

SAA 1250
Infrared Remote-Control
Transmitter IC

Infrared Remote-Control Transmitter IC

This integrated CMOS circuit has been developed for infrared remote control of color TV receivers, but can also be used for other remote-control applications with advantage. It consumes a minimal current and, due to its large instruction repertoire, is highly flexible in application. Up to 1024 commands can be transmitted by one SAA 1250 transmitter IC. As receivers are intended either the SAA 1251 Infrared Remote-Control Receiver IC or the CCU 2030/CCU 2050/CCU 2070 series Central Control Units for the DIGIT 2000 Digital TV System or the MAA 4000 series Microcomputers for Remote Control and PLL Tuning or the SAA 1290/SAA 1293 Remote-Control and Tuning ICs for TV receivers.

1. Description of the System

Pulsecode modulated infrared light serves for the transmission of remote-control commands, the information being defined by the varying time intervals between a sequence of very short infrared pulses. This enables the emitter diode to be driven with a high current (1 A or more), thus achieving a large transmission distance and high interference immunity while ensuring a long battery life.

At the receiver end, a photo-diode converts the received IR-transmissions into electrical signals which are amplified in the TBA 2800 Infrared Preamplifier IC and fed to the receiver IC mentioned above and shown in Fig. 1. In the receiver IC the signals are converted into the respective commands, e. g. for on/off switching, choice of the station to be received, for the setting of analog control values such as volume, brightness etc., for the control of Teletext, and so on.

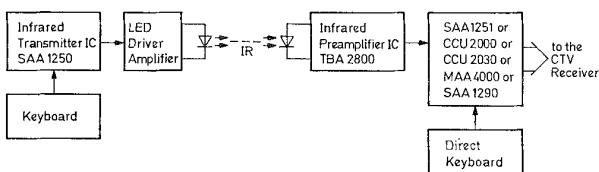


Fig. 1: Block diagram of an infrared remote-control using the SAA 1250 at the transmitter end

Each remote-control signal word contains ten information bits. The transmitter IC SAA 1250, therefore, is capable of delivering 1024 different signals. The word is usually structured into four bits and six bits offering 16 addresses and 64 commands. However, this separation must by no means be rigidly adhered to. The receiver IC allows an operational mode in which commands for calling up subsystems are also used. In this way, the number of transmittable commands and addressable additional integrated circuits becomes practically unlimited.

1.1. Synthesis of the Remote Control Signals

The signals are transmitted by means of infrared light in the shape of packaged pulses. For the transmission of a 10-bit word, 14 pulses are required. The binary information of a bit

is contained in the time interval between two pulses. We define the time T (approx. $100 \mu\text{s}$) as the basis for the code to be employed. A short interval of duration T between any two pulses corresponds to the binary digit "0", while a long interval of the duration $2T$ signifies the binary digit "1". For a 10-bit word, 11 data pulses are therefore required. In addition, every signal contains a preliminary pulse, a start pulse and a stop pulse. The spacing between preliminary pulse and start pulse is $3T$. This is followed after $1T$ by the 11 data pulses and terminated after a $3T$ interval by the stop pulse. Consequently, a command in which the binary digit 0 occurs ten times has a total duration of $17T$. Likewise, a command containing ten 1s has a duration of $27T$.

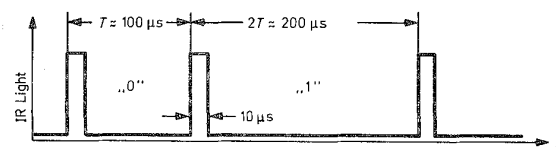


Fig. 2: Representing the binary digits 0 and 1 by intervals of different duration

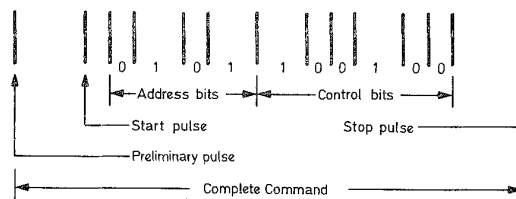


Fig. 3: Command word "0 1 0 1 1 0 0 1 0 0", as an example

1.2. Interference Immunity of the Remote Control System

With high levels of spurious infrared signals, generated for example by infrared sound transmission, it is useful to employ a preamplifier equipped with AGC in the receiver, p. ex. the TBA 2800. The preliminary pulse amplitude enables the gain to be set relative to the intelligence signal strength before the signal is actually evaluated. As an additional anti-interference measure, the infrared input of the receiver IC is blocked after each received pulse and is only reopened after a time T for a short time slot t_F . If a pulse is received during t_F , this indicates a zero signal. If this is not the case, then a time slot is again opened after a further period T . A pulse detected during this time slot signifies a logic "1".

Given this mode of operation, a pulse is bound to occur at least every second time slot while information is being transmitted. If not, a faulty reception must have occurred and when detected, the signal evaluation is interrupted and the receiver input reopened.

Exemptions to this rule are the first data pulse and the stop pulse. The first data pulse should always occur during the first time slot following the start pulse. The start pulse and

the following recognised data pulses are counted. After the 12th pulse, the checking conditions are changed as follows: No pulse must appear during the following two time slots, and the stop pulse should be recognised during the third time slot.

The interference-prevention system, therefore, recognises undesired pulses coinciding with the time slots. It also recognises the suppression of an intelligence pulse because in that case the above-mentioned condition for the stop pulse is not met. The only time an anomaly could remain undetected would be a double error consisting of an undesired pulse that occurs during a time slot and of a suppressed pulse provided the suppressed pulse appeared between two "0"s. However, this, as has been confirmed also by practical tests, is highly unlikely.

As has already been mentioned, the preliminary pulse only serves as a control signal for the AGC of the preamplifier. The receiver IC treats it like any other interference, i. e. the evaluation of the pulse train starts only with the start pulse.

1.3. Synchronisation Between Transmitter and Receiver

Unlike comparable systems, the ITT infrared remote control system with the integrated circuits SAA 1250 and SAA 1251 (or others) offers the advantage of requiring a quartz crystal (0.4 . . . 4.4 MHz) only in the receiver, whereas the transmitter contains merely a simple RC oscillator. Satisfactory synchronisation between transmitter and receiver IC's, necessary to obtain the above-described interference-immunity, is achieved in the receiver IC by measuring the interval between the start pulse and the first data pulse, storing this value and from this determining the base interval T between the time slots. The duration of the time slot t_F for the first data pulse is therefore extended by comparison with later time slots, so that the first data pulse is recognised without fail, provided the oscillator frequency of the transmitter falls within a specified tolerance range. A prerequisite for this type of synchronisation of receiver IC to the oscillator frequency of the transmitter, is that the latter remains constant within the transmission period of a command. This condition is easily met.

2. Functional Description

2.1. Operational Modes

According to Table 2, the SAA 1250 may operate in one of three modes which are determined via the OA and OB address inputs, Table 1 showing the code.

The first command is given about 20 ms after contact actuation. All following commands are sent periodically every 130 ms, as shown in the program flowchart Fig. 4.

Additionally, the free address selection mode can be operated with every one of the above-described options. For this purpose a Free Address Selection (FAS) flip-flop contained in the transmitter IC SAA 1250 must be set. This is done by the brief application of an L signal to both address inputs, OA and OB (min. 30 μ s). In this mode the required address must be initially entered into the address register of the transmitter IC SAA 1250, using one of the commands 17 to 32. Then all following commands are transmitted together with the stored address, including commands 17 to 32. Exceptions to this rule are the FAS off commands 2, 3, 33 and 39. These commands clear the address register and reset the FAS flip-flop. Immediately following this, the command is processed in the preselected option.

If commands are to be transmitted consecutively to various addresses with free address selection, the L signal must be permanently applied to both address inputs. The commands 2, 3, 33 and 39 (FAS off) will, under these conditions, clear only the address register. The operational mode of Free Address Selection remains in force.

Table 1: Code for the OA and OB address inputs

Input	Option I	Option II	Option III	free address selection
OA	H	H	L	L impulse (min. 30 μ s)
OE	H	L	H	L impulse (min. 30 μ s)

Option I: After contact actuation the first command is issued with address 1, all following commands with address 16 as long as the contact is actuated.

Option II: All commands are sent with address 15.

Option III: All commands are sent with address 10.

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Table 2: Command table of the infrared transmitter IC SAA 1250

Com- mand No.	Input code								Option I Addr. 1 and 16	Option II Addr. 15	Option III Addr. 10	Free Address Selection FAS OA and OB briefly to L potential													
	a	b	c	d	e	f	g	h					A	B	C	D	E	F	G	H					
1	x								x									↑	↑	↑	FAS off	↑			
2	x								x												FAS off				
3	x									x											FAS off				
4	x										x														
5	x											x													
6	x												x												
7	x													x											
8	x														x										
9		x								x															
10		x									x														
11		x										x													
12		x											x												
13		x												x											
14		x													x										
15		x														x									
16		x															x								
17			x								x										Address 1	↑ No signal is trans- mitted during the first signal input after FAS on ↓			
18			x									x								Address 2					
19			x										x							Address 3					
20			x											x						Address 4					
21			x												x					Address 5					
22			x													x				Address 6					
23			x														x				Address 7				
24			x															x					Address 8		
25				x								x									Address 9				
26				x									x								Address 10				
27				x										x							Address 11				
28				x											x						Address 12				
29				x												x					Address 13				
30				x													x				Address 14				
31				x														x				Address 15			
32				x															x				Address 16		
33					x							x									FAS off				
34					x								x												
35					x									x											
36					x										x										
37					x											x									
38					x												x								
39					x													x							
40					x														x						
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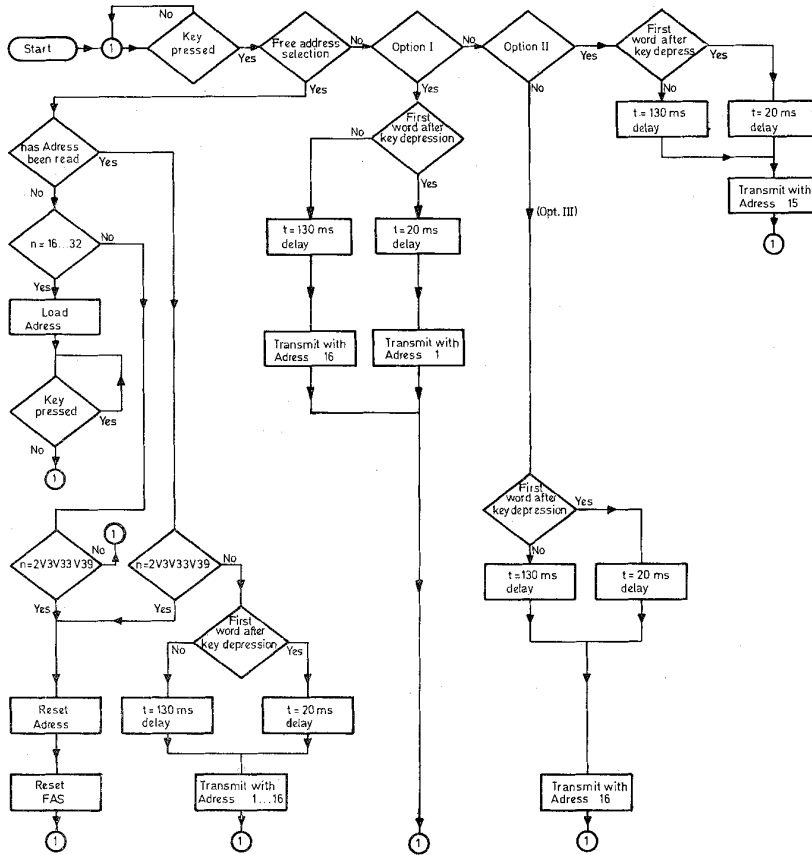


Fig. 4: Program flowchart of the SAA 1250

2.2. The Functional Units of the SAA 1250

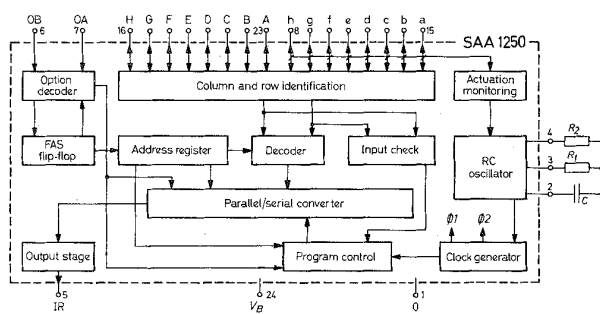


Fig. 5: Block diagram of the SAA 1250

The frequency of the RC oscillator is determined by the external RC element R_1, C at pins 2 and 3. The resistor R_2 compensates for the dependence of the oscillator frequency on the supply voltage. If the receiver IC is driven by a 4.4 MHz crystal, then the oscillator frequency of the transmitter must be within the range of 160 to 220 kHz. We recommend the choice, for this purpose, of the time constant $R_1 \cdot C = 1.8 \cdot 10^{-6}$ seconds $\pm 4.5\%$. If a crystal other than the 4.4 MHz quartz is used, then the time constant will have to be altered in proportion.

The clock generator produces the two-phase clock for all circuit elements of the SAA 1250, except for actuation monitoring. The latter is static and blocks the oscillator as long as no inputs are being activated. This ensures that the current consumption of the transmitter IC is virtually nil in the inactive condition.

Program control regulates the time sequence of all functions.

Two sets of eight terminals are available for operating the infrared transmitter, i. e. the pins 8 to 15 (row inputs a to h) and the pins 16 to 23 (column inputs A to H). Pins 8 to 23 are connected with the column and row identification circuit. For actuating purposes, any one column input must be connected to one row input, see Table 2. Therefore, only single contacts are required. A diode matrix is not necessary.

The input check blocks the infrared output in the case of double and multiple operations, for example when more than one terminal of a group of eight is connected to one of the other group of eight. This check occurs every 130 ms. Contact bounce has no effect on the function of the SAA 1250. If the contact is broken while a command word is being transmitted, the SAA 1250 carries on with the transmission to the end. If a contact is operated for less than 20 ms, no command will be transmitted.

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The decoder converts the input signal, which has been entered in the form of 2×1 or 8, into a 6-bit binary signal. This enables inputting of 64 commands through the 2×8 input pins.

The parallel/serial converter consists of a shift register which receives the parallel-input information from the decoder and delivers it serially to the output stage.

The option decoder detects the chosen mode of operation (see Table 1).

The FAS flip-flop switches the SAA 1250, if required, to the operation mode "Free Address Selection", as described in section 2.1.

The address register stores the address which is defined either by wiring of the pins 6 and 7 or, in the case of free address selection (FAS), is input by means of the keyboard. Every time a command is given, the six instruction bits are preceded by the four address bits stored in the address register.

The output stage is designed in totem-pole push-pull configuration and delivers an amplitude as high as the supply voltage when the output is open-circuit. If an output current of 1 mA is drawn, the voltage drop across each output transistor will amount to 1 V.

2.3. Application Circuits

The suggestions given below for the transmitter amplifier circuit have been developed in the ITT Semiconductors' application lab. for use in the infrared remote control systems for television receivers. We offer them as suggestions only, based on the present state of the art, and emphasise that they do not necessarily represent the best possible solution. For different applications of the infrared transmission system (greater range, transmission paths of different type etc.), the design of the amplifier will have to be modified.

In order to achieve a sufficient transmission range, the infrared transmitter diodes must be driven with current pulses of about 1 A. Since MOS circuits are limited in their output current to a few milliamperes an amplifier is necessary in order to deliver sufficient current to the transmitter diodes. A suitable circuit is shown in Fig. 6. In the standby condition and in the spaces between pulses all three transistors are blocked and the two $150 \mu\text{F}$ electrolytic capacitors charge up to approximately the battery voltage. When this condition is reached the current consumption of the circuit is determined only by the current consumption of the MOS IC SAA 1250 and the leakage current of the capacitors. When a command is to be transmitted the pulses from pin 5 of the SAA 1250 switch on the transistor BC 415 which in turn switches on the other two transistors. The PNP transistor BC 328-40 connects the two capacitors in series so that a supply voltage of about 15 volts is available for the three series-connected transmitter diodes. The second NPN transistor BC 338-40 in connection with the voltage regulator diode ZPD 3,3 forms a constant-current source with an output current of about 1 A. This circuit ensures that, regardless of production spreads of the forward voltage of the transmitter diodes and of the state of the

battery, the necessary current always flows through the transmitter diodes, thus assuring a constant transmission range. The light emitting diode in the supply rail serves to display the otherwise invisible transmission operation.

A simpler and more economic solution of the LED driver amplifier is shown in Fig. 7. Here, the voltage doubler circuit contained in Fig. 6 has been omitted, and only two light-emitting diodes are driven by the amplifier.

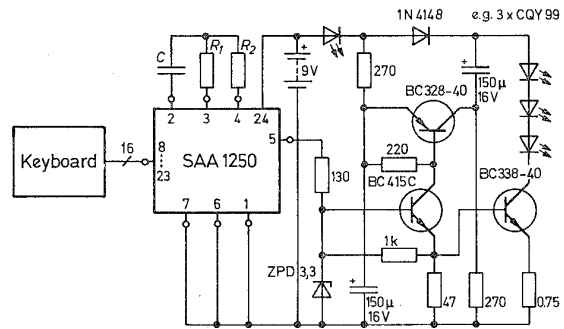


Fig. 6: Circuit suggested for the transmitter amplifier

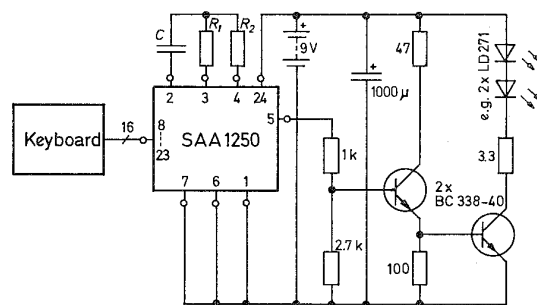


Fig. 7: Simplified transmitter amplifier

3. Outline Dimensions and Pin Connections

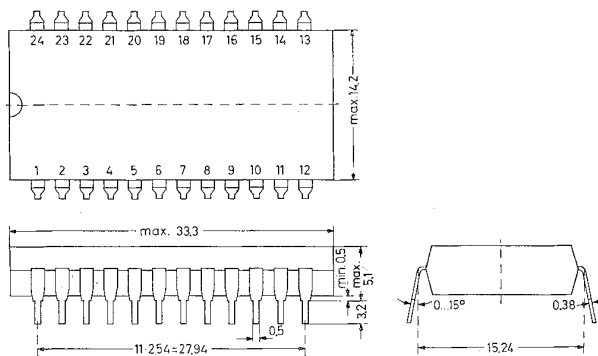


Fig. 8:
SAA 1250 in 24-pin Dip Plastic Package,
20 B 24 according to DIN 41 866

Weight approx. 4.5 g Dimensions in mm

Pin connections

- 1 Ground, 0
- 2 Oscillator Terminal C
- 3 Oscillator Terminal R₁
- 4 Oscillator Terminal R₂
- 5 Infrared Output IR
- 6 Address Input OB
- 7 Address Input OA
- 8 Row Input h
- 9 Row Input g
- 10 Row Input f
- 11 Row Input e
- 12 Row Input d
- 13 Row input c
- 14 Row Input b
- 15 Row Input a
- 16 Column Input H
- 17 Column Input G
- 18 Column Input F
- 19 Column Input E
- 20 Column Input D
- 21 Column Input C
- 22 Column Input B
- 23 Column Input A
- 24 Supply Voltage V_B

4. Electrical Characteristics

All voltages are referred to pin 1.

Absolute Maximum Ratings

	Symbol	Value	Unit	Conditions
Supply Voltage	V _B	-0.3 to +10	V	
Voltage at the other pins	V _n	V _B		
Output Current	I ₅	10	mA	
Ambient Operating Temperature Range	T _A	0 to +65	°C	
Storage Temperature Range	T _S	-40 to +125	°C	

Recommended Operating Conditions

	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply Voltage	V _B	6	—	9	V	
Oscillator Frequency	f _o	160	—	220	kHz	
Resistors	R ₁	—	18 ± 2 %	—	kΩ	
	R ₂	—	33 ± 5 %	—	kΩ	
Capacitor	C	—	100 ± 2.5 %	—	pF	

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Characteristics at $V_B = 8\text{ V}$, $f_o = 200\text{ kHz}$, $T_A = 25\text{ °C}$

	Symbol	Min.	Typ.	Max.	Unit	Conditions
Current Consumption	I_1	—	4	—	mA	oscillator working and IR-output open-circuit
	I_1	—	10	—	μA	oscillator quiescent
Output Impedance of IR-Output	R_{OH}	—	1	—	$\text{k}\Omega$	H-State at $-I_O = 1\text{ mA}$
	R_{OL}	—	1	—	$\text{k}\Omega$	L-State at $I_O = 1\text{ mA}$

ITT Semiconductors Group
 World Headquarters
 INTERMETALL
 Hans-Bunte-Strasse 19
 D-7800 Freiburg
 Telephone (0761) 517-0
 Telex 772715

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End of Data Sheet



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