# DATA SHEET

# SAA3008
## Infrared remote control transmitter (RECS 80 low voltage)

Preliminary specification
File under Integrated Circuits, IC02

December 1988

Philips Semiconductors

PHILIPS

# Infrared remote control transmitter (RECS 80 low voltage)

# SAA3008

## GENERAL DESCRIPTION

The SAA3008 transmitter IC is designed for infrared remote control systems. It has a capacity for 1280 commands arranged in 20 sub-system address groups of 64 commands each. The subsystem address may be selected by press-button, slider switches or be hard-wired.

Commands are transmitted in patterns which are pulse distance coded. Modulated pulse transmissions allow a narrow-band receiver to be used for improved noise rejection. The modulation frequency of the SAA3008 is 38 kHz which is $\frac{1}{12}$ of the oscillator frequency of 455 kHz (typical).

### Features

- Modulated transmission
- Ceramic resonator controlled frequency
- Data-word-start with reference time of unique start pattern
- Supply voltage range 2 V to 6.5 V
- 40 mA output current capability
- Very low standby current (< 4 μA at $V_{DD}$ = 6 V)
- Up to 20 subsystem address groups; up to 1280 commands
- Up to 64 commands per subsystem address; up to 1280 commands
- Requires few additional components

## PACKAGE OUTLINES

SAA3008P: 20-lead DIL; plastic (SOT146); SOT146-1; 1996 December 6.
SAA3008T: 20-lead mini-pack; plastic (SO20; SOT163A); SOT163-1; 1996 December 6.

# Infrared remote control transmitter (RECS 80 low voltage)

# SAA3008

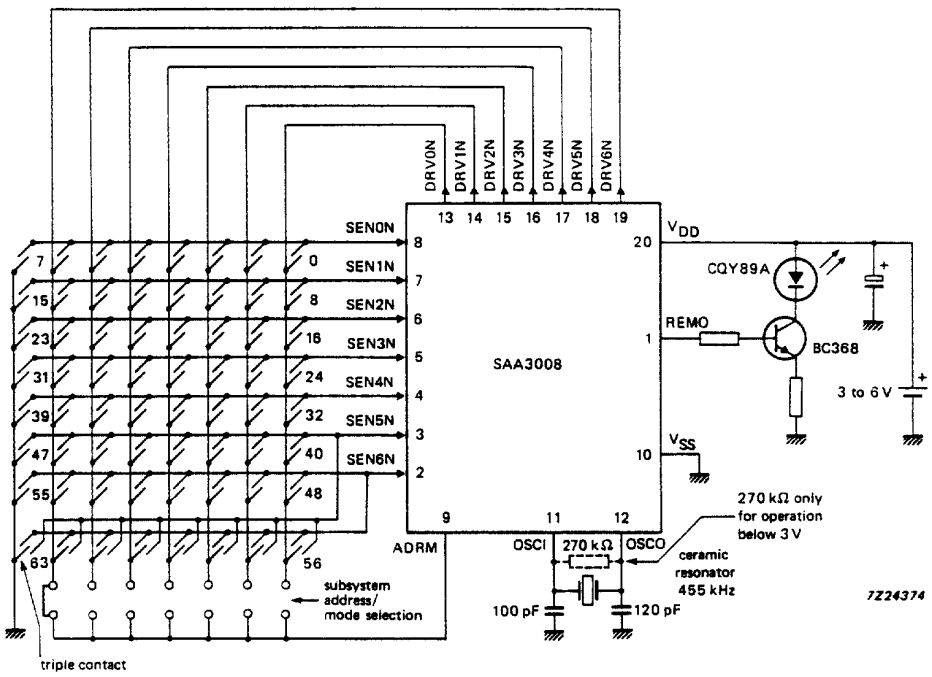



Fig.1 SAA3008 application example.

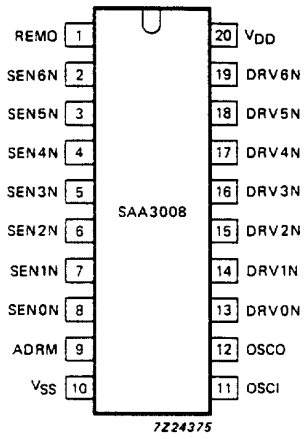



Fig.2 Pinning diagram.

**PINNING**

| | | |
|---|---|---|
| 1 | REMO | remote data output |
| 2 | SEN6N | sense inputs from key matrix |
| 3 | SEN5N | |
| 4 | SEN4N | |
| 5 | SEN3N | |
| 6 | SEN2N | |
| 7 | SEN1N | |
| 8 | SEN0N | |
| 9 | ADRM | address/mode control input |
| 10 | $V_{SS}$ | ground (0 V) |
| 11 | OSCI | oscillator input |
| 12 | OSCO | oscillator output |
| 13 | DRV0N | drive outputs to key matrix |
| 14 | DRV1N | |
| 15 | DRV2N | |
| 16 | DRV3N | |
| 17 | DRV4N | |
| 18 | DRV5N | |
| 19 | DRV6N | |
| 20 | $V_{DD}$ | positive supply voltage |

## FUNCTIONAL DESCRIPTION

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

The transmitter keyboard is arranged as a scanned matrix with seven driver outputs (DRV0N to DRV6N) and seven sensing inputs (SEN0N to SEN6N) as shown in Fig.1. The driver outputs are open-drain n-channel transistors which are conductive in the stand-by mode. The sensing inputs enable the generation of 56 command codes. With two external diodes connected (or triple contact), as in Fig.1, all 64 commands are addressable. The sense lines have p-channel pull-up transistors, so that they are HIGH until pulled LOW by connecting them to an output via a key depression to initiate a code transmission.
The maximum allowable value of contact series resistance for keyboard switches in the ON-state is 7 kΩ.

**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:

- Mode 1 DRV6N not connected to ADRM
- Mode 2 DRV6N connected to ADRM

In Mode 1 the reference time REF equals 3To, this may be used as a reference time for the decoding sequence.
In Mode 2 an additional modulated pulse has been inserted into the middle of the reference time, therefore, these pulses are now separated by 1.5To. This unique start pattern START uses the detection of a beginning word (see Fig.3).
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 stand-by mode only pull-down load is active and ADRM input is held LOW (this condition is independent of the 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.

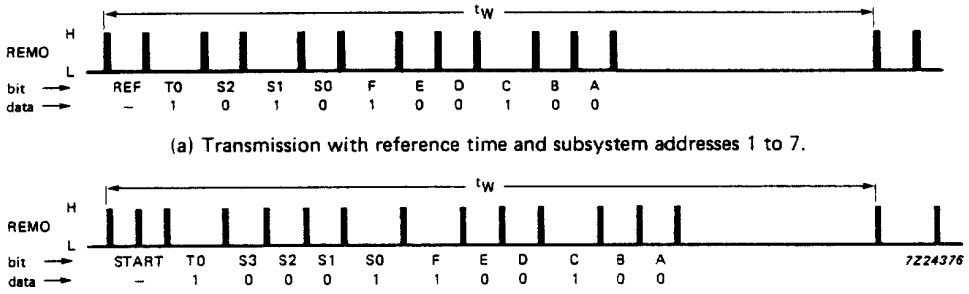
The subsystem address is sensed only within the first scan cycle, whereas the command code is sensed in every scan. The transmitted subsystem address remains unchanged if the subsystem address selection is changed while the command key is pressed. A chance of the subsystem address does not start a transmission.

In a multiple keystroke sequence (Fig.6) the second word B might be transmitted with subsystem address 18 or 19 instead of the preselected subsystem address (Table 1). This is only relevant for systems decoding subsystem address 18 or 19.

**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 (Fig.7).
The information is defined by the distance '$t_b$' between the leading edges of the modulated pulses (Fig.4). The distance $t_b$ is a multiple of the basic unit $T_o$ (Table 3) which equals 1152 periods of the oscillator frequency $f_{osc}$ (Table 3). The pulses are modulated with 6 periods of $\frac{1}{12}$ of the oscillator frequency (38 kHz).

The format of the output data is illustrated in Figs 3 and 4. A data word starts with the reference time and toggle bit T0 and is followed by the definition bits for the subsystem address 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.
The toggle bit T0 acts as an indication for the decoder whether the next instruction should be considered as a new command or not. The codes for the subsystem address and the selected key are given in Table 3.




(a) Transmission with reference time and subsystem addresses 1 to 7.

(b) Transmission with start-pattern and subsystem address 8 to 20.

Where:

Reference time
start pattern T0 toggle bit
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).

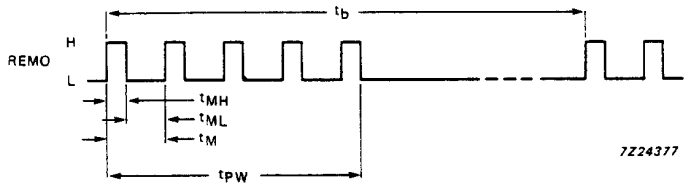



Fig.4 Waveform for one pulse period at REMO output; for timing values see Table 3.

**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. When operating at a supply voltage of below 3 V a 270 kHz resistor should be connected in parallel with the resonator.

**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 |

**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 |
| 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 |

| key pressed | drive-to-sense connection made | command code generated F | E | D | C | B | A |
|---|---|---|---|---|---|---|---|
| 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 kHz; $t_{OSC}$ = 2.2 μs |
|---|---|---|---|
| Modulation period | $^{t}M$ | $12t_{osc}$ | 26.4 μs |
| Modulation LOW time | $^{t}ML$ | $8t_{osc}$ | 17.6 μs |
| Modulation HIGH time | $^{t}MH$ | $4t_{osc}$ | 8.8 μs |
| Modulation pulse width | $^{t}PW$ | $^{5t}M + {}^{t}MH$ | 140.8 μs |
| Basic unit of pulse spacing | $^{t}o$ | $^{1152t}_{osc}$ | 2.53 ms |
| Word length for subsystem addresses | | | |
| 0 to 7 | $^{t}W$ | $55296t_{osc}$ | 121.44 ms |
| 8 to 20 | $^{t}W$ | $59904t_{osc}$ | 132.56 ms |
| Pulse separation for | | | |
| logic 0 | $t_b$ | $2t_o$ | 5.06 ms |
| logic 1 | $t_b$ | $3t_o$ | 7.59 ms |
| reference time | $t_b$ | $3t_o$ | 7.59 ms |
| toggle bit | $t_b$ | $2t_o$ | 5.06 ms |
| | | $3t_o$ | 7.59 ms |
| Start pattern | $t_b$ | $2 \times 1.5t_o$ | $2 \times 3.79$ ms |

## 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 transmission mode, subsystem address and the selected command code are sensed and loaded into an internal data latch. In a multiple keystroke sequence (Fig.6) the command code is always altered according to the sensed key.

### Multiple keystroke protection

The keyboard is protected against multiple keystrokes. If more than one key is pressed the circuit will not generate a new REMO sequence (Fig.6).
In a multiple keystroke sequence the scan repetition rate is increased to detect the release of the key as soon as possible.

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 code of the selected key has been loaded into the internal command register. 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 bit T0 is incremented if the key is released for a minimum time $t_{REL}$ (Fig.5). In a multiple keystroke sequence the toggle bit remains unchanged.

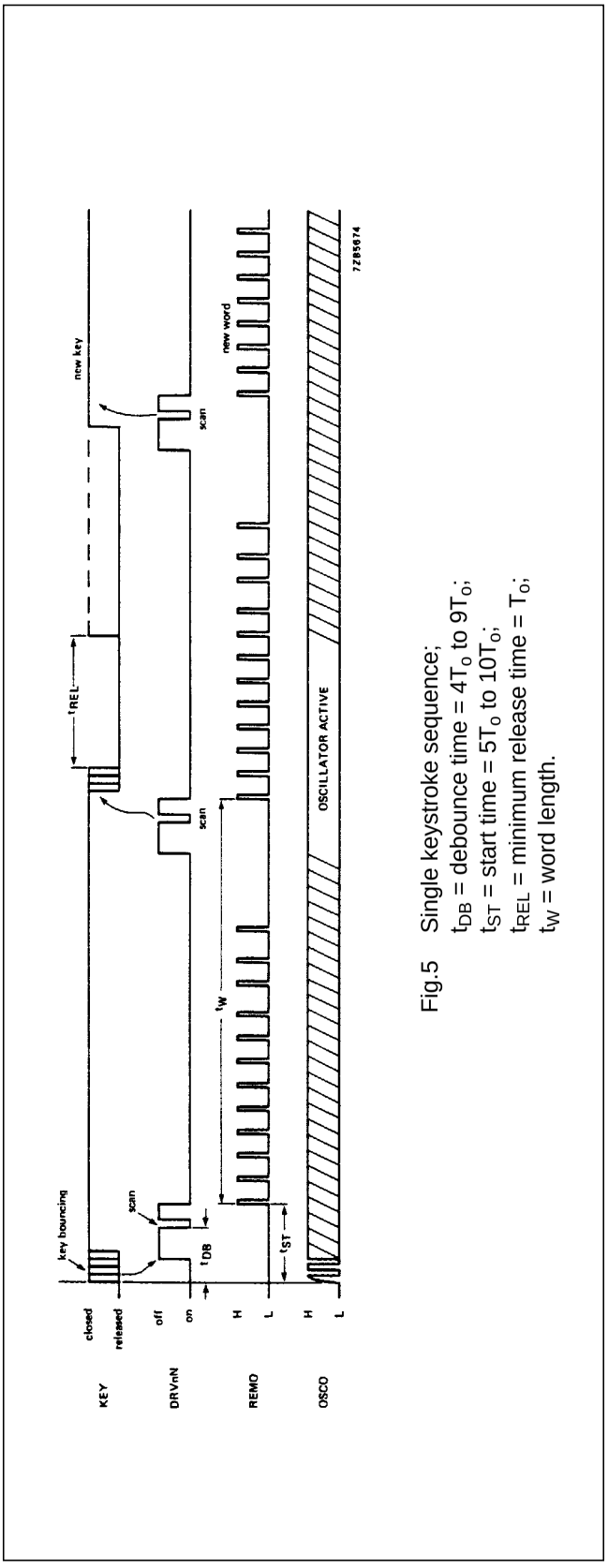



Fig.5 Single keystroke sequence;
$t_{DB}$ = debounce time = $4T_O$ to $9T_O$;
$t_{ST}$ = start time = $5T_O$ to $10T_O$;
$t_{REL}$ = minimum release time = $T_O$;
$t_W$ = word length.

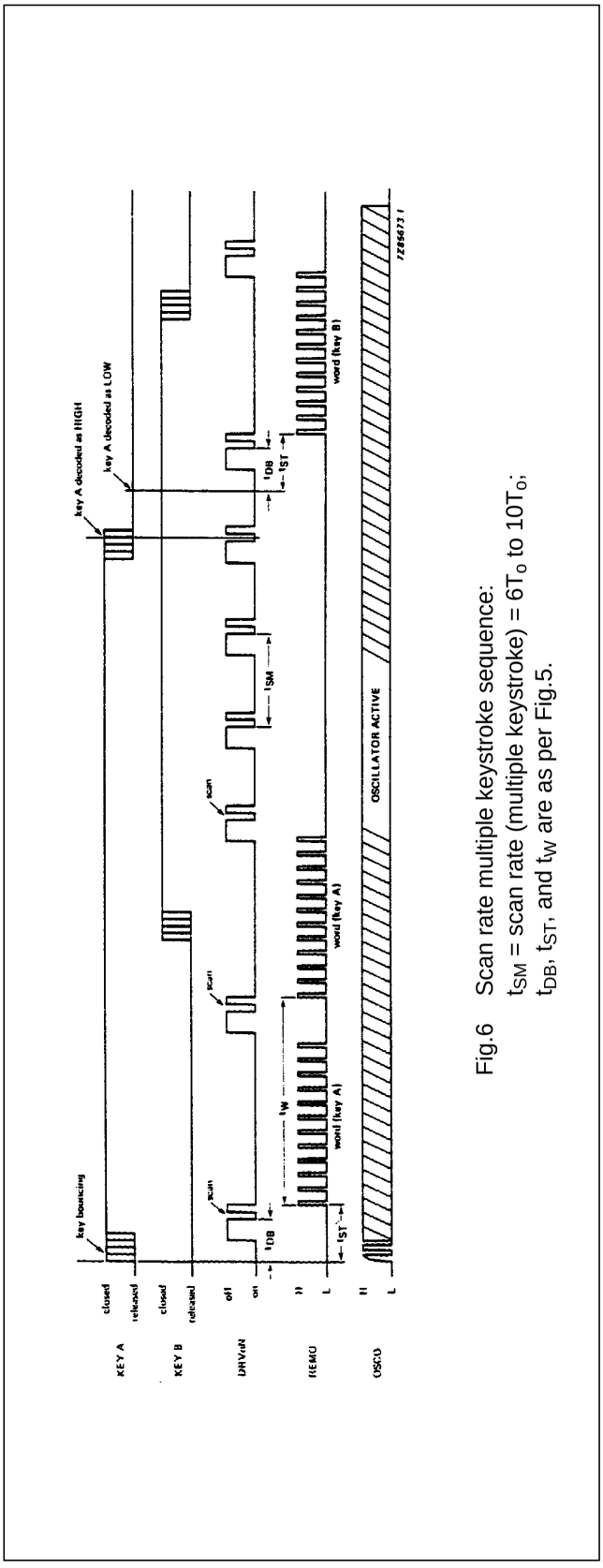



Fig.6 Scan rate multiple keystroke sequence:
$t_{SM}$ = scan rate (multiple keystroke) = $6T_O$ to $10T_O$;
$t_{DB}$, $t_{ST}$, and $t_W$ are as per Fig.5.

## RATINGS

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

| PARAMETER | CONDITIONS | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| Supply voltage range | | $V_{DD}$ | –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 (SOT146) | | $P_{tot}$ | – | 300 | mW |
| mini–pack (SO20; SOT163A) | | $P_{tot}$ | – | 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 V; $T_{amb}$ = 0 to + 70 °C; unless otherwise specified

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Supply voltage | | $V_{DD}$ | 2.0 | – | 6.5 | V |
| Supply current active | $f_{osc}$ = 455 kHz; | | | | | |
| | $V_{DD}$ = 3 V | $I_{DD}$ | – | 0.25 | – | mA |
| | $V_{DD}$ = 4.5 V | $I_{DD}$ | – | 0.5 | – | mA |
| | $V_{DD}$ = 6 V | $I_{DD}$ | – | 1 | – | mA |
| Standby mode | $T_{amb}$ = 25 °C; $V_{DD}$ = 6 V | $I_{DD}$ | – | – | 4 | µA |
| Oscillator frequency (ceramic resonator) | $V_{DD}$ = 2 to 6.5 V | $f_{osc}$ | 350 | – | 500 | kHz |
| **Inputs SEN0N to SEN6N** | | | | | | |
| Input voltage LOW | $V_{DD}$ = 2 to 6.5 V | $V_{IL}$ | – | – | 0.3 $V_{DD}$ | V |
| Input voltage HIGH | $V_{DD}$ = 2 to 6.5 V | $V_{IH}$ | 0.7 $V_{DD}$ | – | – | V |
| Input current (p-channel pull-up) | $V_{IL}$ = 0 V | | | | | |
| | $V_{DD}$ = 2 V | $I_I$ | –10 | – | –100 | µA |
| | $V_{DD}$ = 6.5 V | $I_I$ | –100 | – | –600 | µA |

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Outputs DRV0N to DRV6N** | | | | | | |
| (open drain 1) | | | | | | |
| Output voltage ON | $I_O$ = 0.25 mA | | | | | |
| | $V_{DD}$ = 2 V | $V_{OL}$ | – | – | 0.3 | V |
| | $I_O$ = 2.5 mA | | | | | |
| | $V_{DD}$ = 6.5 V | $V_{OL}$ | – | – | 0.6 | V |
| Output current OFF | $V_{DD}$ = 6.5 V | $I_O$ | – | – | 10 | µA |
| **Input ADRM** | | | | | | |
| Input voltage LOW | | $V_{IL}$ | – | – | 0.4 $V_{DD}$ | V |
| Input voltage HIGH | | $V_{IH}$ | 0.85 $V_{DD}$ | – | – | V |
| Input current | | | | | | |
| (switched p and n channel pull-up and pull-down) | | | | | | |
| pull-up active | $V_I$ = 0 V | | | | | |
| | $V_{DD}$ = 2 V | $I_{IL}$ | –10 | – | –100 | µA |
| | $V_{DD}$ = 6.5 V | $I_{IL}$ | –100 | – | –600 | µA |
| pull-down active | $V_I$ = $V_{DD}$ | | | | | |
| | $V_{DD}$ = 2 V | $I_{IH}$ | 10 | – | 100 | µA |
| | $V_{DD}$ = 6.5 V | $I_{IH}$ | 100 | – | 600 | µA |
| **Output REMO** | | | | | | |
| Output voltage HIGH | $I_{OH}$ = –40 mA; $T_{amb}$ = 25 °C | | | | | |
| | $V_{DD}$ = 2 V | $V_{OH}$ | 0.8 | – | – | V |
| | $V_{DD}$ = 6.5 V | $V_{OH}$ | 5.0 | – | – | V |
| | $I_{OH}$ = 0.5 mA; | | | | | |
| | $V_{DD}$ = 2 V | $V_{OH}$ | 0.8 $V_{DD}$ | – | – | V |
| Output voltage LOW | $I_{OL}$ = 0.5 mA; | | | | | |
| | $V_{DD}$ = 2 V | $V_{OL}$ | – | – | 0.4 | V |
| | $I_{OL}$ = 2.0 mA; | | | | | |
| | $V_{DD}$ = 6.5 V | $V_{OL}$ | – | – | 0.4 | V |
| **Input OSCI** | | | | | | |
| Input current HIGH | $V_{DD}$ = 6.5 V | $I_{IH}$ | 3.0 | – | 7.0 | µA |
| **Output OSCO** | | | | | | |
| Output voltage HIGH | $I_{OH}$ = 100 µA; $V_{DD}$ = 6.5 V | $V_{OH}$ | $V_{DD}$–0.8 | – | – | V |
| Output voltage LOW | $I_{OL}$ = 100 µA; $V_{DD}$ = 6.5 V | $V_{OL}$ | – | – | 0.7 | V |

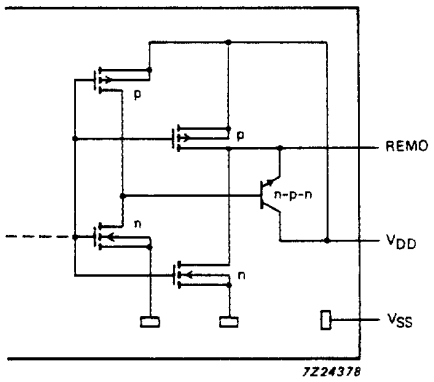
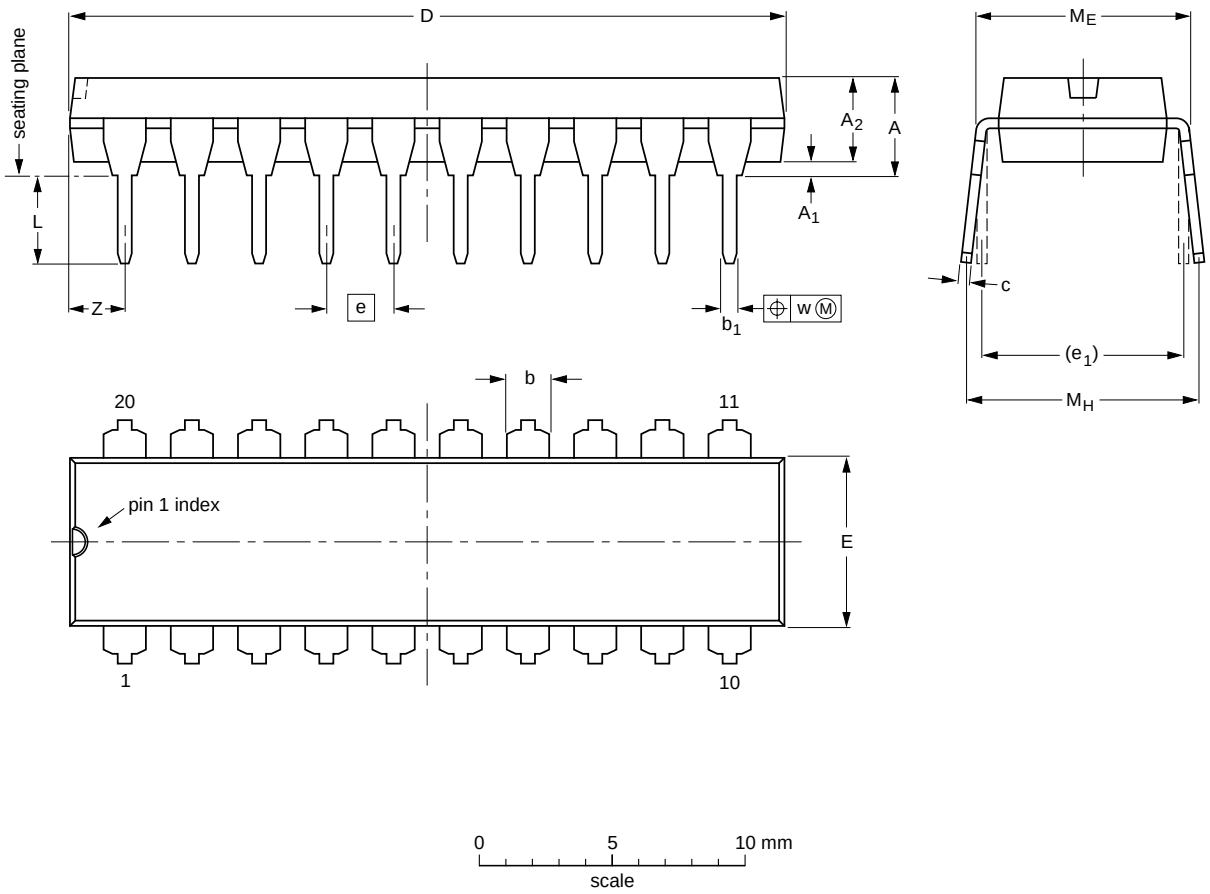



Fig.7 REMO output stage.

## PACKAGE OUTLINES

**DIP20: plastic dual in-line package; 20 leads (300 mil)** **SOT146-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

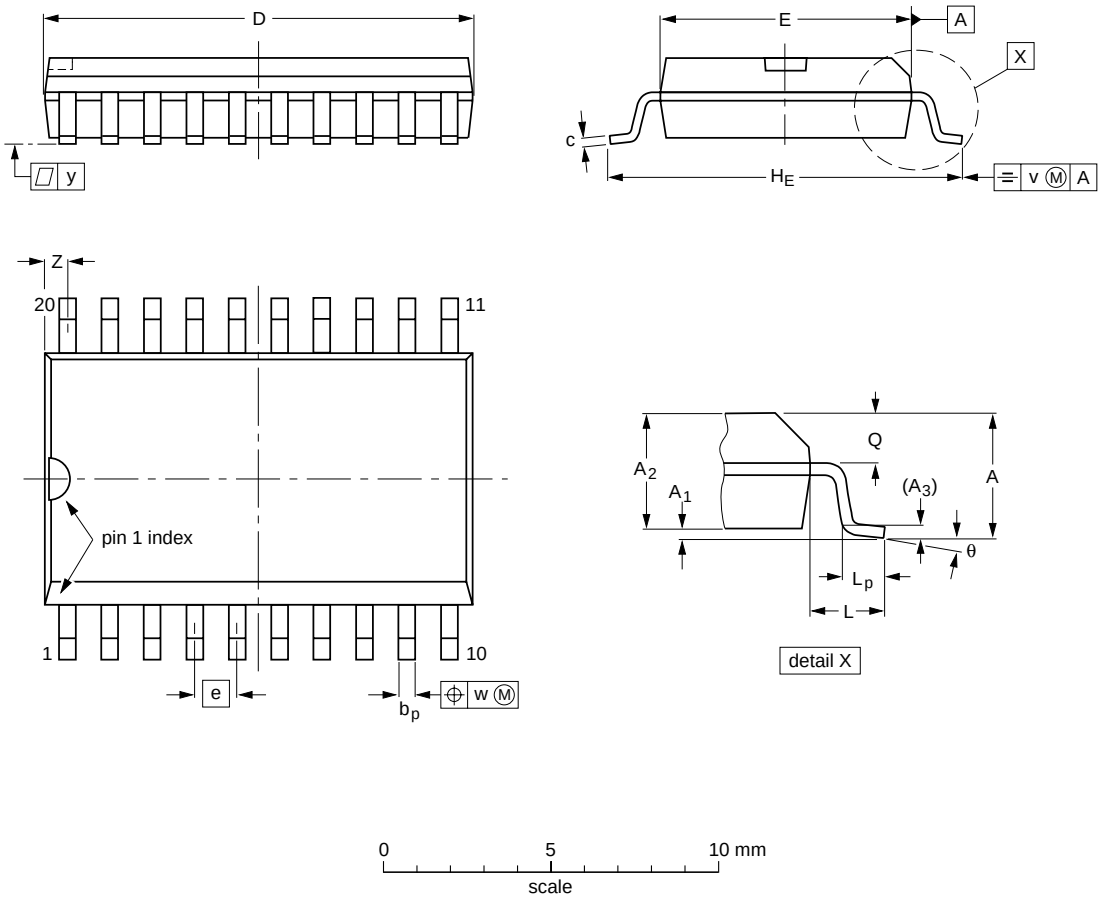
| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | c | D (1) | E (1) | e | $e_1$ | L | $M_E$ | $M_H$ | w | Z (1) max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.2 | 0.51 | 3.2 | 1.73<br>1.30 | 0.53<br>0.38 | 0.36<br>0.23 | 26.92<br>26.54 | 6.40<br>6.22 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 2.0 |
| inches | 0.17 | 0.020 | 0.13 | 0.068<br>0.051 | 0.021<br>0.015 | 0.014<br>0.009 | 1.060<br>1.045 | 0.25<br>0.24 | 0.10 | 0.30 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.078 |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT146-1 | | | SC603 | | | ~~92-11-17~~<br>95-05-24 |

**SO20: plastic small outline package; 20 leads; body width 7.5 mm** **SOT163-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | D (1) | E (1) | e | $H_E$ | L | $L_p$ | Q | v | w | y | Z (1) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.65 | 0.30<br>0.10 | 2.45<br>2.25 | 0.25 | 0.49<br>0.36 | 0.32<br>0.23 | 13.0<br>12.6 | 7.6<br>7.4 | 1.27 | 10.65<br>10.00 | 1.4 | 1.1<br>0.4 | 1.1<br>1.0 | 0.25 | 0.25 | 0.1 | 0.9<br>0.4 | $8^o$<br>$0^o$ |
| inches | 0.10 | 0.012<br>0.004 | 0.096<br>0.089 | 0.01 | 0.019<br>0.014 | 0.013<br>0.009 | 0.51<br>0.49 | 0.30<br>0.29 | 0.050 | 0.419<br>0.394 | 0.055 | 0.043<br>0.016 | 0.043<br>0.039 | 0.01 | 0.01 | 0.004 | 0.035<br>0.016 | |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT163-1 | 075E04 | MS-013AC | | | | ~~95-01-24~~<br>97-05-22 |

## SOLDERING

### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

### DIP

#### Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

#### Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

### SO

#### Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

#### Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A doublewave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

#### Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

## DEFINITIONS

| **Data sheet status** | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| **Limiting values** | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

## LIFE SUPPORT APPLICATIONS

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