

DMI 3110 A Digital MAC Interface

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 **MICRONAS**
INTERMETALL

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DMI 3110 A Digital MAC Interface

1. Introduction

The DMI 3110 A is a D2MAC interface implemented in CMOS technology and housed in a 68-pin PLCC package. It delivers analog RGB signals, a PAL-coded composite video signal (CVBS) and separate PAL-coded luminance and chrominance signals for SVHS. Also included is an 8-bit A/D converter for digitizing the analog D2MAC signal and a digital interface to the Intermetall D2MAC chip set. The main features are:

- 8-bit A/D converter with clamping and AGC
- Clock generation with digital PLL
- Teletext Transcoding MAC to PAL (VBI)
- PAL encoder with OSD and Teletext insertion
- 3 D/A converters for CVBS, Y, C
- 3 D/A converters for RGB or YUV with OSD insertion
- I²C-Bus interface for communication with the CCU

2. Functional Description

The following text describes the functions of the DMI. The descriptions refer to the block diagram.

2.1. Clock Generation

The complete chip runs with a 20.25 MHz clock. This clock is produced by the clock generation circuitry. The clock generator comprises a 20.25 MHz crystal oscillator that is digitally controlled within ± 150 ppm with 9-bit resolution. The frequency will be controlled by two switched capacitors. The input signal for the control loop is generated in the D2MAC decoder IC. The clock output signal itself is fed to the D2MAC chips.

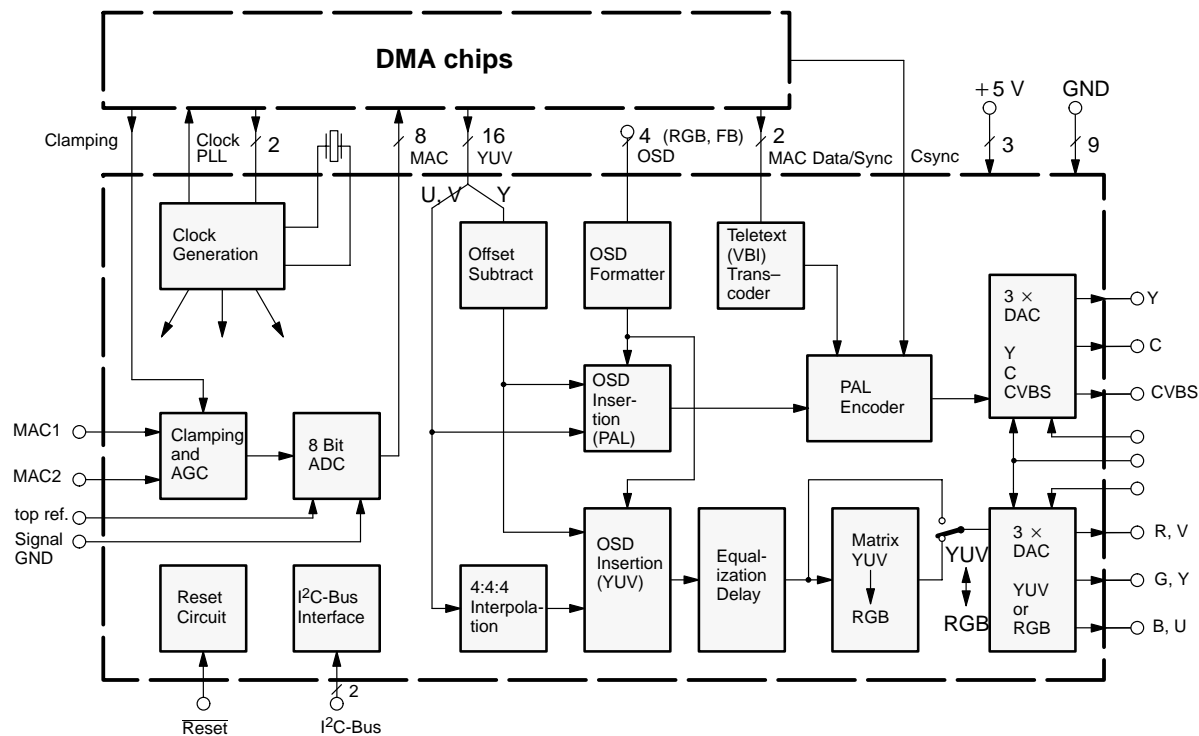


Fig. 2-1: DMI Block Diagram

2.2. Automatic Gain Control

The AGC circuit controls the gain for the analog input signal and feeds the controlled signal to the following A/D converter. The input voltage can vary in the range from $0.5 V_{pp}$ to $2 V_{pp}$ ($1 V_{pp} \pm 6$ dB). The amplitude of the A/D converter output signal will be measured in the D2MAC decoder circuit and read from a central control unit (CCU) over the I²C-bus to calculate the gain control signal. The measurement will be done in line 624, therefore the digital baseband input signal for the D2MAC decoder should not be influenced by other circuits during this line.

The gain control itself is done by a digital gain controlled amplifier in front of the A/D converter. The gain range of ± 6 dB is logarithmically scaled in 64 steps with a step size of 0.19 dB. As the control algorithm is done by software in the CCU, features of the AGC, such as histories and backlash functions can also be provided easily.

2.3. Clamping

The clamping circuit clamps the analog input signal to a fixed level. The offset value of the digital MAC signal is measured in the D2MAC decoder and the clamping signal is fed to the DMI circuit as 4-bit PDM (Pulse Density Modulated) signal. In the DMI a clamping current is generated for the coupling capacitors at the MAC inputs. For proper functioning of the clamping it is required to connect no circuit with an extra clamping function between the digital MAC output of the DMI and the input of the D2MAC decoder.

2.4. A/D Converter

The A/D converter is an 8-bit two-step flash converter which runs at 20.25 MHz. The output signal is purely binary-coded and is fed to the D2MAC decoder. Optionally, the signal can be selected to become Gray code format. The reference voltage is internally generated and is connected to one pin for a decoupling capacitor. The A/D converter (and the D/A converters) are connected to extra 5V and ground pins for a supply with a separate low-noise supply voltage. The analog MAC input signal must be AC-coupled over a coupling capacitor.

2.5. PAL Encoder

The PAL encoder receives the digital 4:2:2 component signal (YUV) from the D2MAC decoder. The encoder is also connected to the on-screen display (OSD) formatter and to the Teletext transcoder. These signals will be coded into a composite video signal in the PAL standard. Three D/A converters produce the composite video signal, the chrominance signal and the luminance signal.

2.6. Teletext Transcoder

The DMI can handle D2MAC Teletext signals transmitted in the vertical blanking interval (VBI). In the transcoder, the Teletext signal is extracted from the D2MAC data signal. The data rate and signal timing are converted according to the WST Teletext standard. Teletext transcoding is active in TV lines 6 to 22 and 319 to 335 of the PAL signal. Thus not all lines that can carry Teletext in the D2MAC standard (2 to 22 and 314 to 334) are transcoded.

A generator in the transcoder generates the correct Teletext bit frequency. A programmable window for enabling the Teletext transcoding will be available. The start and stop times of this window can be programmed between lines 6 and 22 (319 and 335) to span all Teletext lines in the PAL standard. For proper synchronization the MAC Sync signal from the D2MAC decoder will be used.

2.7. OSD Formatter and Insertion

An external on-screen signal (e.g. from the TPU 2735) can be fed into the DMI. The signal is 3×1 bit RGB and Fast Blanking. These input signals are sampled with the double clock frequency and processed with a downsampling filter to the single clock frequency. In the OSD formatter the 3-bit RGB signals are converted to YUV component signals, 6 bit for Y, 5 bit for U and 5 bit for V. This is done in a user-programmable RAM with a size of 8×16 bit. Contrast, brightness and saturation of the OSD can be programmed in this way. The output signal of the OSD formatter is fed into the PAL encoder and into the RGB/YUV outputs. The OSD can be switched off separately for PAL and RGB/YUV.

2.8. Luminance Offset Subtractor

The digital luminance signal coming from the D2MAC decoder has an offset of + 16. This means that the black level is shifted to this value. At the luminance input of the DMI 3110 A a value of 16 can be subtracted from the luminance signal. Therefore, the range of the luminance signal is from 0 to 238. The D/A output range is set to 0.75 V for full-scale (255) input, hence the amplitude of 238 gives 0.7 V at the output.

2.9. Equalization Delay

The PAL encoder has a processing delay of some microseconds. For a time matching between the analog RGB signals and the Y, C and CVBS signals an equalization delay exists. This delay is adjustable because the encoder delay depends on the filter settings.

2.10. 4:4:4 Interpolation

The component signal from the D2MAC decoder is in 4:2:2 format. Before this signal is converted to RGB, the U and V components are upsampled to the full clock frequency of 20.25 MHz. This is done by demultiplexing the U and V signals and by interpolation of the signal with a FIR filter. The frequency response and step response are shown in Fig. 2–2.

2.11. Matrix

A digital matrix converts the 4:4:4 YUV signal to a RGB signal. The matrix can be switched off for outputting YUV signals. The matrix coefficients are fixed and have the following values:

$$\begin{aligned} R &= Y + 0 \times U + 1.079 \times V \\ G &= Y - 0.265 \times U - 0.549 \times V \\ B &= Y + 1.364 \times U + 0 \times V \end{aligned}$$

2.12. D/A Converters

There are six D/A converters in the DMI. Three of them output the RGB or YUV signals, one is for the composite video signal, one for the chrominance signal and one for the luminance signal. The signal delay time of all converters is matched. The minimum load resistor for the nominal output voltages is 75 Ω. The converters consist of current sources from the analog supply voltage VSUPA. With a digital zero input all current sources are switched to ground and the maximal current flows internally. In this case the D/A converters have the maximal power dissipation. At maximal input signal all current sources are switched to the output pin and the current flows over the external load resistor to ground. The outputs are short-circuit protected.

The maximal output currents can be adjusted in a range from 25% to 100% of the values in the table below. The

adjustment is done with two reference resistors. One of them is responsible for the RBG converters, the other one for the Y, C and CVBS converters. At 25% of the current the load resistance has to be 300 Ω to get the correct output voltage. The output voltage should not exceed a value of approx. 1.4 V because at higher values the D/A converter characteristic becomes nonlinear.

If all six D/A converters are used, the load resistance has to be 300 Ω in order to not exceed the maximum power dissipation of 1.325 W for the existing package.

For lower load resistances (higher power dissipation) the package has to be cooled.

For a lower power dissipation the unused group of D/A converters can be switched off by removing the corresponding reference resistor.

Table 2–1: Specifications of the D/A converters

| Signal | Resolution | Max. Current | V _{OUTMAX} at 75 Ω |
|---------|------------|--------------|--------------------------------------|
| CVBS | 9-bit | 16.5 mA | 1.24 V |
| Luma | 9-bit | 16.5 mA | 1.24 V (1 V nominal) |
| Chroma | 9-bit | 16.5 mA | 1.24 V (0.8 V _{pp} nominal) |
| R, G, B | 8-bit | 10.0 mA | 0.75 V |

2.13. I²C-Bus Interface

All parameters of the DMI 3110 A are programmed via an I²C-bus interface. The interface uses an IC address and one level of subaddress. The programming of the DMI 3110 is explained in detail in section 4.

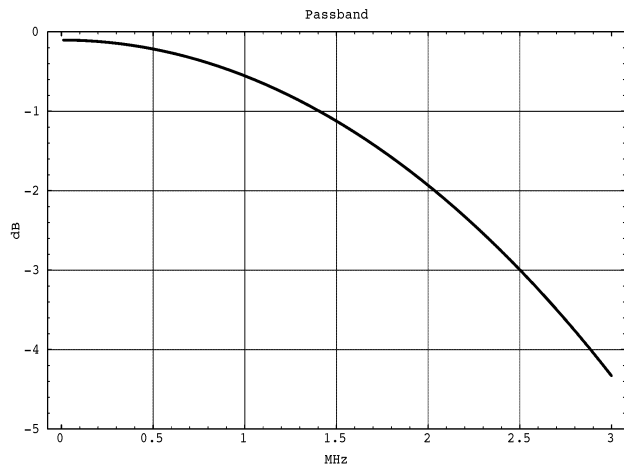
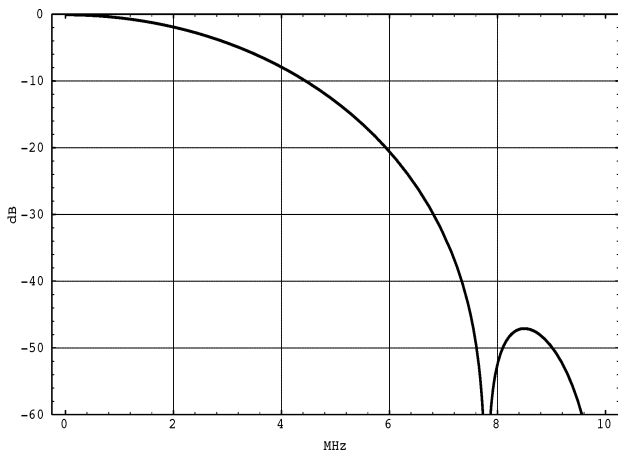


Fig. 2–2: 422 → 444 Chroma Interpolation Filter

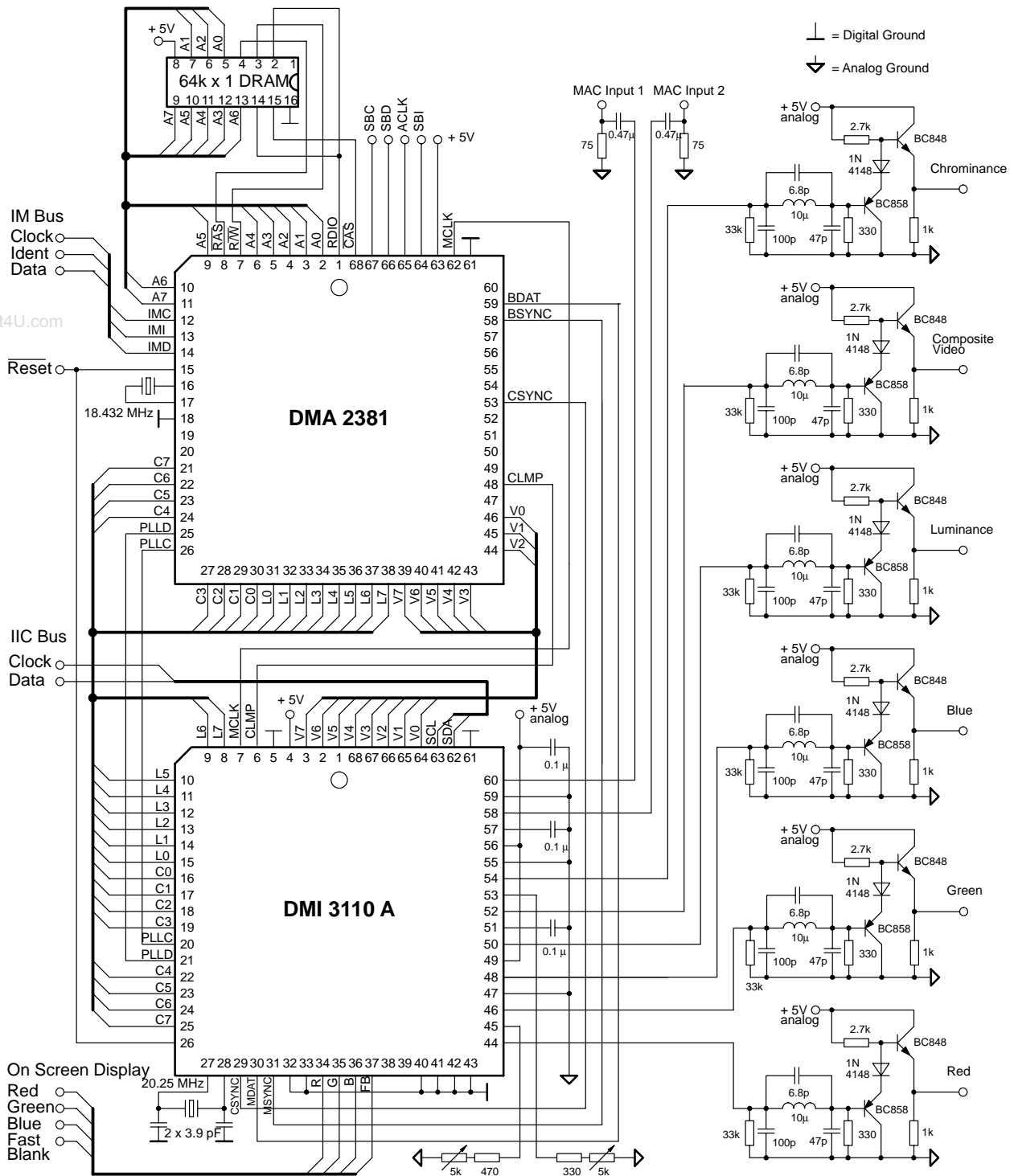


Fig. 2-3: Application circuit

3. Specifications

3.1. Outline Dimensions

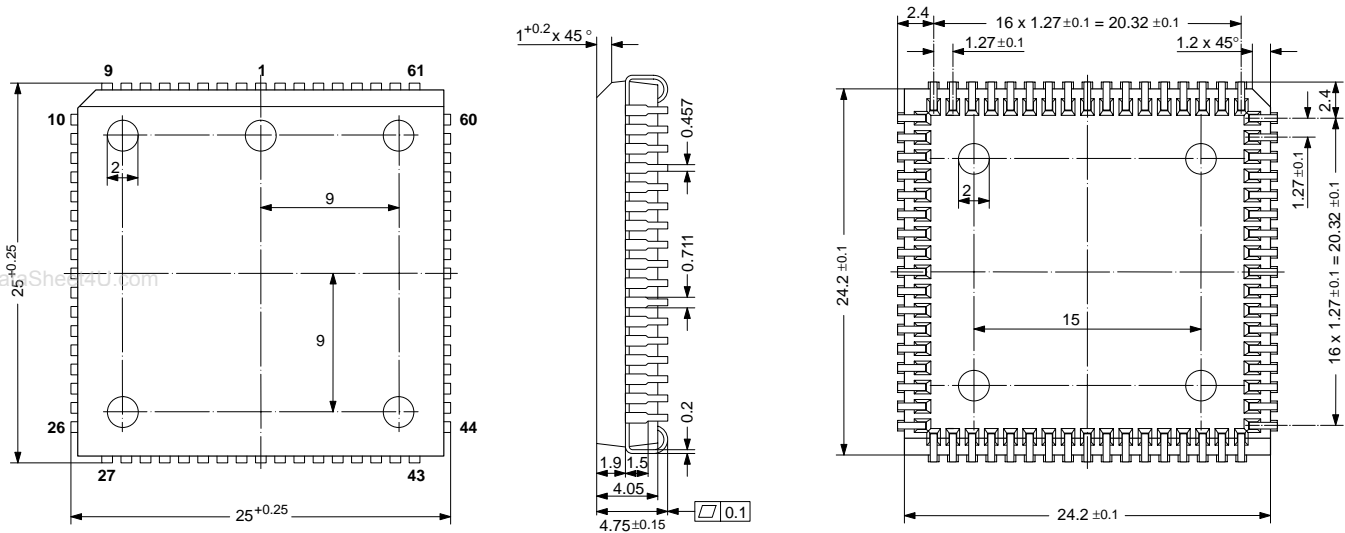


Fig. 3-1:
68-Pin Plastic Leaded Chip Carrier Package
(PLCC68)
Weight approximately 4.8 g
Dimensions in mm

70043/2

3.2. Pin Connections and Short Descriptions

NC = not connected; leave vacant

LV = if not used, leave vacant

X = obligatory, connect as described in circuit diagram

| Pin No. PLCC 68-pin | Connection (if not used) | Pin Name | Type | Short Description |
|---------------------------|-----------------------------|----------|------|---------------------------------|
| 1 | LV | BO5 | OUT | Digital Baseband Output 5 |
| 2 | LV | BO6 | OUT | Digital Baseband Output 6 |
| 3 | LV | BO7 | OUT | Digital Baseband Output 7 (MSB) |
| 4 | X | VSUPD | SUP | Digital Supply Voltage |
| 5 | X | GNDD | SUP | Digital Ground |
| 6 | GNDD | CLMP | IN | Clamping Input |
| 7 | LV | MCLK | OUT | Main Clock Output |
| 8 | GNDD | LI7 | IN | Digital Luma Input 7 (MSB) |
| 9 | GNDD | LI6 | IN | Digital Luma Input 6 |
| 10 | GNDD | LI5 | IN | Digital Luma Input 5 |
| 11 | GNDD | LI4 | IN | Digital Luma Input 4 |
| 12 | GNDD | LI3 | IN | Digital Luma Input 3 |
| 13 | GNDD | LI2 | IN | Digital Luma Input 2 |

Pin Connections and Short Descriptions, continued

| Pin No. | Connection (if not used) | Pin Name | Type | Short Description |
|---------|--------------------------|----------|--------|------------------------------------|
| 14 | GNDD | LI1 | IN | Digital Luma Input 1 |
| 15 | GNDD | LI0 | IN | Digital Luma Input 0 (LSB) |
| 16 | GNDD | CI0 | IN | Digital Chroma Input 0 (LSB) |
| 17 | GNDD | CI1 | IN | Digital Chroma Input 1 |
| 18 | GNDD | CI2 | IN | Digital Chroma Input 2 |
| 19 | GNDD | CI3 | IN | Digital Chroma Input 3 |
| 20 | GNDD | PLL C | IN | PLL Tuning Clock Input |
| 21 | GNDD | PLLD | IN | PLL Tuning Data Input |
| 22 | GNDD | CI4 | IN | Digital Chroma Input 4 |
| 23 | GNDD | CI5 | IN | Digital Chroma Input 5 |
| 24 | GNDD | CI6 | IN | Digital Chroma Input 6 |
| 25 | GNDD | CI7 | IN | Digital Chroma Input 7 (MSB) |
| 26 | X | RESQ | IN | $\overline{\text{Reset}}$ Input |
| 27 | X | XTAL1 | OUT | Crystal 1 (Output) |
| 28 | X | XTAL2 | IN | Crystal 2 (Input) |
| 29 | VSUPD | CSYNC | IN | Composite Sync Input |
| 30 | GNDD | MDAT | IN | MAC Data Input |
| 31 | VSUPD | MSYNC | IN | MAC Sync Input |
| 32 | X | TMODE | IN | Test Mode 1 |
| 33 | X | TLAT | IN | Test Mode 2 |
| 34 | GND | OSDR | IN | On-screen Display Red Input |
| 35 | GND | OSDG | IN | On-screen Display Green Input |
| 36 | GND | OSDB | IN | On-screen Display Blue Input |
| 37 | GND | OSDFB | IN | On-screen Display Fast Blank Input |
| 38 | X | TESTOP1 | OUT | Test Mode 3 |
| 39 | X | TESTOP2 | OUT | Test Mode 4 |
| 40 | X | CKMODE | IN | Test Mode 5 |
| 41 | X | TCKIN | IN | Test Mode 6 |
| 42 | X | | – | Not Connected |
| 43 | X | GNDCON | SUPPLY | Ground Connection |
| 44 | GNDDA | ROUT | OUT | Analog Red or V-Component Output |

Pin Connections and Short Descriptions, continued

| Pin No. | Connection (if not used) | Pin Name | Type | Short Description |
|---------|--------------------------|----------|--------|---|
| 45 | X | RREFR | REF | Reference R for RGB DACs |
| 46 | GNDDA | GOUT | OUT | Analog Green or Luminance Output |
| 47 | X | GNDDA | SUPPLY | Analog Ground D/A Converters |
| 48 | GNDDA | BOUT | OUT | Analog Blue or U-Component Output |
| 49 | X | VSUPDA | SUPPLY | Analog Supply Voltage DACs |
| 50 | GNDDA | YOUT | OUT | Analog Luminance Output |
| 51 | X | CREFDA | REF | Reference Capacitor for DACs |
| 52 | GNDDA | CVBSOUT | OUT | Analog Composite Video Output |
| 53 | X | RREFY | REF | Reference R for Y, C, CVBS DACs |
| 54 | GNDDA | COOUT | OUT | Analog Chrominance Output |
| 55 | X | GNDAD | SUPPLY | Analog Ground A/D Converters |
| 56 | X | VSUPAD | SUPPLY | Analog Supply Voltage ADC |
| 57 | X | VREFT | REF | Top Reference Voltage ADC |
| 58 | VREFT | MAC2 | IN | MAC Input 2 |
| 59 | X | GNDSIG | IN | Signal Ground ADC |
| 60 | VREFT | MAC1 | IN | MAC Input 1 |
| 61 | X | GNDSUB | SUPPLY | Substrate Voltage |
| 62 | X | SDA | IN/OUT | I ² C-Bus Serial Data Input/Output |
| 63 | X | SCL | IN | I ² C-Bus Serial Clock Input |
| 64 | LV | BO0 | OUT | Digital Baseband Output 0 (LSB) |
| 65 | LV | BO1 | OUT | Digital Baseband Output 1 |
| 66 | LV | BO2 | OUT | Digital Baseband Output 2 |
| 67 | LV | BO3 | OUT | Digital Baseband Output 3 |
| 68 | LV | BO4 | OUT | Digital Baseband Output 4 |

3.3. Pin Descriptions

Pin 1 to 3 and 64 to 68 – Digital Baseband Outputs (Interface to DMA, see Fig. 3-9):

Via these pins the DMA circuits will be supplied with the digitized MAC baseband signal. The code of the signal is 8-bit pure binary.

Pin 4 – Digital Supply Voltage:

This pin supplies all digital stages and has to be connected with the positive supply voltage.

Pin 5 – Digital Ground:

This is the common ground connection of all digital stages and has to be connected with the ground of the power supply.

Pin 6 – Clamping Input (Interface to DMA, Fig. 3-3):

To this pin the DMA supplies a PDM (Pulse Density Modulated) signal for clamping the analog MAC baseband signal at the input of the AGC amplifier. This pin has to be connected to pin 48 of the DMA circuit.

Pin 7 – Main Clock Output (Supply of DMA and others, Fig. 3-10):

This pin is the output of the main clock generator. The clock generator drives all circuits with the synchronized clock signal. The clock frequency is 20.25 MHz.

Pin 8 to 15 – Digital Luma Inputs (Interface to DMA, Fig. 3-2):

Via these pins the DMI gets the digital luminance signal in 8-bit pure binary code from the DMA circuit. All bits equal to zero means black, all bits equal to one means white.

Pins 16 to 19 and 22 to 25 – Digital Chroma Inputs (Interface to DMA, Fig. 3-2):

Via these pins the DMI gets the digital chrominance signal from the DMA circuit. The code is 8-bit two's complement. The components U and V are multiplexed, which means that the data rate of each component signal is 10.125 MHz.

Pin 20 – PLL Tuning Clock Input (Interface to DMA, see Fig. 3-3):

This pin gets the clock for the PLL tuning data signal from the DMA. This pin has to be connected with the pin 26 of the DMA circuit.

Pin 21 – PLL Tuning Data Input (Interface to DMA, Fig. 3-3):

This pin gets the data signal for the clock generation PLL from the DMA. The signal is a 12-bit serial data word which will be loaded into a shift register. The data contains the information for the frequency adjustment of the clock generator. The data format is compatible with the MCU 2600 clock generator. The clock phase will be compared with the phase of the MAC signal clock in the DMA circuit. This pin has to be connected with pin 25 of the DMA circuit.

Pin 26 – Reset Input (Fig. 3-4):

A low signal at this pin generates a reset. The low-high transition of this signal should come when the supply voltage is stable (power-on reset). The input has Schmitt trigger characteristics.

Pin 27 and 28 – XTAL 1/2 (Fig. 3-8):

The 20.25 MHz crystal is connected with these two pins. Pin 27 is the input and pin 28 is the output of the oscillator circuit. Both pins need an external capacitor to ground.

Pin 29 – Composite Sync Input (Interface to DMA, Fig. 3-2):

This pin gets the composite sync signal from the DMA. This signal is used as synchronization signal in the PAL coder of the DMI and has to be connected to pin 53 of the DMA circuit.

Pins 30 and 31 – MAC Data and Sync Input (Interface to DMA, Fig. 3-3):

Via this pin the VBI Teletext signal will be supplied from the DMA. The burst data signal contains the binary teletext data in lines 2 to 22 and lines 314 to 334 of the D2MAC signal. The burst sync signal synchronizes the teletext data. Pin 30 has to be connected to pin 59 and pin 31 has to be connected to pin 58 of the DMA circuit.

Pins 32, 33, 38 to 41 – Test Pins:

These pins are for test purposes only. In normal operation the pins 32, 33, 40, and 41 have to be connected to ground.

Pins 34 to 37 – On-screen Display Inputs (Fig. 3-3):

Via these pins the DMI will be supplied with the on-screen signals. Three inputs are for the one-bit RGB signals, the fourth input is for the fast blanking signal. A high level at the fast blanking input enables the OSD signal. This can be inserted (switchable) into all analog output signals of the DMI. The input signals are sampled with twice the clock frequency (40.5 MHz).

Pin 43 – Ground Connection:

This pin has some internal shielding function. It has to be connected to ground.

Pin 44, 46, 48, 50, 52, 54 – Analog Outputs (Fig. 3-5):

These are the outputs of the six D/A converters. The D/A converters are current source types and deliver output currents from VSUPA to ground. The nominal output voltages require 75 Ω load resistances. At higher load resistances the output voltages will increase, but will become nonlinear above approx. 2 V. The outputs are short-circuit protected.

Pin 45 and 53 – Reference Resistors D/A Converters (Fig. 3-6):

The reference currents for the D/A converters can be adjusted with a resistor from each of these pins to ground. With these resistors the output currents can be adjusted in the range of 25% to 100% of the maximal output currents. One resistor is responsible for the RGB D/A converters, the other one for the Y,C, CVBS D/A converters.

DMI 3110 A

The nominal reference resistance value for a given load resistance can be seen in the table “recommended operating conditions”.

Pin 47 and 55 – Analog Ground:

These are the ground pins for the A/D and the D/A converters and have to be connected to the ground of the power supply. Note: the layout of the printing circuit board should take into consideration the need for a relatively noise-free supply.

Pin 49 and 56 – Analog Supply Voltage:

These are the supply voltage pins for the A/D and the D/A converters and have to be connected to the positive supply voltage. Note: The layout of the printing circuit board should take into consideration the need for a relatively noise-free supply.

Pin 51 – Reference Capacitor D/A Converters (Fig. 3–6):

This pin is the internal reference for the D/A converters. It has to be connected to ground over a capacitor with a value of approx. 100 nF. The capacitor should be a type with a low inductance and a high insulation resistance.

Pin 57 – Top Reference Voltage A/D Converter

(Fig. 3–7):

This pin is connected to the top end of the reference resistor chain of the A/D converter. The reference voltage is generated inside the DMI, therefore only a capacitor has to be connected to this pin. The cold end of the capacitor should be connected to the signal ground.

Pin 58 and 60 – MAC Inputs (Fig. 3–3):

These are the inputs of the A/D converter (respectively clamping circuit) and have to be supplied with the analog MAC signals. One of these inputs can be selected via I²C-bus. The signal amplitude is nominal 1 V_{pp} and can vary by ± 6 dB. The input signals must be AC-coupled over a capacitor. The clamping time constant is proportional to the capacity.

Pin 59 – Signal Ground A/D Converter (Fig. 3–7):

This pin has to be connected to the ground of the analog input signal. The layout of the printing circuit board should take into consideration the need for a relatively noise-free signal ground potential.

Pin 61 – Substrate Voltage:

This is the connection to the substrate (platform) of the IC. It has to be connected to ground.

Pin 62 and 63 – I²C-Bus Serial Clock and Data (Fig. 3–3):

These are the connections of the DMI with the I²C-Bus. All adjustments are done via this bus and the information will be provided by a Central Control Unit (CCU).

3.4. Pin Configuration

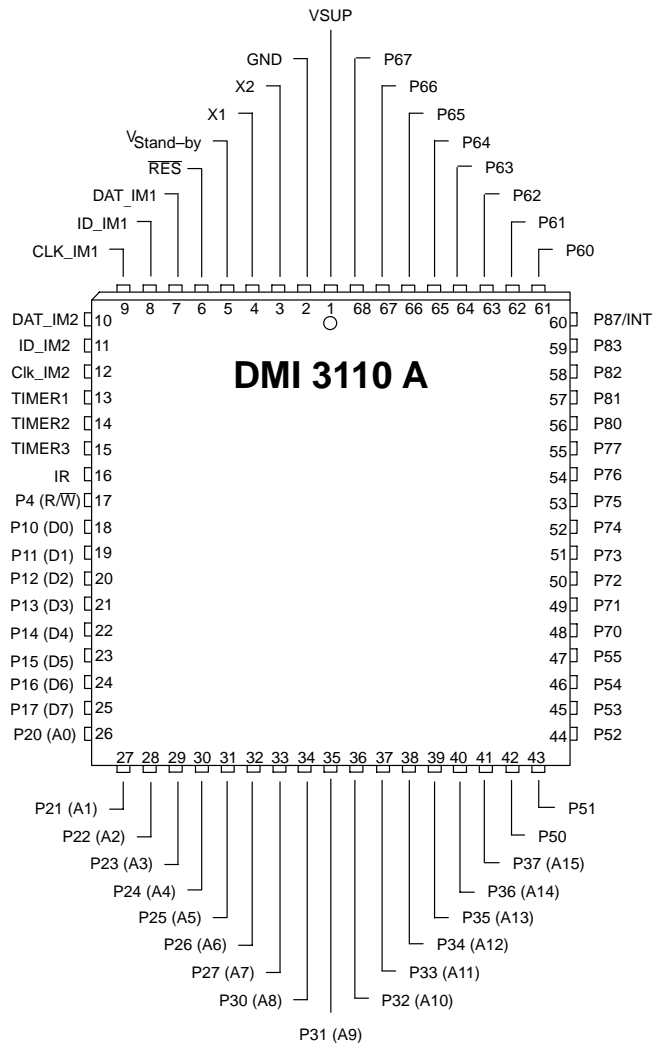


Fig. 3–2: Pinning of the DMI 3110 A in PLCC68 Package

3.5. Pin Circuits

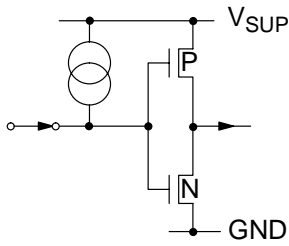


Fig. 3-3: Input pins 8 to 19, 22 to 25, 29

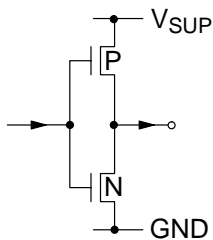


Fig. 3-4: Input pins 6, 20, 21, 30, 31, 34 to 37, 53, 60, 62, 63

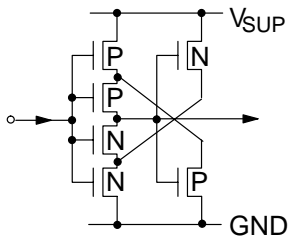


Fig. 3-5: Input pin 26

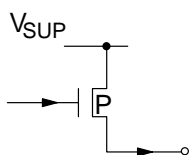


Fig. 3-6: Output pins 44, 46, 48, 50, 52, 54

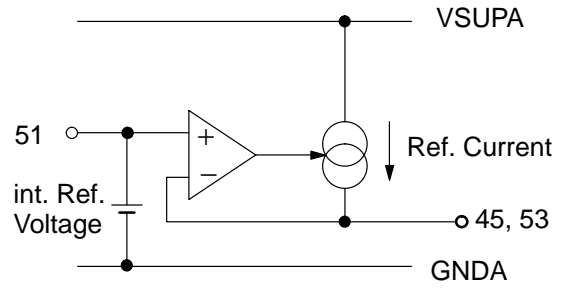


Fig. 3-7: Pins 45, 51, 53

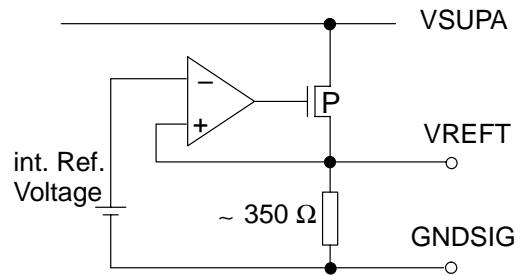


Fig. 3-8: Pins 57, 59

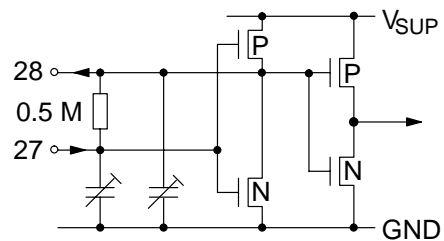


Fig. 3-9: Input pin 27, output pin 28

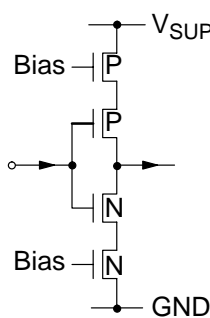


Fig. 3-10: Output pins 1 to 3, 64 to 68

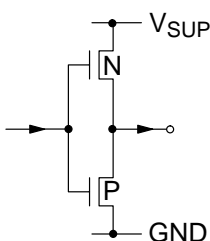


Fig. 3-11: Output Pin 7

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3.6. Electrical Characteristics (pin numbers for 68-pin PLCC package)

3.6.1. Absolute Maximum Ratings

| Symbol | Parameter | Pin No. | Min. | Max. | Unit |
|-----------|-------------------------------|-----------|-------|-----------|------|
| T_A | Ambient Operating Temperature | – | 0 | 65 | °C |
| T_S | Storage Temperature | – | – 40 | 125 | °C |
| V_{SUP} | Supply Voltage | 4, 49, 56 | – | 6 | V |
| V_I | Input Voltage, all pins | – | – 0.3 | V_{SUP} | V |
| I_I | Input Current, all pins | | – 20 | + 20 | mA |
| P_{TOT} | Chip Power Dissipation | – | – | 1.325 | W |

Stresses beyond those listed in the “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions beyond those indicated in the “Recommended Operating Conditions/Characteristics” of this specification is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

3.6.2. Recommended Operating Conditions at $V_{SUP}= 5\text{ V}$, $T_A= 0\text{ °C}$ to 65 °C

| Symbol | Parameter | Pin No. | Min. | Typ. | Max. | Unit |
|-------------|--|------------------------|------|--------|------|------------|
| V_{SUPD} | Digital Supply Voltage | 4 | 4.75 | 5.0 | 5.25 | V |
| V_{SUPA} | Analog Supply Voltage | 49, 56 | 4.75 | 5.0 | 5.25 | V |
| V_{MAC} | Analog MAC Input Voltage | 58, 60 | 0.5 | 1.0 | 2.0 | V_{SS} |
| C_{MACI} | Coupling Capacitance MAC Inputs | | – | 470 | – | nF |
| C_{REFT} | Decoupling Capacitance Top Reference A/D Converter | 57 | – | 10 10 | – | nF μF |
| C_{REFD} | Decoupling Capacitance A/D Converter | 51 | – | 100 | – | nF |
| R_{REFR} | Reference Resistor RGB D/A Converter | 45 | 1100 | – | 4400 | Ω |
| R_{REFY} | Reference Resistor, Y, C, CVBS D/A Converter | 53 | 680 | – | 2720 | Ω |
| R_{LOAD} | Load Resistance D/A Converter | 44, 46, 48, 50, 52, 54 | 0 | 75 | 300 | Ω |
| V_{AMAX} | Maximum Output Voltage Range (all D/A converters) | | – | – | 1.4 | V |
| V_{LCIL} | Digital Luma/Chroma Input Low Voltage | 8 to 19, 22 to 25 | – | – | 0.4 | V |
| V_{LCIH} | Digital Luma/Chroma Input High Voltage | | 2.4 | – | – | V |
| t_{LCIST} | Digital Luma/Chroma Input Setup Time | | 10 | – | – | ns |
| t_{LCIHT} | Digital Luma/Chroma Input Hold Time | | 0 | – | – | ns |

Recommended Operating Conditions, continued

| Symbol | Parameter | Pin No. | Min. | Typ. | Max. | Unit |
|--------------------|--|----------|------|------|------|------|
| V _{OSDL} | OSD Input Low Voltage | 34 to 37 | – | – | 0.2 | V |
| V _{OSDH} | OSD Input High Voltage | | 0.6 | – | – | V |
| t _{OSDSL} | OSD Input Setup Time at Falling Clock Edge | | 10 | – | – | ns |
| t _{OSDHL} | OSD Input Hold Time at Falling Clock Edge | | 0 | – | – | ns |
| t _{OSDSH} | OSD Input Setup Time at Rising Clock Edge | | 10 | – | – | ns |
| t _{OSDHH} | OSD Input Hold Time at Rising Clock Edge | | 0 | – | – | ns |
| V _{REIL} | $\overline{\text{Reset}}$ Input Low Voltage | 26 | – | – | 0.8 | V |
| V _{REIH} | $\overline{\text{Reset}}$ Input High Voltage | | 2.8 | – | – | V |
| t _{REIL} | $\overline{\text{Reset}}$ Input Low Time | | 1 | – | – | μs |
| V _{IIC} | I ² C-bus Input Low Voltage | 62, 63 | – | – | 1.5 | V |
| V _{IIC} | I ² C-bus Input High Voltage | 62, 63 | 3.0 | – | – | V |

3.6.3. Crystal Oscillator (DCO) Characteristics (for TC09)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|--|------|--------|------|------|
| Recommended Crystal Characteristics | | | | | |
| T _A | Operating Ambient Temperature | 0 | – | 65 | °C |
| f _P | Parallel Resonance Frequency with Load Capacitance C_L = 13 pF | – | 20.250 | – | MHz |
| Δf _P /f _P | Accuracy of Adjustment | –20 | – | +20 | ppm |
| Δf _P /f _P | Frequency Temperature Drift | –30 | – | +30 | ppm |
| R _R | Series Resistance | – | – | 25 | Ω |
| C ₀ | Shunt (Parallel) Capacitance | 3 | – | 7 | pF |
| C ₁ | Motional (Dynamic) Capacitance | 20 | – | – | fF |
| Load Capacitance Recommendation | | | | | |
| C _L | External Load Capacitance ¹⁾ from Pins 27 and 28 to Ground (pin names: XTAL_IN, XTAL_OUT) | – | 2.2 | – | pF |
| DCO Characteristics | | | | | |
| C _{ILmin} | Minimum Effective Load Capacity ²⁾ | – | 9.5 | – | pF |
| C _{ILrng} | Effective Load Capacity Range ²⁾ | – | 7.5 | – | pF |
| <p>1) Remark on defining the External Load Capacitance: External capacitors at each crystal pin to ground are required. They are necessary to tune the open-loop frequency of the internal PLL and to stabilize the frequency in closed-loop operation. The higher the capacitors, the lower the clock frequency results. The nominal free running frequency should match 20.250 MHz as closely as possible. Due to different layouts of customer PCBs the matching capacitor size should be defined in the application. The suggested value is a figure based on experience with various PCB layouts. Tuning condition: VCOA = –25 (bits 7...0 of IM-bus register 14 of DMA 2281/DMA 2381)</p> <p>2) DCO Range 128...384</p> | | | | | |

3.6.4. Characteristics at $V_{SUP}=5\text{ V}$, $T_A=0\text{ to }65\text{ °C}$

| Symbol | Parameter | Pin No. | Min. | Typ. | Max. | Unit | Test Conditions |
|------------------|---|--|------------|--------------------|--------------------|--|--|
| I_{SUPD} | Current Consumption Digital | 4 | – | 130 | 160 | mA | $V_{SUPD}=5.0\text{ V}$ |
| I_{SUPAF} | Current Consumption Analog Front-End | 56 | – | 50 | 70 | mA | $V_{SUPAF}=5.0\text{ V}$ |
| I_{SUPAB} | Current Consumption Analog Back-End | 49 | – | 30 | 35 | mA | $V_{SUPAB}=5.0\text{ V}$ $R_{REFY}=2720\ \Omega$ $R_{REFR}=4400\ \Omega$ $R_{LOAD}=6\times 300\ \Omega$ |
| | | | – | 110 ¹⁾ | 130 ¹⁾ | mA | $V_{SUPAB}=5.0\text{ V}$ $R_{REFY}=680\ \Omega$ $R_{REFR}=1100\ \Omega$ $R_{LOAD}=6\times 75\ \Omega$ |
| P_{TOT} | Total Power Dissipation | – | – | 1050 | 1325 | mW | $V_{SUPAB}=5.0\text{ V}$ $R_{REFY}=2720\ \Omega$ $R_{REFR}=4400\ \Omega$ $R_{LOAD}=6\times 300\ \Omega$ |
| | | | – | 1450 ¹⁾ | 1800 ¹⁾ | mW | $V_{SUPAB}=5.0\text{ V}$ $R_{REFY}=680\ \Omega$ $R_{REFR}=1100\ \Omega$ $R_{LOAD}=6\times 75\ \Omega$ |
| FRONT-END | | | | | | | |
| V_{REFT} | A/D Converter Top Reference Voltage | 57 | 2.55 | 2.7 | 2.85 | V | |
| R_{MAC} | Analog Input Impedance | 58, 60 In: 58, 60 Out: 1...3, 64...68 | 1 | – | – | M Ω | |
| C_{MAC} | Analog Input Capacitance | | – | 5 | – | pF | |
| I_{CLMP} | Analog Input Clamping Current range | | +14 –12 | +17 –15 | +20 –18 | μA μA | full range, divided into 17 steps of 2 μA offset +1 μA |
| V_{MAC} | MAC Input Voltage Full Range | | 0.9 | 1.0 | 1.1 | V _{PP} | AGC= 0dB (code 32) |
| G_{MAC} | AGC Range | | ± 6 | ± 7 | ± 8 | dB | full range divided into 64 steps |
| DN_{AGC} | AGC Differential Nonlinearity | | – | 0.8 | – | LSB | |
| B_{MAC} | Frontend –3 dB Bandwidth at 100 % Signal | | 7.5 | 8 | – | MHz | $f_{MCLK}=20.25\text{ MHz}$ AGC= –6 dB (code 0) |
| SND_{MAC} | Frontend Signal to Noise and Distortion Ratio at 100 % Signal | | 42 | 44 | – | dB | 1 MHz sine input AGC= –6 dB (code 0) Bandwidth= fs/2 |
| THD_{MAC} | Total Harmonic Distortion at 100 % Signal | | –42 | –48 | – | dB | 1 MHz sine input AGC= –6 dB (code 0) Bandwidth= 6 MHz |
| $PSRR_{MAC}$ | Power Supply Rejection Ratio at MAC Input | | – | 46 | – | dB | $\Delta V_{SUPAD}/\Delta V_{MAC}$ at DC AGC= 0 dB (code 32) |
| IN_{MAC} | MAC Input Integral Non-linearity | – | ± 2 | – | LSB | | |
| DN_{MAC} | MAC Input Differential Non-linearity | – | ± 0.8 | – | LSB | | |
| CT_{MAC} | Analog Input Adjacent Cross-talk MAC1/MAC2 | – | –55 | –50 | dB | Input1= 1 MHz 80 % signal Input2= 1.1 MHz 80 % signal | |

¹⁾ Cooling required.

Characteristics, continued

| Symbol | Parameter | Pin No. | Min. | Typ. | Max. | Unit | Test Conditions |
|----------------------|--|------------------------|------|------|------|-----------------|---|
| BACK-END | | | | | | | |
| V _{REF} | Reference Voltage for all D/A converters | 51 | 1.9 | 2.1 | 2.3 | V | V _{SUPA} = 4.75 to 5.25 V to be measured with R _j ≥ 1 G Ω |
| -I _{OUTY} | Maximum Analog Output Current CVBS, Y, C | 50, 52, 54 | 15.6 | 16.5 | 17.3 | mA | R _{REFY} = 680 Ω R _L = 0 |
| | | | - | 4.1 | - | mA | R _{REFY} = 2720 Ω R _L = 0 |
| -I _{OUTR} | Maximum Analog Output Current R, G, B | 44, 46, 48 | 9.5 | 10 | 11 | mA | R _{REFR} = 1100 Ω R _L = 0 |
| | | | - | 2.5 | - | mA | R _{REFR} = 4400 Ω R _L = 0 |
| ID _{OUTR} | Output Deviation between R, G and B peak-to-peak current | | - | 3 | 6 | % | 100(I _{MAX} - I _{MIN})/I _{MEAN} R _{REFR} = 1100 Ω R _L = 0 |
| DN _{DAC} | Differential Nonlinearity (all D/A converters) | 44, 46, 48, 50, 52, 54 | - | ±0.3 | - | LSB | |
| IN _{DAC} | Integral Nonlinearity (all D/A converters) | | - | ±0.5 | - | LSB | |
| THD _{DAC} | Total Harmonic Distortion (all D/A converters) | | - | 50 | - | dB | Signal 1MHz Bandwidth 6 MHz |
| MISCELLANEOUS | | | | | | | |
| V _{MCLKD} | Clock Output DC Voltage | 7 | - | 2.5 | - | V | C _L = 50 pF |
| V _{MCLCA} | Clock Output Voltage Swing | | 1.0 | 1.2 | 1.4 | V _{PP} | C _L = 50 pF |
| t _{MCLKR} | Clock Rise Time | | - | 9 | - | ns | C _L = 50 pF |
| t _{MCLKF} | Clock Fall Time | | - | 11 | - | ns | C _L = 50 pF |
| R _{MCLK} | Clock Output Impedance | | - | 30 | - | Ω | AC Coupling |
| V _{LCIT} | Digital Luma/Chroma Input Threshold Voltage | 8 to 19, 22 to 25 | - | 1.1 | - | V | |
| -I _{LCIL} | Digital Luma/Chroma Input Low Current | | 1.4 | 2.0 | 3.0 | mA | V _{IL} = 0.4 V |
| C _{LCI} | Digital Luma/Chroma Input Capacitance | | - | 5 | - | pF | |
| V _{OSDT} | OSD Input Threshold Voltage | 34 to 37 | - | 0.4 | - | V | |
| I _{OSDL} | OSD Input Leakage Current | | - | - | ±1 | μA | |
| C _{OSD} | OSD Input Capacitance | | - | 5 | - | pF | |
| V _{RESQT} | Reset Input Threshold Voltage | 26 | - | 2.2 | - | V | Rising Edge |
| -I _{RESQL} | Reset Input Low Current | | - | 1.2 | - | V | Falling Edge |
| I _{RESQH} | Reset Input High Current | | - | 0 | - | μA | |
| C _{RESQ} | Reset Input Capacitance | | - | 5 | - | pF | |

Characteristics, continued

| Symbol | Parameter | Pin No. | Min. | Typ. | Max. | Unit | Test Conditions |
|--------------|--|---------------------|------|------|---------|---------------|----------------------------|
| V_{BOL} | Digital Baseband Output Low Voltage | 1 to 3, 64 to 68 | – | – | 2.2 | V | |
| V_{BOH} | Digital Baseband Output High Voltage | | 2.8 | – | – | V | |
| t_{BOD} | Digital Baseband Output Delay Time | | – | – | 16.5 | ns | $C_L = 50 \text{ pF}$ |
| $-I_{IICIL}$ | I ² C-Bus Input Leakage Current | 62, 63 | – | – | ± 1 | μA | |
| C_{IIC1} | I ² C-Bus Input Capacitance | | – | 5 | – | pF | |
| V_{IICOL} | I ² C-Bus Output Low Voltage | 62 | – | – | 0.4 | V | $I_{LOW} = 3.0 \text{ mA}$ |

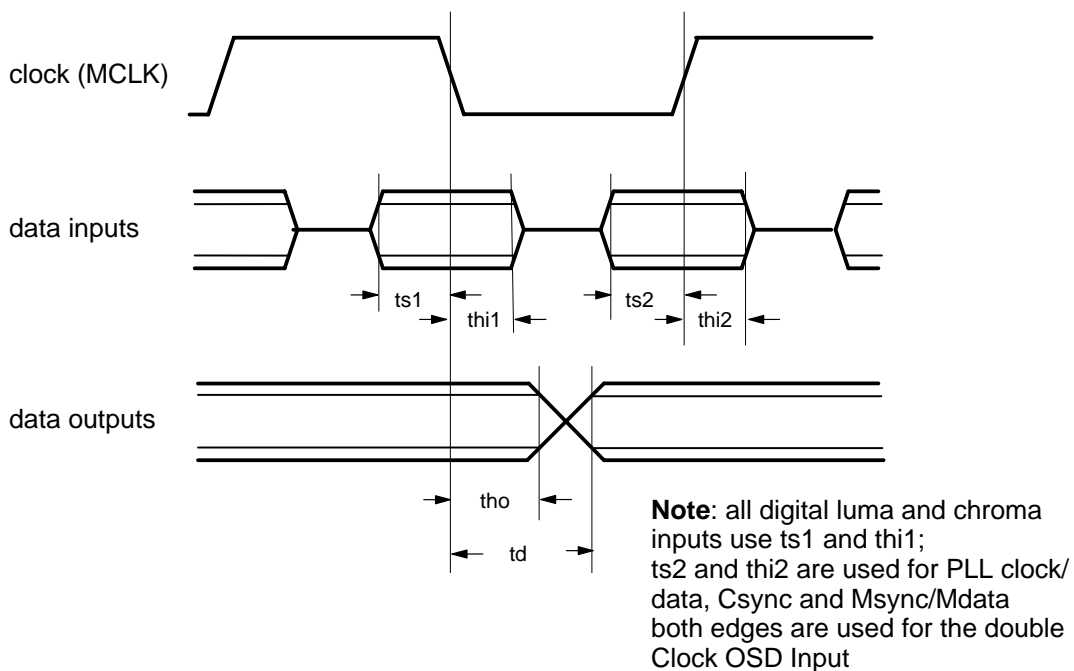


Fig. 3–12: Data input & outputs timing chart and symbols

4. Programming

4.1. I²C-Bus Interface

The I²C-bus interface is used to program all parameters to the DMI 3110 A. Data can only be written to the DMI 3110 A. The I²C-bus interface uses a chip address, a register (sub-) address and an 8-bit data word that is written to the addressed register. The bus protocol is shown in the figure below. The main address is \$0E.

The register assignment for the I²C-bus registers is given in the following table. The DMI 3110 A evaluation software allows the access of all subregisters via the indicated mnemonics.

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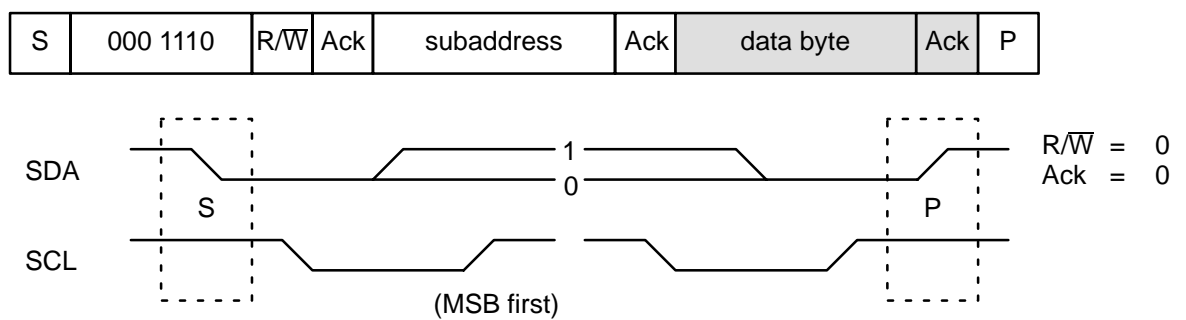


Fig. 4-1: I²C-bus protocol

Table 4–1: I²C-Bus Registers

| I ² C subaddress | I ² C data[7:0] | Name | Default |
|-----------------------------|--|---|---|
| 0 | not used | – | 0 |
| 1 | d[7:0] | Timing Generator disable time | TGDIS 250 |
| 2 | d[7] d[6] d[5:0] | reserved Low Pass Filter On Luma Gain Adjustment | – YLPF YGAIN 0 0 24 |
| 3 | d[4:0] | Chroma Gain Adjustment | CGAIN 22 |
| 4 | d[7:0] | PAL Color Burst Amplitude | BURST – 40 |
| 5 | d[7] d[6] d[5:2] d[1] d[0] | reserved Chroma Demultiplexer Phase (PAL) Chroma Peaking Filter Chroma Lowpass Filter (F2) Chroma Lowpass Filter (F1) | – PALMUX CLPPK CLPF2 CLPF1 0 0 8 1 1 |
| 6 | d[7] d[6:0] | reserved B-Y Gain | – UGAIN 0 63 |
| 7 | d[7] d[6:0] | reserved R-Y Gain | – VGAIN 0 90 |
| 8 | d[7:0] | Luminance Blanking Start | YBLANKS 2 |
| 9 | d[7:0] | Luminance Blanking End | YBLANKE 100 |
| 10 | d[7:0] | Key Pulse Start | KEYS 73 |
| 11 | d[7:0] | Key Pulse End | KEYE 97 |
| 12 | d[7:4] d[3:0] | Vertical blanking length reserved | VBLEN – 10 0 |
| 13 | d[7:6] d[5:0] | reserved Luminance Delay | – YDEL 0 42 |
| 14 | d[7:4] d[3:0] | reserved Composite Sync Delay | – CSDEL 0 4 |
| 15 | d[7] d[6:4] d[3] d[2] d[1:0] | reserved Testbits special sync mode OSD-Insertion Into PAL Enable Testbits | PALOSD 0 0 0 0 0 |
| 16 | d[7:6] d[5] d[4:2] d[1] d[0] | TESTREGISTER Testbits TTX-Insertion Disable Testbits Sync Pulse Output Disable reserved | 0 0 0 0 0 |
| 17 | d[7:0] | Chroma Blanking Start | CBLANKS 13 |
| 18 | d[7:0] | Vertical Sync Trigger Point | VSTRIG 50 |
| 19 | d[7:0] | Chroma Blanking End | CBLANKE 111 |

I²C-Bus Registers, continued

| I ² C subaddress | I ² C data[7:0] | Name | Default | |
|-----------------------------|--|--|---|---------------------------------|
| 20 | d[7:0] | Horizontal Sync Start | HSYNCS | 0 |
| 21 | d[7:0] | Horizontal Sync End | HSYNCE | 1 |
| 22 | d[7:6] d[5] d[4] d[3:0] | TESTREGISTER Testbits B-Y Disable R-Y Disable Testbits | – | 0 0 0 0 |
| 23 | d[7:0] | TTX-Insertion Start | TTXS | 116 |
| 24–25 | | reserved | – | |
| 26 | d[7] d[6] d[5] d[4] d[3] d[2] d[1:0] | reserved Chroma demultiplexer phase (RGB) OSD-Insertion Into RGB(YUV) Enable Luma Offset Subtractor Control Interpolation Filter Bypass RGB-Matrix Bypass Testbits | RGBMUX RGBOSD YOFFSET RGBFBP RGBMBP | 0 0 0 0 0 0 0 |
| 27 | d[7:4] d[3:0] | reserved RG-B (YUV)-Delay | RGBDEL | 0 12 |
| 28 | | not used | – | |
| 29 | d[7:0] | TESTREGISTER Testbits | – | 0 |
| 30 | d[6:0] | TTX-Window 2 End (line = 256 + x) | TTXW2E | 79 |
| 31 | d[7] d[6:0] | Testbit TTX-Window 2 Start (line = 256 + x) | TTXW2S | 0 62 |
| 32 | d[6:0] | TTX-Window 1 End | TTXW1E | 23 |
| 33 | d[7] d[6:0] | Start Sample TTX Read 230/231 (1/0) TTX-Window 1 Start | TTXSS TTXW1S | 0 6 |
| 34 | d[7:6] d[5] d[4] d[3:2] d[1] d[0] | reserved Gray Code off Input Select Testbits Clamping Enable reserved | GRAYOFF MACIN CLAMPEN | 0 0 1 0 1 0 |
| 35 | d[7] d[6] d[5:0] | TESTREGISTER ADC-Standby Control Gray Code Test Control Testbits | – | 0 0 0 |
| 36 | d[5:0] | Automatic Gain Control | AGC | 25 |
| 37 to 47 | | not used | – | |
| 48 to 63 | d[7:0] | OSD Color Look-Up Table | OSDX | |

Table 4–2: Related DMA 2281 IM-Bus Registers

| IM-Bus address | IM-Bus data[15:0] | Name | Default |
|----------------|------------------------------|------|---------|
| 23 | d[15:10] saturation U | SAU | 32 |
| 23 | d[7:2] saturation V | SAV | 32 |
| 200 | d[15:10] luma contrast | CT | 63 |
| 200 | d[8] luma contrast switch | CTS | 1 |
| 202 | d[15:9] composite sync delay | SD | 70 |

4.2. General Remarks

For an easy adjustment of the DMI 3110 A, the MUBI software can be used. The parameter names mentioned below refer to the MUBI software and are in the same order. The register subaddress is always given in parenthesis.

4.2.1. Initialization

Command name: INIT or [F10]

This is a command in the MUBI program. It initializes the DMI 3110 A with the parameters set to the most recent values. Before this command, a hardware reset (power-on reset) should be done.

4.3. Analog Input

4.3.1. Input Select (34)

Command name: MACIN

This command switches between the analog MAC inputs 1 and 2. MACIN = 1 means the MAC input 1 is selected.

| | |
|-------|--|
| MACIN | 0: Input 2 (pin 60) 1: Input 1 (pin 58) |
|-------|--|

4.3.2. Clamping Enable (34)

Command name: CLAMPEN

This command enables the clamping at the analog MAC inputs. CLAMPEN = 1 means that the clamping is enabled.

| | |
|---------|---|
| CLAMPEN | 0: Clamping disabled 1: Clamping enabled |
|---------|---|

4.3.3. Automatic Gain Control (36)

Command name: AGC

The AGC value controls the gain of the input amplifier. In normal operation the CCU reads the amplitude value out of the DMA and adjusts the AGC value in the DMI for a proper signal amplitude at the A/D converter. The range of ± 6 dB is divided into 64 steps.

| | |
|-----|---|
| AGC | Value = Gain[dB] / 0.19 dB range 0 to 63 |
|-----|---|

4.3.4. Baseband Output Code (34)

Command name: GRAY

The digital baseband output code of the DMI 3110 A can be switched over between straight binary code and gray code.

| | |
|---------|--------------------------------|
| GRAYOFF | 1: binary code 0: gray code |
|---------|--------------------------------|

4.4. Chrominance Channel

4.4.1. Chroma Demultiplexer Phase (5, 26)

| | |
|------------------|--------------------------|
| PALMUX RGBMUX | 0: normal 1: inverted |
|------------------|--------------------------|

4.4.2. Chroma Lowpass (5)

Command names: CLPF1, CLPF2, CLPPK

This filter consists of 1 fixed part and 3 adjustable parts in series. Parts 1 to 3 are lowpass filters, part 4 is an adjustable peaking filter.

The transfer functions are:

Table 4–3: Transfer Functions

| | | |
|-----------------|--------|--|
| Part 1 | Fixed | $H(z) = 0.5 \cdot (1 + Z^{-4}) \cdot (1 + Z^{-2})^2$ |
| Part 2 CLPF1 | F1 = 0 | $H(z) = 0.5 \cdot (1 + Z^{-4})$ |
| | F1 = 1 | $H(z) = Z^{-4}$ |
| Part 3 CLPF2 | F2 = 0 | $H(z) = 0.5 \cdot (1 + Z^{-6})$ |
| | F2 = 1 | $H(z) = Z^{-6}$ |
| Part 4 CLPPK | PK = 1 | $H(z) = Z^{-6} - 4/16 \cdot (1 + z^{-12})$ |
| | PK = 2 | $H(z) = Z^{-6} - 3/16 \cdot (1 + z^{-12})$ |
| | PK = 4 | $H(z) = Z^{-6} - 2/16 \cdot (1 + z^{-12})$ |
| | PK = 8 | $H(z) = Z^{-6} - 1/16 \cdot (1 + z^{-12})$ |

4.4.3. Color Component Gain (6,7)

Command names: UGAIN, VGAIN

This is the gain adjustment for the color component signals in front of the 4:4:4 interpolation filter (after the low-pass filter). The B–Y signal is multiplied with the UGAIN value to result in the U component signal. The R–Y signal is multiplied with the VGAIN value to result in the V component signal. The gain should be adjusted as high as possible (short before signal limitation) for a low quantization noise.

| | | |
|-------|-----------------------|-------------------|
| UGAIN | Value = 128 · gain | range 0 to 127 |
| VGAIN | Value = 128 · gain | range 0 to 127 |

4.4.4. Color Burst (4)

Command name: BURST

This is the value of the burst amplitude. The adjustment is relative to a maximum chroma amplitude of 1. This value's sign has to be negative. The positive sign can be

used for test purposes. The formula for the calculation is:

| | |
|---------|------------------------|
| Value = | – 91 · Burst amplitude |
| range | – 128 to + 127 |

4.4.5. Color Carrier Gain (3)

Command name: CGAIN

The gain for the color subcarrier can be adjusted in front of the D/A converter (after the PAL modulator). This adjustment influences the color carrier inclusive the burst. The formulae for the calculation of these values are:

| | | |
|-------|-------------------|------------------|
| CGAIN | Value = 32 · gain | range 0 to 31 |
|-------|-------------------|------------------|

4.5. Luminance Channel

4.5.1. Luminance Offset (26)

Command name: YOFFSET

A luminance offset can be added at the luminance input. The offset will be added in the RGB as well as the PAL coder path.

| | |
|---------|-------------------|
| YOFFSET | 0 → Offset = – 16 |
| | 1 → Offset = 0 |

4.5.2. Luminance Lowpass Filter (2)

Command name: YLPF

In the luma path of the encoder a switchable low-pass filter with a transfer function $1 + z^{-1}$ can be selected.

| | |
|------|--|
| YLPF | 0: bypass 1: lowpass $0.5 \cdot (1 + z^{-1})$ |
|------|--|

4.5.3. Luminance Gain (2)

Command name: YGAIN

The luminance gain for the luminance signal at the composite video output can be adjusted after the chroma trap. The formula for the calculation of this value is:

| | | |
|-------|-------------------|------------------|
| YGAIN | Value = 64 · gain | range 0 to 63 |
|-------|-------------------|------------------|

4.6. Timing

4.6.1. Horizontal Pulses (1, 8 to 11, 17, 19)

Command names: TGDIS, KEYS, -E, YBLANKS, -E, CBLANKS, -E

All these pulses are started with the low transition of the hsync in the composite sync signal. The end of the timing generator (TGDIS) stops the pulse generation. It must therefore have the highest value of all. While the timing generator is running, the trigger input is disabled. This is necessary to prevent the timing generator from triggering at the H/2 pulses (equalization pulses) in the vertical sync signal. All pulses, except timing generator are adjustable within a step width of two clock periods, and have a range of 2 to 510 clock periods. The timing generator has a range of 4 to 1020 clock periods.

| | | |
|--------|---|----------------|
| TGDIS | Value = $t_{\text{delay}} \cdot f_{\text{clock}} / 4$ | range 1 to 255 |
| KEY | Value = $t_{\text{delay}} \cdot f_{\text{clock}} / 2$ | range 1 to 255 |
| YBLANK | Value = $t_{\text{delay}} \cdot f_{\text{clock}} / 2$ | range 1 to 255 |
| CBLANK | Value = $t_{\text{delay}} \cdot f_{\text{clock}} / 2$ | range 1 to 255 |

4.6.2. Short Vertical Sync (15, 20, 21)

Command names: SSYNC, HSYNC, -E

It is possible to replace the vertical sync signal with a special short vertical sync signal with a duration of one horizontal line. The position of this sync pulse is one line before the original vertical sync pulse would appear. This mode can be selected with the SSYNC command. In this mode the composite sync signal is switched off and the short vertical sync pulse is used. The horizontal sync pulses are generated from the timing generator. Therefore the start and end values for the hsync have to be adjusted.

| | | |
|-------|---|----------------|
| SSYNC | 0: composite sync 1: short vertical sync | |
| HSYNC | Value = $t_{\text{delay}} \cdot f_{\text{clock}} / 2$ | range 1 to 255 |

4.6.3. Vertical Pulses (12, 18)

Command names: VSTRIG, VBLEN

The detection level for the vertical sync separator can be

adjusted to start the generated vertical blanking at the start of the equalization pulses or at the start of vertical sync pulses. A counter which runs with $f_c/8$ starts at each rising edge of the composite sync signal. At the falling edge the counted number is compared with the detection level VSTRIG. If the counted number is smaller than the detection level a vertical blanking pulse will be generated.

The duration of the vertical blanking pulse (VBLEN) can be adjusted between 0 and 15.

| | | |
|--------|---|----------------|
| VSTRIG | Value = $f_c \cdot t_{\text{high}} / 8$ | range 0 to 255 |
| VBLEN | Value = n_H | range 0 to 15 |

Example for VSTRIG:

$f_c = 20.25 \text{ MHz}$

High time at normal line = $59.3 \mu\text{s} \cdot 20.25 \text{ MHz} / 8 = 150$

High time at equal. pulses = $29.7 \mu\text{s} \cdot 20.25 \text{ MHz} / 8 = 75$

High time at vsync pulses = $4.7 \mu\text{s} \cdot 20.25 \text{ MHz} / 8 = 12$

For a start of the vertical blanking at the equalization pulses the detection level has to be between 75 and 150.

For a start of the vertical blanking at the vsync pulses the detection level has to be between 12 and 75.

4.6.4. Delay for CSYNC, Luminance and RGB (13, 14, 27)

Command names: CSDEL, YDEL, RGBDEL

The delays for the composite sync, the luminance signal and the RGB signals can be adjusted separately. The luminance delay has to be adjusted for matching with the chroma signal. The RGB delay has to be adjusted for matching with the composite video signal.

| | | |
|--------|---|----------------|
| CSDEL | Value = (see *) | range 0 to 15* |
| YDEL | Value = $t_{\text{delay}} \cdot f_{\text{clock}}$ | range 0 to 63 |
| RGBDEL | Value = $t_{\text{delay}} \cdot f_{\text{clock}}$ | range 0 to 15 |

* the delay is added to the luma delay and the weighting of the bits is not binary weighting: bit 0 = 1, bit 1 = 1, bit 2 = 1, bit 3 = 2 (maximum delay = 5 clock periods).

4.7. Teletext Transcoder (23, 30 to 33)

Command names: TTXS, TTXSS, TTXW1S, _E, TTXW2S, _E

The teletext transcoder allows to select lines from the D2MAC/DMAC signal for the transcoding function. Two blocks of lines can be selected, for each block the first and the last line number must be programmed. If the last line number is smaller than the first line number the transcoding is inactive. The exact time for the insertion of the teletext signal into the luminance and composite signals can be programmed with the value of TTXS.tf. For DMAC TTX transcoding, one of the two bit streams can be selected by selecting the start sample point for the TTX transcoder.

| | | |
|-------|---|-------------------|
| TTXS | Value = $t_{\text{delay}} \cdot f_{\text{clock}}$ | range 0 to 255 |
| TTXSS | sample at 230 / 231 | range 0/1 |
| TTXW1 | Value = n_H | range 0 to 63 |
| TTXW2 | Value = $256 + n_H$ | range 0 to 63 |

4.8. On-Screen Display (48 to 63)

Command names: PALOSD, RGBOSD, OSDY0...7, OSDU0...7, OSDV0...7

The OSD insertion function can be activated separately for the composite video and SVHS signal (encoder) and the RGB path.

The on-screen display colors are programmed by a color look up table. For each color (0 to 7) of a binary RGB sig-

nal a 16-bit entry in the color look up table allows to program luminance with 6-bit resolution and chrominance (U/V) with 5-bit resolution respectively.

| | | |
|-----------|---|----------------------------------|
| PALOSD | 0: OSD disabled into PAL 1: OSD enabled into PAL | |
| RGBOSD | 0: OSD disabled into RGB 1: OSD enabled into RGB | |
| CLUT[7:0] | address: data: | RGB color number 2 byte |
| | d0[7:2] d0[1:0], d1[7:5] d1[4:0] | luma chroma (U) chroma (V) |

4.9. RGB Processing

The component processing path makes it possible to bypass the 4:2:2 to 4:4:4 interpolation filter and also to bypass the YUV to RGB matrix. When the matrix is bypassed, the BLUE/RED outputs which carry the U/V data are switched to signed binary format. The U/V multiplex is resynchronized on every line with the MAC sync signal; the multiplex order is adjustable. The on-screen display can be enabled to the RGB path. The RGB processing path has an adjustable delay to match the timing of composite/component signals.

| | |
|--------|---------------------------|
| RGBFBP | 1 : bypass |
| RGBMBP | 1 : bypass |
| RGBMUX | 1: U/V multiplex inverted |

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5. Data Sheet History

1. Data sheet: "DMI 3110 A Digital MAC Interface", July 1, 1996, 6251-381-1DS. First release of the data sheet.

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