

DATA SHEET

SAA4993H

Field and line rate converter
with noise reduction

Product specification
File under Integrated Circuits, IC02

2001 Nov 23

**Field and line rate converter
with noise reduction**

SAA4993H

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1 FEATURES

- Upconversion of all $1f_H$ film and video standards up to 292 active input lines per field
- 100/120 Hz 2 : 1, 50/60 Hz 1 : 1 and 100/120 Hz 1 : 1 output formats
- 4 : 1 : 1, 4 : 2 : 2 and 4 : 2 : 2 Differential Pulse Code Modulation (DPCM) input colour formats; 4 : 1 : 1 and 4 : 2 : 2 output colour formats
- Full 8-bit accuracy
- Scalable performance by applying 2 or 3 external field memories
- Improved recursive de-interlacing
- Film (25 and 30 Hz) upconversion to 100/120 movement phases per second
- Variable vertical sharpness enhancement
- Motion compensated 3D dynamic noise reduction
- High quality vertical zoom
- 2 Mbaud serial interface (SNERT)
- Demonstration mode for noise reduction, motion compensation and colour overlay.

2 GENERAL DESCRIPTION

The SAA4993H is a completely digital monolithic integrated circuit which can be used for field and line rate conversion of all global TV standards.

It features improved Natural Motion™⁽¹⁾ performance.

It can be configured to emulate the SAA4990H as well as the SAA4991WP. For demonstration purposes a split screen mode to show the Dynamic Noise Reduction (DNR) function and natural motion is available, and a colour vector overlay mode exists.

The SAA4993H supports a Boundary Scan Test (BST) circuit in accordance with IEEE 1149.

2.1 Patent notice

Notice is herewith given that the subject integrated circuit uses one or more of the following US patents and that each of these patents may have corresponding patents in other jurisdictions.

US 4740842, US 5929919, US 6034734, US 5534946, US 5532750, US 5495300, US 5903680, US 5365280, US 5148269, US 5072293, US 5771074, and US 5302909.

(1) Natural Motion is a trademark of Koninklijke Philips Electronics N.V.

3 QUICK REFERENCE DATA

| SYMBOL | PARAMETER | MIN. | TYP. | MAX. | UNIT |
|-------------|---------------------------------------|------|------|------|------|
| V_{DDI} | core supply voltage | 2.3 | 2.5 | 2.7 | V |
| V_{DDE} | external supply voltage (output pads) | 3.0 | 3.3 | 3.6 | V |
| I_{DD} | supply current | – | 280 | – | mA |
| f_{CLK32} | operating clock frequency | – | 32 | 33.3 | MHz |
| T_{amb} | ambient temperature | 0 | – | 70 | °C |

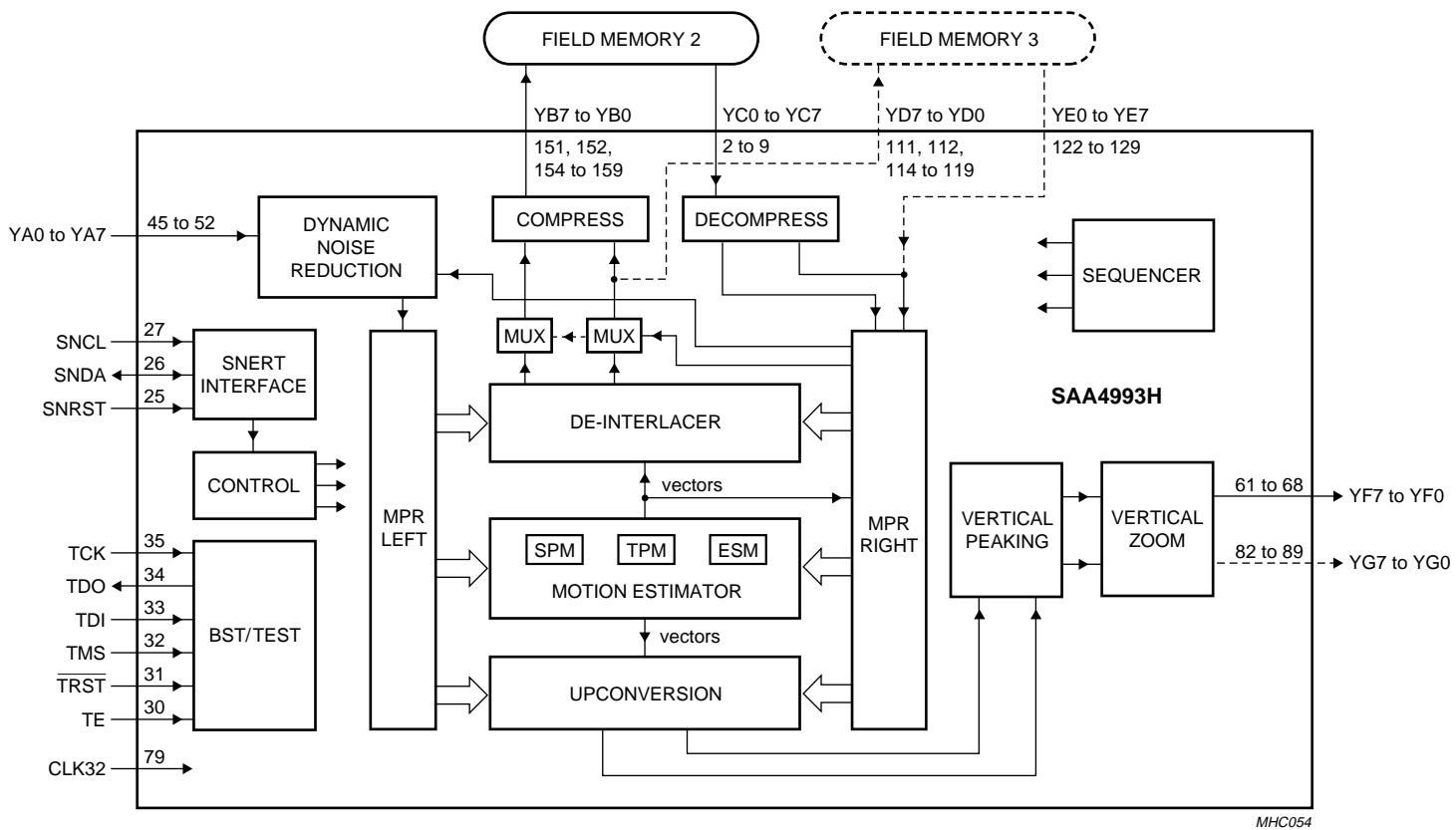
4 ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|-------------|---------|---|----------|
| | NAME | DESCRIPTION | VERSION |
| SAA4993H | QFP160 | plastic quad flat package; 160 leads (lead length 1.6 mm); body 28 × 28 × 3.4 mm; high stand-off height | SOT322-2 |

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5 BLOCK DIAGRAMS

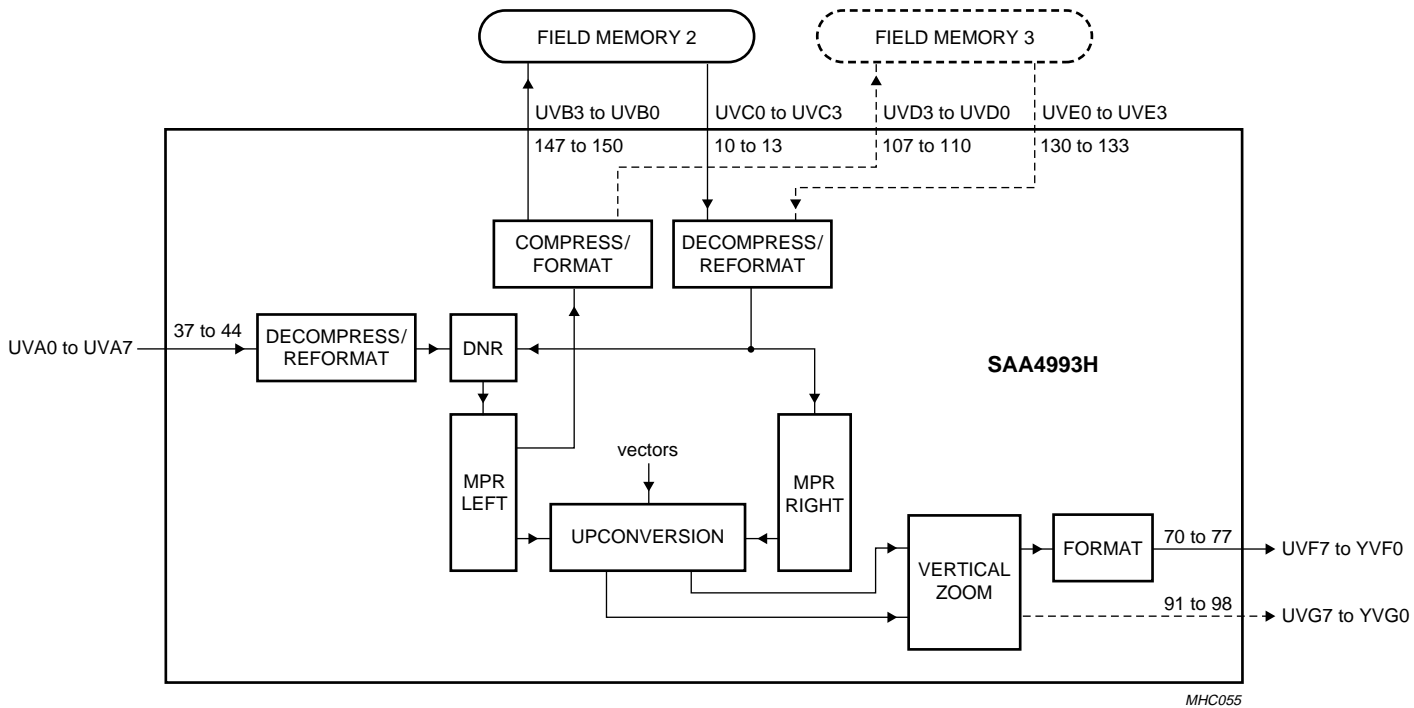


The solid lines represent pixel data; the broken lines represent controls.

Fig.1 Block diagram of the luminance part.

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The solid lines represent pixel data; the broken lines represent the data flow, if the (optional) field memory 3 is also used.

Fig.2 Block diagram of the chrominance part.

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6 PINNING

| SYMBOL | PIN | TYPE | DESCRIPTION ⁽¹⁾⁽²⁾ |
|------------------|-----|--------|---|
| V _{SSE} | 1 | ground | ground of output pads |
| YC0 | 2 | input | bus C luminance input from field memory 2 bit 0 (LSB) |
| YC1 | 3 | input | bus C luminance input from field memory 2 bit 1 |
| YC2 | 4 | input | bus C luminance input from field memory 2 bit 2 |
| YC3 | 5 | input | bus C luminance input from field memory 2 bit 3 |
| YC4 | 6 | input | bus C luminance input from field memory 2 bit 4 |
| YC5 | 7 | input | bus C luminance input from field memory 2 bit 5 |
| YC6 | 8 | input | bus C luminance input from field memory 2 bit 6 |
| YC7 | 9 | input | bus C luminance input from field memory 2 bit 7 (MSB) |
| UVC0 | 10 | input | bus C chrominance input from field memory 2 bit 0 (LSB) |
| UVC1 | 11 | input | bus C chrominance input from field memory 2 bit 1 |
| UVC2 | 12 | input | bus C chrominance input from field memory 2 bit 2 |
| UVC3 | 13 | input | bus C chrominance input from field memory 2 bit 3 (MSB) |
| REC | 14 | output | read enable output for bus C |
| V _{SSE} | 15 | ground | ground of output pads |
| V _{DDE} | 16 | supply | external supply voltage (output pads) |
| V _{SSI} | 17 | ground | core ground |
| V _{DDI} | 18 | supply | core supply voltage |
| JUMP0 | 19 | input | configuration pin 0; will be stored in register 0B3 e.g. to indicate presence of 3rd field memory; should be connected to ground or to V _{DDE} via a pull-up resistor of 47 k Ω |
| JUMP1 | 20 | input | configuration pin 1; will be stored in register 0B5 e.g. to indicate presence of 16-bit 1st field memory for full 4 : 2 : 2; should be connected to ground or to V _{DDE} via a pull-up resistor of 47 k Ω |
| V _{DDE} | 21 | supply | external supply voltage (output pads) |
| V _{DDI} | 22 | supply | core supply voltage |
| V _{SSI} | 23 | ground | core ground |
| RAMTST1 | 24 | input | test pin 1 input for internal RAM testing with internal pull-down; connect to ground for normal operation |
| SNRST | 25 | input | SNERT bus reset input |
| SNDA | 26 | I/O | SNERT bus data input and output |
| SNCL | 27 | input | SNERT bus clock input |
| V _{SSE} | 28 | ground | ground of output pads |
| RAMTST2 | 29 | input | test pin 2 input for internal RAM testing with internal pull-down; connect to ground for normal operation |
| TE | 30 | input | test mode input with internal pull-down; if not used it has to be connected to ground |
| TRST | 31 | input | boundary scan test reset input (active LOW); if not used it has to be connected to V _{DDE} via a pull-up resistor of 47 k Ω |
| TMS | 32 | input | boundary scan test mode select input; if not used it has to be connected to V _{DDE} via a pull-up resistor of 47 k Ω |
| TDI | 33 | input | boundary scan test data input; if not used it has to be connected to V _{DDE} via a pull-up resistor of 47 k Ω |

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| SYMBOL | PIN | TYPE | DESCRIPTION ⁽¹⁾⁽²⁾ |
|------------------|-----|---------|--|
| TDO | 34 | 3-state | boundary scan test data output |
| TCK | 35 | input | boundary scan test clock input; if not used it has to be connected to V _{DDE} via a pull-up resistor of 47 kΩ |
| V _{SSE} | 36 | ground | ground of output pads |
| UVA0 | 37 | input | bus A chrominance input from field memory 1 bit 0 (LSB) |
| UVA1 | 38 | input | bus A chrominance input from field memory 1 bit 1 |
| UVA2 | 39 | input | bus A chrominance input from field memory 1 bit 2 |
| UVA3 | 40 | input | bus A chrominance input from field memory 1 bit 3 |
| UVA4 | 41 | input | bus A chrominance input from field memory 1 bit 4 |
| UVA5 | 42 | input | bus A chrominance input from field memory 1 bit 5 |
| UVA6 | 43 | input | bus A chrominance input from field memory 1 bit 6 |
| UVA7 | 44 | input | bus A chrominance input from field memory 1 bit 7 (MSB) |
| YA0 | 45 | input | bus A luminance input from field memory 1 bit 0 (LSB) |
| YA1 | 46 | input | bus A luminance input from field memory 1 bit 1 |
| YA2 | 47 | input | bus A luminance input from field memory 1 bit 2 |
| YA3 | 48 | input | bus A luminance input from field memory 1 bit 3 |
| YA4 | 49 | input | bus A luminance input from field memory 1 bit 4 |
| YA5 | 50 | input | bus A luminance input from field memory 1 bit 5 |
| YA6 | 51 | input | bus A luminance input from field memory 1 bit 6 |
| YA7 | 52 | input | bus A luminance input from field memory 1 bit 7 (MSB) |
| REA | 53 | output | read enable output for bus A |
| V _{SSE} | 54 | ground | ground of output pads |
| V _{SSI} | 55 | ground | core ground |
| V _{DDI} | 56 | supply | core supply voltage |
| V _{DDI} | 57 | supply | core supply voltage |
| V _{SSI} | 58 | ground | core ground |
| V _{SSE} | 59 | ground | ground of output pads |
| REF | 60 | input | read enable input for bus F and G |
| YF7 | 61 | output | bus F luminance output bit 7 (MSB) |
| YF6 | 62 | output | bus F luminance output bit 6 |
| YF5 | 63 | output | bus F luminance output bit 5 |
| YF4 | 64 | output | bus F luminance output bit 4 |
| YF3 | 65 | output | bus F luminance output bit 3 |
| YF2 | 66 | output | bus F luminance output bit 2 |
| YF1 | 67 | output | bus F luminance output bit 1 |
| YF0 | 68 | output | bus F luminance output bit 0 (LSB) |
| V _{DDE} | 69 | supply | external supply voltage (output pads) |
| UVF7 | 70 | output | bus F chrominance output bit 7 (MSB) |
| UVF6 | 71 | output | bus F chrominance output bit 6 |
| UVF5 | 72 | output | bus F chrominance output bit 5 |
| UVF4 | 73 | output | bus F chrominance output bit 4 |

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| SYMBOL | PIN | TYPE | DESCRIPTION ⁽¹⁾⁽²⁾ |
|------------------|-----|---------|---|
| UVF3 | 74 | output | bus F chrominance output bit 3 |
| UVF2 | 75 | output | bus F chrominance output bit 2 |
| UVF1 | 76 | output | bus F chrominance output bit 1 |
| UVF0 | 77 | output | bus F chrominance output bit 0 (LSB) |
| V _{SSE} | 78 | ground | ground of output pads |
| CLK32 | 79 | input | system clock input |
| V _{SSI} | 80 | ground | core ground |
| V _{SSE} | 81 | ground | ground of output pads |
| YG7 | 82 | 3-state | bus G luminance output bit 7 (MSB) |
| YG6 | 83 | 3-state | bus G luminance output bit 6 |
| YG5 | 84 | 3-state | bus G luminance output bit 5 |
| YG4 | 85 | 3-state | bus G luminance output bit 4 |
| YG3 | 86 | 3-state | bus G luminance output bit 3 |
| YG2 | 87 | 3-state | bus G luminance output bit 2 |
| YG1 | 88 | 3-state | bus G luminance output bit 1 |
| YG0 | 89 | 3-state | bus G luminance output bit 0 (LSB) |
| V _{DDE} | 90 | supply | external supply voltage (output pads) |
| UVG7 | 91 | 3-state | bus G chrominance output bit 7 (MSB) or vector output bit 7 |
| UVG6 | 92 | 3-state | bus G chrominance output bit 6 or vector output bit 6 |
| UVG5 | 93 | 3-state | bus G chrominance output bit 5 or vector output bit 5 |
| UVG4 | 94 | 3-state | bus G chrominance output bit 4 or vector output bit 4 |
| UVG3 | 95 | 3-state | bus G chrominance output bit 3 or vector output bit 3 |
| UVG2 | 96 | 3-state | bus G chrominance output bit 2 or vector output bit 2 |
| UVG1 | 97 | 3-state | bus G chrominance output bit 1 or vector output bit 1 |
| UVG0 | 98 | 3-state | bus G chrominance output bit 0 (LSB) or vector output bit 0 |
| V _{SSE} | 99 | ground | ground of output pads |
| V _{SSI} | 100 | ground | core ground |
| V _{DDI} | 101 | supply | core supply voltage |
| V _{DDE} | 102 | supply | external supply voltage (output pads) |
| V _{DDI} | 103 | supply | core supply voltage |
| V _{SSI} | 104 | ground | core ground |
| V _{SSE} | 105 | ground | ground of output pads |
| WED | 106 | 3-state | write enable output for bus D |
| UVD3 | 107 | 3-state | bus D chrominance output to field memory 3 bit 3 (MSB) |
| UVD2 | 108 | 3-state | bus D chrominance output to field memory 3 bit 2 |
| UVD1 | 109 | 3-state | bus D chrominance output to field memory 3 bit 1 |
| UVD0 | 110 | 3-state | bus D chrominance output to field memory 3 bit 0 (LSB) |
| YD7 | 111 | 3-state | bus D luminance output to field memory 3 bit 7 (MSB) |
| YD6 | 112 | 3-state | bus D luminance output to field memory 3 bit 6 |
| V _{DDE} | 113 | supply | external supply voltage (output pads) |
| YD5 | 114 | 3-state | bus D luminance output to field memory 3 bit 5 |

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| SYMBOL | PIN | TYPE | DESCRIPTION ⁽¹⁾⁽²⁾ |
|------------------|-----|---------|--|
| YD4 | 115 | 3-state | bus D luminance output to field memory 3 bit 4 |
| YD3 | 116 | 3-state | bus D luminance output to field memory 3 bit 3 |
| YD2 | 117 | 3-state | bus D luminance output to field memory 3 bit 2 |
| YD1 | 118 | 3-state | bus D luminance output to field memory 3 bit 1 |
| YD0 | 119 | 3-state | bus D luminance output to field memory 3 bit 0 (LSB) |
| V _{SSE} | 120 | ground | ground of output pads |
| V _{SSE} | 121 | ground | ground of output pads |
| YE0 | 122 | input | bus E luminance input from field memory 3 bit 0 (LSB) |
| YE1 | 123 | input | bus E luminance input from field memory 3 bit 1 |
| YE2 | 124 | input | bus E luminance input from field memory 3 bit 2 |
| YE3 | 125 | input | bus E luminance input from field memory 3 bit 3 |
| YE4 | 126 | input | bus E luminance input from field memory 3 bit 4 |
| YE5 | 127 | input | bus E luminance input from field memory 3 bit 5 |
| YE6 | 128 | input | bus E luminance input from field memory 3 bit 6 |
| YE7 | 129 | input | bus E luminance input from field memory 3 bit 7 (MSB) |
| UVE0 | 130 | input | bus E chrominance input from field memory 3 bit 0 (LSB) |
| UVE1 | 131 | input | bus E chrominance input from field memory 3 bit 1 |
| UVE2 | 132 | input | bus E chrominance input from field memory 3 bit 2 |
| UVE3 | 133 | input | bus E chrominance input from field memory 3 bit 3 (MSB) |
| REE | 134 | output | read enable output for bus E |
| V _{SSE} | 135 | ground | ground of output pads |
| HREF | 136 | input | horizontal reference synchronization input |
| V _{SSI} | 137 | ground | core ground |
| V _{DDI} | 138 | supply | core supply voltage |
| OSCI | 139 | input | test pin input with internal pull-down; connect to ground for normal operation |
| RESFM | 140 | output | reset field memory output for pin OSCI = LOW or test output OSCOUT for pin OSCI = HIGH |
| V _{DDE} | 141 | supply | external supply voltage (output pads) |
| V _{DDI} | 142 | supply | core supply voltage |
| V _{SSI} | 143 | ground | core ground |
| ACV | 144 | output | active video output |
| V _{SSE} | 145 | ground | ground of output pads |
| WEB | 146 | output | write enable output for bus B |
| UVB3 | 147 | output | bus B chrominance output to field memory 2 bit 3 (MSB) |
| UVB2 | 148 | output | bus B chrominance output to field memory 2 bit 2 |
| UVB1 | 149 | output | bus B chrominance output to field memory 2 bit 1 |
| UVB0 | 150 | output | bus B chrominance output to field memory 2 bit 0 (LSB) |
| YB7 | 151 | output | bus B luminance output to field memory 2 bit 7 (MSB) |
| YB6 | 152 | output | bus B luminance output to field memory 2 bit 6 |
| V _{DDE} | 153 | supply | external supply voltage (output pads) |
| YB5 | 154 | output | bus B luminance output to field memory 2 bit 5 |

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| SYMBOL | PIN | TYPE | DESCRIPTION⁽¹⁾⁽²⁾ |
|------------------|------------|-------------|--|
| YB4 | 155 | output | bus B luminance output to field memory 2 bit 4 |
| YB3 | 156 | output | bus B luminance output to field memory 2 bit 3 |
| YB2 | 157 | output | bus B luminance output to field memory 2 bit 2 |
| YB1 | 158 | output | bus B luminance output to field memory 2 bit 1 |
| YB0 | 159 | output | bus B luminance output to field memory 2 bit 0 (LSB) |
| V _{SSE} | 160 | ground | ground of output pads |

Notes

1. Not used input pins (e.g. bus E) should be connected to ground.
2. Because of the noisy characteristic of the output pad supply, it is recommended not to connect the core supply and the output pad supply directly at the device. The output pad supply should be buffered as close as possible to the device.

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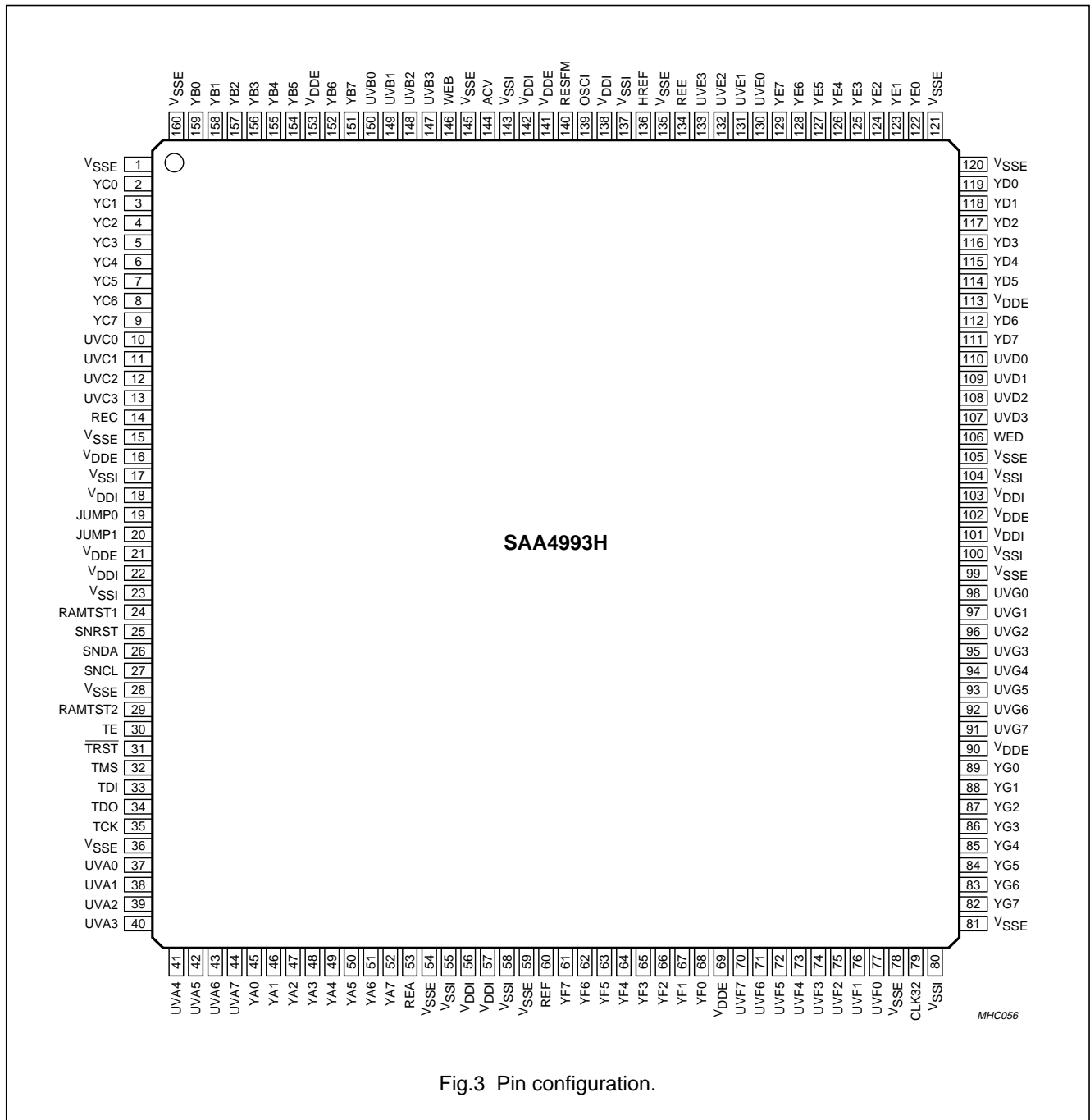


Fig.3 Pin configuration.

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7 FUNCTIONAL DESCRIPTION

The fal_top module builds the functional top level of the SAA4993H. It connects the luminance data path, the chrominance data path and the luminance (de)compression with SAA4993H inputs and outputs as well as controlling logic. Outside of the fal_top module, there are only the pad cells, boundary scan test cells, the boundary scan test controller, the clock tree, the test enable tree and the input port registers.

Figure 4 shows a simplified block diagram of the fal_top module. It displays the flow of pixel data (solid lines) and controls (broken lines) between the modules inside.

Basic functionality of the modules in the fal_top module is as follows:

- KER (kernel): Y (luminance) data path
- COL (colour): UV (chrominance) data path
- YDP (Y-DPCM): compression (and decompression) of luminance output (and input) data by Differential Pulse Code Modulation (DPCM)
- LSE (line sequencer): generate line frequent control signals
- SNE (interface): Synchronous No parity Eight bit Reception and Transmission (SNERT) interface to a microcontroller.

The SNERT interface operates in a slave receive and transmit mode for communication with a microcontroller, which resides on peripheral circuits (e.g. SAA4978H) together with a SNERT master. The SNERT interface transforms serial data from the microcontroller (via the SNERT bus) into parallel data to be written into the SAA4993Hs write registers and parallel data from SAA4993Hs read registers into serial data to be sent to the microcontroller. The SNERT bus consists of 3 signals:

1. SNCL: used as serial clock signal, generated by the master
2. SNDA: used as bidirectional data line
3. SNRST: used as a reset signal, generated by the microcontroller to indicate the start of a transmission.

The processing of a video field begins on the rising edge of the RE_F input signal. As indicated in Fig.4, the SAA4993H receives its inputs and generates its outputs at the following clock cycles after RE_F (see Table 1).

Table 1 Clock cycle references

| SIGNAL | LATENCY |
|---------------------|--|
| RE_F | 0 |
| RE_C and RE_E | 62 cycles + REceShift |
| YC, YE, UVC and UVE | 63 cycles |
| RE_A | 93 cycles + REaShift |
| YA and UVA | 94 cycles |
| YF, YG, UVF and UVG | 147 cycles + 3 input lines |
| WE_B and WE_D | 159 cycles + 4 input lines + WEbdShift |
| YB, YD, UVB and UVD | 159 cycles + 4 input lines |

There is an algorithmic delay of 3 lines between input and output data. Therefore, the main data output on the F and G bus begins while the fourth input line is read. Writing to the B and D bus starts one input line later. The read and write enable signals RE_A, WE_B, RE_C, WE_D and RE_E can be shifted by control registers REaShift, WEbdShift and REceShift, which are implemented in the line sequencer.

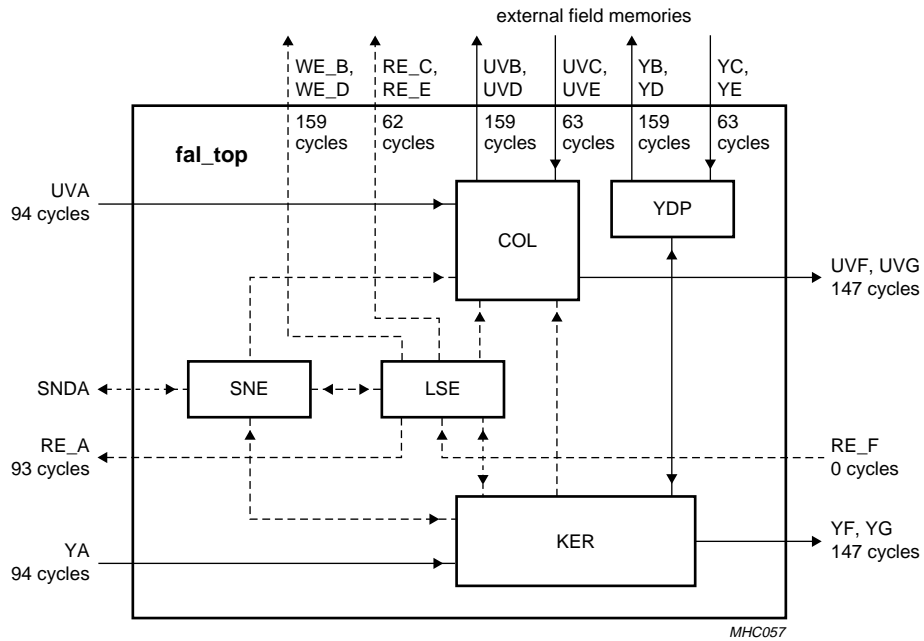
The fal_top module itself reads the following control register bits (addresses):

- NrofFMs (017H)
- MatrixOn (026H) and BusGControl (028H)
- MemComp and MemDecom (026H).

NrofFMs, MatrixOn and BusGControl are used to enable the D and G output bus, respectively. MemComp and MemDecom are connected to YDP to control luminance data compression and decompression. These control register signals are not displayed in Fig.4. Further information on the control registers is given in Chapter 8.

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MHC057

The solid lines represent pixel data; the broken lines represent controls.

Fig.4 Block diagram of fal_top.

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8 CONTROL REGISTER DESCRIPTION

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|---------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|---|
| DNR/peaking/colour | | | | | | | | | | | |
| Kstep10 | 010 | write; S | | | | | | | | | |
| Kstep0 | | | | | | X | X | X | X | | set LUT value: $k = 1/16$ if difference below (0 to 15) |
| Kstep1 | | | X | X | X | X | | | | | set LUT value: $k = 1/8$ if difference below (0 to 15) |
| Kstep32 | 011 | write; S | | | | | | | | | |
| Kstep2 | | | | | | X | X | X | X | | set LUT value: $k = 2/8$ if difference below (0 to 30 in multiples of 2) |
| Kstep3 | | | X | X | X | X | | | | | set LUT value: $k = 3/8$ if difference below (0 to 30 in multiples of 2) |
| Kstep54 | 012 | write; S | | | | | | | | | |
| Kstep4 | | | | | | X | X | X | X | | set LUT value: $k = 4/8$ if difference below (0 to 60 in multiples of 4) |
| Kstep5 | | | X | X | X | X | | | | | set LUT value: $k = 5/8$ if difference below (0 to 60 in multiples of 4) |
| Kstep76 | 013 | write; S | | | | | | | | | |
| Kstep6 | | | | | | X | X | X | X | | set LUT value: $k = 6/8$ if difference below (0, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112 or 120) |
| Kstep7 | | | X | X | X | X | | | | | set LUT value: $k = 7/8$ if difference below (0, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112 or 120) |
| Gain_fix_y | 014 | write; S | | | | | | | | | |
| FixvalY | | | | | | X | X | X | X | | set fixed Y value; used when FixY = 1 or in left part of split screen (0, 1/16 to 14/16 or 16/16) |
| GainY | | | | X | X | X | | | | | set gain in difference signal for adaptive DNR Y ($1/8, 1/4, 1/2, 1, 2$ or 4) |
| FixY | | | X | | | | | | | | select fixed Y (adaptive or fixed) (full screen) |
| Gain_fix_uv | 015 | write; S | | | | | | | | | |
| FixvalUV | | | | | | X | X | X | X | | set fixed UV value; used when FixUV = 1 or in left part of split screen (0, 1/16 to 14/16 or 16/16) |
| GainUV | | | | X | X | X | | | | | set gain in difference signal for adaptive DNR UV ($1/8, 1/4, 1/2, 1, 2$ or 4) |
| FixUV | | | X | | | | | | | | select fixed UV (adaptive or fixed) (full screen) |
| Peak_Vcomp | 016 | write; S | | | | | | | | | |
| VecComp | | | | | | | X | X | X | | set degree of horizontal vector compensation in Y DNR: (0, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8 or 7/8) of the vector |
| PeakCoef | | | X | X | X | X | | | | | set vertical peaking level: (0, +2, +3.5, +5, +6, x, x, x, x, x, x, x, x, -12, -6 or -2.5) dB |

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| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|
| DNR_Colour_mode | 017 | write; S | | | | | | | | | |
| ColourIn | | | | | | | | | X | X | select colour input format: (4 : 1 : 1, 4 : 2 : 2, 4 : 2 : 2 DPCM or 4 : 2 : 2) |
| ColourOut | | | | | | | | X | | | select colour output format: (4 : 1 : 1 or 4 : 2 : 2) |
| NrofFMs | | | | | | | X | | | | set number of field memories connected: (1 or 2 plus 3) |
| ColOvl | | | | | | | X | | | | select vector overlay on colour output: (vector overlay or colour from video path) |
| SlaveUVtoY | | | | | | X | | | | | slave UV noise reduction to K factor of Y: (separate or slaved) |
| DnrSplit | | | | | X | | | | | | select split screen mode for DNR: (normal or split screen) |
| DnrHpon | | | | | X | | | | | | switch DNR high-pass on (DNR only active on low frequent spectrum: (all through DNR or high bypassed)) |
| Vertical zoom | | | | | | | | | | | |
| Zoom1 | 018 | write; F | | | | | | | | | |
| ZoomSt98 | | | | | | | | | X | X | zoom line step bits 9 and 8; line step = vertical distance between successive output lines; usable range = 0 to 2 frame lines; resolution $\frac{1}{256}$ frame line |
| ZoomPo98 | | | | | X | X | | | | | zoom start position bits 9 and 8; start position = vertical position of the top display line; usable range = 1 to 3 frame lines; resolution $\frac{1}{256}$ frame line |
| Zoom2 | 019 | write; F | | | | | | | | | |
| ZoomSt70 | | | X | X | X | X | X | X | X | X | zoom line step bits 7 to 0 (see above) |
| Zoom3 | 01A | write; F | | | | | | | | | |
| ZoomPo70 | | | X | X | X | X | X | X | X | X | zoom start position bits 7 to 0 (see above) |
| Zoom4 | 01B | write; F | | | | | | | | | |
| ZoomEnVal | | | | | | | X | X | X | X | zoom run in value = number of lines without zoom active (0 to 15 lines) |
| ZoomDiVal | | | X | X | X | X | | | | | zoom run out value = number of lines without zoom active (-8 to +7 lines) |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|----------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| De-interlacer | | | | | | | | | | | |
| Proscan1 | 01C | write; S | | | | | | | | | |
| KlfLim | | | | | | | X | X | X | X | limitation of recursion factor in calculation of original line positions: (1 to 16) ; 1 limits to almost full recursion, 16 limits to no recursion |
| KlfOfs | | | X | X | X | X | | | | | |
| Proscan2 | 01D | write; S | | | | | | | | | |
| PflLim | | | | | | | X | X | X | X | limitation of recursion factor in calculation of interpolated line positions: (1 to 16) ; 1 limits to almost full recursion, 16 limits to no recursion |
| PflOfs | | | X | X | X | X | | | | | see KlfOfs; this offset applies to interpolated lines |
| Proscan3 | 01E | write; S | | | | | | | | | |
| PeakLim | | | | | | | X | X | X | X | Maximum that the peaked pixel is allowed to deviate from original pixel value: deviation (0 to 30 in steps of 2) . Above this deviation, the peaked pixel is clipped to (original pixel + or – PeakLim). |
| DeiOfs | | | X | X | X | X | | | | | offset to bias between average and median in the initial de-interlacing, if the KplFad = MIX option is chosen |

Field and line rate converter with noise reduction

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|-----------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Proscan4 | 01F | write; F | | | | | | | | | |
| PifThr | | | | | | | | X | X | X | Multiplier threshold at which to switch the lower limit of the filter coefficient for interpolated lines. Above this threshold, the differences corresponding to the two neighbouring lines are used as clipping parameters, below this threshold, the interpolated line difference is used as clipping level. This parameter can be used to optimize the de-interlacing quality in slowly moving edges; it is not likely to have effect if PifLim is high. |
| AdRecOut | | | | | | | X | | | | select adaptive recursive or order statistic output (order statistic or adaptive) |
| ProDiv | | | | X | X | | | | | | Scaling factor to control the strength of the filtering for the interpolated lines. A value 0 means no scaling (normal filtering), while 3 means scaling by factor 8 (very strong filtering). This parameter can be used to adjust the de-interlacing to varying level of noise in the input picture; use higher scaling for higher noise. |
| KplOff | | | X | | | | | | | | disable all recursion in calculating pixels for frame memory (recursive or non recursive); to be true SAA4991WP and digital scan emulation modes |
| Proscan5 | 0CB | write; S | | | | | | | | | |
| VecRbf | | | | | | X | X | X | X | Roll back factor on vectors used for motion-compensated de-interlacing. Values 0 to 14 (on a scale of 16) indicate attenuation. A value of 15 indicates no attenuation. | |
| FadDiv | | | X | X | X | | | | | sensitivity scaling factor in transition from average to median in initial de-interlacing | |
| KplFad | | | X | | | | | | | chooses between majority selection and median/average mix for initial de-interlacing (majority or mix); when KplFad = 0, FadDiv and DeiOfs are don't cares | |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ | |
|--|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|---|
| General | | | | | | | | | | | | |
| NrBlks NrBlks TotalLnsAct98 | 020 | write; S | | | | | | | | | | |
| | | | | | X | X | X | X | X | X | X | number of blocks in active video (6 to 53 , corresponds to 96 to 848 pixels), to be set as $\frac{1}{16}$ (number of active pixels per line + 15); take remarks on TotalPxDiv8 into consideration |
| | | | X | X | | | | | | | | total number of output lines (bits 9 and 8) |
| TotalLnsAct70 | 021 | write; S | X | X | X | X | X | X | X | X | total number of output lines (bits 7 to 0) | |
| TotalPxDiv8 | 022 | write; S | X | X | X | X | X | X | X | X | Total number of pixels per line divided-by-8 (80 to 128 , corresponds to 640 to 1024 pixels). The horizontal blanking interval is calculated as $\text{TotalPxDiv8} - 2 \times \text{NrBlks}$ and has to be in the range from 12 to 124 (corresponds to 96 to 992 pixels). Conclusion: TotalPxDiv8 has to be set to $12 + 2 \times \text{NrBlks} < \text{TotalPxDiv8} < 124 + 2 \times \text{NrBlks}$ and NrBlks has to be set to $\frac{\text{TotalPxDiv8} - 124}{2} < \text{NrBlks} < \frac{\text{TotalPxDiv8} - 12}{2}$ | |
| REaShift | 023 | write; S | | | | | | X | X | X | shift of RE_A signal in number of pixels (0, +1, +2, +3, -4, -3, -2 or -1) | |
| WEbdREceShift WEbdShift REceShift | 024 | write; S | | | | | | | | | | |
| | | | | | | | | X | X | X | shift of WE_B and WE_D signal in number of pixels (0, +1, +2, +3, -4, -3, -2 or -1) | |
| | | | X | X | X | | | | | | shift of RE_C and RE_E signal in number of pixels (0, +1, +2, +3, -4, -3, -2 or -1) | |
| POR | 025 | write; S | | | | | | | X | power-on reset command, to be set high temporarily during start-up (normal or reset); note 3 | | |
| ScalingFactor | 0D6 | write; S | X | X | X | X | X | X | X | X | 8-bit scaling factor for EggSliceMix, EggSliceRgt and global activity (the same factor for all registers). output value (n+1) = $\frac{\text{ScalingFactor}}{128} \times \text{output value (n)}$ | |

**Field and line rate converter
with noise reduction**

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|---------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|---|
| Mode control | | | | | | | | | | | |
| Control1 | 026 | write; F | | | | | | | | | |
| EstMode | | | | | | | | | X | | Set estimator mode; 0 = line alternating use of left and right estimator: use in progressive scan except with vertical compress. 1 = field alternating use of left and right estimator: use in field doubling and progressive scan with vertical compress. |
| FilmMode | | | | | | | | X | | | set film mode; 0 = video camera mode; 1 = film mode |
| UpcMode | | | | | | X | X | | | | select upconversion quality; 00 = full, 01 = economy (DPCM), 10 = SAA4991WP, 11 = SAA4990H |
| MatrixOn | | | | | X | | | | | | set matrix output mode; 1 = double output, disabling vertical peaking; 0 = normal single output mode; this bit setting is the AND function of BusGControl bits |
| EmbraceOn | | | | X | | | | | | | Master enable for embrace mode (off or on); SwapMpr in control2 should be at 'swap' position to really cross-switch FM1 and FM3 field outputs. Should be set to logic 0 except in film mode and FM3 is present, or in SAA4991WP film mode and MemComp bit is active. |
| MemComp | | | X | | | | | | | | set memory compression (luminance DPCM) (off or on) |
| MemDecom | | | X | | | | | | | | set memory decompression (luminance DPCM) (off or on) |

**Field and line rate converter
with noise reduction**

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ | |
|-----------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|----------------------------|---|
| | | | | | | | | | | | | |
| Control2 | 027 | write; F | | | | | | | | | | |
| QQcurr | | | | | | | | | | X | | Quincunx phase of current field (in TPM) (phase0 or phase1); this needs to toggle each time a new field comes from FM1. In phase0 the estimator operates on a checker-board pattern that starts with the left upper block; in phase1 the other blocks are estimated. |
| QQprev | | | | | | | | | | X | | quincunx phase of previous field (in TPM) (phase0 or phase1); this is the value of QQcur during the last estimate written into the temporal prediction memory |
| FldStat | | | | | | | | | X | | | Field status (same input field or new input field); reflects whether the output of FM1 is a new or a repeated field. This bit will toggle field by field in field doubling mode and is continuously HIGH in progressive output mode. |
| FieldWeYUV | | | | | | | | X | | | | enable writing FM2 and FM3 for both luminance and chrominance (recirculation of data for luminance alone can be controlled with OrigFmEnY and IntpFmEnY in Control3) (off or on) |
| OddFM1 | | | | | | | X | | | | | odd input field (even or odd), this is to be set equal to the detected field interlace for the field that comes out of FM1 |
| SwapMpr | | | | | | X | | | | | | Swap multi port RAMs (normal or swap); this bit needs to be set to get real frame data at the temporal position from FM1. If swapped, the current field (FM1) will be stored in the right line memory tree, while the original lines from the stored frame (FM2/3) are stored in the left memory tree. Should be set only in film mode if FM3 is present; EmbraceOn must be set as well. |
| VecOffs | | | X | X | | | | | | | | |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|---------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Control3 | 028 | write F | | | | | | | | | |
| OddLeft | | | | | | | | | | X | interlace (even or odd) phase of the field which is written to the left line memory tree (left MPRAM) |
| OrigFmEnY | | | | | | | | | X | | enables writing luminance from de-interlacer in original field memory (FM2), otherwise recirculation of luminance that is just read from FM2 (recirculate or update) |
| IntpFmEnY | | | | | | | | X | | | enables writing luminance from de-interlacer in interpolated field memory (FM3), otherwise recirculation of luminance that is just read from FM3 (recirculate or update) |
| FillTPM | | | | | | | X | | | | Enables writing in temporal prediction memory (keep or update); FillTPM should be set to 'keep' in SAA4991WP/film mode, in those output fields where FM1 and FM2 contain the same motion phase. FillTPM should be set to 'update' in all other situations. |
| VertOffsDNR | | | | | | X | X | | | | |
| BusGControl | | | S | X | X | | | | | | |
| Upconversion | | | | | | | | | | | |
| Upconv1 | 029 | write; F | | | | | | | | | |
| UpcShFac | | | | | X | X | X | X | X | X | temporal interpolation factor used in luminance upconverter; value ranges from 0 (for current field position) to 32 (for previous field position) |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | | | | | | | | | DESCRIPTION ⁽²⁾ | | | | |
|----------------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|--|---|---|---|
| | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | |
| Upconv2 YVecClip | 02A | write | | | | | | | | | | | | | |
| | | S | | | | | | X | X | X | value used for coring the vertical vector component before application in the upconverter; range: 0 to 3.5 in steps of 0.5 line; should remain at logic 0 in normal operation | | | | |
| RollBack | | F | X | X | X | X | X | | | | | | roll back factor ranging from 0 (use 0% of estimated vectors) to 16 (use 100% of estimated vectors) | | |
| Upconv3 MelzLfbm | 02B | write; S | | | | | | | | | | | | | |
| Melzmemc | | | | | | | | | | X | | | | SAA4991WP type local fallback method instead of more robust local fallback (complex or SAA4991WP type fallback) | |
| MelDeint | | | | | | | | | | X | | | | | SAA4991WP film mode memory control (normal or SAA4991WP type); should be set in SAA4991WP film mode to ensure that only original lines are selected as output when UpcShFac is 0 or 32 |
| MixCtrl | | | | | | | | | | X | | | | | use (as in SAA4991WP) horizontal motion compensated median for upconverter de-interlacing (normal or SAA4991WP type de-interlacing) |
| | | | X | X | X | X | X | | | | | | | Bits 3 and 4 are used to control sensitivity to local vector smoothness (0 = sensitive to unsmoothness, 3 = hardly sensitive to unsmoothness). Bits 5 to 7 define the maximum contribution of non-motion compensated pixels to the output (0, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8 or 7/8). | |
| UpcColShiFac | 0C4 | write; F | | | X | X | X | X | X | X | X | | | temporal interpolation factor used in chrominance upconverter; value ranges from 0 (for current field position) to 32 (for previous field position) | |
| Upconv4 LfIndex | 0C5 | write; S | | | | | | | X | X | X | | | Number of consecutive lines to have bad egg-slice values before upconverter goes into protection mode (0, 1, 2, 4, 8, 16, 32 or 64). A value of 0 switches off the possibility to go into protection. | |
| MCDemo | | | X | | | | | | | | | | | | mode switch on left side of the screen; 0 (natural motion); 1 (digital scan-like processing) |
| EggSlice1 EggStartLine | 0C6 | write; S | | | | | | | | | | | | | |
| | | | X | X | X | X | X | X | X | X | X | | | | Reference line number at which the egg slice measurement should start. SAA4993H defines a window internally as number of lines between EggStartLine and (MaxRefLine – EggStartLine). |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|-------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|
| EggSlice2 | 0C7 | write; S | | | | | | | | | |
| EggSlcThr | | | | | X | X | X | X | X | X | Minimum line egg slice right value to activate reliability measurement. The parameter is multiplied internally by 4. |
| EggRelInd | | | X | X | | | | | | | the egg slice reliability is computed internally as EggSliceRgt (ESR) > RelFactor × EggSliceMix (ESM). RelFactor is determined by EggRelInd ($\frac{2}{8}$, $\frac{3}{8}$, $\frac{4}{8}$, or $\frac{6}{8}$). |
| SafeShiFac | 0C8 | write; F | | | X | X | X | X | X | X | upconverter shift factor to be used in protection mode; 0 (for current field position) to 32 (for previous field position) |
| Motion estimator | | | | | | | | | | | |
| Motest1 | 02C | write; S | | | | | | | | | |
| PenOdd | | | | | | | | X | X | X | additional penalty on vector candidates with odd vertical component (0, 8, 16, 32, 64, 128, 256 or 511) |
| SpcThr | | | | | X | X | X | | | | Active when EstMode = 0; replace the spatial prediction of one estimator (left or right) by that of the other if the match error of the former exceeds that of the latter by more than (0, 8, 16, 32, 64, 128, 256 or 511). A higher threshold means the two estimators are very independent. |
| BmsThr | | | X | X | | | | | | | Active when EstMode = 0; select as estimated vector the output of the right estimator unless its match error exceeds that of the left estimator by more than (0, 8, 16 or 32). This parameter should normally be set to logic 0. |
| Motest2 | 02D | write; S | | | | | | | | | |
| TavLow | | | | | | | | | | X | If the difference between the current vector and the previous one in the same spatial location is within a small window, then the two vectors are averaged to improve temporal consistency. TavLow is the lower threshold of this window (1 or 2). |
| TavUpp | | | | | | | | X | X | | see above; TavUpp is the upper threshold (0, 4, 8 or 16) |
| MedEns | | | | | | X | X | | | | scaling factor to reduce all sizes of update vectors in the ensemble with medium sized vector templates (1, $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{8}$) |
| LarEns | | | X | X | | | | | | | scaling factor to reduce all sizes of update vectors in the ensemble with large sized vector templates (1, $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{8}$) |

Field and line rate converter with noise reduction

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ | |
|--|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|---|
| Motest3 MotShiFac | 02E | write; F | | | | | | | | | | |
| | | | | | X | X | X | X | X | X | X | Motion estimator shift factor, being the temporal position used in the estimator at which the matching is done; value 32 for matching at previous field position down to 0 for matching at current field position. Keeping MotShiFac equal to UpShiFac in the next upconverted output field estimates for minimum matching errors (minimum Halo's). MotShiFac at value 16 gives the largest natural vector range (twice as large as with value 0 or 32). Going above the range with MotShiFac \neq 16 is dealt with in SAA4993H by shifting towards 16, but for the horizontal and vertical component separately (consequence is that vector candidates tend to rotate towards the diagonal directions). |
| Motest4 PenRng CndSet ErrThr ErrHbl TstMod | 02F | write; S | | | | | | | | | | |
| | | | | | | | | | | X | Penalty for vectors estimated on the first row and the first column (if left estimator is used) or the right column (if right estimator is used), whenever the spatial prediction candidate is selected (64 or 511). For noisy pictures, this register could be set to logic 1 to improve border processing in the estimator. | |
| | | | | | | | | | | X | choice of candidate set (left or right) for which data (Candidate1 to Candidate8) is written in this field (becomes active in next field); note 3 | |
| | | | | | | | | X | X | X | | threshold on block match error for considering a block to be bad (16, 32, 64, 128, 256, 512, 1024 or 2032) |
| | | | | X | X | | | | | | | number of horizontally adjacent blocks that have to be all bad before considering an occurrence of a burst error (1, 2, 4 or 8) (counting of burst errors is read out with BlockErrCnt, address 0A8H) |
| | | | X | | | | | | | | | to be kept to logic 1 for normal operation |
| Motest5 ActOption ClearTPM | 0CC | write; S | | | | | | | X | X | selection of the vector component to take in the activity count ($ x + y $, $ x $, $ y $ or $-$) | |
| | | | X | | | | | | | | write zeros in the temporal prediction memory (no writing or writing zeros) | |
| LoActThr | 0CD | write; S | X | X | X | X | X | X | X | X | blocks having an activity value below or equal to this threshold are counted as having LOW activity | |
| HiActThr | 0CE | write; S | X | X | X | X | X | X | X | X | blocks having an activity value above this threshold are counted as having HIGH activity | |

**Field and line rate converter
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SAA4993H

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|---|---------------------|----------------------------|---|---|---|---|---|---|---|---|----------------------------|--|--|
| | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | |
| LeftBorder LeftBorder WinNullWrite | 0CF | write; S | | | | | | | | | | | |
| | | | | X | X | X | X | X | X | X | | estimator left border (in 8-pixel blocks) | |
| | | | X | | | | | | | | | | enable writing of null vectors outside estimators' active window (off or on) |
| RightBorder | 0D0 | write; S | | X | X | X | X | X | X | X | | estimator right border (in 8-pixel blocks) | |
| TopBorder | 0D1 | write; S | | X | X | X | X | X | X | X | | estimator top border (in 4-line blocks) | |
| BottomBorder | 0D2 | write; S | | X | X | X | X | X | X | X | | estimator bottom border (in 4-line blocks) | |
| Candidate1 Candidat1 Update1 Penalty1 | 090 | write; S | | | | | | | | | | | |
| | | | | | | | | X | X | X | | selection Candidate1 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | |
| | | | | | | X | X | | | | | | update for Candidate1 (zero update, medium update, large update or zero update) |
| | | | X | X | X | | | | | | | | penalty for Candidate1 (0, 8, 16, 32, 64, 128, 256 or 511) |
| Candidate2 Candidat2 Update2 Penalty2 | 091 | write; S | | | | | | | | | | | |
| | | | | | | | | X | X | X | | selection Candidate2 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | |
| | | | | | | X | X | | | | | | update for Candidate2 (zero update, medium update, large update or zero update) |
| | | | X | X | X | | | | | | | | penalty for Candidate2 (0, 8, 16, 32, 64, 128, 256 or 511) |
| Candidate3 Candidat3 Update3 Penalty3 | 092 | write; S | | | | | | | | | | | |
| | | | | | | | | X | X | X | | selection Candidate3 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | |
| | | | | | | X | X | | | | | | update for Candidate3 (zero update, medium update, large update or zero update) |
| | | | X | X | X | | | | | | | | penalty for Candidate3 (0, 8, 16, 32, 64, 128, 256 or 511) |
| Candidate4 Candidat4 Update4 Penalty4 | 093 | write; S | | | | | | | | | | | |
| | | | | | | | | X | X | X | | selection Candidate4 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | |
| | | | | | | X | X | | | | | | update for Candidate4 (zero update, medium update, large update or zero update) |
| | | | X | X | X | | | | | | | | penalty for Candidate4 (0, 8, 16, 32, 64, 128, 256 or 511) |

**Field and line rate converter
with noise reduction**

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | | | | | | | | | DESCRIPTION ⁽²⁾ | | |
|----------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|--|--|
| | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | |
| Candidate5 | 094 | write; S | | | | | | | | | | | |
| Candidat5 | | | | | | | | X | X | X | selection Candidate5 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | | |
| Update5 | | | | | | X | X | | | | update for Candidate5 (zero update, medium update, large update or zero update) | | |
| Penalty5 | | | X | X | X | | | | | | penalty for Candidate5 (0, 8, 16, 32, 64, 128, 256 or 511) | | |
| Candidate6 | 095 | write; S | | | | | | | | | | | |
| Candidat6 | | | | | | | | X | X | X | selection Candidate6 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | | |
| Update6 | | | | | | X | X | | | | update for Candidate6 (zero update, medium update, large update or zero update) | | |
| Penalty6 | | | X | X | X | | | | | | penalty for Candidate6 (0, 8, 16, 32, 64, 128, 256 or 511) | | |
| Candidate7 | 096 | write; S | | | | | | | | | | | |
| Candidat7 | | | | | | | | X | X | X | selection Candidate7 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | | |
| Update7 | | | | | | X | X | | | | update for Candidate7 (zero update, medium update, large update or zero update) | | |
| Penalty7 | | | X | X | X | | | | | | penalty for Candidate7 (0, 8, 16, 32, 64, 128, 256 or 511) | | |
| Candidate8 | 097 | write; S | | | | | | | | | | | |
| Candidat8 | | | | | | | | X | X | X | selection Candidate8 (SpatLeft, SpatRight, TemporalRight, TemporalLeft, TemporalCentre, Null, Panzoom or Max) | | |
| Update8 | | | | | | X | X | | | | update for Candidate8 (zero update, medium update, large update or zero update) | | |
| Penalty8 | | | X | X | X | | | | | | penalty for Candidate8 (0, 8, 16, 32, 64, 128, 256 or 511) | | |
| PZpositionLeftUpX | 098 | write; S | | | X | X | X | X | X | X | X | X position of LeftUp measurement point for pan-zoom calculations (resolution: 16 pixels) | |
| PZpositionLeftUpY | 099 | write; S | | X | X | X | X | X | X | X | Y position of LeftUp measurement point for pan-zoom calculations (resolution: 4 lines) | | |
| PZpositionRightLowX | 09A | write; S | | | X | X | X | X | X | X | X position of RightLow measurement point for pan-zoom calculations (resolution: 16 pixels) | | |
| PZpositionRightLowY | 09B | write; S | | X | X | X | X | X | X | X | Y position of RightLow measurement point for pan-zoom calculations (resolution: 4 lines) | | |
| PZvectorStartX | 09C | write; F | X | X | X | X | X | X | X | X | X start value of pan-zoom vectors | | |

Field and line rate converter with noise reduction

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| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|--------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|
| PZvectorDeltaX | 09D | write; F | X | X | X | X | X | X | X | X | X delta value of pan-zoom vectors |
| PZvectorStartY | 09E | write; F | X | X | X | X | X | X | X | X | Y start value of pan-zoom vectors |
| PZvectorDeltaY | 09F | write; F | X | X | X | X | X | X | X | X | Y delta value of pan-zoom vectors |
| Read data; note 3 | | | | | | | | | | | |
| GlobalMSEmsb | 0A0 | read; F | X | X | X | X | X | X | X | X | Global Mean Square Error (MSE) = summation within a field period of squared differences in comparing vector shifted video from frame memory (FM2/3) with new field input (FM1) in those lines coinciding with new field lines. The window for the measurement is kept at 40 pixels horizontal and 20 field lines vertical from the border of the video. Measurements is only done in fields where the de-interlacer is active, otherwise reading is zero. In field doubling mode, MSE is zero at the end of every new input field. |
| GlobalMSElsb | 0A1 | read; F | X | X | X | X | X | X | X | X | |
| GlobalMTIm sb | 0A2 | read; F | X | X | X | X | X | X | X | X | Global Motion Trajectory Inconsistency (MTI) = summation within a field period of squared differences comparing shifted video from frame memory (FM2/3 output) with filtered data that is rewritten to the frame memory (FM2/3 input) in those lines coinciding with new field lines. The window for the measurement is kept at 40 pixels horizontal and 20 field lines vertical from the border of the video. Measurement is done only in fields where de-interlacer is active, otherwise reading is zero; in field doubling mode, MTI is zero at the end of every new input field. |
| GlobalMTIlsb | 0A3 | read; F | X | X | X | X | X | X | X | X | |
| GlobalACTmsb | 0A4 | read; F | X | X | X | X | X | X | X | X | global activity (ACT) = summation over a field period of the horizontal plus the vertical components of the vectors of all blocks |
| GlobalACTlsb | 0A5 | read; F | X | X | X | X | X | X | X | X | |
| VectTempCons | 0A6 | read; F | X | X | X | X | X | X | X | X | Vector temporal consistency = summation over a field period of absolute differences of horizontal plus vertical components of vectors newly estimated for each block compared with those vectors estimated in the previous run at the same spatial block position. It should be noted that a lower figure implies better consistency. |
| VectSpatCons | 0A7 | read; F | X | X | X | X | X | X | X | X | Vector spatial consistency = summation over a field period of absolute differences of horizontal and vertical components of vectors compared with those of the neighbour blocks (L, R, U and D); in the comparison, all vector data is used from the previous estimator run. It should be noted that a lower figure implies better consistency. |
| BlockErrCnt | 0A8 | read; F | X | X | X | X | X | X | X | X | burst error count (number of burst errors) |

Field and line rate converter with noise reduction

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| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|-------------------------------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|
| LeastErrSum | 0A9 | read; F | X | X | X | X | X | X | X | X | least error sum (summation over a field period of the smallest match error that the estimator has found for each block: indicates reliability of the estimation process) |
| YvecRangeErrCntmsb | 0AA | read; F | X | X | X | X | X | X | X | X | Y vector range error count (number of vectors that have a vertical component that is out of range for upconversion at the chosen temporal position) (15 to 8) |
| YvecRangeErrCntlsb | 0AB | read; F | X | X | X | X | X | X | X | X | Y vector range error count (7 to 0) |
| RefLineCountPrev | 0AC | read; F | X | X | X | X | X | X | X | X | read out of (number of input (run-) lines – 40) used in previous field |
| RefLineCountNew | 0AD | write; F | X | X | X | X | X | X | X | X | Write of [number of input (run-) lines – 40] to be used in new field (actual maximum number of input lines in normal operation: 292; register value 252). Nominally this is to be set as an exact copy of the value read from RefLineCountPrev before a new field starts. In case the effective number of input (run-) lines has increased, RefLineCountNew should, for one field, be set to 255. This will occur e.g. with decreasing vertical zoom magnification or changing from 525 lines video standard to 625 lines standard. If this is not done, a deadlock will occur with too few lines processed correctly by the motion estimator. |
| PanZoomVec0-X | 0B0 | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 0 (8-bit X value) |
| PanZoomVec0-Y FalconIdent | 0B1 | read S | 0 | | | | | | | | SAA4993H identification: fixed bit, reading this bit as zero means SAA4993H is present |
| PanZoomVec0-Y | | F | | X | X | X | X | X | X | X | pan-zoom vector 0 (7-bit Y value) |
| PanZoomVec1-X | 0B2 | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 1 (8-bit X value) |
| PanZoomVec1-Y StatusJump0 | 0B3 | read S | X | | | | | | | | read out of configuration pin JUMP0 |
| PanZoomVec1-Y | | F | | X | X | X | X | X | X | X | pan-zoom vector 1 (7-bit Y value) |
| PanZoomVec2-X | 0B4 | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 2 (8-bit X value) |
| PanZoomVec2-Y StatusJump1 | 0B5 | read S | X | | | | | | | | read out of configuration pin JUMP1 |
| PanZoomVec2-Y | | F | | X | X | X | X | X | X | X | pan-zoom vector 2 (7-bit Y value) |
| PanZoomVec3-X | 0B6 | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 2 (8-bit X value) |
| PanZoomVec3-Y | 0B7 | read; F | | X | X | X | X | X | X | X | pan-zoom vector 3 (7-bit Y value) |

**Field and line rate converter
with noise reduction**

SAA4993H

| NAME | SNERT ADDRESS (HEX) | READ/ WRITE ⁽¹⁾ | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | DESCRIPTION ⁽²⁾ |
|----------------|---------------------|----------------------------|---|---|---|---|---|---|---|---|--|
| PanZoomVec4-X | 0B8 | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 4 (8-bit X value) |
| PanZoomVec4-Y | 0B9 | read; F | | X | X | X | X | X | X | X | pan-zoom vector 4 (7-bit Y value) |
| PanZoomVec5-X | 0BA | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 5 (8-bit X value) |
| PanZoomVec5-Y | 0BB | read; F | | X | X | X | X | X | X | X | pan-zoom vector 5 (7-bit Y value) |
| PanZoomVec6-X | 0BC | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 6 (8-bit X value) |
| PanZoomVec6-Y | 0BD | read; F | | X | X | X | X | X | X | X | pan-zoom vector 6 (7-bit Y value) |
| PanZoomVec7-X | 0BE | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 7 (8-bit X value) |
| PanZoomVec7-Y | 0BF | read; F | | X | X | X | X | X | X | X | pan-zoom vector 7 (7-bit Y value) |
| PanZoomVec8-X | 0AE | read; F | X | X | X | X | X | X | X | X | pan-zoom vector 8 (8-bit X value) |
| PanZoomVec8-Y | 0AF | read; F | | X | X | X | X | X | X | X | pan-zoom vector 8 (7-bit Y value) |
| EggSliceRgtMSB | 0C0 | read; F | X | X | X | X | X | X | X | X | result of right pixels egg-slice detector (15 to 8) |
| EggSliceRgtLSB | 0C1 | read; F | X | X | X | X | X | X | X | X | result of right pixels egg-slice detector (7 to 0) |
| EggSliceMixMSB | 0C2 | read; F | X | X | X | X | X | X | X | X | result of mixed pixels egg-slice detector (15 to 8) |
| EggSliceMixLSB | 0C3 | read; F | X | X | X | X | X | X | X | X | result of mixed pixels egg-slice detector (7 to 0) |
| SafeFbLine | 0C9 | read; F | X | X | X | X | X | X | X | X | reference line number (divided by two) at which the upconverter goes into protection mode |
| EggBinGoodness | 0CA | read; F | X | X | X | X | X | X | X | X | Goodness of the four egg-slice sections, from top to bottom, 2 bits per section. Each section is represented with 2 bits in this register, where bits 0 and 1 represent the top section and bits 6 and 7 represent the lowest of the 4 sections. Each pair of bits indicate 00 = ($ESR > \frac{3}{4}ESM$), 01 = ($\frac{1}{2}ESM < ESR \leq \frac{3}{4}ESM$), 10 = ($\frac{1}{4}ESM < ESR \leq \frac{1}{2}ESM$), 11 = ($ESR \leq \frac{1}{4}ESM$). |
| LoActCnt | 0D3 | read; F | X | X | X | X | X | X | X | X | number of blocks having low activity |
| HiActCnt | 0D4 | read; F | X | X | X | X | X | X | X | X | number of blocks having high activity |
| NullErrSum | 0D5 | read; F | X | X | X | X | X | X | X | X | sum of errors for the null candidate over the complete field; when no null candidate is selected a value of 0xFF will be read |

**Field and line rate converter
with noise reduction**

SAA4993H**Notes**

1. S means semi static, used at initialization or mode changes; F means field frequent, in general updated in each display field.
2. Selectable items are marked bold.
3. Almost all of the R(ead) and W(rite) registers of SAA4993H are double buffered. The Write registers are latched by a signal called New_field. New_field gets set, when RE_F rises after RSTR (New_field is effectively at the start of active video). The Read registers are latched by a signal called Reg_upd. Reg_upd gets set, when half the number of active pixels of the fourth line of vertical blanking have entered the SAA4993H (Reg_upd will effectively be active 3½ lines after the RE_A, RE_C and RE_E have ended). The only exception are the registers which are not double buffered, these are as follows:
 - a) Write register 025H: power_on_reset
 - b) Write register 02FH, bit 1: CndSet
 - c) Read register 0B0H to 0BFH, 0AEH and 0AFH: pan_zoom_vectors, including FalconIdent (= 0), StatusJump0 and StatusJump1.

Field and line rate converter with noise reduction

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9 LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

| SYMBOL | PARAMETER | MIN. | MAX. | UNIT |
|-----------|---------------------------------------|------|------|------|
| V_{DDI} | core supply voltage | -0.5 | +2.7 | V |
| V_{DDE} | external supply voltage (output pads) | -0.5 | +3.6 | V |
| I_{DD} | supply current | - | 600 | mA |
| I_o | output current | - | 4 | mA |
| V_i | input voltage for all I/O pins | -0.5 | +3.6 | V |
| T_{stg} | storage temperature | -40 | +125 | °C |
| T_j | junction temperature | 0 | 125 | °C |

10 THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---------------|---|-------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | 27 | K/W |
| $R_{th(j-c)}$ | thermal resistance from junction to case | | 2.9 | K/W |

11 CHARACTERISTICS

$V_{DDE} = 3.0$ to 3.6 V; $T_{amb} = 0$ to 70 °C; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------|---------------------------------------|---|------|------|------|------|
| Supplies | | | | | | |
| V_{DDI} | core supply voltage | | 2.3 | 2.5 | 2.7 | V |
| V_{DDE} | external supply voltage (output pads) | | 3.0 | 3.3 | 3.6 | V |
| I_{DD} | supply current | | - | 280 | - | mA |
| General | | | | | | |
| V_{OH} | HIGH-level output voltage | | 2.4 | - | - | V |
| V_{OL} | LOW-level output voltage | | - | - | 0.4 | V |
| V_{IH} | HIGH-level input voltage | | 2 | - | - | V |
| V_{IL} | LOW-level input voltage | | - | - | 0.8 | V |
| I_{OH} | HIGH-level output current | 10 ns slew rate output; $V_{OH} = 2.4$ V | -4 | - | - | mA |
| I_{OL} | LOW-level output current | 10 ns slew rate output; $V_{OL} = 0.4$ V | 4 | - | - | mA |
| C_L | load capacitance | | - | - | 50 | pF |
| C_i | input capacitance | | - | - | 8 | pF |
| I_{LI} | input leakage current | | - | - | 1 | µA |

Field and line rate converter with noise reduction

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| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------|--------------------------------------|--------------------|------|------|------|---------|
| Outputs; see Fig.5; note 1 | | | | | | |
| I_{OZ} | output current in 3-state mode | $-0.5 < V_o < 3.6$ | – | – | 1 | μA |
| $t_{d(o)}$ | output delay time (except pin RESFM) | | – | – | 21 | ns |
| $t_{h(o)}$ | output hold time (except pin RESFM) | | 4 | – | – | ns |
| SR | slew rate | | 300 | – | 700 | mV/ns |
| Inputs; see Fig.5; note 2 | | | | | | |
| $t_{su(i)}$ | input set-up time | | 6 | – | – | ns |
| $t_{h(i)}$ | input hold time | | 2 | – | – | ns |
| Input CLK32; see Fig.5 | | | | | | |
| t_r | rise time | | – | – | 4 | ns |
| t_f | fall time | | – | – | 4 | ns |
| δ | duty factor | | 40 | – | 60 | % |
| T_{cy} | cycle time | | 30 | – | 39 | ns |
| BST interface; see Fig.6 | | | | | | |
| $T_{cy(BST)}$ | BST cycle time | | – | 1 | – | μs |
| $t_{su(i)(BST)}$ | input set-up time | | 3 | – | – | ns |
| $t_{h(i)(BST)}$ | input hold time | | 6 | – | – | ns |
| $t_{h(o)(BST)}$ | output hold time | | 4 | – | – | ns |
| $t_{d(o)(BST)}$ | output delay | | – | – | 30 | ns |
| SNERT interface; see Fig.7 | | | | | | |
| $t_{SNRST(H)}$ | SNRST pulse HIGH time | | 500 | – | – | ns |
| $t_{d(SNRST-SNCL)}$ | delay SNRST pulse to SNCL LOW time | | 200 | – | – | ns |
| $T_{cy(SNCL)}$ | SNCL cycle time | | 0.5 | – | 1 | μs |
| $t_{su(i)(SNCL)}$ | input set-up time to SNCL | | 53 | – | – | ns |
| $t_{h(i)(SNCL)}$ | input hold time to SNCL | | 10 | – | – | ns |
| $t_{h(o)}$ | output hold time | | 30 | – | – | ns |
| $t_{d(o)}$ | output delay | | – | – | 330 | ns |
| $t_{o(en)}$ | output enable time | | 210 | – | – | ns |

Notes

1. Timing characteristics are measured with $C_L = 15 \text{ pF}$; $I_{OL} = 2 \text{ mA}$; $R_L = 2 \text{ k}\Omega$.
2. All inputs except SNERT interface inputs, CLK32 input and BST/TEST inputs.

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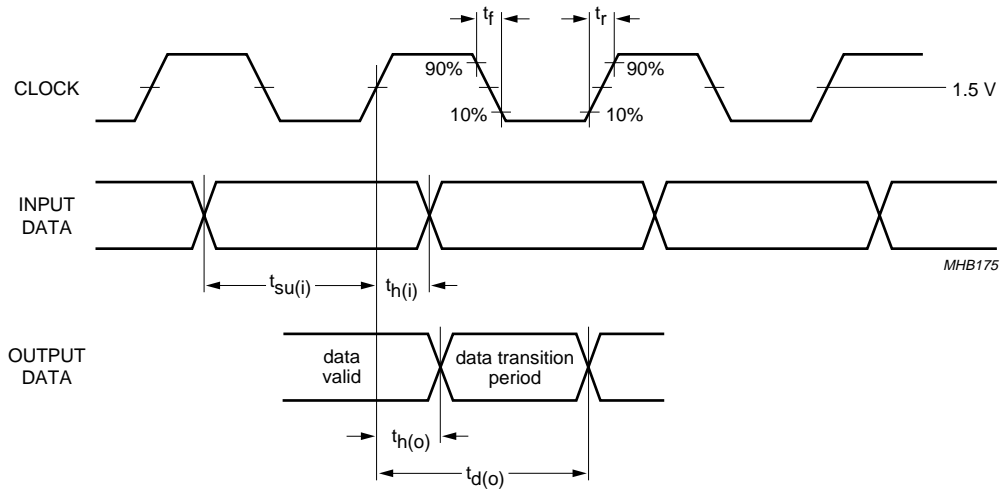


Fig.5 Data input/output timing diagram.

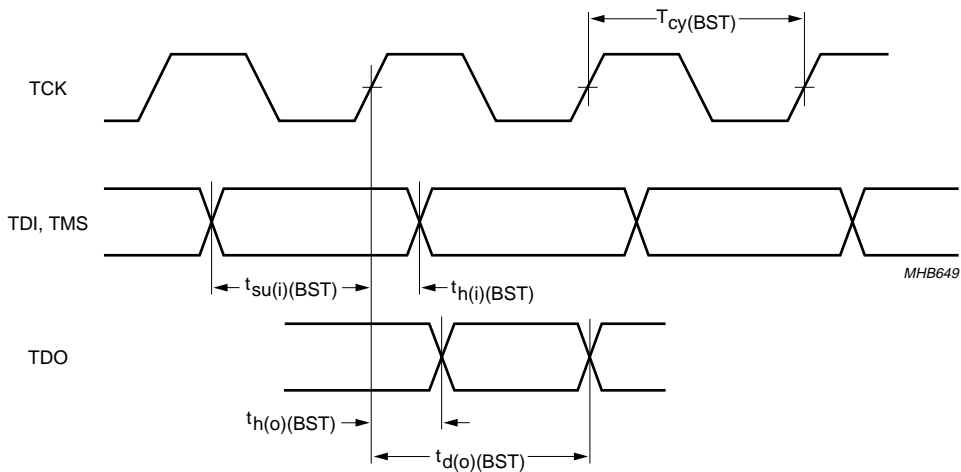


Fig.6 Boundary scan test interface timing diagram.

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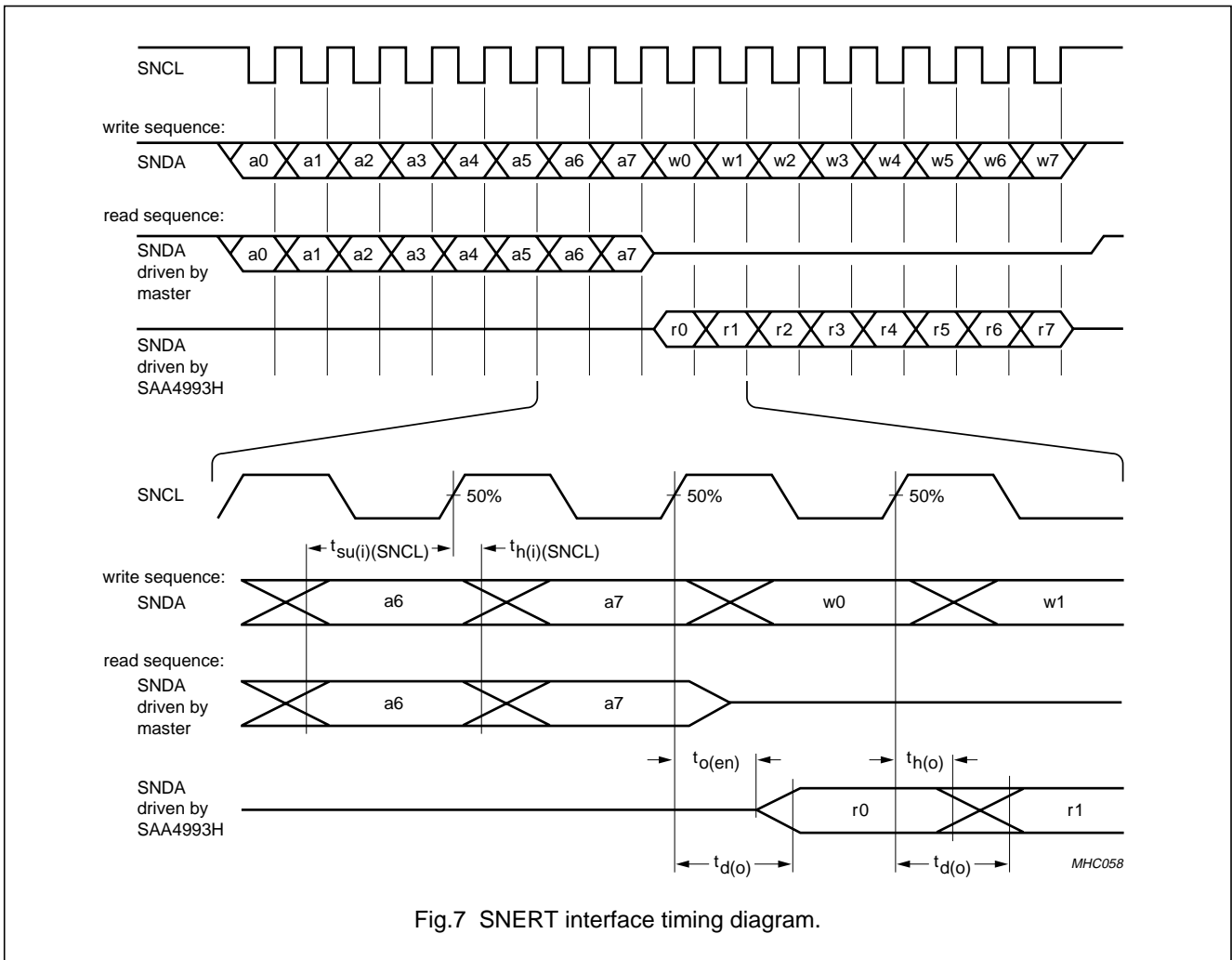


Fig.7 SNERT interface timing diagram.

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Table 2 YUV formats

| I/O PIN ⁽¹⁾ | FORMAT ⁽²⁾ | | | | | | | |
|------------------------|-----------------------|-----|-----|-----|-----------|-----|----------------|------|
| | 4 : 1 : 1 | | | | 4 : 2 : 2 | | 4 : 2 : 2 DPCM | |
| YX7 | Y07 | Y17 | Y27 | Y37 | Y07 | Y17 | Y07 | Y17 |
| YX6 | Y06 | Y16 | Y26 | Y36 | Y06 | Y16 | Y06 | Y16 |
| YX5 | Y05 | Y15 | Y25 | Y35 | Y05 | Y15 | Y05 | Y15 |
| YX4 | Y04 | Y14 | Y24 | Y34 | Y04 | Y14 | Y04 | Y14 |
| YX3 | Y03 | Y13 | Y23 | Y33 | Y03 | Y13 | Y03 | Y13 |
| YX2 | Y02 | Y12 | Y22 | Y32 | Y02 | Y12 | Y02 | Y12 |
| YX1 | Y01 | Y11 | Y21 | Y31 | Y01 | Y11 | Y01 | Y11 |
| YX0 | Y00 | Y10 | Y20 | Y30 | Y00 | Y10 | Y00 | Y10 |
| UVX7 | U07 | U05 | U03 | U01 | U07 | V07 | UC03 | VC03 |
| UVX6 | U06 | U04 | U02 | U00 | U06 | V06 | UC02 | VC02 |
| UVX5 | V07 | V05 | V03 | V01 | U05 | V05 | UC01 | VC01 |
| UVX4 | V06 | V04 | V02 | V00 | U04 | V04 | UC00 | VC00 |
| UVX3 | – | – | – | – | U03 | V03 | – | – |
| UVX2 | – | – | – | – | U02 | V02 | – | – |
| UVX1 | – | – | – | – | U01 | V01 | – | – |
| UVX0 | – | – | – | – | U00 | V00 | – | – |

Notes

- Digit X refers to different I/O buses:
 - A = input from 1st field memory
 - B = output to 2nd field memory
 - C = input from 2nd field memory
 - D = output to 3rd field memory
 - E = input from 3rd field memory
 - F = main output
 - G = 2nd output for matrix purposes.
- The first index digit defines the sample number and the second defines the bit number.

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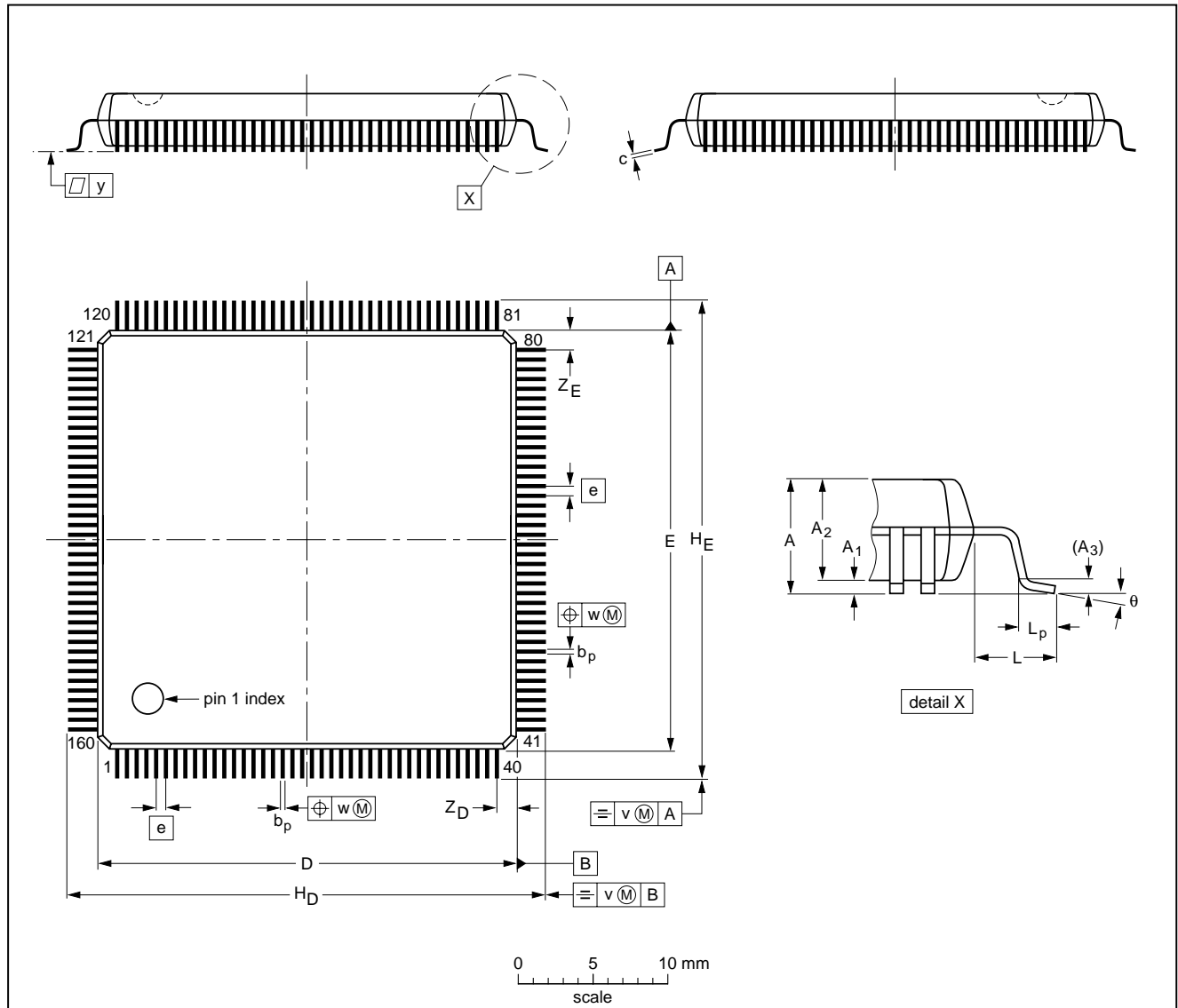
SAA4993H

12 PACKAGE OUTLINE

QFP160: plastic quad flat package;

160 leads (lead length 1.6 mm); body 28 x 28 x 3.4 mm; high stand-off height

SOT322-2



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _D | H _E | L | L _p | v | w | y | Z _D ⁽¹⁾ | Z _E ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|----------------|-----|----------------|-----|------|-----|-------------------------------|-------------------------------|----------|
| mm | 4.07 | 0.50 0.25 | 3.60 3.20 | 0.25 | 0.38 0.22 | 0.23 0.13 | 28.1 27.9 | 28.1 27.9 | 0.65 | 31.45 30.95 | 31.45 30.95 | 1.6 | 1.03 0.73 | 0.3 | 0.13 | 0.1 | 1.5 1.1 | 1.5 1.1 | 7° 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 | | | |
| SOT322-2 | 135E12 | MS-022 | | | | 99-11-03 00-01-19 |

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13 SOLDERING

13.1 Introduction to soldering surface mount packages

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"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

13.2 Reflow soldering

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, convection or convection/infrared heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

13.3 Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint 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.

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.

13.4 Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

Field and line rate converter
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13.5 Suitability of surface mount IC packages for wave and reflow soldering methods

| PACKAGE | SOLDERING METHOD | |
|---|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, HBGA, LFBGA, SQFP, TFBGA | not suitable | suitable |
| HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, SMS | not suitable ⁽²⁾ | suitable |
| PLCC ⁽³⁾ , SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended ⁽³⁾⁽⁴⁾ | suitable |
| SSOP, TSSOP, VSO | not recommended ⁽⁵⁾ | suitable |

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

Field and line rate converter with noise reduction

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14 DATA SHEET STATUS

| DATA SHEET STATUS ⁽¹⁾ | PRODUCT STATUS ⁽²⁾ | DEFINITIONS |
|----------------------------------|-------------------------------|--|
| Objective data | Development | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice. |
| Preliminary data | Qualification | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. |
| Product data | Production | This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A. |

Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

15 DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

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Printed in The Netherlands

753504/01/pp40

Date of release: 2001 Nov 23

Document order number: 9397 750 08704

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