DATA SHEET

SAD1009
Universal DAC (UDAC)

Preliminary specification
File under Integrated Circuits, IC02

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Philips
Semiconductors

PHILIPS

GENERAL DESCRIPTION

The SAD1009 is intended as a peripheral to a microcontroller-based servo system in video cassette recorders.
The device relieves the microcontroller of some of the real time functions. These functions include; generation of programmable pulse width signals (duty factor etc.) and accurate measurement of time period signals (tacho signal etc.).
The SAD1009 has nine programmable output ports. All functions of the UDAC are programmable. Commands and data from the microcontroller are loaded via a bidirectional bus using a 16-bit format. Data from the time period measurement is transferred to the microcontroller via the same bidirectional bus, also using a 16-bit format. The clock signal for this device is provided by the quartz oscillator of the microcontroller.

Features

- Generation of programmable pulse width signals
- Measurement of time period signals
- All functions are programmable

QUICK REFERENCE DATA

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply						
Supply voltage range		V_{DD}	4,75	5,0	5,25	V
Inputs						
Input voltage						
LOW		V_{IL}	–	–	0,8	V
HIGH		V_{IH}	2,4	–	–	V
Input leakage current		$\pm I_I$	–	–	1	µA
Input capacitance		C_I	–	–	7,5	pF
Outputs						
Output voltage						
LOW	I_{OL} = 1,6 mA	V_{OL}	–	–	0,4	V
HIGH	I_{OH} = – 1,0 mA	V_{OH}	V_{DD} –0,4	–	–	V
Output sink current		I_O	–	–	1,6	mA
Output source current		$- I_O$	–	–	1,0	mA

PACKAGE OUTLINES

SAD1009P: 24-lead DIL; plastic (SOT101A); SOT101-1; 1996 November 18.
SAD1009T: 24-lead mini-pack; plastic (SO24; SOT137A); SOT 137-1; 1996 November 18.

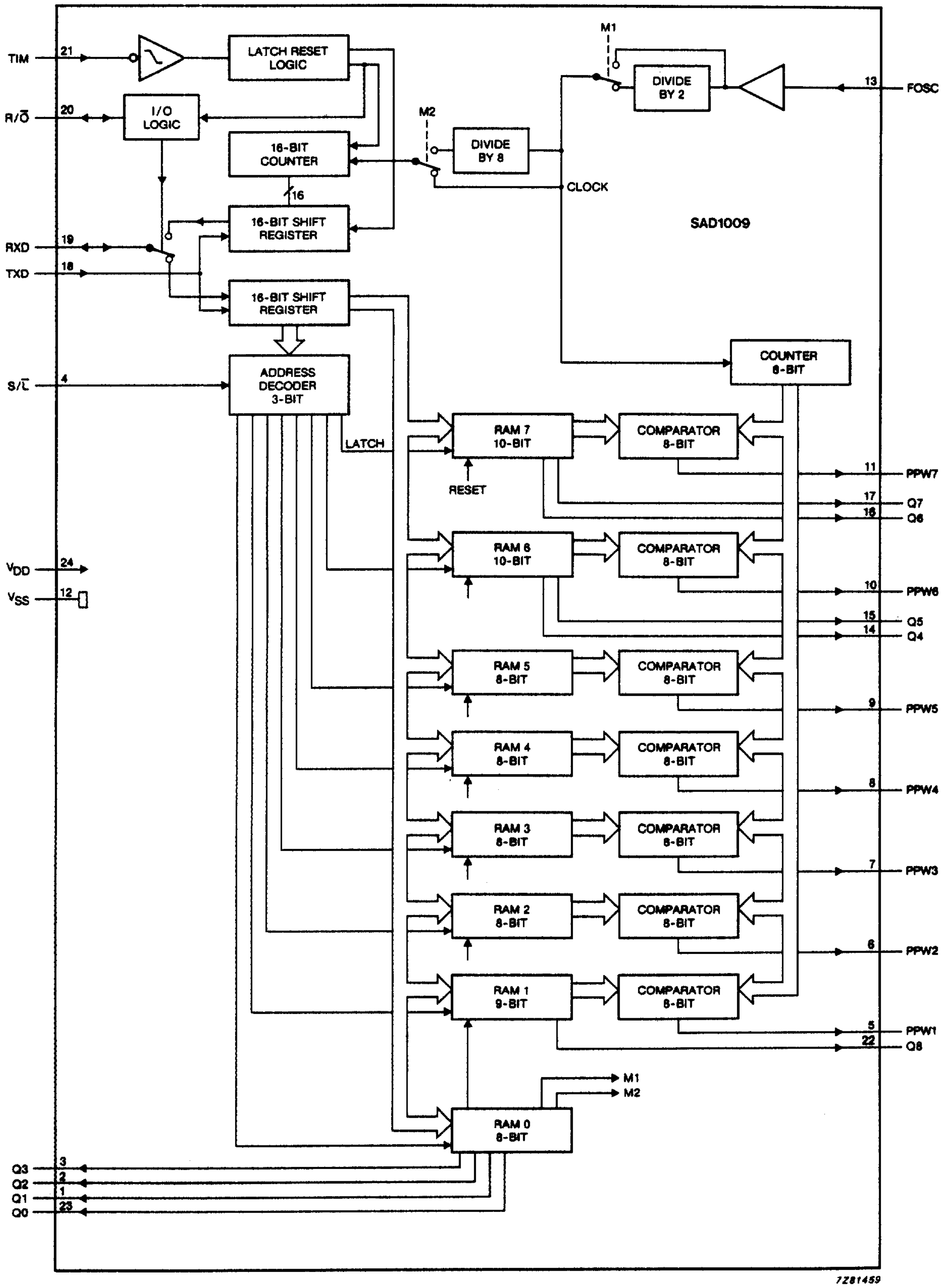


Fig.1 Block diagram.

PINNING

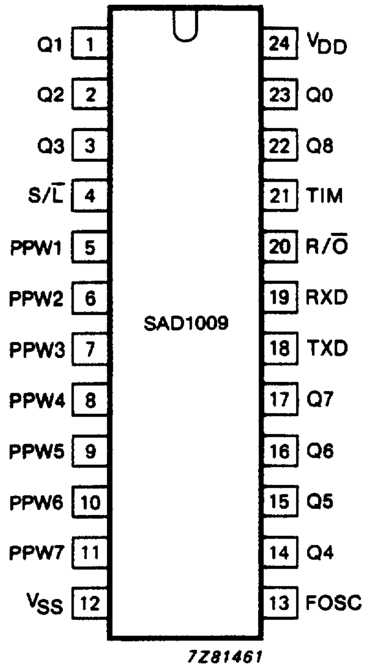


Fig.2 Pinning diagram.

Power supply

V_{DD}	positive supply voltage (+5 V)
V_{SS}	ground (0 V)

Inputs

S/$\overline{L}$	shift/$\overline{\text{latch}}$ input
FOSC	oscillator input
TXD	serial clock

Special inputs

TIM	timer input

Outputs

Q0 to Q8	programmable output ports
PPW1 to PPW7	programmable pulse width outputs

Input/outputs

RXD	serial data
R/$\overline{O}$	handshake

FUNCTIONAL DESCRIPTION

Loading data

All commands and data are loaded into the SAD1009 via the bidirectional bus (TXD, RXD). The bidirectional bus is compatible with the serial interface of the ‘8051’ microcontroller, using mode 0.

A 16-bit word is used to program a function of the UDAC. The first 3-bits received from the RAM constitute the address and the remaining 13-bits are data (LSB first, MSB last). None of the functions require all 13-bits of data, therefore, 16-bit words contain a number of immaterial bits (x). The programming format is shown in Table 1.

To shift a program word into the input buffer of the UDAC the $S/\overline{L}$ line (shift/latch not) must be HIGH. The contents of the input buffer are transferred to the appropriate RAM on the HIGH-to-LOW transition of the $S/\overline{L}$ signal. When $S/\overline{L}$ is LOW the input buffer is disabled and cannot accept new incoming information. Fig.3 illustrates the program reception cycle.

Table 1 Programming format

BIT	STATUS	PPW1	PPW2	PPW3	PPW4	PPW5	PPW6	PPW7
1	L	H	L	H	L	H	L	H
2	L	L	H	H	L	L	H	H
3	L	L	L	L	H	H	H	H
4	$\overline{\text{RESET}}$	Q8	X	X	X	X	Q4	Q6
5	X	X	X	X	X	X	Q5	Q7
6	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X
8	X	X	X	X	X	X	X	X
9	Q0	D8	D8	D8	D8	D8	D8	D8
10	Q1	D7	D7	D7	D7	D7	D7	D7
11	Q2	D6	D6	D6	D6	D6	D6	D6
12	Q3	D5	D5	D5	D5	D5	D5	D5
13	X	D4	D4	D4	D4	D4	D4	D4
14	X	D3	D3	D3	D3	D3	D3	D3
15	M1	D2	D2	D2	D2	D2	D2	D2
16	M2	D1	D1	D1	D1	D1	D1	D1

Where:

X : don’t care

D 1 to D8: data for programming pulse width, D1 = MSB and D8 = LSB

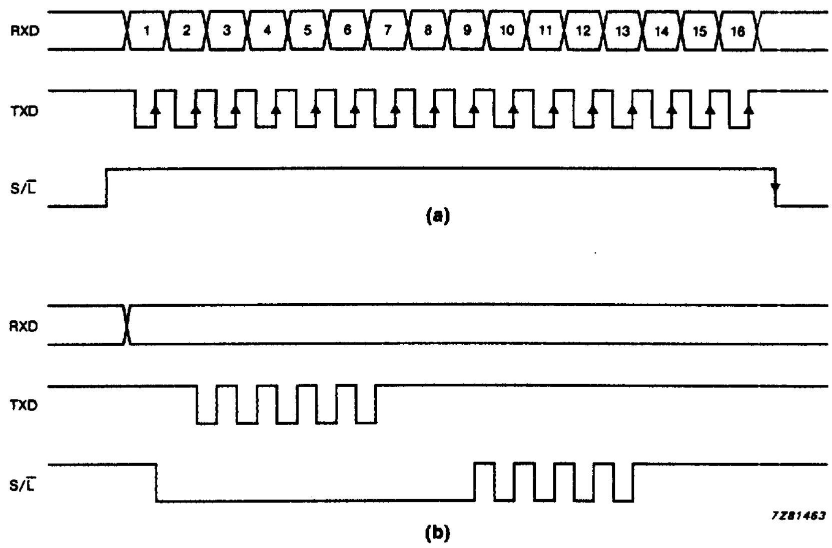


Fig.3 Program reception cycle: a) normal reception cycle; b) no information is loaded into the input buffer, the RAMs contents remain unchanged.

Pulse width modulated outputs

The UDAC has seven pulse width modulated outputs (PPW1 to PPW7). The output PPW1 is slightly different to outputs PPW2 to PPW7, the difference is explained below. Each output produces a pulse width modulated signal with a duty factor programmable in steps of 1/256 and has a repetition frequency of approximately 23 kHz. These pseudo analogue signals are used to control the capstan and reel drives. Motor control can be performed in the following ways:

- convert the pulse width modulated signal into an analogue signal using filtering and analogue power amplification
- by feeding the pulse width modulated signal to the motor via a power switch and a switch mode filter

To conserve power use the second method for control of the capstain and reel motors. For the scanner control two outputs are available, so that by weighted addition a higher resolution can be achieved.

PPW1 is also an 8-bit programmable output, with a repetition frequency of 23 kHz. The difference is the low frequency contents of the signal are reduced by changing the distribution of the HIGH and LOW level portions. This redistribution means that a filter with two poles; each at 43 µs, is sufficient to reduce the peak-to-peak ripple to less than 1 LSB. This output is for use in applications where long filter delays are not tolerated.

Clock frequency

The clock signal of the UDAC is derived from the quartz oscillator of the microcontroller. The clock frequency should not exceed 6 MHz. The device also contains a programmable ‘divide by two’ circuit which allows these frequencies to be doubled, thus 6 MHz or 12 MHz microcontrollers can be used. The FOSC signal can be divided by two using bit M1 of RAM 0 (see Table 2).

Table 2 UDAC adjustment

BIT M1	QUARTZ FREQUENCY (MHz)
L	12
H	6

Programmable output ports

A total of nine output ports can be programmed to supply a HIGH or LOW level signal. Four of these outputs (Q4 to Q7) are intended to supply information about the breaking and direction of the capstan and reel motors, therefore these output ports must be programmed at the same time as the pulse widths of PPW6 and PPW7. Output port Q8 is programmed at the same time as PPW1. The other four output ports (Q0 to Q3) are programmed by RAM 0.

Measurement of the time period

To facilitate accurate measurement of the time period (falling edge to falling edge) of a signal applied to TIM, the UDAC contains a 16-bit counter and a buffer to store the contents of the previous counter measurement. The counter operates at a frequency of $f_{CLOCK}/2$ or $f_{CLOCK}/16$, the counter can be programmed using bit M2 of RAM 0. This timer can record periods of up to 21,8 ms and 175 ms respectively (see Table 3). When the time period is too long and the timer overflows, the microcontroller is loaded with a hex ‘FFFF’ when it reads the time period after the next pulse.

Table 3 Counter frequency

M2	DIVISION RATIO	TIME PERIOD (MAX.)	FREQUENCY	RESOLUTION
L	2	21,8 ms	46 Hz	333 ns
H	6	175 ms	5,7 Hz	2,67 µs

Data from the timer can be transferred to the microcontroller via a bidirectional bus when the handshaking signal pin R/$\overline{\text{O}}$ is pulled LOW by the microcontroller. The LSB is transferred first and the MSB last. After the data has been transferred pin R/$\overline{\text{O}}$ remains in a LOW state (pulled down by the UDAC) until a new measurement of the time period is concluded. Note that each measurement of a time period can only be read once. After the next input pulse the 'data ready' state is signalled to the microcontroller by releasing the R/$\overline{\text{O}}$ pin, so that the microcontroller reads a HIGH level on this pin.

Note

During the 'data not ready' state the R/$\overline{\text{O}}$ is in a low impedance state and during the 'data ready' state the R/$\overline{\text{O}}$ is in a high impedance state (= HIGH). To speed up the transition from LOW-to-HIGH, the high impedance state is preceded by a short period of low impedance HIGH state.

Reset

The device can be reset by software by loading a LOW into the $\overline{\text{RESET}}$ bit of RAM 0. The effect of this reset is as follows:

- RAM 0; not influenced
- RAM 1; duty factor = 50%, Q8 = LOW
- RAM 2 to 5; duty factor = 50%
- RAM 6 to 7; duty factor = 0 and Q4 to Q7 = LOW

The reset is de-activated automatically on the next LOW-to-HIGH transition of S/$\overline{\text{L}}$. This allows new program information to be loaded and transferred to any RAM without having finished the reset. Due to RAM 0 not being influenced by the reset, the data required after the reset can be loaded along with the reset command.

RATINGS

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

PARAMETER	CONDITIONS	SYMBOL	MIN.	MAX.	UNIT
Supply voltage range		V_{DD}	–	7	V
Input voltage range	note 1	V_I	–0,5	V_{DD} + 0,5	V
Input voltage at $S/\overline{L}$		$V_{4\text{-}12}$	–0,5	V_{DD} + 2,0	V
D.C. current into any input		$\pm I_I$	–	10	mA
D.C. current from any output		$\pm I_O$	–	10	mA
D.C. current into V_{DD}		$\pm I_I$	–	25	mA
D.C. current into V_{SS}		$\pm I_I$	–	25	mA
Total power dissipation	note 2	P_{tot}	–	200	mW
Storage temperature range		T_{stg}	–55	+150	°C
Operating ambient temperature range		T_{amb}	–20	+70	°C

Notes to ratings

1. Input voltage should not exceed 7 V unless otherwise specified.
2. Diminishes by 5 mW/K from 60 °C

HANDLING

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

D.C. CHARACTERISTICS

V_{DD} = 4,75 to 5,25 V; T_{amb} = –20 to 70 °C, unless otherwise specified

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply						
Supply voltage range		V_{DD}	4,75	5,0	5,25	V
Supply current range	V_O = V_{DD}, I_O = 0 mA on all outputs; V_I = V_{SS} on all inputs	I_{DD}	–	100	–	µA
TXD, RXD, S/$\overline{L}$, R/$\overline{O}$						
Input voltage						
LOW		V_{IL}	–	–	0,8	V
HIGH		V_{IH}	2,4	–	–	V
Input leakage current	note 1	$\pm I_I$	–	–	1	µA
Input capacitance		C_I	–	–	7,5	pF
RXD, R/$\overline{O}$, Q0 to Q7						
Output voltage	note 2					
LOW	I_{OL} = 1,6 mA	V_{OL}	–	–	0,4	V
HIGH	I_{OH} = –1,0 mA	V_{OH}	V_{DD}–0,4	–	–	V
Output sink current		I_O	–	–	1,6	mA
Output source current		$-I_O$	–	–	1,0	mA
FOSC						
Input voltage						
LOW		V_{IL}	–	–	0,8	V
HIGH		V_{IH}	2,4	–	–	V
Input leakage current		$\pm I_I$	–	–	1	µA
Input capacitance		C_I	–	–	7,5	pF

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
RXD	used as input					
Input leakage current		$\pm I_I$	–	–	10	μA
TIM						
Input voltage						
LOW		V_{IL}	–	–	$0,3 \times V_{DD}$	V
LOW	V_{DD} = 5 V at 20 °C	V_{IL}	–	1,8	–	V
HIGH		V_{IH}	$0,7 \times V_{DD}$	–	–	V
HIGH	V_{DD} = 5 V at 20 °C	V_{IH}	–	2,9	–	V
Hysteressis	used as input	V_{hys}	–	730	–	mV
R/$\overline{O}$	used as input					
Output resistance		R_O	500	–	1000	Ω
Input leakage current		$\pm I_I$	–	–	10	μA
R/$\overline{O}$	used as output; open drain output; note 3; see Fig.7					
Output voltage						
LOW	I_{OL} = 0,4 mA	V_{OL}	–	–	0,8	V
HIGH	I_{OH} = –0,4 mA	V_{OH}	V_{DD}–0,8	–	–	V
PPW1 to PPW7						
Output voltage						
LOW	I_{OL} = 4 mA	V_{OL}	–	–	0,4	V
HIGH	I_{OH} = –4 mA	V_{OH}	V_{DD}–0,4	–	–	V
Output sink current		I_O	–	–	4	mA
Output source current		$-I_O$	–	–	4	mA

Notes to the d.c. characteristics

1. This value applies to TXD and S/$\overline{L}$, the input leakage current for RXD and R/$\overline{O}$ is shown above.
2. This value applies to RXD and Q0 to Q7, the output voltage for R/$\overline{O}$ is shown above.
3. After a LOW-to-HIGH transition of the R/$\overline{O}$ output, the port is held HIGH for approximately one clock cycle. This low impedance HIGH period is followed by the high impedance OFF-state.

A.C. CHARACTERISTICS

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
RXD, R/$\overline{O}$, Q0 to Q7						
Output transition time	C_L = 50 pF					
LOW-to-HIGH		t_{TLH}	–	–	30	ns
HIGH-to-LOW		t_{THL}	–	–	30	ns
FOSC						
Maximum pulse						
frequency	M1 = L	f_{max}	–	–	12	MHz
	M1 = H	f_{max}	–	–	6	MHz
Minimum pulse width						
LOW		t_{WL}	20	–	–	ns
HIGH		t_{WH}	20	–	–	ns
TXD						
Pulse frequency		f_{max}	–	–	6	MHz
Pulse width						
LOW		t_{WL}	50	–	–	ns
HIGH		t_{WH}	50	–	–	ns
RXD	used as input; see Fig.5					
Set-up time						
RXD to TXD		t_{SURXD}	50	–	–	ns
Hold time						
RXD to TXD		t_{HDRXD}	50	–	–	ns
RXD	used as output; see Fig.6					
Propagation delay						
TXD to RXD		t_{PRXD}	–	–	50	ns
R/$\overline{O}$ to RXD		$t_{PR/O}$	–	–	50	ns
S/$\overline{L}$	see Fig.7					
Pulse width LOW						
Set-up time						
TXD to S/$\overline{L}$		t_{SUTXD}	50	–	–	ns
Hold time						
TXD to S/$\overline{L}$		t_{HDTXD}	50	–	–	ns
Propagation delay						
S/$\overline{L}$ to Q0 – Q7		t_p	–	–	50	ns

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
TIM						
Pulse width						
LOW	M2 = LOW	t_{WL}	700	–	–	ns
LOW	M2 = HIGH	t_{WL}	5,4	–	–	µs
HIGH		t_{WH}	100	–	–	ns

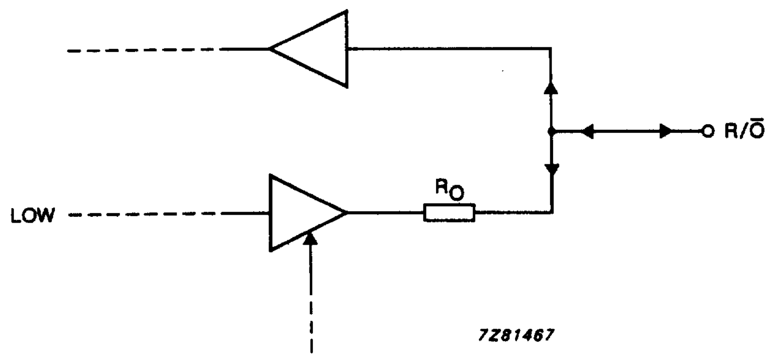


Fig.4 Equivalent R/$\overline{O}$ output port.

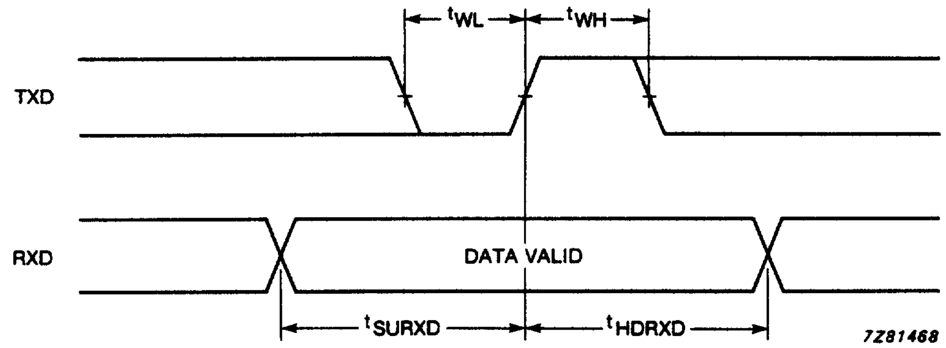


Fig.5 RXD input waveform.

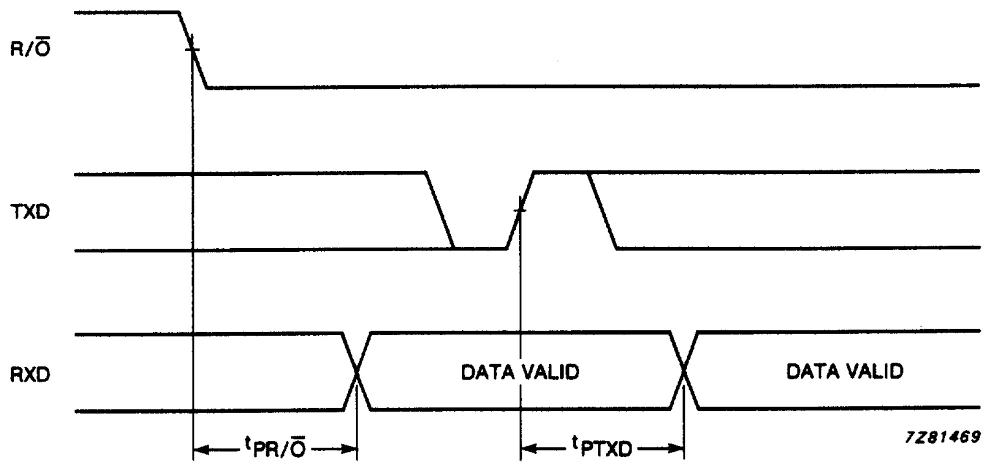


Fig.6 RXD output waveform.

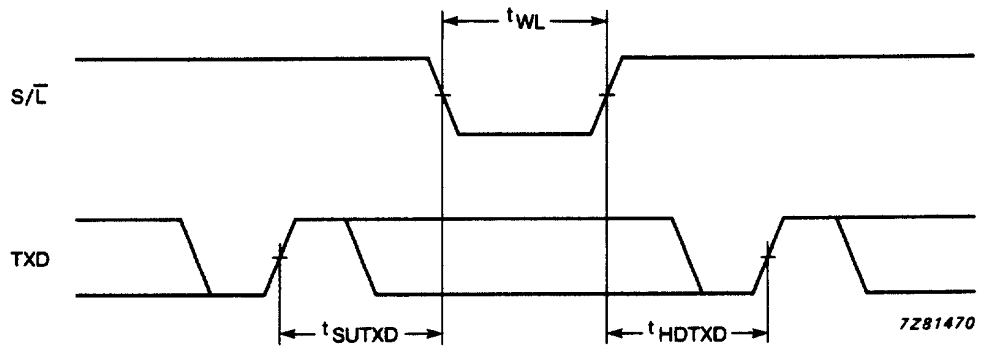
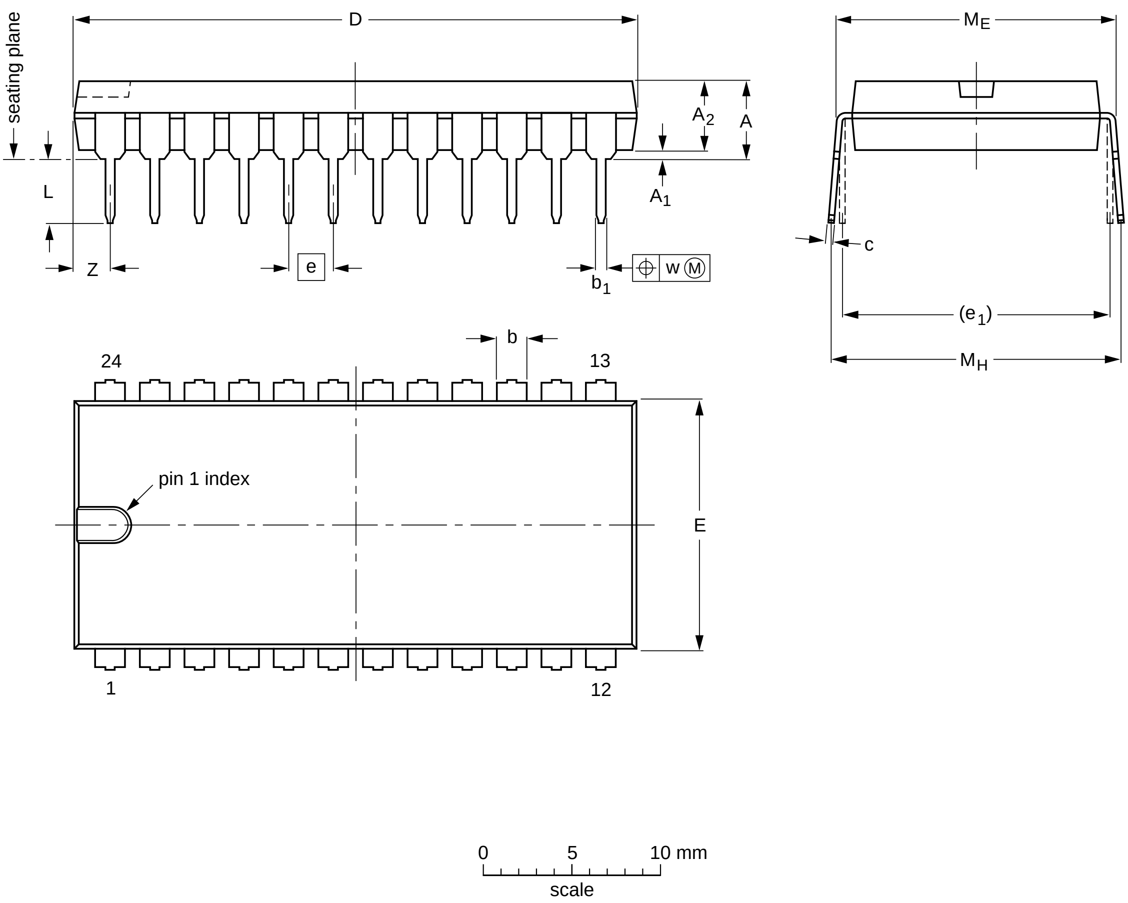


Fig.7 S/$\overline{L}$ input waveform.

PACKAGE OUTLINE

DIP24: plastic dual in-line package; 24 leads (600 mil) **SOT101-1**



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

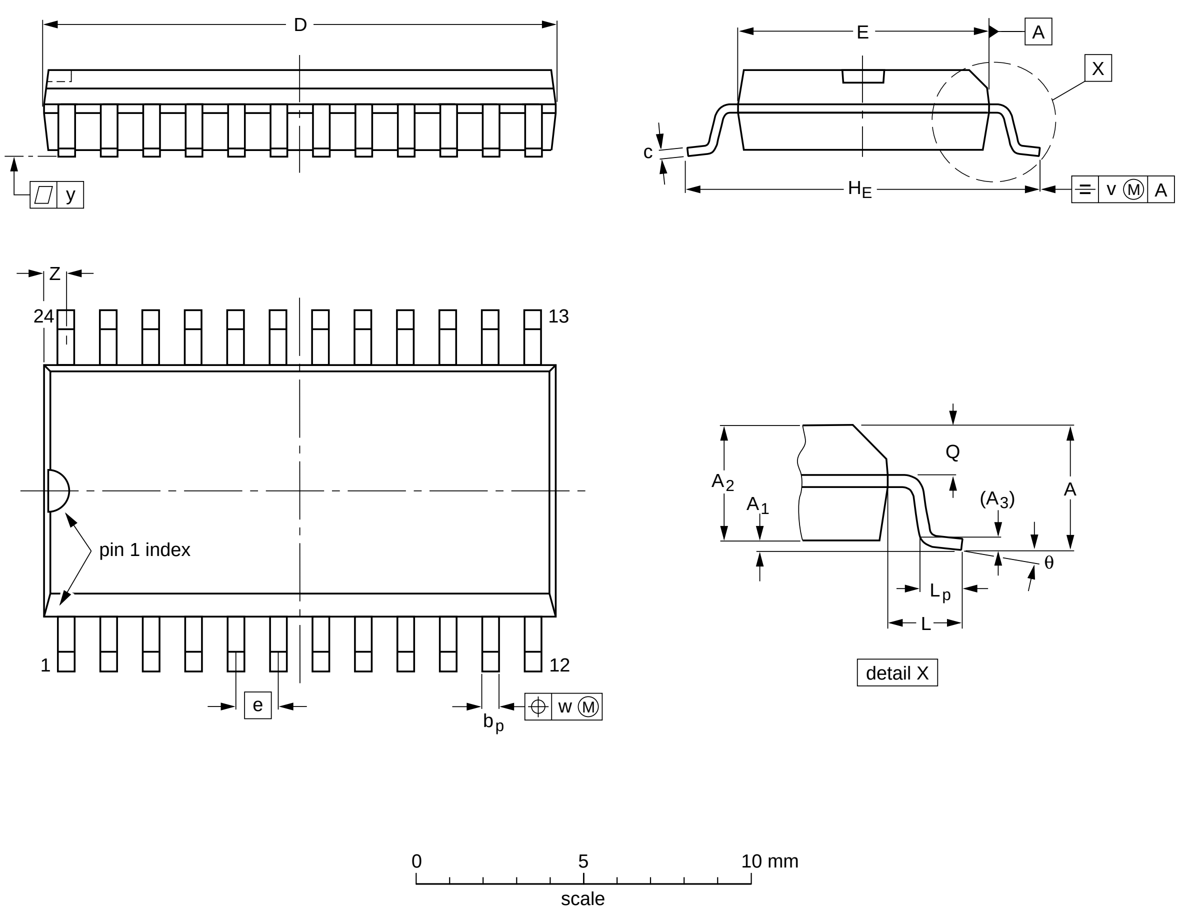
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	5.1	0.51	4.0	1.7 1.3	0.53 0.38	0.32 0.23	32.0 31.4	14.1 13.7	2.54	15.24	3.9 3.4	15.80 15.24	17.15 15.90	0.25	2.2
inches	0.20	0.020	0.16	0.066 0.051	0.021 0.015	0.013 0.009	1.26 1.24	0.56 0.54	0.10	0.60	0.15 0.13	0.62 0.60	0.68 0.63	0.01	0.087

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			
SOT101-1	051G02	MO-015AD				~~92-11-17~~ 95-01-23

SO24: plastic small outline package; 24 leads; body width 7.5 mm **SOT137-1**



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 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	15.6 15.2	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.61 0.60	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 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			
SOT137-1	075E05	MS-013AD				~~92-11-17~~ 95-01-24

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 double-wave (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

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.