REMOTE CONTROL TRANSMITTER

GENERAL DESCRIPTION

The SAA3004 transmitter IC is designed for infrared remote control systems. It has a total of 448 commands which are divided into 7 sub-system groups with 64 commands each. The sub-system code may be selected by a press button, a slider switch or hard wired.

The SAA3004 generates the pattern for driving the output stage. These patterns are pulse distance coded. The pulses are infrared flashes or modulated. The transmission mode is defined in conjunction with the sub-system address. Modulated pulses allow receivers with narrow-band preamplifiers for improved noise rejection to be used. Flashed pulses require a wide-band preamplifier within the receiver.

The SAA3004 has the following features:

- Flashed or modulated transmission
- 7 sub-system addresses
- Up to 64 commands per sub-system address
- High-current remote output at V_{DD} = 6 V ($-I_{OH}$ = 40 mA)
- Low number of additional components
- Key release detection by toggle bits
- Very low stand-by current (< 2 μA)
- Operational current < 2 mA at 6 V supply
- Wide supply voltage range (4 to 11 V)
- Ceramic resonator controlled frequency (typ. 450 kHz)
- Encapsulation: 20-lead plastic DIL or 20-lead plastic mini-pack (SO-20)

PACKAGE OUTLINES

SAA3004P: 20-lead DIL; plastic (SOT146).
SAA3004T: 20-lead mini-pack; plastic (SO20; SOT163A).

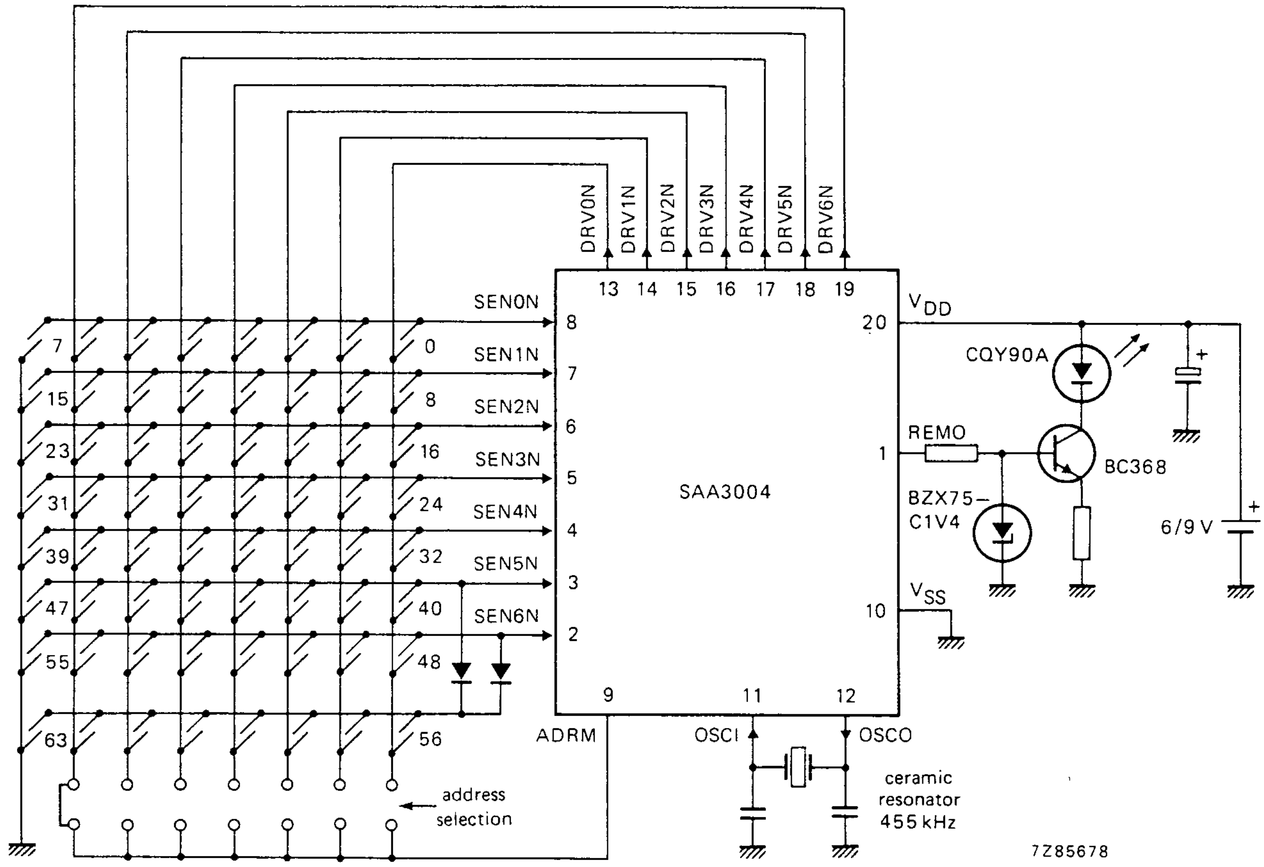


Fig. 1 Transmitter with SAA3004.

INPUTS AND OUTPUTS

Key matrix inputs and outputs (DRV0N to DRV6N and SEN0N to SEN6N)

The transmitter keyboard is arranged as a scanned matrix. The matrix consists of 7 driver outputs and 7 sense inputs as shown in Fig. 1. The driver outputs DRV0N to DRV6N are open drain N-channel transistors and they are conductive in the stand-by mode. The 7 sense inputs (SEN0N to SEN6N) enable the generation of 56 command codes. With 2 external diodes all 64 commands are addressable.The sense inputs have P-channel pull-up transistors, so that they are HIGH until they are pulled LOW by connecting them to an output via a key depression to initiate a code transmission.

Address mode input (ADRM)

The sub-system address and the transmission mode are defined by connecting the ADRM input to one or more driver outputs (DRV0N to DRV6N) of the key matrix. If more than one driver is connected to ADRM, they must be decoupled by a diode. This allows the definition of seven sub-system addresses as shown in Table 3. If driver DRV6N is connected to ADRM the data output format of REMO is modulated or if not connected, flashed.

The ADRM input has switched pull-up and pull-down loads. In the stand-by mode only the pull-down device is active. Whether ADRM is open (sub-system address 0, flashed mode) or connected to the driver outputs, this input is LOW and will not cause unwanted dissipation. When the transmitter becomes active by presssing a key, the pull-down device is switched off and the pull-up device is switched on, so that the applied driver signals are sensed for the decoding of the sub-system address and the mode of transmission.

The arrangement of the sub-system address coding is such that only the driver DRVnN with the highest number (n) defines the sub-system address, e.g. if driver DRV2N and DRV4N are connected to ADRM, only DRV4N will define the sub-system address. This option can be used in transmitters for more than one sub-system address. The transmitter may be hard-wired for sub-system address 2 by connecting DRV1N to ADRM. If now DRV3N is added to ADRM by a key or a switch, the transmitted sub-system address changes to 4.

A change of the sub-system address will not start a transmission.

Remote control signal output (REMO)

The REMO signal output stage is a push-pull type. In the HIGH state a bipolar emitter-follower allows a high output current. The timing of the data output format is listed in Tables 1 and 2.

The information is defined by the distance t_b between the leading edges of the flashed pulses or the first edge of the modulated pulses (see Fig. 3).

The format of the output data is given in Figs 2 and 3. In the flashed transmission mode the data word starts with two toggle bits T1 and T0, followed by three bits for defining the sub-system address S2, S1 and S0, and six bits F, E, D, C, B and A, which are defined by the selected key.

In the modulated transmission mode the first toggle bit T1 is replaced by a constant reference time bit (REF). This can be used as a reference time for the decoding sequence.

The toggle bits function as an indication for the decoder that the next instruction has to be considered as a new command.

The codes for the sub-system address and the selected key are given in Tables 3 and 4.

Oscillator input/output (OSCI and OSCO)

The external components must be connected to these pins when using an oscillator with a ceramic resonator. The oscillator frequency may vary between 400 kHz and 500 kHz as defined by the resonator.

FUNCTIONAL DESCRIPTION

Keyboard operation

In the stand-by mode all drivers (DRV0N to DRV6N) are on. Whenever a key is pressed, one or more of the sense inputs (SENnN) are tied to ground. This will start the power-up sequence. First the oscillator is activated and after the debounce time t_{DB} (see Fig. 4) the output drivers (DRV0N to DRV6N) become active successively.

Within the first scan cycle the transmission mode, the applied sub-system address and the selected command code are sensed and loaded into an internal data latch. In contradiction to the command code the sub-system address is sensed only within the *first* scan cycle. If the applied sub-system address is changed while the command key is pressed, the transmitted sub-system address is not altered.

In a multiple key-stroke sequence (see Fig. 5) the command code is always altered in accordance with the sensed key.

Multiple key-stroke protection

The keyboard is protected against multiple key-strokes. If more than one key is pressed at the same time, the circuit will not generate a new output at REMO (see Fig. 5). In case of a multiple key-stroke the scan repetition rate is increased to detect the release of a key as soon as possible.

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

FUNCTIONAL DESCRIPTION (continued)

– The keys switching to ground (code numbers 7, 15, 23, 31, 39, 47, 55 and 63) and the keys connected to SEN5N and SEN6N are not covered completely by the multiple key protection. If one sense input is switched to ground, further keys on the same sense line are ignored.
– SEN5N and SEN6N are not protected against multiple key-stroke on the same driver line, because this condition has been used for the definition of additional codes (code numbers 56 to 63).

Output sequence (data format)

The output operation will start when the selected code is found. A burst of pulses, including the latched address and command codes, is generated at the output REMO as long as a key is pressed. The format of the output pulse train is given in Figs 2 and 3. The operation is terminated by releasing the key or if more than one key is pressed at the same time. Once a sequence is started, the transmitted words will always be completed after the key is released.

The toggle bits T0 and T1 are incremented if the key is released for a minimum time t_{REL} (see Fig. 4). The toggle bits remain unchanged within a multiple key-stroke sequence.

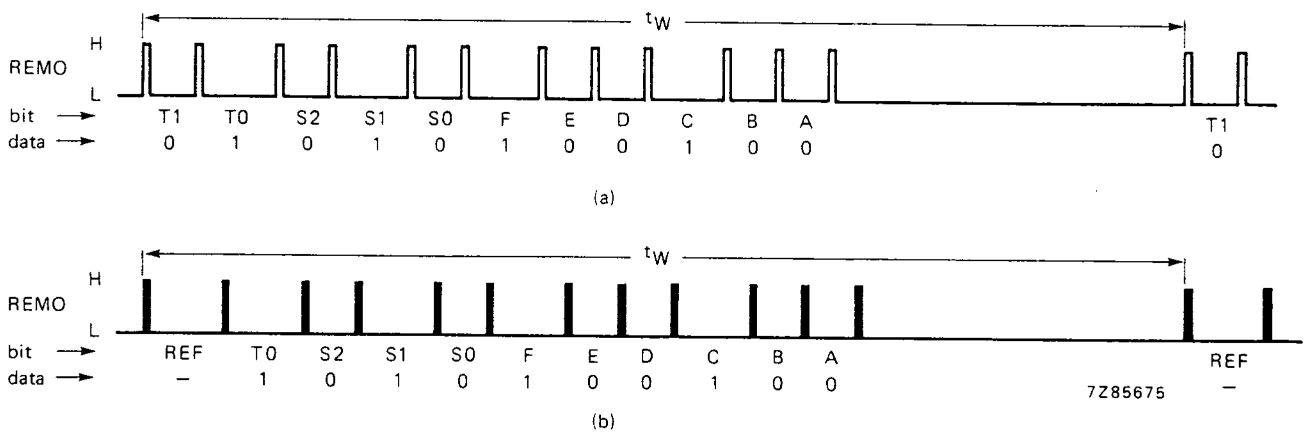
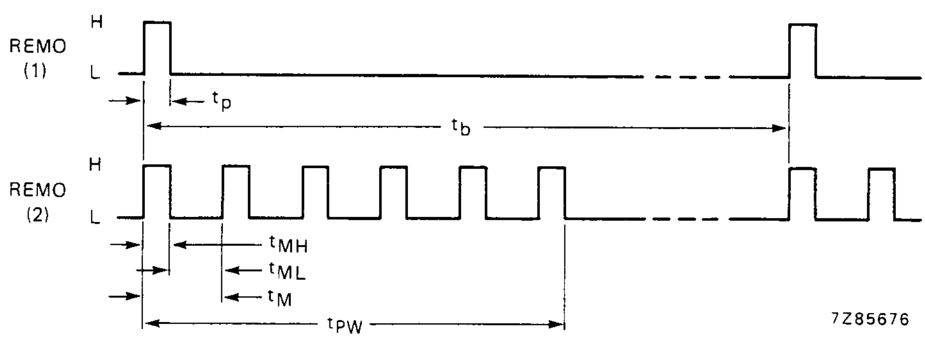


Fig. 2 Data format of REMO output; REF = reference time; T0 and T1 = toggle bits; S0, S1 and S2 = system address; A, B, C, D, E and F = command bits.
(a) flashed mode: transmission with 2 toggle bits and 3 address bits, followed by 6 command bits (pulses are flashed).
(b) modulated mode: transmission with reference time, 1 toggle bit and 3 address bits, followed by 6 command bits (pulses are modulated).



(1) Flashed pulse.
(2) Modulated pulse ($t_{PW} = (5 \times t_M) + t_{MH}$.

Fig. 3 REMO output waveform.

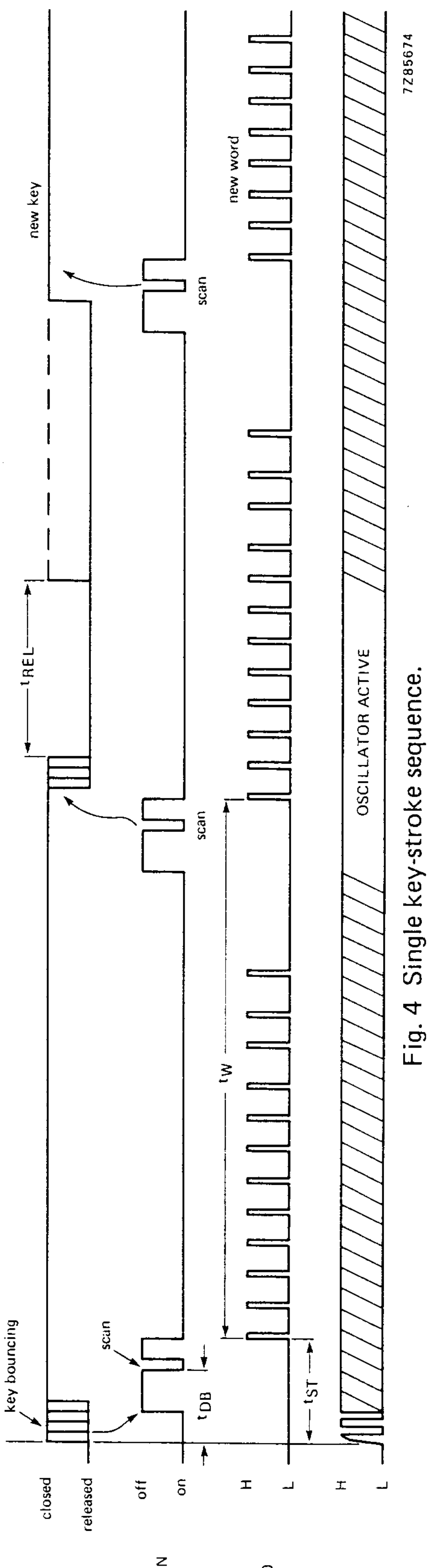


Fig. 4 Single key-stroke sequence.
Debounce time: t_{DB} = 4 to 9 x T_O.
Start time: t_{ST} = 5 to 10 x T_O.
Minimum release time: t_{REL} = T_O.
Word distance: t_W.

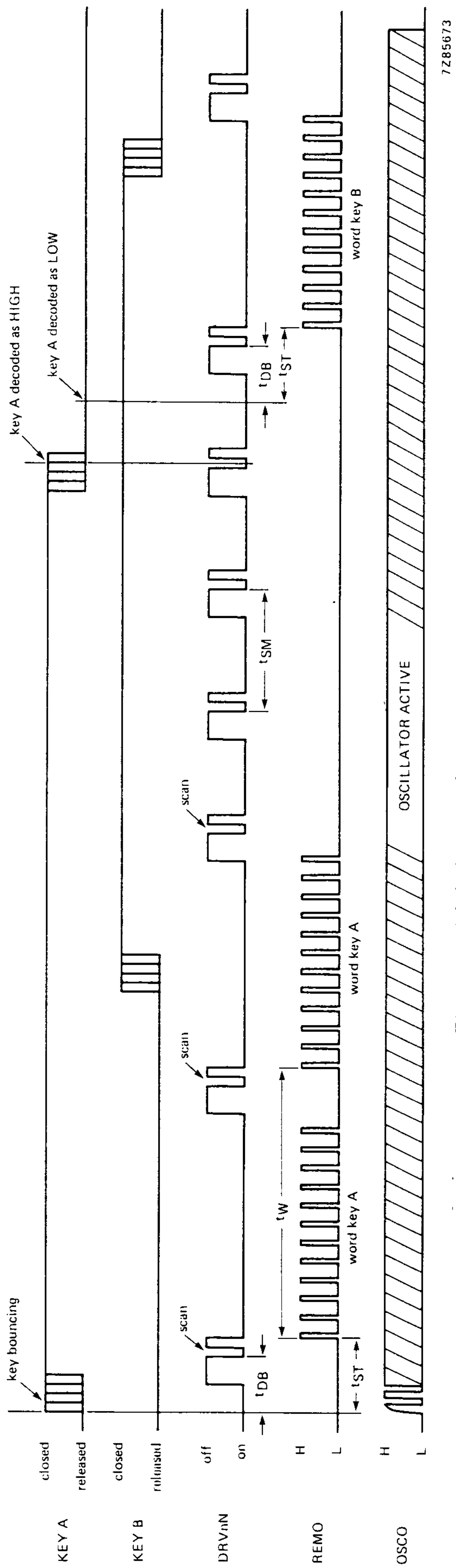


Fig. 5 Multiple key-stroke sequence.
Scan rate multiple key-stroke: t_{SM} = 6 to 10 x T_O.
For t_{DB}, t_{ST} and t_W see Fig. 4.

Table 1 Pulse train timing

mode	T_o ms	t_p μs	t_M μs	t_{ML} μs	t_{MH} μs	t_W ms
flashed	2,53	8,8	–	–	–	121
modulated	2,53	–	26,4	17,6	8,8	121

f_{osc}	455 kHz	t_{osc} = 2,2 μs
t_p	4 x t_{osc}	flashed pulse width
t_M	12 x t_{osc}	modulation period
t_{ML}	8 x t_{osc}	modulation period LOW
t_{MH}	4 x t_{osc}	modulation period HIGH
T_o	1152 x t_{osc}	basic unit of pulse distance
t_W	55 296 x t_{osc}	word distance

Table 2 Pulse train separation (t_b)

code	t_b
logic "0"	2 x T_o
logic "1"	3 x T_o
reference time	3 x T_o
toggle bit time	2 x T_o or 3 x T_o

Table 3 Transmission mode and sub-system address selection

The sub-system address and the transmission mode are defined by connecting the ADRM input to one or more driver outputs (DRV0N to DRV6N) of the key matrix. If more than one driver is connected to ADRM, they must be decoupled by a diode.

mode	sub-system address				driver DRVnN for n =						
	#	S2	S1	S0	0	1	2	3	4	5	6
F	0	1	1	1							
L	1	0	0	0	o						
A	2	0	0	1	X	o					
S	3	0	1	0	X	X	o				
H	4	0	1	1	X	X	X	o			
E	5	1	0	0	X	X	X	X	o		
D	6	1	0	1	X	X	X	X	X	o	
M											
O	0	1	1	1							o
D	1	0	0	0	o						o
U	2	0	0	1	X	o					o
L	3	0	1	0	X	X	o				o
A	4	0	1	1	X	X	X	o			o
T	5	1	0	0	X	X	X	X	o		o
E	6	1	0	1	X	X	X	X	X	o	o
D											

o = connected to ADRM
blank = not connected to ADRM
X = don't care

Table 4 Key codes

matrix drive	matrix sense	code F	E	D	C	B	A	matrix position
DRV0N	SEN0N	0	0	0	0	0	0	0
DRV1N	SEN0N	0	0	0	0	0	1	1
DRV2N	SEN0N	0	0	0	0	1	0	2
DRV3N	SEN0N	0	0	0	0	1	1	3
DRV4N	SEN0N	0	0	0	1	0	0	4
DRV5N	SEN0N	0	0	0	1	0	1	5
DRV6N	SEN0N	0	0	0	1	1	0	6
V_{SS}	SEN0N	0	0	0	1	1	1	7
*	SEN1N	0	0	1	**			8 to 15
*	SEN2N	0	1	0	**			16 to 23
*	SEN3N	0	1	1	**			24 to 31
*	SEN4N	1	0	0	**			32 to 39
*	SEN5N	1	0	1	**			40 to 47
*	SEN6N	1	1	0	**			48 to 55
*	SEN5N and SEN6N	1	1	1	**			56 to 63

* The complete matrix drive as shown above for SEN0N is also applicable for the matrix sense inputs SEN1N to SEN6N and the combined SEN5N/SEN6N.

** The C, B and A codes are identical to SEN0N as given above.

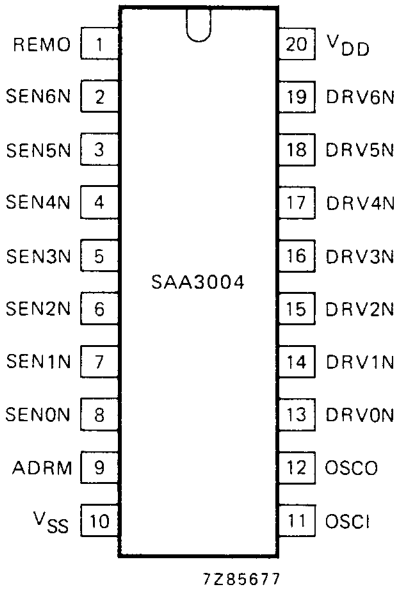


Fig. 6 Pinning diagram.

PINNING

1	REMO	remote data output
2	SEN6N	key matrix sense inputs
3	SEN5N	
4	SEN4N	
5	SEN3N	
6	SEN2N	
7	SEN1N	
8	SEN0N	
9	ADRM	address mode control input
10	V_{SS}	ground
11	OSCI	oscillator input
12	OSCO	oscillator output
13	DRV0N	key matrix drive outputs
14	DRV1N	
15	DRV2N	
16	DRV3N	
17	DRV4N	
18	DRV5N	
19	DRV6N	
20	V_{DD}	positive supply

RATINGS

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

Supply voltage range	V_{DD}	−0,5 to +15		V
Input voltage range	V_I	−0,5 to V_{DD} +0,5		V
Output voltage range	V_O	−0,5 to V_{DD} +0,5		V
D.C. current into any input or output	±I	max.	10	mA
Peak REMO output current during 10 μs; duty factor = 1%	$-I_{(REMO)M}$	max.	300	mA
Power dissipation per package for T_{amb} = −20 to +70 °C	P_{tot}	max.	200	mW
Storage temperature range	T_{stg}	−55 to +150		°C
Operating ambient temperature range	T_{amb}	−20 to +70		°C

CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °C; unless otherwise specified

parameter	V_{DD} (V)	symbol	min.	typ.	max.	unit
Supply voltage						
T_{amb} = 0 to +70 °C	–	V_{DD}	4	–	11	V
Supply current; active						
f_{osc} = 455 kHz;	6	I_{DD}	–	1	–	mA
REMO output unloaded	9	I_{DD}	–	3	–	mA
Supply current; inactive						
(stand-by mode)	6	I_{DD}	–	–	2	μA
T_{amb} = 25 °C	9	I_{DD}	–	–	2	μA
Oscillator frequency						
(ceramic resonator)	4 to 11	f_{osc}	400	–	500	kHz
Keyboard matrix						
Inputs SEN0N to SEN6N						
Input voltage LOW	4 to 11	V_{IL}	–	–	0,2 x V_{DD}	V
Input voltage HIGH	4 to 11	V_{IH}	0,8 x V_{DD}	–	–	V
Input current	4	$-I_I$	10	–	100	μA
V_I = 0 V	11	$-I_I$	30	–	300	μA
Input leakage current						
V_I = V_{DD}	11	I_I	–	–	1	μA
Outputs DRV0N to DRV6N						
Output voltage "ON"						
I_O = 0,1 mA	4	V_{OL}	–	–	0,3	V
I_O = 1,0 mA	11	V_{OL}	–	–	0,5	V
Output current "OFF"						
V_O = 11 V	11	I_O	–	–	10	μA
Control input ADRM						
Input voltage LOW	–	V_{IL}	–	–	0,8 x V_{DD}	V
Input voltage HIGH	–	V_{IH}	0,2 x V_{DD}	–	–	V
Input current (switched P- and N-channel pull-up/ pull-down)						
Pull-up active	4	I_{IL}	10	–	100	μA
stand-by voltage: 0 V	11	I_{IL}	30	–	300	μA
Pull-down active	4	I_{IH}	10	–	100	μA
stand-by voltage: V_{DD}	11	I_{IH}	30	–	300	μA

CHARACTERISTICS (continued)

V_{SS} = 0 V; T_{amb} = 25 °C; unless otherwise specified

parameter	V_{DD} (V)	symbol	min.	typ.	max.	unit
Data output REMO						
Output voltage HIGH	6	V_{OH}	3	–	–	V
$-I_{OH}$ = 40 mA	9	V_{OH}	6	–	–	V
Output voltage LOW	6	V_{OL}	–	–	0,2	V
I_{OL} = 0,3 mA	9	V_{OL}	–	–	0,1	V
Oscillator						
Input current OSCI at V_{DD}	6	I_I	0,8	–	2,7	μA
Output voltage HIGH $-I_{OL}$ = 0,1 mA	6	V_{OH}	–	–	V_{DD}–0,6	V
Output voltage LOW I_{OH} = 0,1 mA	6	V_{OL}	–	–	0,6	V