

## INFRARED REMOTE CONTROL TRANSMITTER (LOW VOLTAGE)

### GENERAL DESCRIPTION

The SAA3007 transmitter IC for infrared remote control systems has a capacity for 1280 commands arranged in 20 subsystem address groups of 64 commands each. The subsystem address may be selected by press-button or slider switches, or be hard-wired.

Commands are transmitted in patterns of pulses coded by the pulse spacing. The pulses can be infrared flashed (single pulse) or modulated. Flashed infrared transmissions require a wideband preamplifier at the receiver, but modulated transmissions allow a narrow band receiver to be used for improved noise rejection. The modulation frequency of the SAA3007 is 455 kHz which allows disturbance-free infrared operation in the presence of 10 - 100 kHz fluorescent lamps.

### Features

- Flashed or modulated transmission modes
  - Immune from fluorescent lamp disturbance in modulated mode
  - Supply voltage range 2 V to 6,5 V
  - 40 mA output current capability
  - Very low standby current ( $< 4 \mu\text{A}$  at  $V_{DD} = 6 \text{ V}$ )
  - Up to 20 subsystem address groups
  - Up to 64 commands per subsystem address
  - Requires few additional components
- } up to 1280 commands

### PACKAGE OUTLINES

SAA3007P: 20-lead DIL; plastic (SOT146).

SAA3007T: 20-lead mini-pack; plastic (SO20; SOT163A).

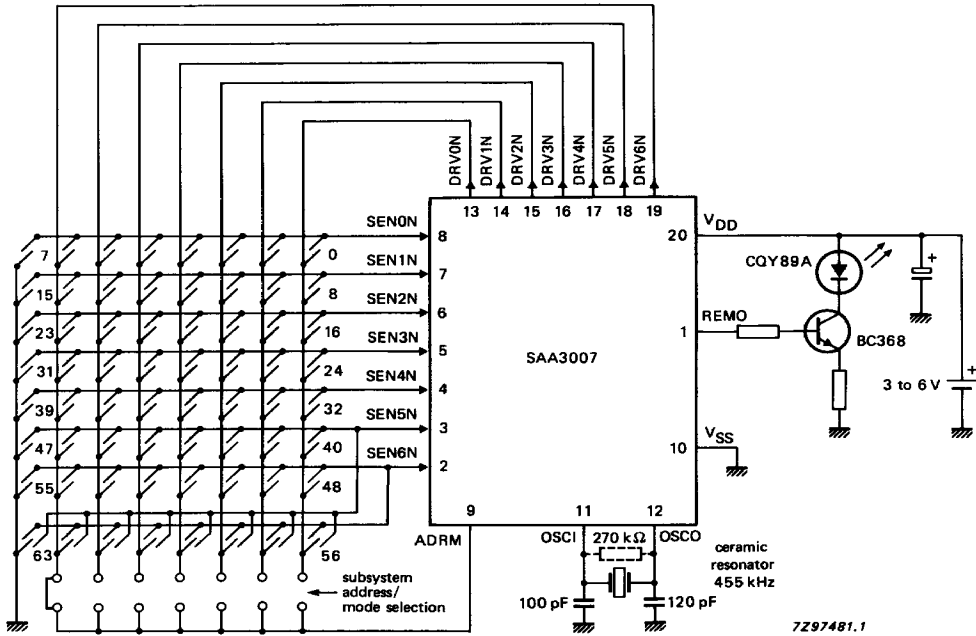


Fig. 1 SAA3007 application example.

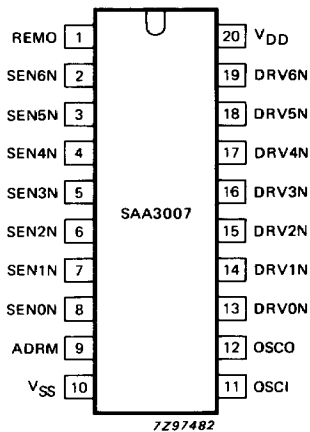


Fig. 2 Pinning diagram.

**PINNING**

- 1. REMO remote data output
- 2. SEN6N
- 3. SEN5N
- 4. SEN4N
- 5. SEN3N
- 6. SEN2N
- 7. SEN1N
- 8. SEN0N
- 9. ADRM address/mode control input
- 10. VSS ground (0 V)
- 11. OSCI oscillator input
- 12. OSCO oscillator output
- 13. DRV0N
- 14. DRV1N
- 15. DRV2N
- 16. DRV3N
- 17. DRV4N
- 18. DRV5N
- 19. DRV6N
- 20. VDD positive supply voltage

## FUNCTIONAL DESCRIPTION

### Key matrix (DRV0N - DRV6N and SEN0N - SEN6N)

The transmitter keyboard is arranged as a scanned matrix with seven driver lines (DRV0N to DRV6N) and seven sensing lines (SEN0N to SEN6N) as shown in Fig. 1. The matrix allows generation of 56 command codes per subsystem address, with triple contacts all 64 commands are addressable, giving a maximum possibility of 1280 commands.

Lines DRV0N to DRV6N are driven by open drain N-channel transistors (conductive in standby mode). The sense lines go to P-channel pull-up transistors, so that they are HIGH until they are pulled LOW by key contact with a driver line. This key operation initiates a code transmission.

The maximum allowable value of contact series resistance for keyboard switches in the ON-state is 7 k $\Omega$ .

### Address/mode input (ADRM)

Subsystem addresses are defined by connecting one or two of the key matrix driver lines (DRV0N to DRV6N) to the ADRM input. This allows up to 20 subsystem addresses to be generated for the REMO output (bits S3, S2, S1 and S0) as shown in Table 1 and Fig. 3.

The transmission mode is defined by the DRV6N to ADRM connection as follows:

Flashed mode    DRV6N not connected to ADRM  
Modulated mode    DRV6N connected to ADRM

When more than one connection is made to ADRM then all connections should be decoupled using diodes.

The ADRM input has switched pull-up and pull-down loads. In the standby mode only 'pull-down' is active and ADRM is held LOW (this condition is independent of ADRM circuit configuration and minimizes power loss in the standby mode).

When a key is pressed the transmitter becomes active, 'pull-down' is switched off, 'pull-up' is switched on and the driver line signals are sensed for the subsystem address coding.

The subsystem address is sensed only within the first scan cycle, whereas the command code is sensed in every scan. The transmitted subsystem address remains unchanged if the subsystem address selection is changed while the command key is pressed. A change of the subsystem address does not start a transmission.

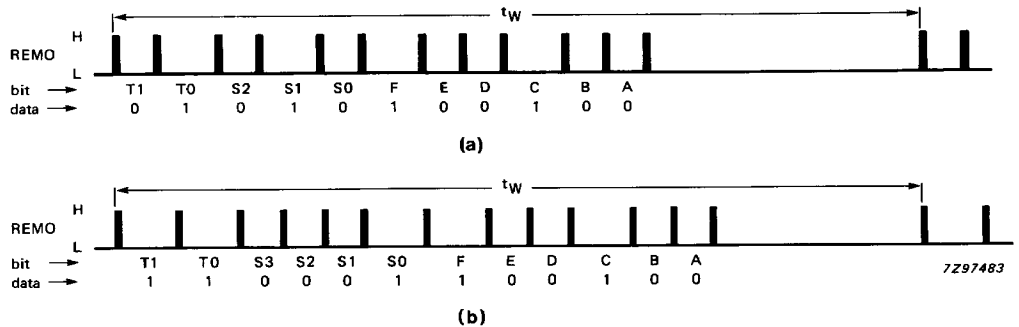
### Remote control signal output (REMO)

The REMO output driver stage incorporates a bipolar emitter-follower which allows a high output current in the output active (HIGH) state. The format of the output pulse trains are shown in Fig. 3 and one cycle of the output waveform for flashed or modulated mode is shown in Fig. 4.

A data word starts with two toggle bits T0, T1 (Fig. 3) which indicate by changing state that the next instruction is a new command. The subsystem address is defined by the bits S3, S2, S1 and S0 (bit S3 is transmitted only for subsystem addresses 8 to 20). The selected command key is defined by bits F, E, D, C, B and A as shown in Table 2.

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FUNCTIONAL DESCRIPTION (continued)



T1, T0                    toggle bits  
 S3, S2, S1, S0        subsystem address  
 A to F                    command bits  
 tw                        word length  
 binary values         determined by pulse spacing

Fig. 3 Data format of remote control signal (REMO); (a) subsystem addresses 1 to 7, (b) subsystem addresses 8 to 20.

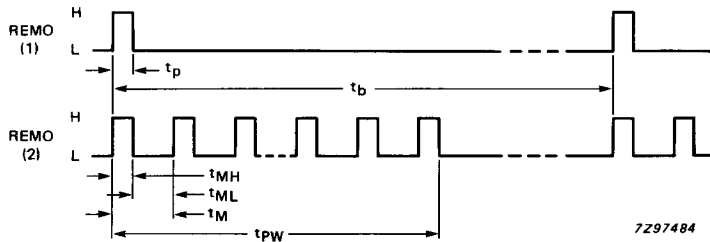


Fig. 4 Waveform for one pulse period at REMO output; for timing values see Table 3.

All pulse timings are multiples of the oscillator period ( $t_{osc}$ ) as given in Table 3. Information carried on the REMO output is defined as logic 1 or logic 0 by the time ( $t_b$ ) between leading edges of the initial pulses of adjacent pulse periods.

**Oscillator (OSCI, OSCO)**

The external components for the oscillator circuit are connected to OSCI and OSCO. The oscillator operates with a ceramic resonator in the frequency range 350 kHz to 500 kHz, as defined by the resonator. With a supply voltage of less than 3 V a 270 K $\Omega$  resistor should be connected in parallel with the resonator (see Fig. 1).

Table 1 Definition of subsystem addresses

address number	driver line(s) connected to ADRM	subsystem address			
		S3	S2	S1	S0
1	no connection	—	1	1	1
2	DRV0N	—	0	0	0
3	DRV1N	—	0	0	1
4	DRV2N	—	0	1	0
5	DRV3N	—	0	1	1
6	DRV4N	—	1	0	0
7	DRV5N	—	1	0	1
8	DRV0N and DRV2N	0	0	0	0
9	DRV0N and DRV3N	1	0	0	0
10	DRV0N and DRV4N	0	1	0	0
11	DRV0N and DRV5N	1	1	0	0
12	DRV1N and DRV2N	0	0	0	1
13	DRV1N and DRV3N	1	0	0	1
14	DRV1N and DRV4N	0	1	0	1
15	DRV1N and DRV5N	1	1	0	1
16	DRV2N and DRV3N	1	0	1	0
17	DRV2N and DRV4N	0	1	1	0
18	DRV2N and DRV5N	1	1	1	0
19	DRV3N and DRV4N	0	1	1	1
20	DRV3N and DRV5N	1	1	1	1

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Table 2 Definition of command codes

key pressed	drive-to-sense connection made	command code generated					
		F	E	D	C	B	A
0	DRV0N to SEN0N	0	0	0	0	0	0
1	DRV1N to SEN0N	0	0	0	0	0	1
2	DRV2N to SEN0N	0	0	0	0	1	0
3	DRV3N to SEN0N	0	0	0	0	1	1
4	DRV4N to SEN0N	0	0	0	1	0	0
5	DRV5N to SEN0N	0	0	0	1	0	1
6	DRV6N to SEN0N	0	0	0	1	1	0
7	DRV7N to SEN0N	0	0	0	1	1	1
8	DRV0N to SEN1N	0	0	1	0	0	0
9	DRV1N to SEN1N	0	0	1	0	0	1
10	DRV2N to SEN1N	0	0	1	0	1	0
11	DRV3N to SEN1N	0	0	1	0	1	1
12	DRV4N to SEN1N	0	0	1	1	0	0
13	DRV5N to SEN1N	0	0	1	1	0	1
14	DRV6N to SEN1N	0	0	1	1	1	0
15	DRV7N to SEN1N	0	0	1	1	1	1

Table 2 Definition of command codes (continued)

key pressed	drive-to-sense connection made	command code generated					
		F	E	D	C	B	A
16	DRV0N to SEN2N	0	1	0	0	0	0
17	DRV1N to SEN2N	0	1	0	0	0	1
18	DRV2N to SEN2N	0	1	0	0	1	0
19	DRV3N to SEN2N	0	1	0	0	1	1
20	DRV4N to SEN2N	0	1	0	1	0	0
21	DRV5N to SEN2N	0	1	0	1	0	1
22	DRV6N to SEN2N	0	1	0	1	1	0
23	DRV7N to SEN2N	0	1	0	1	1	1
24	DRV0N to SEN3N	0	1	1	0	0	0
25	DRV1N to SEN3N	0	1	1	0	0	1
26	DRV2N to SEN3N	0	1	1	0	1	0
27	DRV3N to SEN3N	0	1	1	0	1	1
28	DRV4N to SEN3N	0	1	1	1	0	0
29	DRV5N to SEN3N	0	1	1	1	0	1
30	DRV6N to SEN3N	0	1	1	1	1	0
31	DRV7N to SEN3N	0	1	1	1	1	1
32	DRV0N to SEN4N	1	0	0	0	0	0
33	DRV1N to SEN4N	1	0	0	0	0	1
34	DRV2N to SEN4N	1	0	0	0	1	0
35	DRV3N to SEN4N	1	0	0	0	1	1
36	DRV4N to SEN4N	1	0	0	1	0	0
37	DRV5N to SEN4N	1	0	0	1	0	1
38	DRV6N to SEN4N	1	0	0	1	1	0
39	DRV7N to SEN4N	1	0	0	1	1	1
40	DRV0N to SEN5N	1	0	1	0	0	0
41	DRV1N to SEN5N	1	0	1	0	0	1
42	DRV2N to SEN5N	1	0	1	0	1	0
43	DRV3N to SEN5N	1	0	1	0	1	1
44	DRV4N to SEN5N	1	0	1	1	0	0
45	DRV5N to SEN5N	1	0	1	1	0	1
46	DRV6N to SEN5N	1	0	1	1	1	0
47	DRV7N to SEN5N	1	0	1	1	1	1
48	DRV0N to SEN6N	1	1	0	0	0	0
49	DRV1N to SEN6N	1	1	0	0	0	1
50	DRV2N to SEN6N	1	1	0	0	1	0
51	DRV3N to SEN6N	1	1	0	0	1	1
52	DRV4N to SEN6N	1	1	0	1	0	0
53	DRV5N to SEN6N	1	1	0	1	0	1
54	DRV6N to SEN6N	1	1	0	1	1	0
55	DRV7N to SEN6N	1	1	0	1	1	1
56	DRV0N to SEN5N and SEN6N	1	1	1	0	0	0
57	DRV1N to SEN5N and SEN6N	1	1	1	0	0	1
58	DRV2N to SEN5N and SEN6N	1	1	1	0	1	0
59	DRV3N to SEN5N and SEN6N	1	1	1	0	1	1
60	DRV4N to SEN5N and SEN6N	1	1	1	1	0	0
61	DRV5N to SEN5N and SEN6N	1	1	1	1	0	1
62	DRV6N to SEN5N and SEN6N	1	1	1	1	1	0
63	DRV7N to SEN5N and SEN6N	1	1	1	1	1	1

Table 3 Pulse timing

parameter	symbol	duration	duration at $f_{osc} = 455 \text{ kHz}$ ; $t_{osc} = 2,2 \mu\text{s}$
Flashed pulse width	$t_p$	$4 \times t_{osc}$	$8,8 \mu\text{s}$
Modulation period	$t_M$	$1 \times t_{osc}$	$2,2 \mu\text{s}$
Modulation LOW time	$t_{ML}$	$0,5 \times t_{osc}$	$1,1 \mu\text{s}$
Modulation HIGH time	$t_{MH}$	$0,5 \times t_{osc}$	$1,1 \mu\text{s}$
Modulation pulse width	$t_{pw}$	$7t_M + t_{MH}$	$16,5 \mu\text{s}$
Basic unit of pulse spacing	$t_o$	$1152 \times t_{osc}$	$2,53 \text{ ms}$
Word length for sub-system addresses			
1 to 7	$t_W$	$55296 \times t_{osc}$	$121 \text{ ms}$
8 to 20	$t_W$	$59904 \times t_{osc}$	$132 \text{ ms}$
Pulse spacing for logic 0	$t_b$	$2 \times t_o$	$5,06 \text{ ms}$
logic 1	$t_b$	$3 \times t_o$	$7,59 \text{ ms}$

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## OPERATION

### Keyboard

In the standby mode all drivers DRV0N - DRV6N are 'on' but are non-conducting due to their open drain configuration. When a key is pressed, a completed drain connection pulls down one or more of the sense lines to ground. Referring to Fig. 5, the power-up sequence for the IC commences as a key is pressed. The oscillator becomes active and then, following the debounce time ( $t_{DB}$ ), the output drivers become active successively.

Within the first scan cycle the mode selection, subsystem address and the selected command are sensed and loaded into an internal data latch.

### Multiple keystroke protection

In a multiple keystroke sequence the command selected is always that of the first key to be sensed and the scan rate increases to speed detection of a key-release (Fig. 6).

If more than one key is pressed at the same time, the output sequence is not changed.

There are two restrictions caused by the special structure of the keyboard matrix:

The keys switching directly to ground (codes 7, 15, 23, 31, 39, 47, 55, 63) are not completely covered by multiple keystroke protection. If one sense input is switched to ground, other keys on that sense line are ignored.

The sense lines SEN5N and SEN6N are not protected against multiple keystrokes on the same driver line because this has been used to define codes 56 to 63.

**Output sequence**

The output operation starts when the selected code has been detected. A burst of pulses, including the latched address and command codes, is generated at the output REMO for as long as the key is pressed. The format of the output pulse train is as shown in Figs 3 and 4. The operation is terminated by releasing the key, or by pressing more than one key at the same time. Once a sequence has been started, the transmitted words will always be completed after the key has been released.

The toggle bits T0, T1 are incremented if the key is released for a minimum time  $t_{REL}$  (Fig. 5). They remain unchanged in a multiple keystroke sequence.



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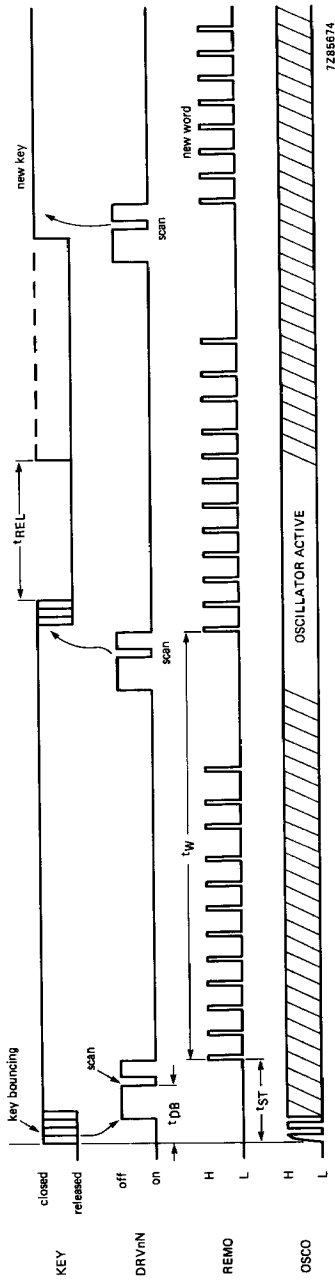


Fig. 5 Single keystroke sequence:  $t_{DB}$  = debounce time =  $4 T_0$  to  $9 T_0$ ;  
 $t_{ST}$  = start time =  $5 T_0$  to  $10 T_0$ ;  $t_{REL}$  = minimum release time =  $T_0$ ;  
 $t_w$  = word length.

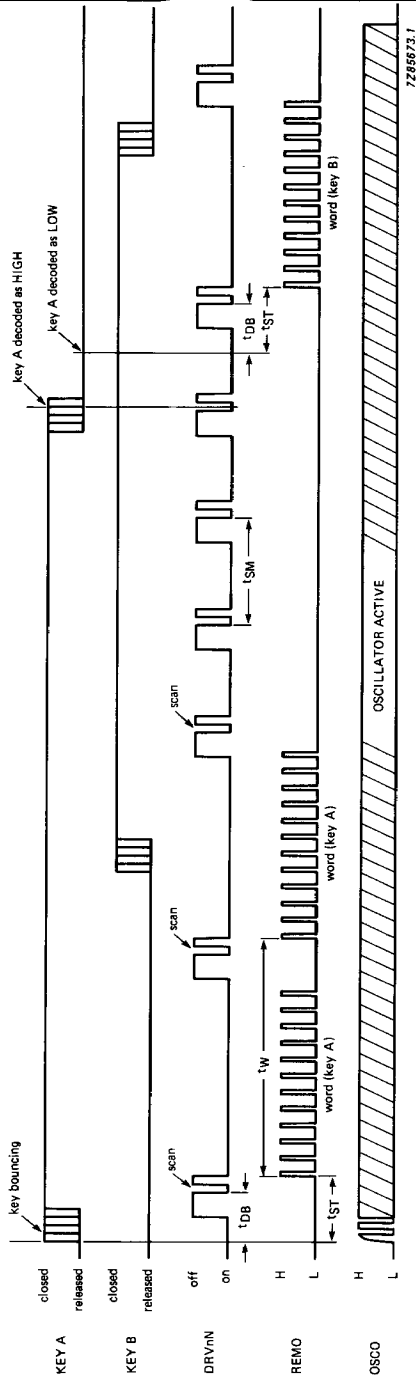


Fig. 6 Multiple keystroke sequence:  $t_{SM}$  = scan rate (multiple keystroke) =  $6 T_0$  to  $10 T_0$ .  
 $t_{DB}$ ,  $t_{ST}$  and  $t_W$  are as per Fig. 5.

**RATINGS**

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

parameter	symbol	min.	max.	unit
Supply voltage range	$V_{DD} = V_{20-10}$	-0,3	+ 7	V
Input voltage range	$V_I$	-0,3	$V_{DD} + 0,3$	V
Output voltage range	$V_O$	-0,3	$V_{DD} + 0,3$	V
Total power dissipation				
DIL package (SOT-146C1)	$P_{tot}$	—	300	mW
mini-pack (SO-20; SOT-163A)	$P_{tot}$	—	200	mW
Power dissipation				
matrix outputs DRV0N to DRV6N	$P_O$	—	50	mW
remote data output REMO	$P_O$	—	200	mW
Operating ambient temperature range	$T_{amb}$	-20	+ 70	°C
Storage temperature range	$T_{stg}$	-20	+ 125	°C

**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').

**CHARACTERISTICS**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 0\text{ to }+70\text{ °C}$ ; unless otherwise specified

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage	pin 20	$V_{DD}$	2,0	—	6,5	V
Supply current <b>active</b>	$f_{osc} = 455\text{ kHz}$ ; $V_{DD} = 3,0\text{ V}$ $V_{DD} = 4,5\text{ V}$ $V_{DD} = 6,0\text{ V}$	$I_{DD}$	—	0,25	—	mA
		$I_{DD}$	—	0,5	—	mA
		$I_{DD}$	—	1,0	—	mA
Supply current <b>standby mode</b>	$T_{amb} = 25\text{ °C}$ ; $V_{DD} = 6,0\text{ V}$	$I_{DD}$	—	—	4	$\mu\text{A}$
Oscillator frequency (ceramic resonator)	$V_{DD} = 2\text{ to }6,5\text{ V}$	$f_{osc}$	350	—	500	kHz

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## CHARACTERISTICS (continued)

parameter	conditions	symbol	min.	typ.	max.	unit
<b>Inputs SEN0N to SEN6N</b>						
Input voltage LOW	$V_{DD} = 2 \text{ to } 6,5 \text{ V}$	$V_{IL}$	—	—	$0,3 \times V_{DD}$	V
Input voltage HIGH	$V_{DD} = 2 \text{ to } 6,5 \text{ V}$	$V_{IH}$	$0,7 \times V_{DD}$	—	—	V
Input current (P-channel pull-up)	$V_{IL} = 0 \text{ V}; V_{DD} = 2 \text{ V}$	$-I_I$	10	—	100	$\mu\text{A}$
	$V_{IL} = 0 \text{ V}; V_{DD} = 6,5 \text{ V}$	$-I_I$	100	—	600	$\mu\text{A}$
<b>Outputs DRV0N to DRV6N (open drain)</b>						
Output voltage "ON"	$I_O = 0,25 \text{ mA}; V_{DD} = 2 \text{ V}$	$V_{OL}$	—	—	0,3	V
	$I_O = 2,5 \text{ mA}; V_{DD} = 6,5 \text{ V}$	$V_{OL}$	—	—	0,6	V
Output current "OFF"	$V_{DD} = 6,5 \text{ V}$	$I_O$	—	—	10	$\mu\text{A}$
<b>Input ADRM</b>						
Input voltage LOW		$V_{IL}$	—	—	$0,4 \times V_{DD}$	V
Input voltage HIGH		$V_{IH}$	$0,85 \times V_{DD}$	—	—	V
Input current (switched P- and N-channel pull-up and pull-down)						
pull-up active	$V_I = 0 \text{ V}; V_{DD} = 2 \text{ V}$	$-I_{IL}$	10	—	100	$\mu\text{A}$
	$V_I = 0 \text{ V}; V_{DD} = 6,5 \text{ V}$	$-I_{IL}$	100	—	600	$\mu\text{A}$
pull-down active	$V_I = V_{DD}; V_{DD} = 2 \text{ V}$	$I_{IH}$	10	—	100	$\mu\text{A}$
	$V_I = 0 \text{ V}; V_{DD} = 6,5 \text{ V}$	$I_{IH}$	100	—	600	$\mu\text{A}$
<b>Output REMO</b>						
Output voltage HIGH	$-I_{OH} = 40 \text{ mA};$ $T_{amb} = 25 \text{ }^\circ\text{C};$ $V_{DD} = 2 \text{ V}$	$V_{OH}$	0,8	—	—	V
	$V_{DD} = 6,5 \text{ V}$	$V_{OH}$	5,0	—	—	V
	$-I_{OH} = 100 \text{ mA};$ $T_{amb} = 25 \text{ }^\circ\text{C};$ $V_{DD} = 4 \text{ V}$	$V_{OH}$	1,5	—	—	V
	$V_{DD} = 6,5 \text{ V}$	$V_{OH}$	4,5	—	—	V
	$-I_{OH} = 0,5 \text{ mA};$ $V_{DD} = 2 \text{ V}$	$V_{OH}$	$0,8 \times V_{DD}$	—	—	V
Output voltage LOW	$I_{OL} = 0,5 \text{ mA};$ $V_{DD} = 2 \text{ V}$	$V_{OL}$	—	—	0,4	V
	$I_{OL} = 2,0 \text{ mA};$ $V_{DD} = 6,5 \text{ V}$	$V_{OL}$	—	—	0,4	V

parameter	conditions	symbol	min.	typ.	max.	unit
<b>Input OSCI</b>						
Input current HIGH	$V_{DD} = 2\text{ V}$	$I_{IH}$	—	—	5,0	$\mu\text{A}$
	$V_{DD} = 6,5\text{ V}$	$I_{IH}$	5,0	—	70	$\mu\text{A}$
<b>Output OSCO</b>						
Output voltage HIGH	$-I_{OH} = 100\ \mu\text{A};$ $V_{DD} = 6,5\text{ V}$	$V_{OH}$	$V_{DD} - 0,8$	—	—	V
Output voltage LOW	$I_{OL} = 100\ \mu\text{A};$ $V_{DD} = 6,5\text{ V}$	$V_{OL}$	—	—	0,7	V

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