

# DATA SHEET

## **SAA7212** Integrated MPEG AVG decoder

Preliminary specification  
Supersedes data of 1998 Feb 18  
File under Integrated Circuits, IC02

1998 Sep 07

## Integrated MPEG AVG decoder

## SAA7212

### FEATURES

#### General features

- Single external Synchronous DRAM organized as 1 M × 16 interfacing at 81 MHz. Due to efficient memory use in MPEG decoding, more than 1 Mbit available for graphics
- Fast 16-bit data + 8-bit address interface with external controller on 27 MHz. Sustained data rate to external SDRAM ≤9 Mbytes/s in bursts of 128 bytes
- Dedicated input for audio and video in PES or ES in byte wide. Data input rate: ≤9 Mbytes/s in byte mode. Accompanying strobe signals distinguish between audio and video data
- Dedicated compressed data input compatible with the VLSI VES2020/2030 demultiplexers; video is received in byte format and audio serially
- Audio and/or video can also be input via the CPU interface in PES/ES in 8 or 16-bit parallel format up to a peak data rate of 9 Mbytes/s
- Single 27 MHz external clock for time base reference and internal processing. Internal system time base at 90 kHz can be synchronized via CPU port. All required decoding and presentation clocks are generated internally
- Flexible memory allocation under control of the external CPU enables optimized partitioning of memory for different tasks
- Boundary scan testing implemented
- External SDRAM self test
- Supply voltage 3.3 V
- Package QFP160.

#### CPU related features

- 16 bits data, 8 bits address, or 16 bits multiplexed bus. Motorola 68xxx and Intel x 86 compatible.
- Support fast DMA transfer
- Flexible bidirectional interface to external SDRAM. Minimum sustained rate is 9 Mbytes/s
- Enhanced block mover allows 3 D data move in the external SDRAM. Picture move/Graphic bit maps construction can be done with minimum CPU support.

#### MPEG2 system features

- Parsing of MPEG2 PES and MPEG1 packet streams
- Double system time clock counters
- Stand-alone or supervised audio/video synchronization
- Processing of errors flagged by channel decoding section
- Support for retrieval of PES header.

#### MPEG2 video features

- Decoding of MPEG2 video up to main level, main profile
- Output picture format: CCIR-601 4 : 2 : 2 interlaced pictures. Picture format 720 × 576 at 50 Hz or 720 × 480 at 60 Hz
- Support of constant and variable bit rates up to 15 Mbits/s
- Stand-alone or CPU controlled mode for decoding/display processes
- Stand-alone mode can be used by applications requiring still pictures manipulations
- Output interface at 8-bit wide, 27 MHz UYVY multiplexed bus
- Horizontal and vertical pan and scan allows the extraction of a window from the coded picture
- Flexible horizontal scaling from 0.5 up to 4 allows easy aspect ratio conversion including support for 2.21 : 1 aspect ratio movies. In case of shrinking an anti-aliasing pre-filter is applied
- Vertical scaling with fixed factors 0.5, 1 or 2. Factor 0.5, realizing picture shrink. Factor 2 can be used for up-conversion of pictures with 288 (240) lines or less.
- Vertical down-scaling with 0.75 factor, realizing letter box conversion
- Horizontal and vertical scaling can be combined to scale pictures to 1/4 their original size, thus freeing up screen space for graphic applications like electronic program guides
- Non full screen MPEG pictures will be displayed in a box of which position and background colour are adjustable by the external microcontroller
- Nominal video input buffer size for ml@mp 2.7 Mbit
- Video output may be slaved to internally (master) generated or externally (slave) supplied HV synchronization signals. The position of active video is programmable. Display phase is not affected by MPEG timebase changes.

## Integrated MPEG AVG decoder

## SAA7212

- Video output direct connectable to SAA718x encoder family
- Various trick modes under control of external microcontroller in stand-alone mode:
  - Freeze field/frame on I or P pictures; restart on I picture
  - Freeze field on B pictures; restart on the next I or P picture.
  - Scanning and decoding of I or I + P pictures in a IBP sequence
  - Single step mode
  - Repeat/skip field for time base correction.

### MPEG2 audio features

- Decoding of 2 channels, layer I and II MPEG audio. Support for mono, stereo, intensity stereo and dual channel mode.
- Constant and variable bit rates up to 448 kbit/s
- Supported audio sampling frequencies: 48, 44.1, 32, 24, 22.05 and 16 kHz
- CRC error detection
- 3 decoding modes for dual channel streams: decoding of CH1 only, decoding of CH2 only and decoding of both CH1 and CH2
- Storage of last 54 bytes in ancillary data field
- Dynamic Range Control (DRC) at output
- Independent channel volume control and programmable inter channel crosstalk through a baseband audio processing unit
- Muting possibility via external controller. Automatic muting in case of errors or data lack.
- Generation of 'beeps' with programmable tone height, duration and amplitude
- Serial two channel digital audio output with 16, 18, 20 or 22 bits per sample, compatible either to I<sup>2</sup>S or Japanese formats. Output can be set to high-impedance mode via the external controller.
- Serial SPDIF audio output. Output can be set to high-impedance mode.
- Clock output 256 or 384 × f<sub>s</sub> for external DA converter. Output can be set to high-impedance mode.
- Audio FIFO in external SDRAM. Programmable buffer size, at least 64 kbit is available.
- Synchronization modes: PTS controlled, PTS free running, software controlled, buffer controlled
- PTS register can be set via external controller
- Programmable processing delay compensation
- Software controlled stop and restart functions.

### Graphics features

- Graphics are presented in boxes independent of video format
- Screen arrangement of boxes is determined by display list mechanism which allows for multiple boxes, background loading, fast switching, scrolling and fading of regions
- Support of 2, 4, 8-bit/pixel in fixed bit maps format or coded in accordance to the DVB variable/run length standard for region based graphics
- Display colours are obtained via colour look up tables. CLUT output is YUVT at 8-bit for each signal component thus enabling 16 M different colours and 6-bit for T which gives 64 mixing levels with video, (T = transparency).
- Bit-map table mechanism to specify a sub set of entries if the CLUT is larger than required by the coded bit pattern. Supported bit-map tables are 16 to 256, 4 to 256 and 4 to 16.
- Graphics boxes may not overlap vertically. If 256 entry CLUT has to be down loaded, a vertical separation of 1 line is mandatory.
- Optimized memory utilization in MPEG video decoding allows for a storage capacity of 1.2 Mbit for graphics bit maps. Flexibility in memory control enables larger capacity in a lot of applications. Moreover variable length/run length encoding makes better use of available memory capacity for graphics bit maps thus making full screen graphics at 8-bit/pixel feasible.
- Fast CPU access (9 Mbytes/s) enables full 1.2 Mbit bit map update within 20 ms
- Internal support for fast block moves in external SDRAM
- Graphics mechanism can be used for signal generation in the vertical blanking interval. Useful for teletext, wide screen signalling, closed caption, etc.
- Support for a single down loadable cursor of 1k pixel with programmable shape. Supported shapes are 8 × 128 pixels, 16 × 64 pixels, 32 × 32 pixels, 64 × 16 pixels and 128 × 8 pixels.
- Cursor colours obtained via 4 entry CLUT with YUVT at 6,4,4 respectively 2 bits. Mixing of cursor with video + graphics in 4 levels.
- Cursor can be moved freely across the screen without overlapping restrictions.

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**Integrated MPEG AVG decoder**
**SAA7212**


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**APPLICATIONS**

- Tbf.

**GENERAL DESCRIPTION**

The SAA7212 is an MPEG2 source decoder which combines audio decoding and video decoding. Additionally to these basic MPEG functions it also provides means for enhanced graphics and/or on-screen display (OSD). Due to an optimized architecture for audio and video decoding, maximum capacity in external memory and processing power from the external CPU is available for graphics support.

**QUICK REFERENCE DATA**

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
$V_{DD}$	functional supply voltage	3.0	3.3	3.6	V
$I_{DD(tot)}$	total supply current; $V_{DD} = 3.3$ V	–	tbf	–	mA
$f_{clk}$	device clock frequency	–30 ppm	27.0	+30 ppm	MHz

**ORDERING INFORMATION**

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
SAA7212H	QFP160	plastic quad flat package; 160 leads (lead length 1.95 mm); body $28 \times 28 \times 3.4$ mm; high stand-off height	SOT322-1

Integrated MPEG AVG decoder

SAA7212

BLOCK DIAGRAM

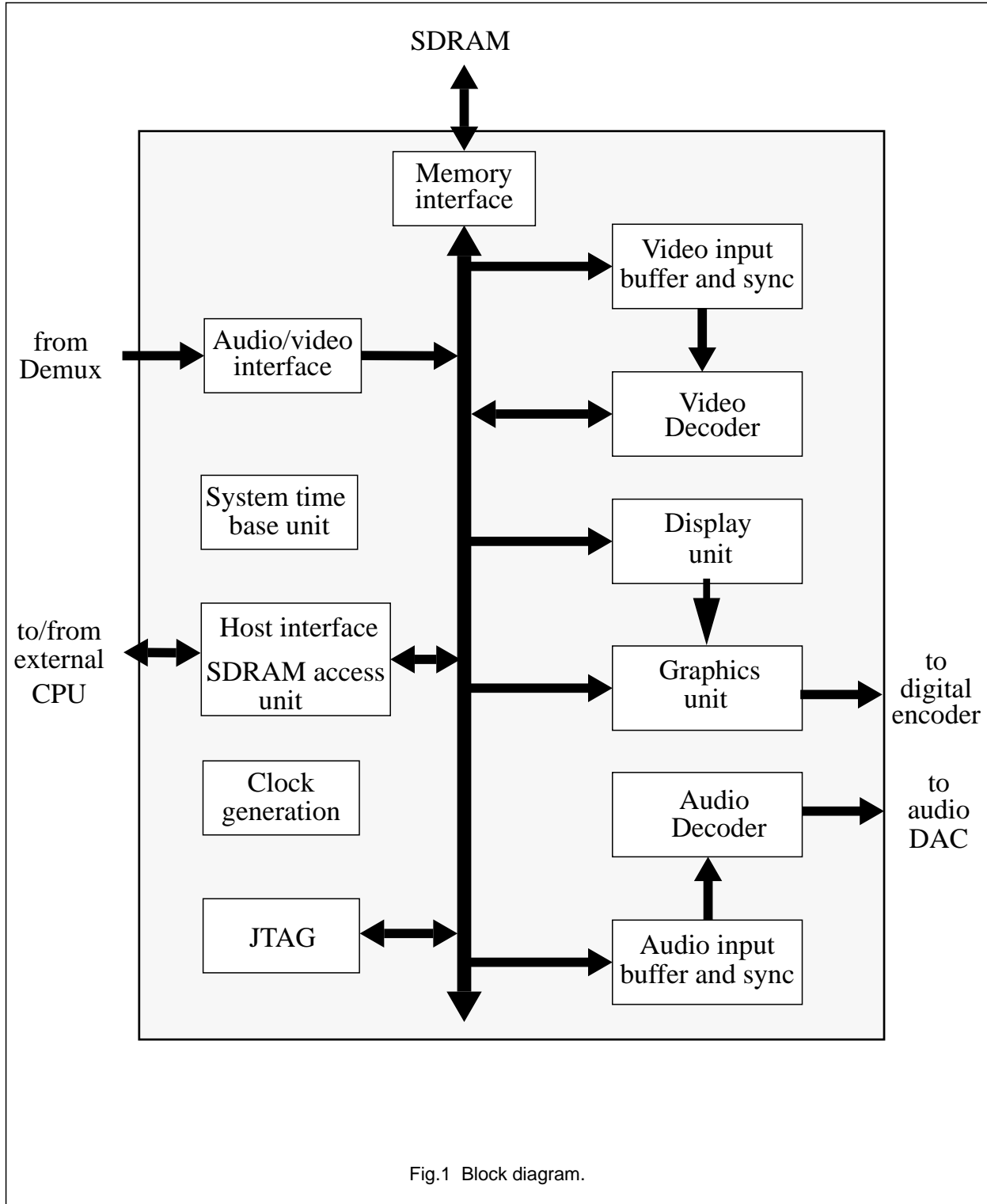


Fig.1 Block diagram.

## Integrated MPEG AVG decoder

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**PINNING**

<b>SYMBOL</b>	<b>PIN</b>	<b>DESCRIPTION</b>
MUX	1	multiplexed/non multiplexed bus
CPU_TYPE	2	Intel/Motorola selection
DMA_ACK	3	DMA acknowledge
DMA_REQ	4	DMA request
DMA_DONE	5	DMA end
DMA_RDY	6	DMA ready
V <sub>SS</sub>	7	ground for pad ring
CS	8	chip select.
DS	9	data strobe
AS	10	address strobe
RWN	11	read/write
DTACK	12	data acknowledge
V <sub>DD</sub>	13	3.3 V supply for pad ring
IRQ 0	14	individually maskable interrupts
IRQ 1	15	individually maskable interrupts
V_REQ	16	compressed video data request
A_REQ	17	compressed audio data request
V <sub>SS</sub>	18	ground for pad ring
V <sub>SSCO</sub>	19	ground for core logic
V <sub>DDCO</sub>	20	3.3 V supply for core logic
DATA 0	21	CPU data interface
DATA 1	22	CPU data interface
DATA 2	23	CPU data interface
DATA 3	24	CPU data interface
V <sub>DD</sub>	25	3.3 V supply for pad ring
DATA 4	26	CPU data interface
DATA 5	27	CPU data interface
DATA 6	28	CPU data interface
DATA 7	29	CPU data interface
V <sub>SS</sub>	30	ground for pad ring
DATA 8	31	CPU data interface
DATA 9	32	CPU data interface
DATA 10	33	CPU data interface
DATA 11	34	CPU data interface
V <sub>DD</sub>	35	3.3 V supply for pad ring
DATA 12	36	CPU data interface
DATA 13	37	CPU data interface
DATA 14	38	CPU data interface
DATA 15	39	CPU data interface
V <sub>SS</sub>	40	ground for pad ring

## Integrated MPEG AVG decoder

## SAA7212

SYMBOL	PIN	DESCRIPTION
ADDRESS 1	41	CPU address interface
ADDRESS 2	42	CPU address interface
ADDRESS 3	43	CPU address interface
ADDRESS 4	44	CPU address interface
V <sub>DD</sub>	45	3.3 V supply for pad ring
ADDRESS 5	46	CPU address interface
ADDRESS 6	47	CPU address interface
ADDRESS 7	48	CPU address interface
ADDRESS 8	49	CPU address interface
V <sub>SS</sub>	50	ground for pad ring
V <sub>SSCO</sub>	51	ground for core logic
V <sub>DDCO</sub>	52	3.3 V supply for core logic
SDRAM_DATA 0	53	SDRAM data
SDRAM_DATA 15	54	SDRAM data
SDRAM_DATA 1	55	SDRAM data
V <sub>DD</sub>	56	3.3 V supply for pad ring
SDRAM_DATA 14	57	SDRAM data
SDRAM_DATA 2	58	SDRAM data
SDRAM_DATA 13	59	SDRAM data
V <sub>SS</sub>	60	ground for pad ring
SDRAM_DATA 3	61	SDRAM data
SDRAM_DATA 12	62	SDRAM data
SDRAM_DATA 4	63	SDRAM data
V <sub>DD</sub>	64	3.3 V supply for pad ring
SDRAM_DATA 11	65	SDRAM data
SDRAM_DATA 5	66	SDRAM data
SDRAM_DATA 10	67	SDRAM data
V <sub>SS</sub>	68	ground for pad ring
SDRAM_DATA 6	69	SDRAM data
SDRAM_DATA 9	70	SDRAM data
SDRAM_DATA 7	71	SDRAM data
V <sub>DD</sub>	72	3.3 V supply for pad ring
SDRAM_DATA 8	73	SDRAM data
SDRAM_WE	74	SDRAM write enable
SDRAM_CAS	75	SDRAM column address strobe
V <sub>SS</sub>	76	ground for pad ring
SDRAM_RAS	77	SDRAM row address strobe
SDRAM_UDQ	78	SDRAM write mask
V <sub>DD</sub>	79	3.3 V supply for pad ring
READ_IN	80	read command in
READ_OUT	81	read command out

## Integrated MPEG AVG decoder

SAA7212

SYMBOL	PIN	DESCRIPTION
V <sub>SS</sub>	82	ground for pad ring
CP81MEXT	83	81 MHz SDRAM clock return path
CP81M	84	81 MHz SDRAM memory clock
V <sub>DD</sub>	85	3.3 V supply for pad ring
SDRAM_ADDR 8	86	SDRAM address
SDRAM_ADDR 9	87	SDRAM address
SDRAM_ADDR 11	88	SDRAM address
V <sub>SS</sub>	89	ground for pad ring
SDRAM_ADDR 7	90	SDRAM address
SDRAM_ADDR 10	91	SDRAM address
SDRAM_ADDR 6	92	SDRAM address
V <sub>DD</sub>	93	3.3 V supply for pad ring
SDRAM_ADDR 0	94	SDRAM address
SDRAM_ADDR 5	95	SDRAM address
SDRAM_ADDR 1	96	SDRAM address
V <sub>SS</sub>	97	ground for pad ring
SDRAM_ADDR 4	98	SDRAM address
SDRAM_ADDR 2	99	SDRAM address
SDRAM_ADDR 3	100	SDRAM address
V <sub>SSCO</sub>	101	ground for core logic
V <sub>DDCO</sub>	102	3.3 V supply for core logic
V <sub>DD</sub>	103	3.3 V supply for pad ring
Test 5	104	IC test interface (see note 2)
Test 6	105	IC test interface (see note 2)
HS	106	horizontal synchronization
VS	107	vertical synchronization
V <sub>SS</sub>	108	ground for pad ring
YUV 0	109	YUV video output at 27 MHz
YUV 1	110	YUV video output at 27 MHz
YUV 2	111	YUV video output at 27 MHz
YUV 3	112	YUV video output at 27 MHz
V <sub>DD</sub>	113	3.3 V supply for pad ring
YUV 4	114	YUV video output at 27 MHz
YUV 5	115	YUV video output at 27 MHz
YUV 6	116	YUV video output at 27 MHz
YUV 7	117	YUV video output at 27 MHz
Test 4	118	IC test interface (see note 3)
GRPH	119	indicator for graphics information
Test 3	120	IC test interface (see note 4)
V <sub>DDAN</sub>	121	3.3 V supply for analog blocks
V <sub>SSAN</sub>	122	ground for analog blocks



## Integrated MPEG AVG decoder

## SAA7212

SYMBOL	PIN	DESCRIPTION
V <sub>SS</sub>	123	ground for pad ring
CLK	124	27 MHz Clock input
V <sub>SS</sub>	125	ground for pad ring
TCK	126	boundary scan test clock
TRST	127	boundary scan test reset
TMS	128	boundary scan test mode select
TDO	129	boundary scan test data output
TDI	130	boundary scan test data input
V <sub>DD</sub>	131	3.3 V supply for pad ring
Test 0	132	IC test interface (see note 4)
Test 1	133	IC test interface (see note 4)
Test 2	134	IC test interface (see note 4)
AUDDEN	135	synchronization of the serial audio input (A_DATA)
A_DATA	136	serial audio input
V <sub>DD</sub>	137	3.3 V supply for pad ring
RESET	138	hard reset input, active LOW
FSCLK	139	256 or 384f <sub>s</sub> (audio sampling)
V <sub>DDCO</sub>	140	3.3 V supply for core logic
V <sub>SSCO</sub>	141	ground for core logic
SCK	142	serial audio clock
SD	143	serial audio data output
V <sub>SS</sub>	144	ground for pad ring
WS	145	word select
SPDIF	146	digital audio output
ERROR	147	flag for bitstream error.
V_STROBE	148	video strobe
V <sub>DD</sub>	149	3.3 V supply for pad ring
AV_DATA 0	150	MPEG stream input port
AV_DATA 1	151	MPEG stream input port
AV_DATA 2	152	MPEG stream input port
AV_DATA 3	153	MPEG stream input port
V <sub>SS</sub>	154	ground for pad ring
AV_DATA 4	155	MPEG stream input port
AV_DATA 5	156	MPEG stream input port
AV_DATA 6	157	MPEG stream input port
AV_DATA 7	158	MPEG stream input port
A_STROBE	159	audio strobe
V <sub>DD</sub>	160	3.3 V supply for pad ring

## Integrated MPEG AVG decoder

SAA7212

**Notes**

1. 5 V tolerant outputs swing between  $V_{SS}$  and  $V_{DD}$  but 5 V tolerant input can receive signal swinging between  $V_{SS}$  and 3.3 V or  $V_{SS}$  and 5 V.
2. Should be left open in normal mode.
3. Should be tied up to  $V_{DD}$  in normal mode.
4. Should be tied down to ground in normal mode.

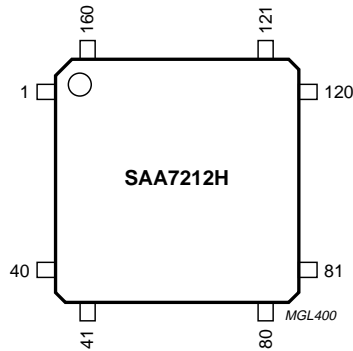


Fig.2 Pin configuration.

## Integrated MPEG AVG decoder

SAA7212

**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{DD}$	supply voltage		-0.5	+5	tbf	V
$V_{n(max)}$	voltage on all pins		0	5	tbf	V
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	–	1	tbf	W
$T_{stg}$	IC storage temperature		-55	150	tbf	°C
$T_{amb}$	operating ambient temperature		0	70	tbf	°C

**THERMAL CHARACTERISTICS**

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient in free air	30	K/W

**HANDLING**

Inputs and outputs are protected against electrostatic discharges in normal handling. However, to be totally safe, it is desirable to take normal precautions appropriate to handling integrated circuits.

**CHARACTERISTICS**

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>					
$V_{DD}$	functional supply voltage	3.0	3.3	3.6	V
$I_{DD(tot)}$	total supply current; $V_{DD} = 3.3\text{ V}$	–	tbf	–	mA
<b>Inputs</b>					
$V_{IH(5V\text{ tolerant})}$	input voltage HIGH	2.0	–	6.5	V
$V_{IH}$	input voltage HIGH	$0.7V_{DD}$	–	$V_{DD}+2.0$	V
$V_{IL(5V\text{ tolerant})}$	input voltage LOW	-0.5	–	0.8	V
$V_{IL}$	input voltage LOW	-0.5	–	$0.3V_{DD}$	V
$I_L$	leakage current	–	–	20	μA
$C_i$	input capacitance	0	–	10	pF
<b>Outputs</b>					
$V_{OH(5V\text{ tolerant})}$	output voltage HIGH	2.4	–	–	V
$V_{OH}$	output voltage HIGH	$V_{DD} - 0.4$	–	–	V
$V_{OL(5V\text{ tolerant})}$	output voltage LOW	–	–	0.4	V
$V_{OL}$	output voltage LOW	–	–	0.4	V
<b>DC timing</b>					
$T_{cy}$	cycle time	–	37.037	–	ns
$\delta$	duty factor	40	–	60	%

Integrated MPEG AVG decoder

SAA7212

APPLICATION INFORMATION

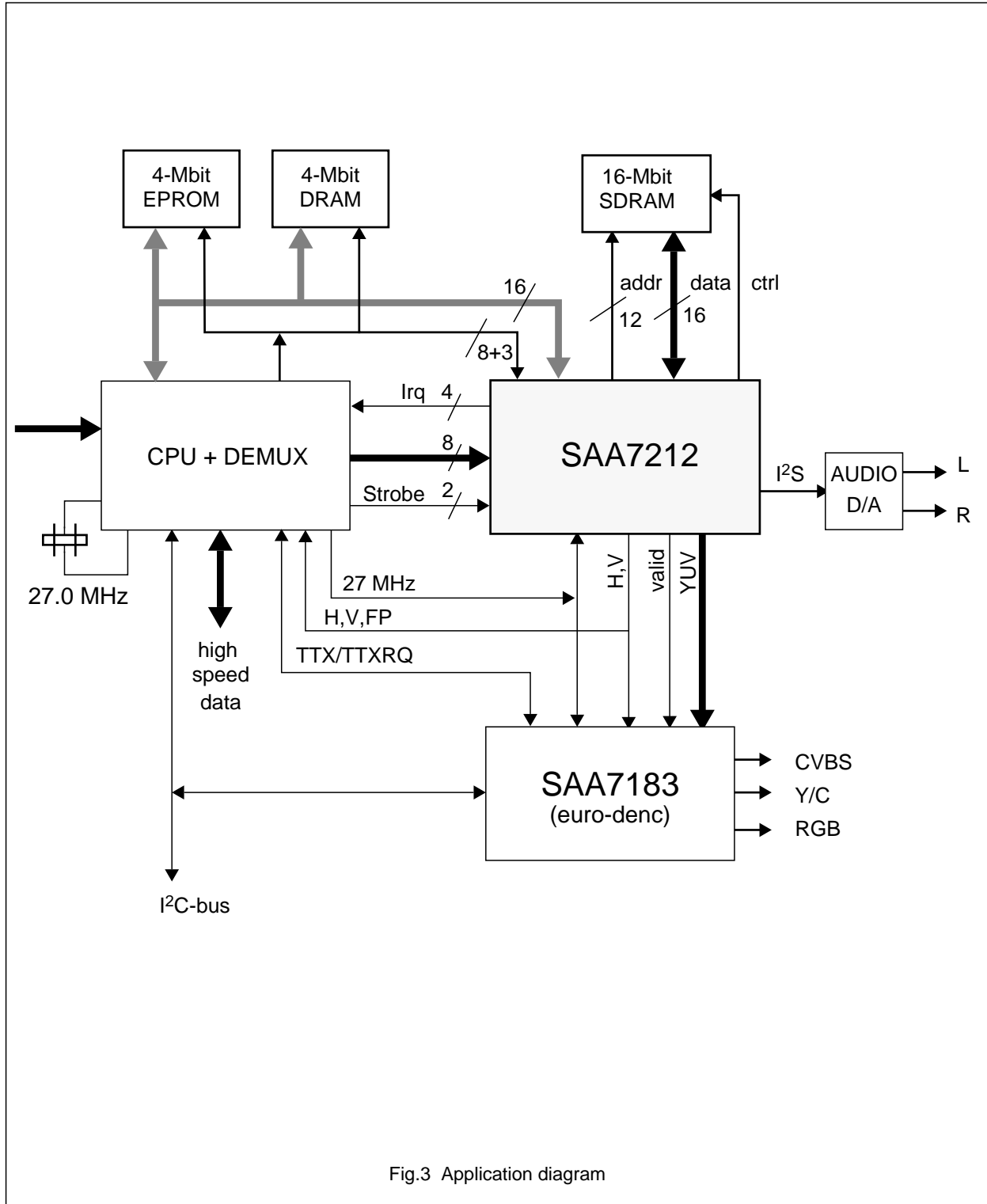
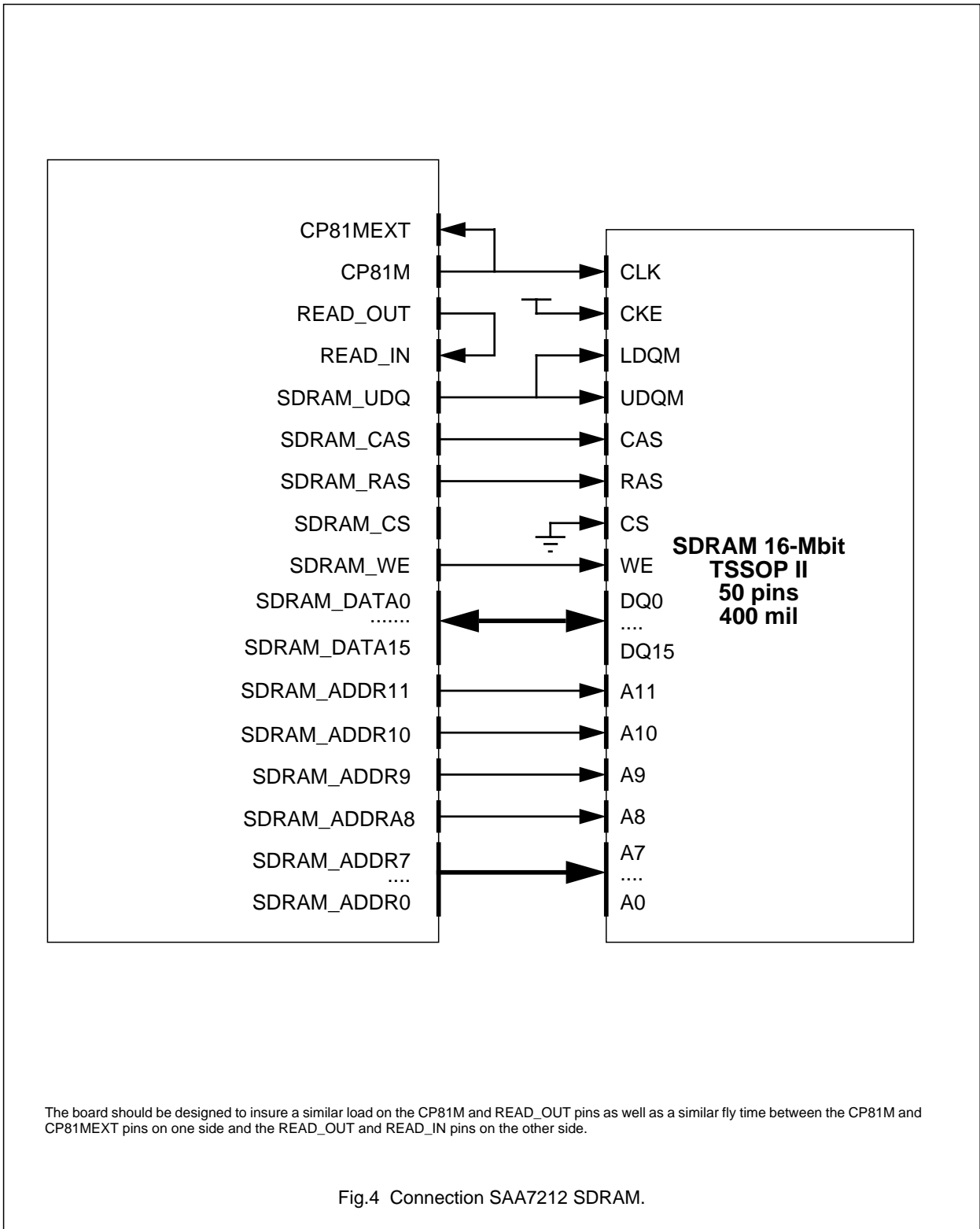


Fig.3 Application diagram

Integrated MPEG AVG decoder

SAA7212



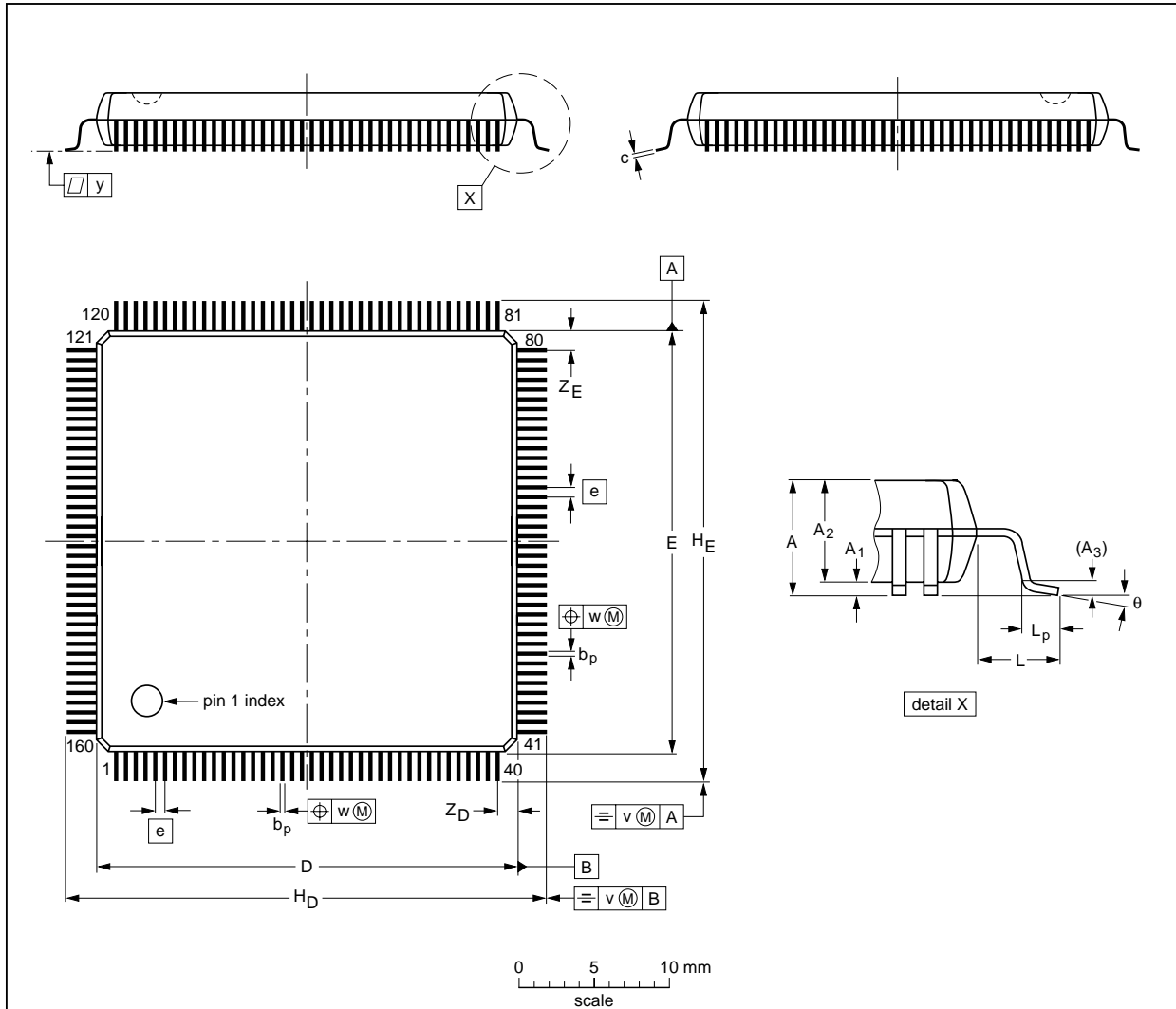
# Integrated MPEG AVG decoder

SAA7212

## PACKAGE OUTLINE

**QFP160: plastic quad flat package;**  
**160 leads (lead length 1.95 mm); body 28 x 28 x 3.4 mm; high stand-off height**

**SOT322-1**



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>D</sub>	H <sub>E</sub>	L	L <sub>p</sub>	v	w	y	Z <sub>D</sub> <sup>(1)</sup>	Z <sub>E</sub> <sup>(1)</sup>	θ
mm	3.95	0.40 0.25	3.70 3.15	0.25	0.40 0.25	0.23 0.13	28.1 27.9	28.1 27.9	0.65	32.2 31.6	32.2 31.6	1.95	1.1 0.7	0.3	0.15	0.1	1.5 1.1	1.5 1.1	8° 0°

**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			
SOT322-1		MO112DD1				95-02-04 97-08-04

## Integrated MPEG AVG decoder

SAA7212

### 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 *"Data Handbook IC26; Integrated Circuit Packages"* (order code 9398 652 90011).

#### Reflow soldering

Reflow soldering techniques are suitable for all QFP packages.

The choice of heating method may be influenced by larger plastic QFP packages (44 leads, or more). If infrared or vapour phase heating is used and the large packages are not absolutely dry (less than 0.1% moisture content by weight), vaporization of the small amount of moisture in them can cause cracking of the plastic body. For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 50 and 300 seconds depending on heating method. Typical reflow peak temperatures range from 215 to 250 °C.

#### Wave soldering

Wave soldering is **not** recommended for QFP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

CAUTION
<b>Wave soldering is NOT applicable for all QFP packages with a pitch (e) equal or less than 0.5 mm.</b>

**If wave soldering cannot be avoided, for QFP packages with a pitch (e) larger than 0.5 mm, the following conditions must be observed:**

- **A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.**
- **The footprint must be at an angle of 45° to the board direction and must incorporate solder thieves downstream and at the side corners.**

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.

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**Integrated MPEG AVG decoder**
**SAA7212**


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**DEFINITIONS**

<b>Data sheet status</b>	
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.
<b>Limiting values</b>	
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.	
<b>Application information</b>	
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.



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Integrated MPEG AVG decoder

SAA7212

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**NOTES**

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Integrated MPEG AVG decoder

SAA7212

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**NOTES**

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**NOTES**

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