RECEIVER AND ANALOGUE MEMORY

The SAB3023 is a MOS N-channel integrated circuit which demodulates the pulse width modulated command words from a remote transmitter system (e.g. SAB3021). It also has four memories to provide control of four analogue functions, and five inputs to allow the use of up to 31 local commands.

Features

- Receiver for 2 x 64 commands. 6 + 1 bit code word (selectable).
- Four 63-step analogue memories with D/A converter; basic setting 50% (31/64); VOLU 30% (19/64) or 50% (31/64).
- Short response time (speed for altering the analogue memories): 115 ms/step; 7,3 s/63 steps.
- ON/OFF (standby) output.
- Serial instruction output (IBUS).
- High immunity to interference.
- The output signals of the station memory and the IBUS commands are available simultaneously.
- Inputs for local operation via diode-encoded keys; up to 31 commands; mask-programmable.
- Various repetition rates at the IBUS for single commands, step commands (2/second) and analogue commands (8/second).
- Outputs for sub-systems.

QUICK REFERENCE DATA

Supply voltage	V_{DD}	typ.	5 V
Operating ambient temperature range	T_{amb}	0 to +70	°C
Clock frequency	f_{CLCK}		62,5 kHz
Supply current at V_{DD} = 5 V; T_{amb} = 25 °C	I_{DD}	typ.	20 mA

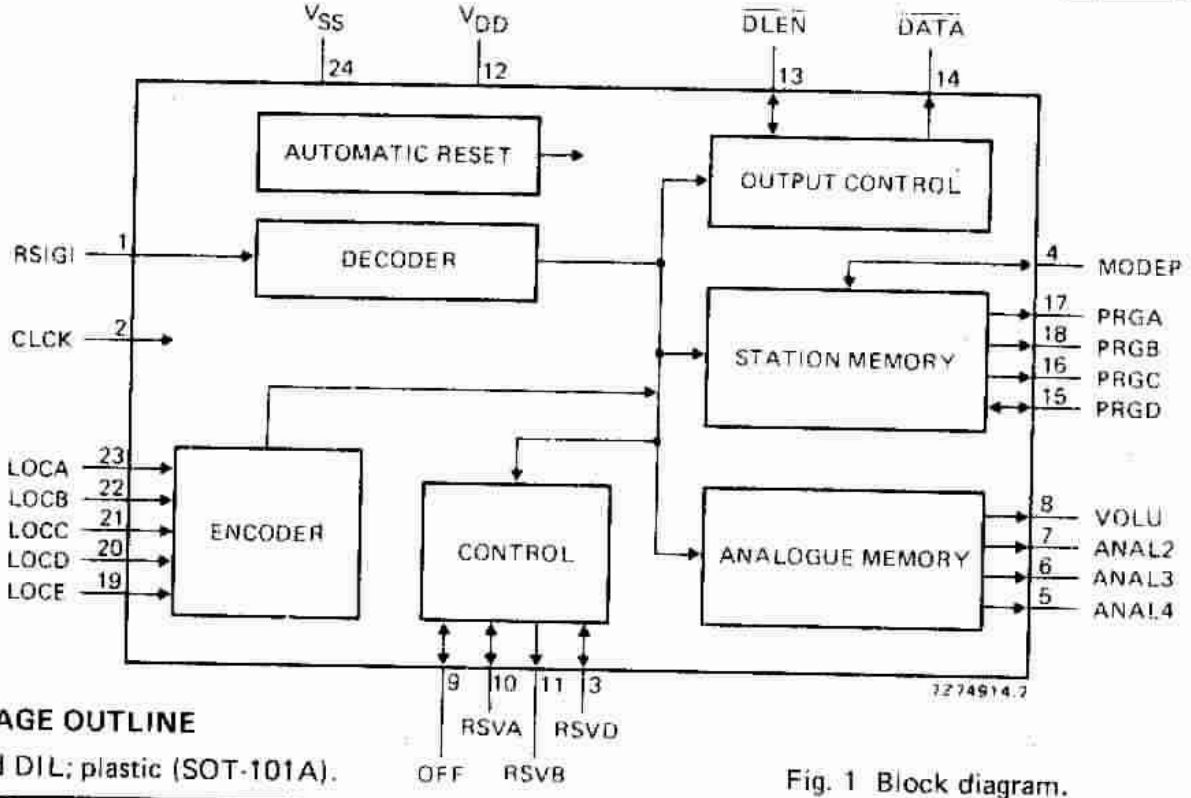


Fig. 1 Block diagram.

PACKAGE OUTLINE

24-lead DIL; plastic (SOT-101A).

Programming of modes using outputs as inputs

Several outputs can be used as inputs (MODEP, RSVD, PRGD), for programming other operating modes. This can be obtained in 2 ways:

1. By means of a connection to ground (V_{SS}). In this case the output signal is not available.
2. By means of a bipolar transistor in a common emitter circuit which clamps the output level at V_{BE} (see Fig. 8). The output signal is available with reversed polarity at the collector of the transistor.

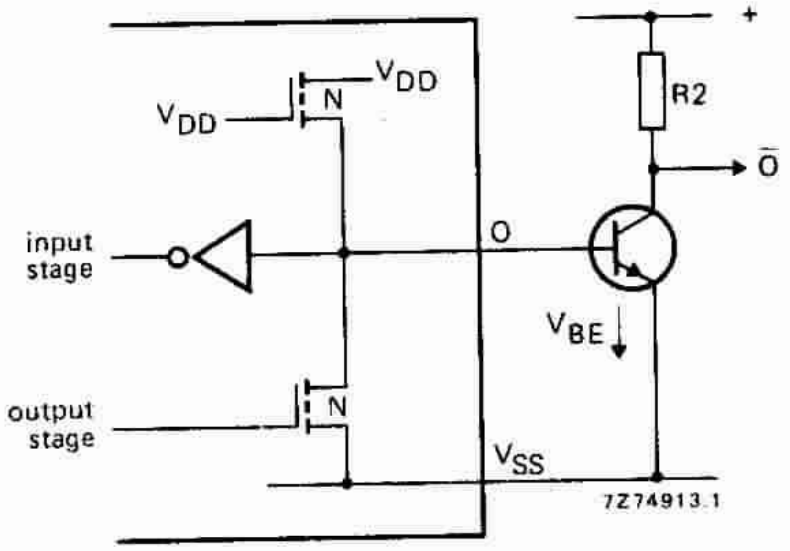


Fig. 8 Clamping the output voltage to V_{BE}.

APPLICATION INFORMATION

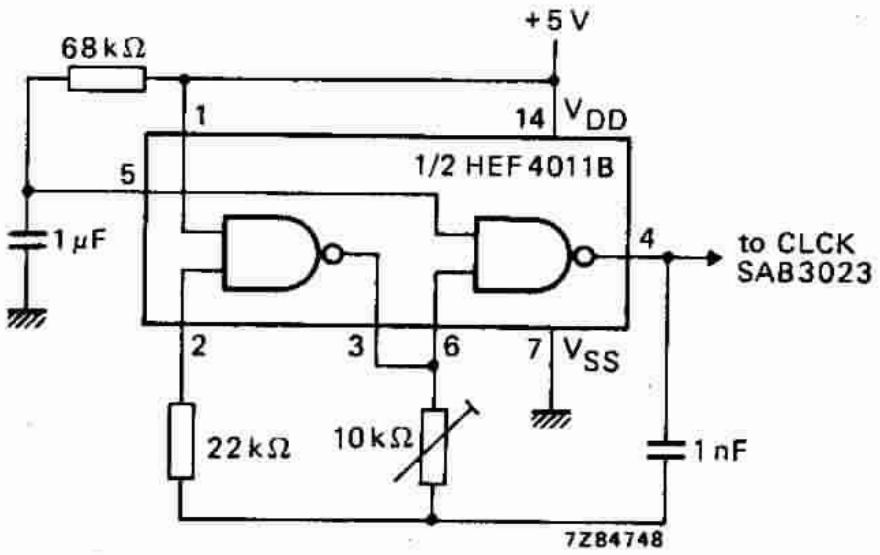


Fig. 9 Example of a clock oscillator with oscillation delay.

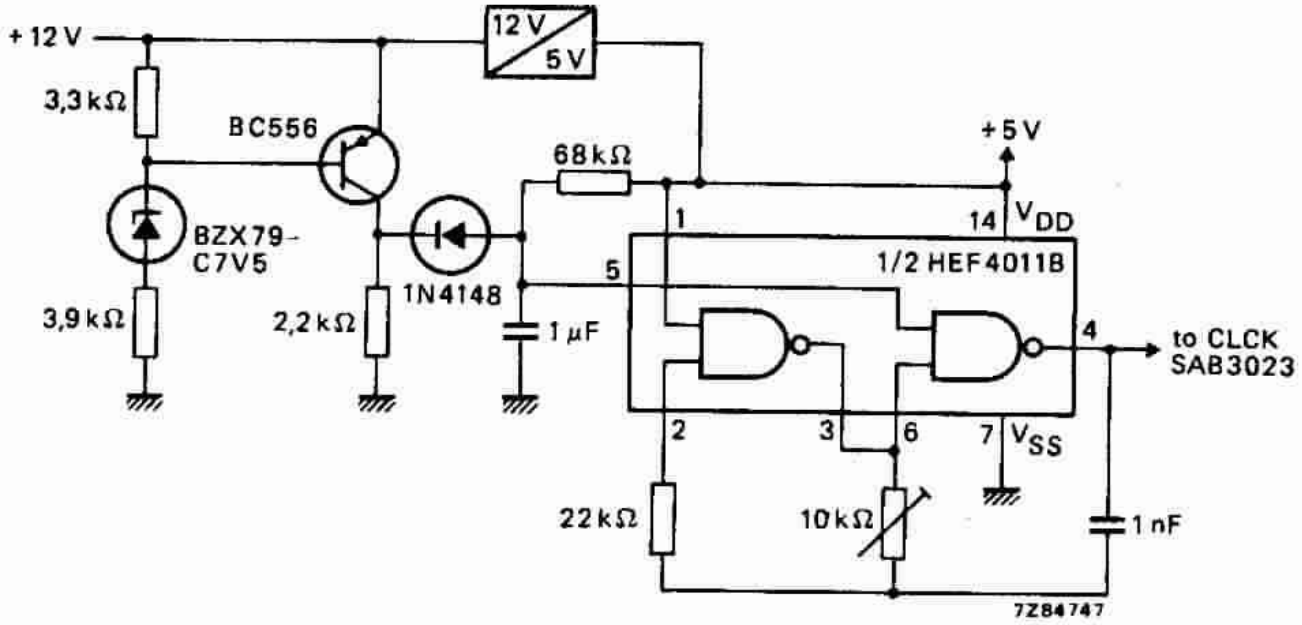


Fig. 10 Example of a clock oscillator as shown in Fig. 9, however with additional protection of voltage interruption.

APPLICATION INFORMATION (continued)

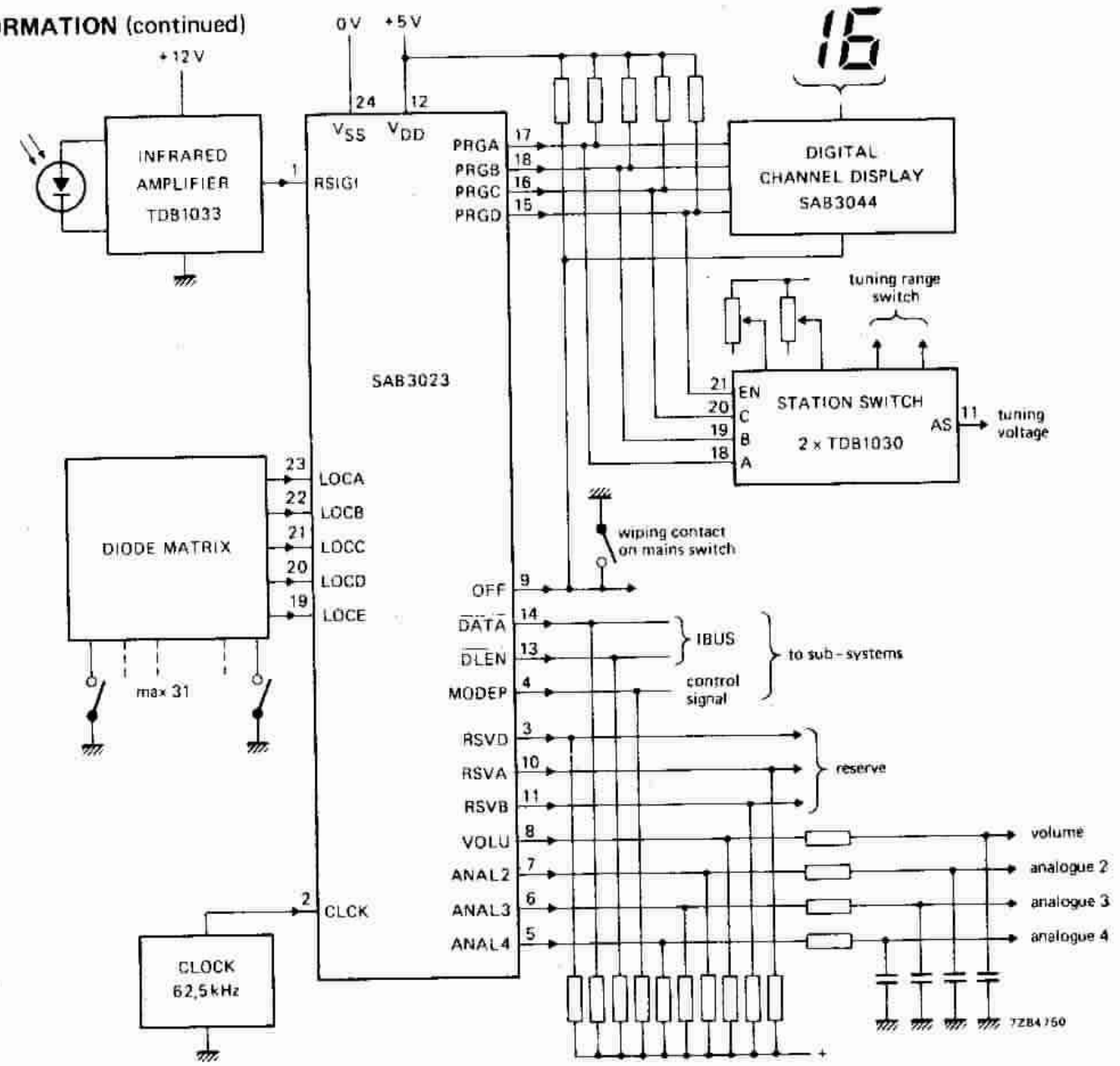


Fig. 11 Typical receiver circuit using SAB3023.

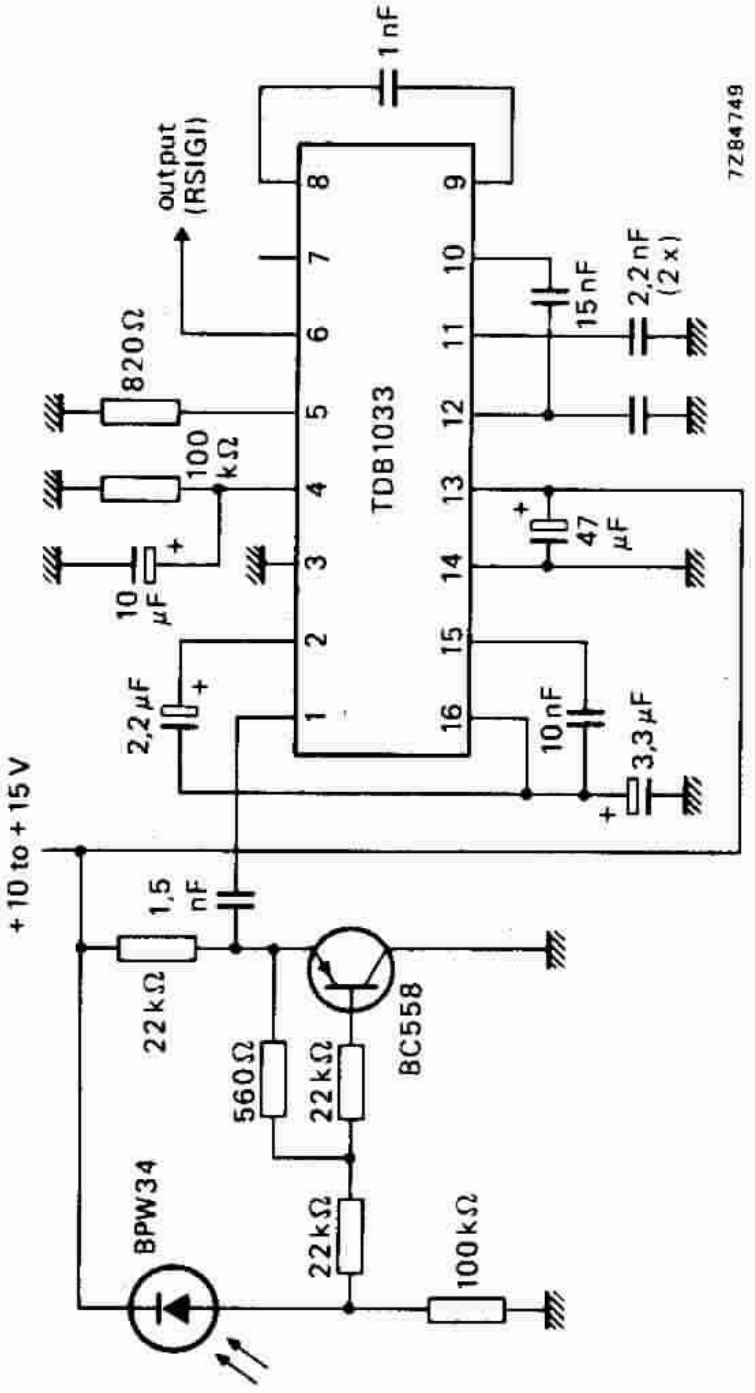
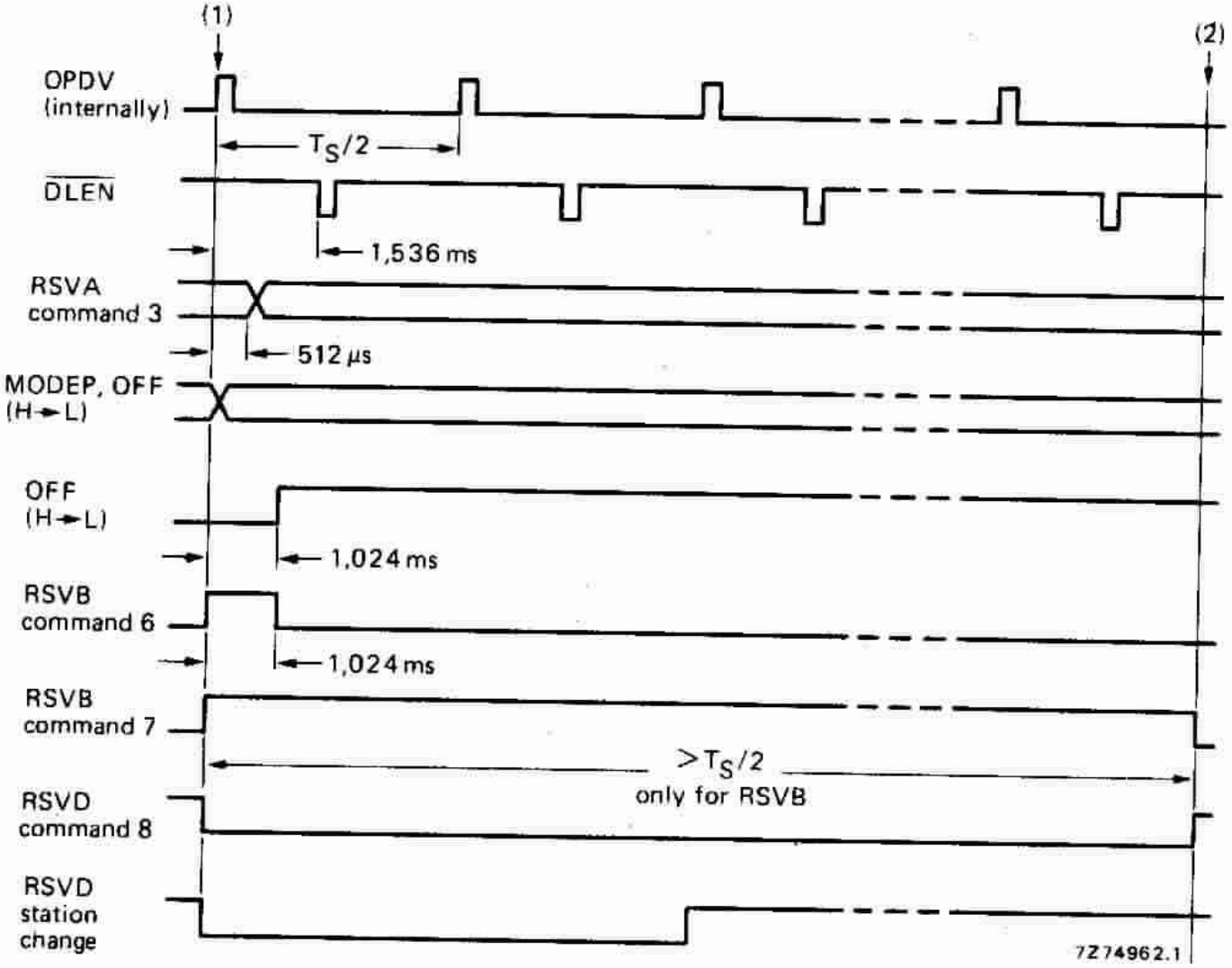


Fig. 12 Circuit diagram of infrared detector and amplifier.



(1) Key down; bouncing time finished; signal RSIGI; word comparison effective.

(2) Key up; bouncing time finished; signal RSIGI: word comparison uneffective, or the time-window has been exceeded.

Fig. 7 Timing diagram for some outputs; f_{CLCK} = 62,5 kHz.

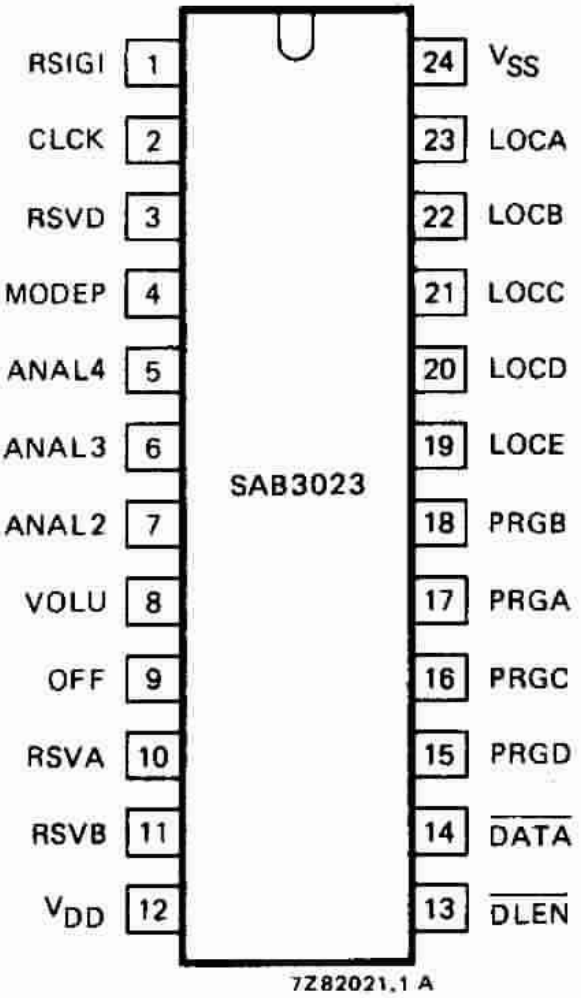


Fig. 2 Pinning diagram.

PINNING

no.	type		
1	I	RSIGI	data input
2	I	CLCK	clock input
3	I/O	RSVD	reserve D input/output
4	I/O	MODEP	sub-system selection
5	O	ANAL 4	analogue outputs
6	O	ANAL 3	
7	O	ANAL 2	
8	O	VOLU	
9	I/O	OFF	standby input/output
10	I/O	RSVA	reserve A input/output
11	O	RSVB	reserve B output
12		V_{DD}	positive supply
13	I/O	$\overline{DLEN}$	IBUS information
14	O	$\overline{DATA}$	
15	I/O	PRGD	station memory
16	O	PRGC	
17	O	PRGA	
18	O	PRGB	
19	I	LOCE	local keyboard inputs
20	I	LOCD	
21	I	LOCC	
22	I	LOCB	
23	I	LOCA	
24		V_{SS}	ground

GENERAL DESCRIPTION

The circuit is implemented in N-channel MOS technology. Serial data is derived from the transmitter SAB3021 in remote or extended local operation mode. This data is applied to the RSIGI input, where it is checked and decoded and serially applied as commands to the IBUS. Some commands are also used internally for control of 4 analogue functions and the station memory. Moreover, the circuit has available an input/output for the ON/OFF function, three auxiliary outputs for reserve commands, each containing the station-change signal and a sub-system identification signal. For local operation, five inputs are available, via which 31 commands are parallel addressable (can be chosen by mask-programming).

Special features:

- Serial output for 64 commands.
- Universal control functions for sub-systems, e.g. tuning systems, Teletext, Viewdata, videogames, clock with addressable memory, etc.
- After addressing a sub-system, the analogue functions and the reserve functions remain available.
- Parallel station outputs.

HANDLING

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

RATINGS (V_{SS} = 0)

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	V_{DD}	max.	7,5	V
Input voltage	V_I	max.	15	V
Input current	$\pm I_I$	max.	10	mA
Output current	I_O	max.	10	mA
Power dissipation per output	P_O	max.	50	mW
Total power dissipation per package	P_{tot}	max.	500	mW
Operating ambient temperature range	T_{amb}	−20 to	+70	°C
Storage temperature range	T_{stg}	−20 to	+125	°C

CHARACTERISTICS

V_{SS} = 0; V_{DD} = 4,5 to 5,5 V; T_{amb} = 0 to + 70 °C; unless otherwise specified

	symbol	min.	typ.	max.	conditions
Supply voltage	V_{DD}	4,5	5,0	5,5 V	
Supply current	I_{DD}	–	–	35 mA	
Input voltage LOW	V_{IL}	−0,3	–	1,2 V	
Input voltage HIGH	V_{IH}	3,5	–	15 V	
Input leakage current RSIGI, CLCK	I_{IR}	–	–	1 µA	V_I = 15 V
Input current LOW LOCA to LOCE	$-I_{IL}$	20	–	250 µA	V_I = 0 V
Inputs/outputs (except $\overline{\text{DLEN}}$)					
Output voltage LOW	V_{OL}	–	–	0,8 V	I_{OL} = 1 mA
Output current HIGH	I_{OH}	–	–	20 µA	V_{OH} = 15 V
Input current LOW	$-I_{IL}$	20	–	500 µA	V_I = 0 V
Outputs PRGA, PRGB, PRGC, RSVB					
Output voltage LOW	V_{OL}	–	–	0,8 V	I_{OL} = 1 mA
Output current HIGH	I_{OH}	–	–	20 µA	V_{OH} = 15 V
Outputs $\overline{\text{DATA}}$, $\overline{\text{DLEN}}$					
Output voltage LOW	V_{OL}	–	–	0,8 V	I_{OL} = 2 mA
Output current HIGH	I_{OH}	–	–	20 µA	V_{OH} = 15 V
Input $\overline{\text{DLEN}}$					
Input current LOW	$-I_{IL}$	20	–	500 µA	V_I = 0 V

CHARACTERISTICS (continued)

V_{SS} = 0; V_{DD} = 4,5 to 5,5 V; T_{amb} = 0 to + 70 °C; unless otherwise specified

	symbol	min.	typ.	max.	conditions
Outputs VOLU, ANAL 2, ANAL 3, ANAL 4					
Output voltage LOW	V_{OL}	–	–	1 V	I_{OL} = 4 mA
Output current HIGH	I_{OH}	–	–	20 μA	V_{OH} = 15 V
Timing					
Clock frequency	f_{CLCK}	40	62,5	80 kHz	
Duty cycle	δ	0,4	0,5	0,6	
Rise and fall times (all inputs)	t_r, t_f	–	–	1 μs	

OPERATION DESCRIPTION

Remote control data input (RSIGI)

Serial data is derived from the transmitter in remote or local operation mode. This data is applied to the RSIGI input (see Fig. 3), where it is checked and decoded. The instruction bus (IBUS) is then enabled and an output operation takes place.

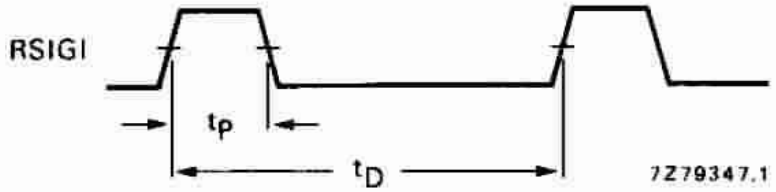
Response time for infrared operation: ≈ 110 ms.

The following tests are carried out for each signal or signal group:

- Dead-time (time between two pulses).
- Word separation.
- Bit counting.
- Word comparison.

Signals which do not come within the zero or one 'window', restart the input detection procedure. The signals are within the 'window', if the ratio of the transmitter (SAB3021) oscillator frequency (nom. 4 MHz) and the SAB3023 clock frequency (nom. 62,5 kHz) is equal to 64 ± 14%.
The commands are transmitted as 7-bit words (1 start bit; 6 data bits A, B, C, D, E and F). The system will accept leading '0' commands (start bit S = 0) for RSVD = HIGH and leading '1' commands (S = 1) for RSVD = LOW.
Table 1 shows the IBUS codes.

zero time (t_D)	one time (t_D)	infrared operation mode
5,1 ms ± 1 ms	7,2 ms ± 1 ms	IRA (wide window)
5,1 ms ± 0,13 ms	7,2 ms ± 0,13 ms	IRB (narrow window); mask-programmable



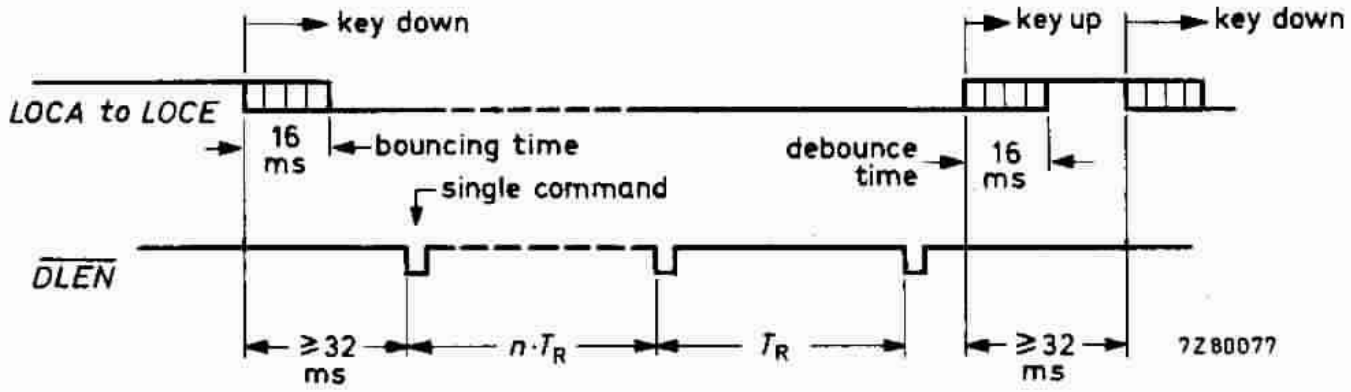
t_P = 1,1 ms

Fig. 3 Specification of the timing of the input signal.

Local keyboard inputs (LOCA, LOCB, LOCC, LOCD and LOCE)

Up to 31 commands (see Tables 2 and 3) for local control are possible by addressing these 5 inputs from a binary encoded keyboard. The inputs are drawn internally to V_{DD} at standby. Out of the 64 commands 31 can be stored in the mask-programmable ROM with the desired key addresses. This ROM can be chosen by the user. The ROM of the standard version SAB3023B (see Table 2) is programmed by the manufacturer. Table 3 shows another version, the SAB3023E.

A keyboard input (local control) overrides the remote control commands at input RSIGI (from SAB3021). Current IBUS output data is completely stopped.



Repetition rate: 2/second x T_R = 516 ms
8/second x T_R = 129 ms.

Fig. 4 Relationship between key operation and command output.

Table 1 Specifications of the IBUS-code (continued on next page).

RSIGI/ IBUS code no.	instruction code F	E	D	C	B	A	function	CL.*	OFF	RSVA	RSVB	VOLU	ANAL2	ANAL3	ANAL4	RSVD	MODEP	PRCA	PRCB	PRCC	PRCD
0	0	0	0	0	0	0	basic set analogue	S				**	31/64	31/64	31/64						
1				0	0	1	mute/on	S	0			0									
2				0	1	0	OFF	S	1								1				
3				0	1	1	reserve A	S		0/1											
4				1	0	0	on	R8	0												
5				1	0	1	on	S	0												
6				1	1	0	reserve B/on	S	0												
7				1	1	1	reserve C/on	S	0												
8	0	0	1	0	0	0	reserve D▲	R8													
9				0	0	1	–	R8													
10				0	1	0	–	R8													
11				0	1	1	–	R8													
12				1	0	0	–	R8													
13				1	0	1	–	R8													
14				1	1	0	–	R8													
15				1	1	1	–	R8													
16	0	1	0	0	0	0	on/station 16	S	0									1	1	1	1
17				0	0	1	on/ 1	S	0									0	0	0	0
18				0	1	0	on/ 2	S	0									1	0	0	0
19				0	1	1	on/ 3	S	0									0	1	0	0
20				1	0	0	on/ 4	S	0									1	1	0	0
21				1	0	1	on/ 5	S	0									0	0	1	0
22				1	1	0	on/ 6	S	0									1	0	1	0
23				1	1	1	on/ 7	S	0									0	1	1	0
24	0	1	1	0	0	0	on/ 8	S	0									1	1	1	0
25				0	0	1	on/ 9	S	0									0	0	0	1
26				0	1	0	on/ 10	S	0									1	0	0	1
27				0	1	1	on/ 11	S	0									0	1	0	1
28				1	0	0	on/ 12	S	0									1	1	0	1
29				1	0	1	on/ 13	S	0									0	0	1	1
30				1	1	0	on/ 14	S	0									1	0	1	1
31				1	1	1	on/ 15	S	0									0	1	1	1

32	1	0	0	0	0	0	–	S	–												
33				0	0	1	–	S	–												
34				0	1	0	on	S	0												
35				0	1	1	on	S	0												
36				1	0	0	on/step station up	R2	0			⊔				⊔		X	X	X	X
37				1	0	1	on/step station down	R2	0			⊔				⊔		X	X	X	X
38				1	1	0	on	R2	0												
39				1	1	1	on	R2	0												
40	1	0	1	0	0	0	volume up	R8				→ 1									
41				0	0	1	volume down	R8				→ 0									
42				0	1	0	ANAL2 up	R8					→ 1								
43				0	1	1	ANAL2 down	R8					→ 0								
44				1	0	0	ANAL3 up	R8						→ 1							
45				1	0	1	ANAL3 down	R8						→ 0							
46				1	1	0	ANAL4 up	R8							→ 1						
47				1	1	1	ANAL4 down	R8							→ 0						
48	1	1	0	0	0	0	–	S													
49				0	0	1	–	S													
50				0	1	0	–	S													
51				0	1	1	on	S	0												
52				1	0	0	on	R8	0												
53				1	0	1	on	R8	0												
54				1	1	0	on	R8	0												
55				1	1	1	on	R8	0												
56	1	1	1	0	0	0	on } station memory disconnected	R8	0								0				
57				0	0	1	on	R8	0								0				
58				0	1	0	on	R8	0								0				
59				0	1	1	on	R8	0								0				
60				1	0	0	on	R8	0								0				
61				1	0	1	on	R8	0								0				
62				1	1	0	on	R8	0								0				
63▲				1	1	1	on	R8	0								1				

* Instruction class (CL.): S = single
R2 = repeat ≈ 2/second
R8 = repeat ≈ 8/second

** Mask-programmed;
19/64, 31/64 or unchanged.
▲ MODEP = LOW.

⊔ : mute control

X : change of station counter

Table 2 Allocation of local command codes for the standard version **SAB3023B.**

local control inputs					IBUS output code						IBUS code no.
LOCE	LOCD	LOCC	LOCB	LOCA	F	E	D	C	B	A	
1	1	1	1	1	—	—	—	—	—	—	—
0	0	1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	1	1
0	1	1	1	0	0	0	0	0	1	0	2
1	0	1	1	1	0	0	0	1	0	0	4
1	1	0	1	1	0	0	0	1	0	1	5
0	0	1	1	0	0	0	0	1	1	0	6
0	0	1	0	1	0	0	0	1	1	1	7
0	0	0	1	0	0	1	0	0	0	1	17
1	0	1	1	0	1	0	0	0	0	0	32
1	1	1	0	1	1	0	0	0	0	1	33
1	0	0	0	0	1	0	0	0	1	0	34
0	0	0	0	1	1	0	0	0	1	1	35
1	1	1	1	0	1	0	0	1	0	0	36
0	1	1	1	1	1	0	0	1	0	1	37
1	1	0	1	0	1	0	0	1	1	0	38
1	0	0	0	1	1	0	0	1	1	1	39
1	1	0	0	1	1	0	1	0	0	0	40
1	1	0	0	0	1	0	1	0	0	1	41
1	0	1	0	1	1	0	1	0	1	0	42
1	0	1	0	0	1	0	1	0	1	1	43
1	0	0	1	1	1	0	1	1	0	0	44
1	0	0	1	0	1	0	1	1	0	1	45
0	1	0	1	1	1	0	1	1	1	0	46
0	1	0	1	0	1	0	1	1	1	1	47
0	1	1	0	1	1	1	0	0	0	0	48
0	1	1	0	0	1	1	0	0	0	1	49
0	1	0	0	1	1	1	0	0	1	0	50
0	1	0	0	0	1	1	1	0	0	0	56
0	0	1	0	0	1	1	1	0	0	1	57
0	0	0	1	1	1	1	1	0	1	0	58
0	0	0	0	0	1	1	1	0	1	1	59

The basic setting at output VOLU is about 30% (19/64). The command 0, the basic setting, does not have influence on the analogue memory VOLU.

Table 3 Allocation of local command codes for the version **SAB3023E.**

local control inputs					IBUS output code						IBUS code no.
LOCE	LOCD	LOCC	LOCB	LOCA	F	E	D	C	B	A	
1	1	1	1	1	–	–	–	–	–	–	–
1	0	0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	1	0	0	0	0	16
0	0	0	0	1	0	1	0	0	0	1	17
0	0	0	1	0	0	1	0	0	1	0	18
0	0	0	1	1	0	1	0	0	1	1	19
0	0	1	0	0	0	1	0	1	0	0	20
0	0	1	0	1	0	1	0	1	0	1	21
0	0	1	1	0	0	1	0	1	1	0	22
0	0	1	1	1	0	1	0	1	1	1	23
0	1	0	0	0	0	1	1	0	0	0	24
0	1	0	0	1	0	1	1	0	0	1	25
0	1	0	1	0	0	1	1	0	1	0	26
0	1	0	1	1	0	1	1	0	1	1	27
0	1	1	0	0	0	1	1	1	0	0	28
0	1	1	0	1	0	1	1	1	0	1	29
0	1	1	1	0	0	1	1	1	1	0	30
0	1	1	1	1	0	1	1	1	1	1	31
1	0	1	1	1	1	0	0	1	0	0	36
1	1	0	1	1	1	0	0	1	0	1	37
1	1	1	0	1	1	0	1	0	0	0	40
1	1	1	1	0	1	0	1	0	0	1	41
1	0	1	0	1	1	0	1	0	1	0	42
1	0	1	1	0	1	0	1	0	1	1	43
1	1	0	0	1	1	0	1	1	0	0	44
1	1	0	1	0	1	0	1	1	0	1	45
1	0	0	1	1	1	0	1	1	1	0	46
1	1	1	0	0	1	0	1	1	1	1	47
1	0	0	0	1	1	1	0	0	0	0	48
1	0	1	0	0	1	1	0	1	0	0	52
1	1	0	0	0	1	1	0	1	1	0	54
1	0	0	1	0	1	1	0	1	1	1	55

The basic setting at output VOLU is about 50% (31/64). The command 0, the basic setting, resets the analogue memory VOLU to the basic setting.

IBUS outputs

Outputs $\overline{DATA}$ and $\overline{DLEN}$ are inverted.

Correctly received commands are available for the duration of a key operation as a single command or as repeated commands, in accordance with the sub-system requirements (see Table 1). The following output modes are provided:

- Single command; e.g. digits.
- Repetition rate: 2/second; e.g. step functions.
- Repetition rate: 8/second; e.g. analogue functions.

The IBUS command is available at output $\overline{DATA}$ synchronous with the system clock; the word length is 7 bits, one start bit and 6 data bits.

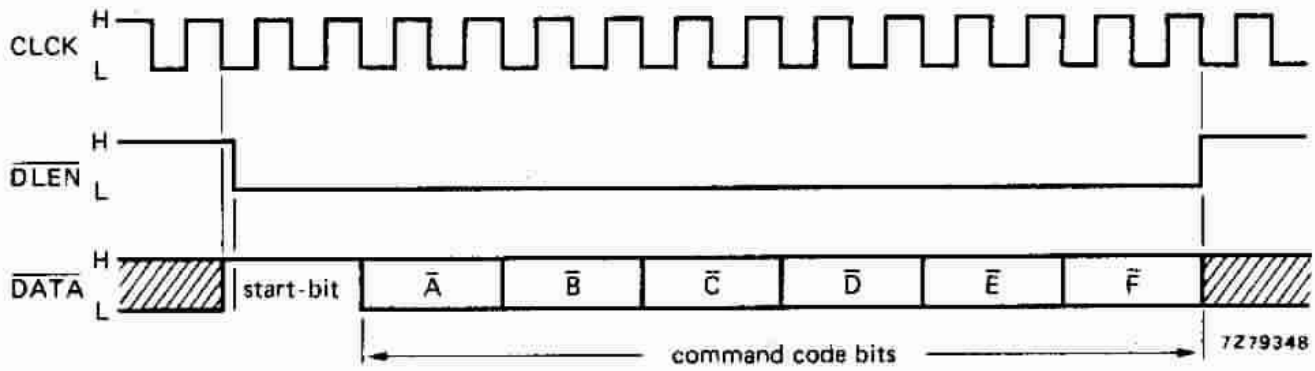


Fig. 5 Output waveforms of a command transmission.

Various word formats can be transmitted between the sub-systems, so it is necessary that each receiver should carry out recognition of a word format. Word formats which do not correspond with the requirements have no effect on the system. It is also necessary that all sub-systems which receive or supply information to the BUS-line should check whether or not the BUS is occupied, if it is, the output is delayed. Output $\overline{DLEN}$ acts as an input for this procedure. The output delay is 32 x t_{CLCK} = 512 μs.

Analogue memories

The SAB3023 contains four 63-step memories for analogue functions. The maximum speed of stepping is 115 ms/step.

Stepping through the full range takes: 7,3 seconds.

When operating in the local mode, via inputs LOCA to LOCE, the stepping speed becomes 129 ms/step; 8,2 seconds for the full range.

The output waveform of the analogue values is pulse-width modulated and has a repetition rate of approximately 2 kHz; the duty factor determines the analogue values. The analogue voltage is available at the output of an externally connected low-pass filter.

By the command (0) 'basic setting' and after switching-on the supply, the analogue memories (ANAL2, ANAL3 and ANAL4) are preset to a mid-position (31/64 in the standard version). The VOLU memory is set to 30% in the standard version, after switching-on the supply (set to 50% or set to normal by command 0 can be obtained by mask-programming).

The volume control output (VOLU) is set LOW when, by a mute command (1), the flip-flop is set. The volume output will be set LOW for T_S = 200 ms (see Fig. 6) when the station is changed by the following commands (only if MODEP = HIGH):

16 to 31 (station 1 to 16).
36 and 37 (step station up/down).

The flip-flop will be reset by the following commands:

mute command (1).
volume up command (40); the volume output increases from LOW.
basic setting command (0); if chosen by mask-programming.
OFF command (2).

In the standby mode, output OFF = HIGH, the analogue memories cannot be changed. The output VOLU = LOW, independent of memory values.

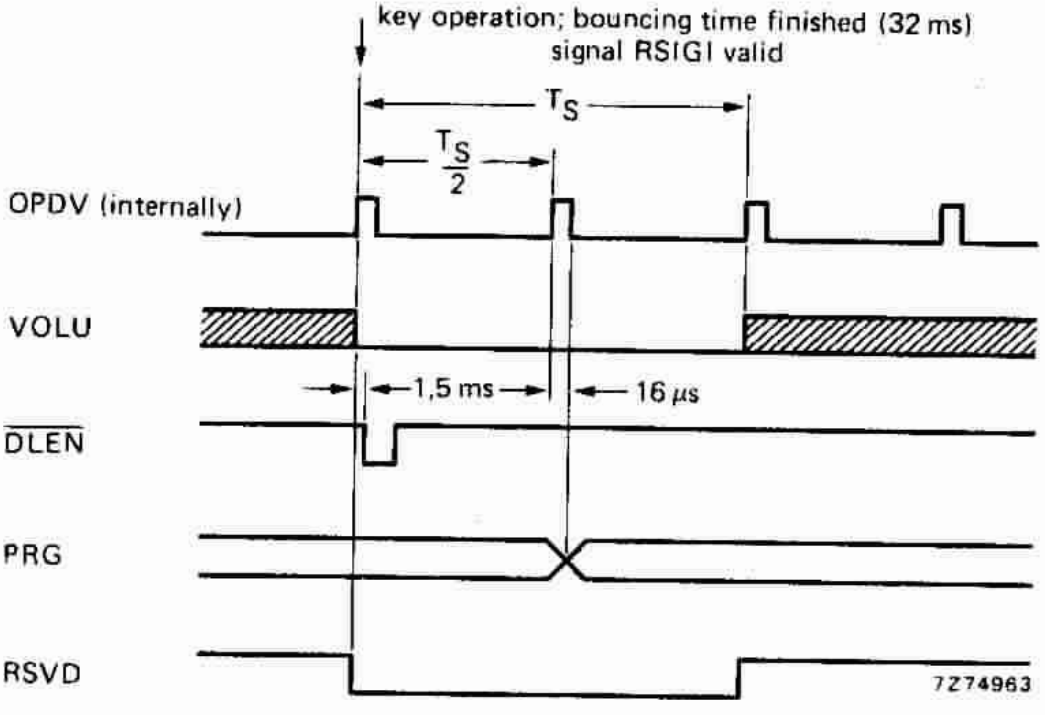


Fig. 6 Timing diagram for muting at station and channel selection; T_S = 200 ms for remote control; T_S = 260 ms for local operation.

Input/output OFF

OFF is the output of a flip-flop (ON-OFF-flag). If this output is LOW, the system is in the ON-mode, if HIGH, the system is in the standby mode. The system is set to the standby mode by switching-on the supply or using the command OFF. Terminal OFF operates as an input and allows setting of the flip-flop to the on-state e.g. switching on via a wiping contact on the mains switch, while OFF is forced to V_{SS} for at least two clock cycles. The flip-flop can be set LOW = ON by a number of commands (see Table 1).

Reserve outputs (RSVA, RSVB and RSVD)

RSVA is the output of a flip-flop which changes its state after each RESERVE A command (3).

RSVB provides a single positive pulse for 1 ms upon receipt of a RESERVE B command (6).

A RESERVE C command (7) generates a HIGH level on the RSVB output for as long as the command is received, with a minimum of 100 ms (error-free reception assumed).

The function of the RSVD output depends upon the use of the MODEP output. If MODEP is LOW, the RSVD output is LOW as long as the RESERVE D command (8) is received, with a minimum of 100 ms.
If MODEP = HIGH, a LOW pulse appears on the RSVD output during a change of the station memory contents by the commands 16 to 31, 36 and 37 (see also Figs 6 and 7).
RSVD can also be used as an input: if it is connected to ground (V_{SS}), the circuit will expect to receive remote commands with a leading one in place of a leading zero.

Station memory outputs (PRGA, PRGB, PRGC, PRGD and MODEP)

The station memory outputs are coded as shown in Table 1.

These are the outputs of a 4-bit station memory, the content of which is changed by commands 16 to 31 (station 1 to 16) or commands 36 and 37 (step station up/down). A step station command (36 and 37) in the standby mode switches the system into the ON-mode without station alteration.

The MODEP terminal indicates whether a sub-system is selected (MODEP = LOW) or not (MODEP = HIGH). A sub-system is selected by the commands 56 to 62. When a sub-system is selected, or when MODEP is switched LOW externally, the commands 16 to 31, 36 and 37 do not influence the station memory contents. Output VOLU is not mute controlled and RSVD delivers no station change signal, and can only be influenced by command 8 (reserve D).

At commands 2 (OFF), 63 (on) and after switching on the supply voltage, the circuit is in the MODEP = HIGH state, meaning the station memory can be addressed.

When the SAB3023 is used in the VTS (Video Tuning System) system, MODEP should be switched LOW externally, to avoid unwanted muting during input of digits.

The step station cycle is reduced from 16 to 12 stations, if PRGD is connected to ground (V_{SS}).

Standby state

The SAB3023 has a built-in reset circuit. After switching on the supply voltage, the next two clock cycles will reset the circuit into the standby mode.
The circuit will be in the following operating states:

1. VOLU = LOW.
2. Analogue memories are set to 50%; VOLU is set to 30% (for the **SAB3023B**) or 50% (for the **SAB3023E**).
3. Station memory is at station 1.
4. OFF = HIGH.
5. Mute-flag is not set.
6. All reserve outputs (except RSVD) are LOW.
7. MODEP = HIGH.