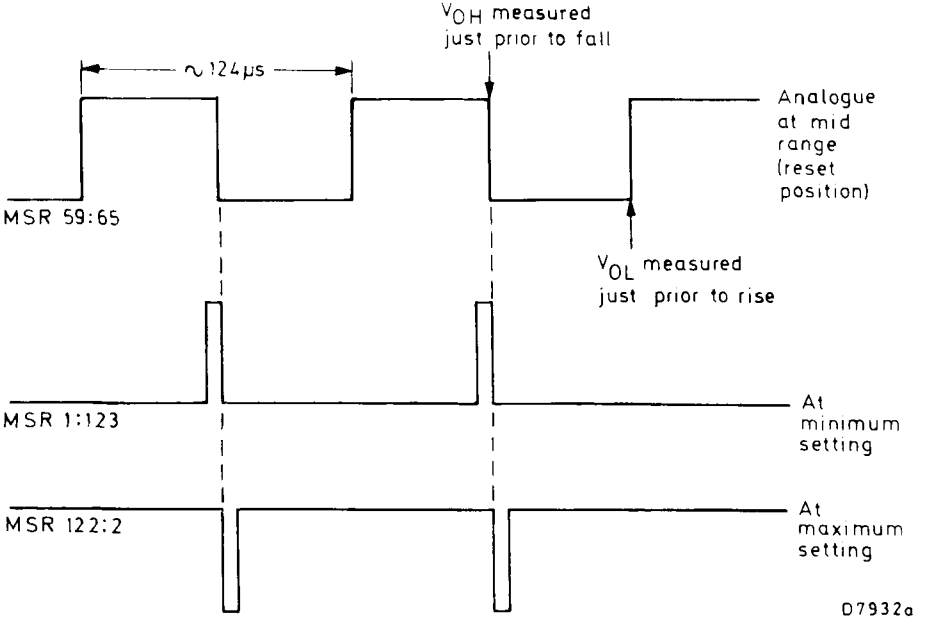


Fig.3

Analogue output waveforms

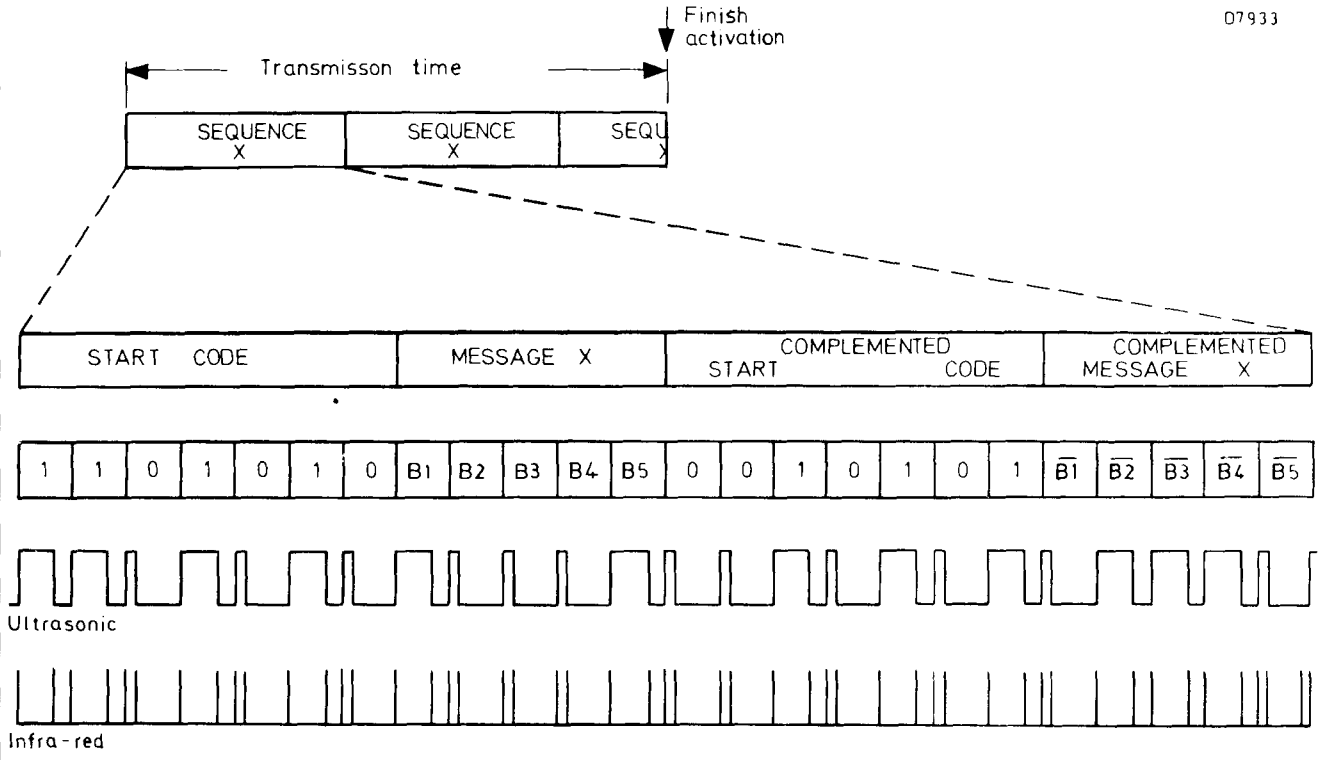
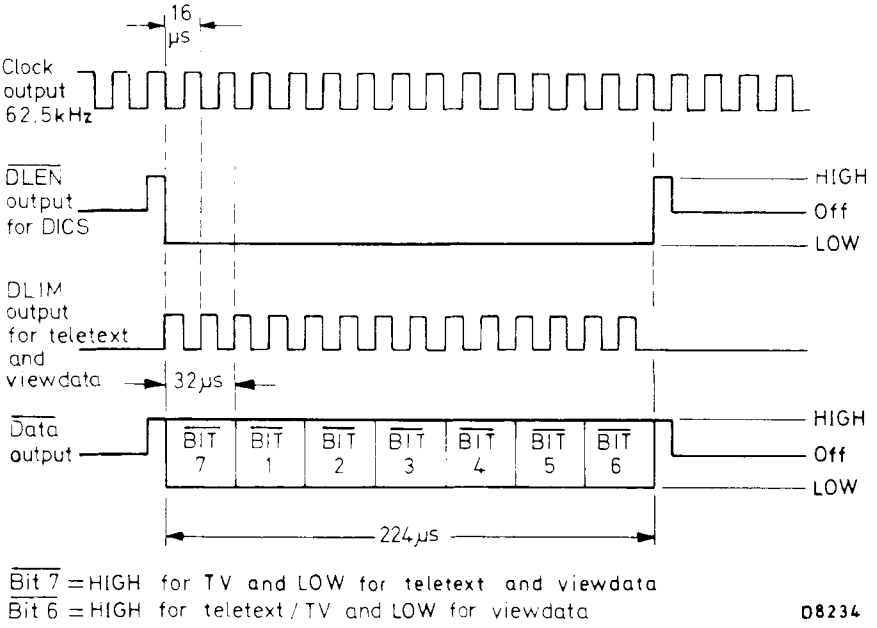


Fig.4

Input data waveforms



$\overline{\text{Bit 7}}$ = HIGH for TV and LOW for teletext and viewdata
$\overline{\text{Bit 6}}$ = HIGH for teletext / TV and LOW for viewdata

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Fig.5
Data output and clock output waveforms

	Code received					MODE				
	B5	B4	B3	B2	B1	TV	Teletext (Pin 17 LOW)	Teletext (Pin 17 HIGH)	Viewdata (Pin 17 LOW)	Viewdata (Pin 17 HIGH)
1	0	0	0	0	0	Reset/on	Transfer to TV/reset	Transfer to TV/reset	Transfer to TV/reset	Transfer to TV/reset
2	0	0	0	0	1	Mute	Mute	Mute	Mute	Mute
3	0	0	0	1	0	Standby	Transfer to TV/standby	Transfer to TV/standby	Transfer to TV/standby	Transfer to TV/standby
4	0	0	0	1	1	On	Transfer to TV	Transfer to TV	Transfer to TV	Transfer to TV
5	0	0	1	0	0	–	–	–	–	–
6	0	0	1	0	1	–	–	–	–	–
7	0	0	1	1	0	1 ✳ (1)	–	–	–	–
8	0	0	1	1	1	–	–	–	–	–
9	0	1	0	0	0	Analogue 1+	Analogue 1+	Analogue 1+	Analogue 1+	Analogue 1+
10	0	1	0	0	1	Analogue 1–	Analogue 1–	Analogue 1–	Analogue 1–	Analogue 1–
11	0	1	0	1	0	Analogue 2+	Analogue 2+	Analogue 2+	Analogue 2+	Analogue 2+
12	0	1	0	1	1	Analogue 2–	Analogue 2–	Analogue 2–	Analogue 2–	Analogue 2–
13	0	1	1	0	0	Analogue 3+	–	Analogue 3+	–	Analogue 3+
14	0	1	1	0	1	Analogue 3–	–	Analogue 3–	–	Analogue 3–
15	0	1	1	1	0	Analogue 4+	–	Analogue 4+	–	Analogue 4+
16	0	1	1	1	1	Analogue 4–	–	Analogue 4–	–	Analogue 4–
17	1	0	0	0	0	Programme 1/on	–	–	–	–
18	1	0	0	0	1	Programme 2/on	–	–	–	–
19	1	0	0	1	0	Programme 3/on	–	–	–	–
20	1	0	0	1	1	Programme 4/on	–	–	–	–
21	1	0	1	0	0	Programme 5/on	–	–	–	–
22	1	0	1	0	1	Programme 6/on	–	–	–	–
23	1	0	1	1	0	Programme 7/on	–	–	–	–
24	1	0	1	1	1	Programme 8/on	–	–	–	–
25	1	1	0	0	0	Programme 9/on	–	–	–	–
26	1	1	0	0	1	Programme 10/on	–	–	–	–
27	1	1	0	1	0	Programme 11/on	–	–	–	–
28	1	1	0	1	1	Programme 12/on	–	–	–	–
29	1	1	1	0	0	–	–	–	–	–
30	1	1	1	0	1	Transfer to viewdata/on	Transfer to viewdata	Transfer to viewdata	–	–
31	1	1	1	1	0	Transfer to teletext (2)	–	–	Transfer to teletext	Transfer to teletext
32	1	1	1	1	1	Transfer to teletext/on	–	–	Transfer to teletext	Transfer to teletext

Blank entries indicate those codes for which the only device function is a possible transmission on the Data outputs (See Table 2)

TABLE 1: Input code responses

Notes. (1) This code is used before codes 17 to 22 to select programmes 11 to 16 (programmes 11 and 12 may also be selected by using codes 27 and 28).

(2) This transfer to teletext mode does not occur if on/standby output is low.

	Code received					MODE								
						TV			Teletext			Viewdata		
	B5	B4	B3	B2	B1	B7	B6	Repetition frequency of output	B7	B6	Repetition frequency of output	B7	B6	Repetition frequency of output
1	0	0	0	0	0	0	0	S			NT			NT
2	0	0	0	0	1	0	0	S	1	0	S	1	1	S
3	0	0	0	1	0	0	0	S			NT			NT
4	0	0	0	1	1	0	0	S			NT			NT
5	0	0	1	0	0	0	0	S	1	0	S	1	1	S
6	0	0	1	0	1	0	0	S	1	0	S	1	1	S
7	0	0	1	1	0	0	0	S	1	0	R100	1	1	R100
8	0	0	1	1	1	0	0	S	1	0	R100	1	1	R100
9	0	1	0	0	0			NT			NT			NT
10	0	1	0	0	1			NT			NT			NT
11	0	1	0	1	0			NT			NT			NT
12	0	1	0	1	1			NT			NT			NT
13	0	1	1	0	0			NT	1	0	S (3)	1	1	S (3)
14	0	1	1	0	1			NT	1	0	S (3)	1	1	S (3)
15	0	1	1	1	0			NT	1	0	S (3)	1	1	S (3)
16	0	1	1	1	1			NT	1	0	S (3)	1	1	S (3)
17	1	0	0	0	0	0	0	S	1	0	S	1	1	S
18	1	0	0	0	1	0	0	S	1	0	S	1	1	S
19	1	0	0	1	0	0	0	S	1	0	S	1	1	S
20	1	0	0	1	1	0	0	S	1	0	S	1	1	S
21	1	0	1	0	0	0	0	S	1	0	S	1	1	S
22	1	0	1	0	1	0	0	S	1	0	S	1	1	S
23	1	0	1	1	0	0	0	S	1	0	S	1	1	S
24	1	0	1	1	1	0	0	S	1	0	S	1	1	S
25	1	1	0	0	0	0	0	S	1	0	S	1	1	S
26	1	1	0	0	1	0	0	S	1	0	S	1	1	S
27	1	1	0	1	0	0	0	S	1	0	S	1	1	S
28	1	1	0	1	1	0	0	S	1	0	S	1	1	S
29	1	1	1	0	0			NT	1	0	S	1	1	S
30	1	1	1	0	1	0	0	S (2)			NT	1	1	S
31	1	1	1	1	0	0	0	S (1)	1	0	S			NT
32	1	1	1	1	1	0	0	S (2)	1	0	S			NT

TABLE 2: Data output codes

(1) This code is NT if Teledata inhibit is low and on/standby output is high.

(2) These codes are NT if Teledata inhibit is low.

(3) These codes are NT if Picture on sense input is high.

Key to symbols: NT = Not transmitted

S = Single transmission

R100 = Repeated approximately every 100 ms.

Note

Table shows logic output of B6 and B7, $\overline{B6}$ and $\overline{B7}$ are transmitted.

B1 to B5 are as received input, $\overline{B1}$ to $\overline{B5}$ are transmitted.

DEVELOPMENT SAMPLE DATA