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VERSION CHANGE

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Data Sheet

MTCS - TIAM2

Integral True Colour Sensor IC XYZ Tri-stimulus function with integrated amplifier

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1 INTRODUCTION

MTCS – TIAM2 is a True Colour Sensor IC with integrated amplifier. The IC is packaged into a FR4-board / plastic package. It includes XYZ (RGB) filters and is specialized for colour measurements based on the tri-stimulus function.

The True Colour Sensors are made of 19 x 3 photo diodes (special PIN silicon technology with extended sensibility) integrated on chip. The diodes are carried out as segments of a multiple-element hexagonal matrix structure with the diameter of 2,0 mm.

The design as Si-PIN photo diodes allows signal frequencies up to high-range. In order to achieve a small cross talk between the photodiodes the individual sectors were separated from each other by additional structures.

Each of these photodiodes is sensitized with new dielectric spectral filter (named True Colour Filter¹) for its colour range, preferably for the primary colour standard CIE (Commission Internationale de l'Eclairage or International Commission on Illumination) colour space.

The TIAM2 comes with an integrated multi-channel amplifier (see also the data sheet MTI04 of MAZeT) with the ability to set customized the transimpedance at eight different levels. It gives the customer a wide area in which to accommodate all application requirements in light power and frequency.

2 APPLICATION

- General Colour detection and measurements
- Consumer appliances
- Portable colour detector/reader
- RGB-LCD backlight monitors
- Regulation of RGB-power LEDs
- Detector for various light sources

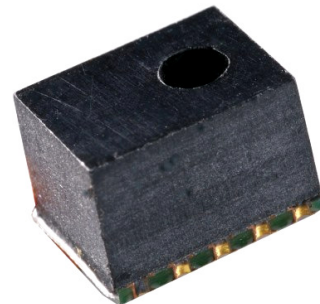


Figure 1: TIAM2 - Var. A

3 FEATURES

Dielectric filters guaranties the good optical properties of the colour sensors, such as:

- high transmission
- slight ageing of the filter
- high temperature stability
- high signal frequency
- reduced cross talk
- small size
- alike tri-stimulus interference filter for colour measurement to DIN 5033 (CIE 1931)
- LCC package
- RoHS-conform

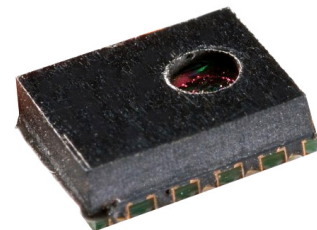


Figure 2: TIAM2 - Var. B

¹ The new generation of JENCOLOUR sensors is committed to implementing (see relative sensitivity) the standard distribution functions as defined under DIN 5033 Part 2 – Color Measurement; CIE 1931 Standard Colorimetric Systems. This implementation method allows colors to be determined according to the three-range procedure that is defined in part 6 of DIN 5033.

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4 BLOCK DIAGRAM

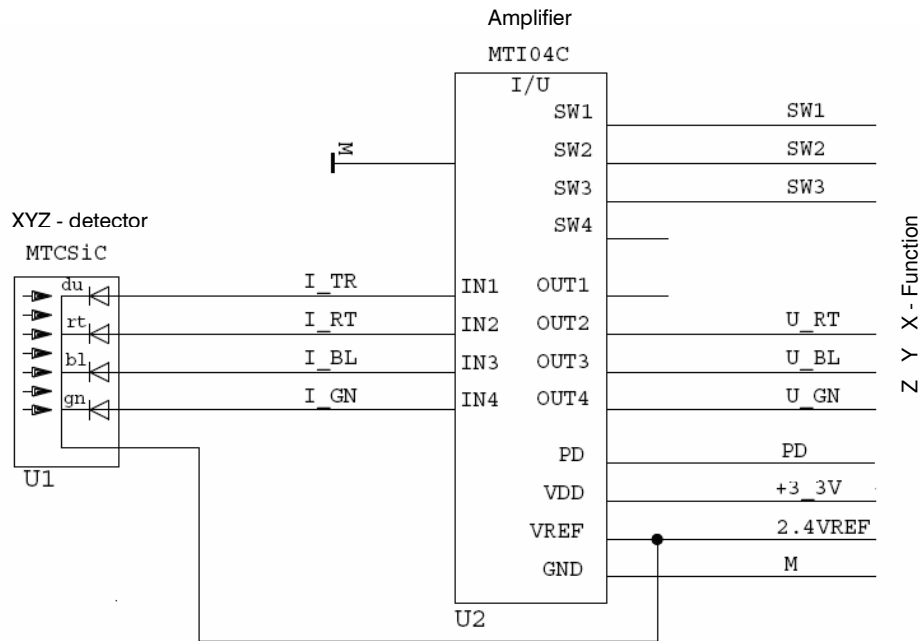


Figure 3: on Chip detector MTCSi and amplifier MTI04C

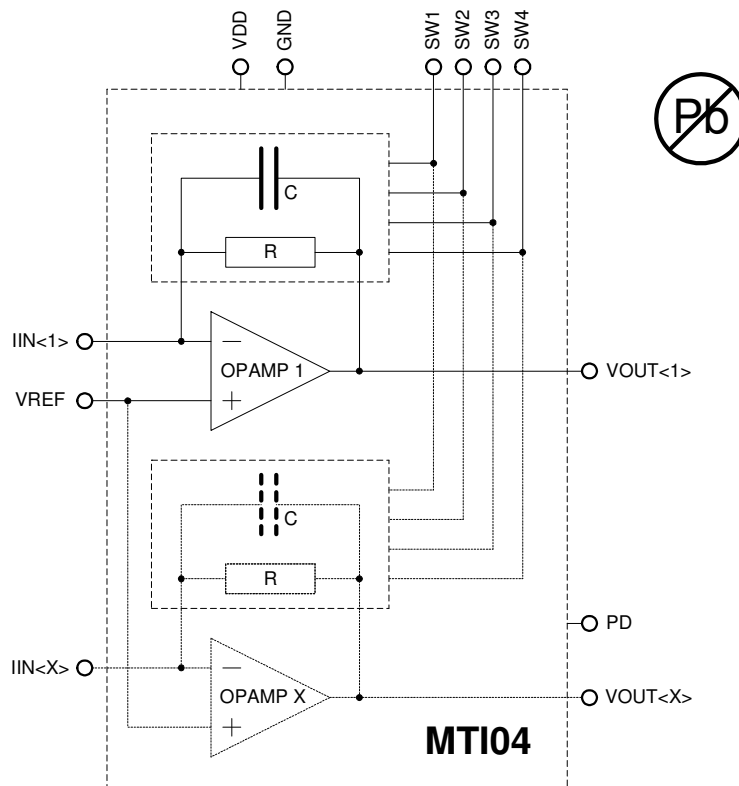


Figure 4: amplifier corresponds the MTI04C

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5 SPECTRAL RESPONSE

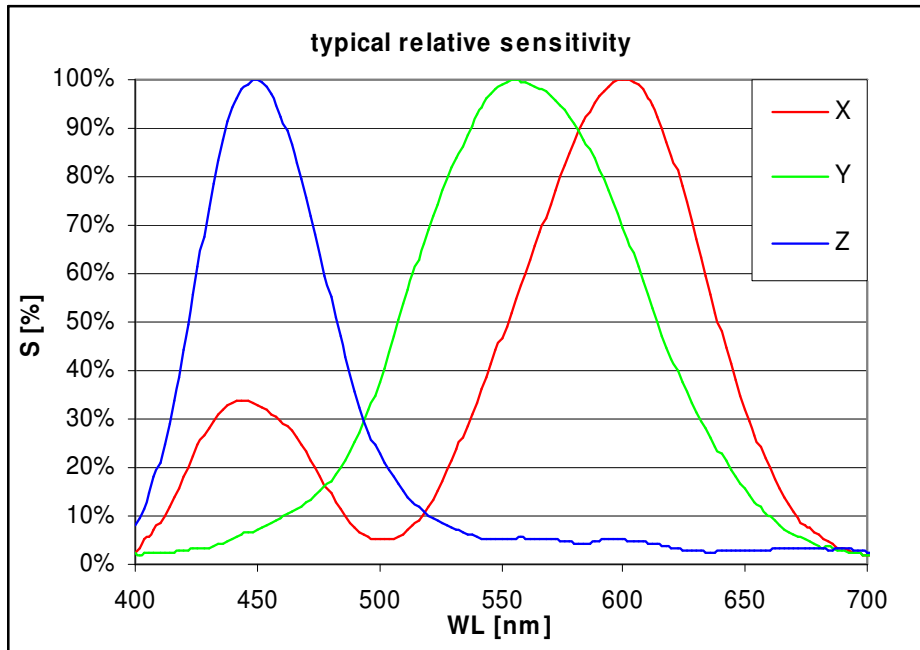


Figure 5: typical (relative) sensitivity (XYZ) of the colour sensor2, scanned by width broadband light (FWHM 30nm)

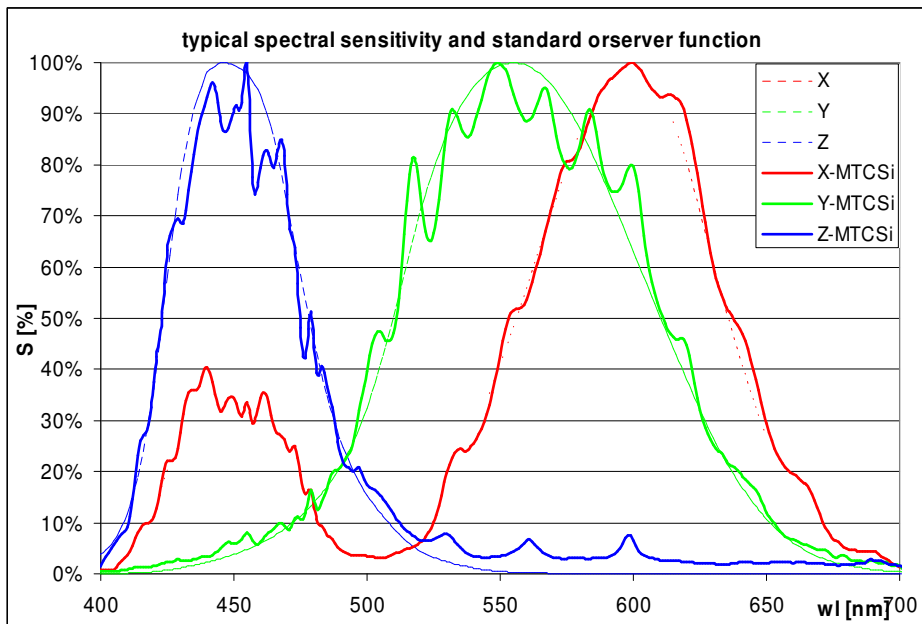


Figure 6: typical (relative) sensitivity (XYZ) of the colour sensor3 scanned by narrow-band light (FWHM 3nm)

² Typical characteristic sensitivity; scanned by monochromatic light with FWHM 27nm

³ Typical characteristic sensitivity; scanned by monochromatic light with FWHM 2nm

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6 DESCRIPTION OF INTERFACE

| signal name | typ. | a/d ^a | function |
|-------------|--------|------------------|---|
| VDD | input | a/d | power supply |
| GND | input | a/d | power supply |
| VREF | input | a | reference voltage |
| SW1 | input | d | input 1 for adjustment of transimpedance of MTI-amplifier (pull down) |
| SW2 | input | d | input 2 for adjustment of transimpedance of MTI-amplifier (pull down) |
| SW3 | input | d | input 3 for adjustment of transimpedance of MTI-amplifier (pull down) |
| PD | input | d | power down modus (pull down) |
| VOUT<n> | output | a | analog voltage output of amplifier channel n for X Y Z function of detector (see chapter 5) |

a.) analog or digital

6.1 Adjustment of Transimpedance

| settings of digital inputs | | | transimpedance R |
|----------------------------|-----|-----|-------------------------------------|
| SW1 | SW2 | SW3 | |
| VDD | VDD | VDD | 20M Ω – stage 1 |
| GND | VDD | VDD | 10M Ω – stage 2 |
| GND | VDD | GND | 5M Ω – stage 3 |
| VDD | GND | VDD | 2M Ω – stage 4 |
| GND | GND | VDD | 1M Ω – stage 5 |
| VDD | GND | GND | 500k Ω – stage 6 |
| VDD | VDD | GND | 100k Ω – stage 7 |
| GND | GND | GND | 25k Ω ^b – stage 8 |

b.) default by pull down

6.2 Power Down Modus

| settings of digital input | bias current of the IC |
|---------------------------|------------------------|
| PD = 1 | |
| VDD | < 8 μ A |
| GND | typical ^c |

c.) default by pull down

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7 SPECIFICATION

7.1 ELECTRICAL AND OPTICAL CHARACTERISTICS OF PHOTO DIODE ARRAY

($T_A = 25^\circ\text{C}$; per single diode)

| Parameter | Symbol | Condition | min. | typ. | max. | Unit |
|---|--------------------------|--|------------------------------|------------------------------|------------------------------|----------------------------|
| Diameter of the light sensitivity area | D | | | 2,0 | | mm |
| Light sensitivity area per single colour array (19 diodes) | A | | | 0,76 | | mm ² |
| Typical photo diode sensitivity of colour ranges | S_{\max} | $\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$ | 0,21 0,30 0,11 0,31 | 0,23 0,33 0,12 0,35 | 0,25 0,36 0,13 0,38 | A/W |
| Spectral tolerance of filter curve | $\Delta\lambda(\lambda)$ | | | | $<1\%*\lambda$ | nm |
| Reverse voltage | V_R | | 0 | 2,5 | 5 | V |
| Dark current | I_R | $V_R = 2,5\text{V}$ | | | 10 | pA |
| Noise equivalent power | NEP | $f_R = 100 \text{ Hz}$ | | | $<10^{-13}$ | W/ $\sqrt{\text{Hz}}$ z |
| Cross-talk | | | | | <1 | % |
| Angle of incidence | φ | $\Delta\lambda_{(\text{Filter})} < 1\%*\lambda$ | | | 10 | Grad |

7.2 ELECTRICAL CHARACTERISTICS

All voltages are referenced to GND = 0V.

| Parameter | Symbol | Condition | min. | typ. | max. | Unit |
|--------------------|--------|-------------------|------|--------|---------|---------------|
| supply voltage | VDD | | 2.7 | 3 to 5 | 5.5 | V |
| bias current MTI04 | I(VDD) | 27°C, VDD=5.5V | | 2.5 | 4.0 | mA |
| bias current MTI04 | I(VDD) | PD=VDD | | | 8 | μA |
| reference voltage | VREF | | 0.4 | | VDD-0.4 | V |

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7.3 AC/DC-Characteristics

Unless otherwise specified the data in this table is valid for $T_{OP} = 27^{\circ}\text{C}$ and $V_{DD} = 5\text{V}$. All voltages are referenced to $\text{GND} = 0\text{V}$.

| Parameter | Symbol | Condition | min. | typ. | max. | Unit |
|--|-----------|--|-------|------------------------------|-------|-------------------------------------|
| feedback resistor | R | stage 20M Ω | 14000 | 20000 | 26700 | k Ω |
| | | stage 10M Ω | 7000 | 10000 | 13350 | k Ω |
| | | stage 5M Ω | 3500 | 5000 | 6700 | k Ω |
| | | stage 2M Ω | 1400 | 2000 | 2670 | k Ω |
| | | stage 1M Ω | 700 | 1000 | 1335 | k Ω |
| | | stage 0,5M Ω | 350 | 500 | 670 | k Ω |
| | | stage 0,1M Ω | 70 | 100 | 133 | k Ω |
| | | stage 0,025M Ω | 17 | 25 | 34 | k Ω |
| Typical photo sensitivity of colour ranges at stage 20M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$ | | 34,9 50,1 18,2 53,2 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| Typical photo sensitivity of colour ranges at stage 10M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$ | | 17,5 25,1 9,1 26,6 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| Typical photo sensitivity of colour ranges at stage 5M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$ | | 8,7 12,5 4,5 13,3 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| Typical photo sensitivity of colour ranges at stage 2M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$ | | 3,5 5,0 1,8 5,3 | | V/ ($\mu\text{W}/\text{cm}^2$) |

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| Parameter | Symbol | Condition | min. | typ. | max. | Unit |
| Typical photo sensitivity of colour ranges at stage 1M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ | | 1,75 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| | | $\lambda_y = 555 \text{ nm}$ | | 2,51 | | |
| | | $\lambda_{xk} = 445 \text{ nm}$ | | 0,91 | | |
| | | $\lambda_{xl} = 600 \text{ nm}$ | | 2,66 | | |
| Typical photo sensitivity of colour ranges at stage 0,5M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ | | 0,874 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| | | $\lambda_y = 555 \text{ nm}$ | | 1,254 | | |
| | | $\lambda_{xk} = 445 \text{ nm}$ | | 0,456 | | |
| | | $\lambda_{xl} = 600 \text{ nm}$ | | 1,330 | | |
| Typical photo sensitivity of colour ranges at stage 0,1M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ | | 0,175 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| | | $\lambda_y = 555 \text{ nm}$ | | 0,251 | | |
| | | $\lambda_{xk} = 445 \text{ nm}$ | | 0,091 | | |
| | | $\lambda_{xl} = 600 \text{ nm}$ | | 0,266 | | |
| Typical photo sensitivity of colour ranges at stage 0,025M Ω | S_{max} | $\lambda_z = 445 \text{ nm}$ | | 0,044 | | V/ ($\mu\text{W}/\text{cm}^2$) |
| | | $\lambda_y = 555 \text{ nm}$ | | 0,063 | | |
| | | $\lambda_{xk} = 445 \text{ nm}$ | | 0,023 | | |
| | | $\lambda_{xl} = 600 \text{ nm}$ | | 0,067 | | |
| signal frequency | f_{3dB} | stage 20M Ω , T_{OP} | 4 | 6 | 16 | kHz |
| | | stage 10M Ω , T_{OP} | 7 | 11 | 28 | kHz |
| | | stage 5M Ω , T_{OP} | 11 | 16 | 42 | kHz |
| | | stage 2M Ω , T_{OP} | 18 | 26 | 66 | kHz |
| | | stage 1M Ω , T_{OP} | 25 | 35 | 95 | kHz |
| | | stage 0,5M Ω , T_{OP} | 35 | 50 | 130 | kHz |
| | | stage 0,1M Ω , T_{OP} | 80 | 120 | 280 | kHz |
| | | stage 0,025M Ω , T_{OP} | 160 | 300 | 580 | kHz |
| temperature coefficient of the feedback resistor | TC_R | | | -3300 | | ppm/K |

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| Parameter | Symbol | Condition | min. | typ. | max. | Unit |
|--|-------------|---|------|------|------|---------|
| offset voltage | V_{OFF}^4 | T_{OP} | -10 | | 10 | mV |
| capacitive load at VOUT<X> | C_{LOAD} | $I_{LOAD} < 0.5mA$ per output | | | 50 | pF |
| pull down current SW1, SW2, SW3, SW4, PD | I_{PDPAD} | digital inputs | | | 200 | μA |
| tolerance of the feedback resistors between the four channels | TOL_R^5 | DC input current; for all stages | 1 | | 10 | % |

7.4 Maximum Conditions

Violations of absolute maximum conditions are not allowed under any circumstances, otherwise the IC can be destroyed. All voltages are referenced to GND = 0V.

| Parameter | Symbol | min. | max. | Unit |
|---------------------------|--------------------------|------|---------|-------------|
| power supply | VDD | 0.3 | 7.0 | V |
| input and output voltages | \Rightarrow IC-pinning | 0.3 | VDD+0.3 | V |
| power dissipation | POP | | 0.025 | W |
| operating temperature | TOP | -40 | + 100 | $^{\circ}C$ |
| storage temperature | TSTG | -40 | + 100 | $^{\circ}C$ |

⁴ $V_{OFF} = V_{OUT<X>} - V_{REF}$; results from input offset voltage and input leakage current

⁵ up to max. 1% available on request

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8 PACKAGE AND OUTLINE DIMENSIONS

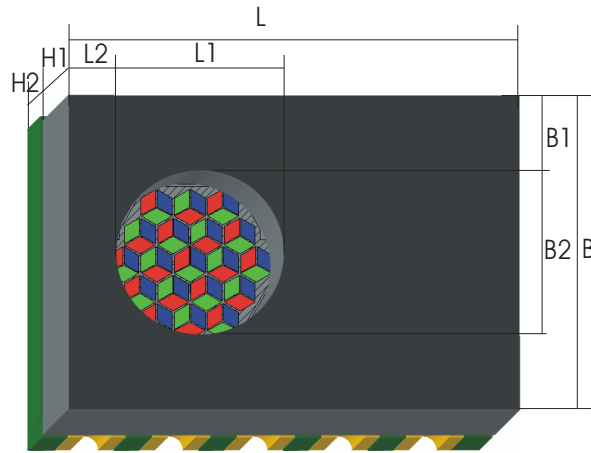


Figure 7: Sizes of packaged TIAM2

| Type | H1+H2 | H1 | H2 | L | L1 | L2 | B | B1 | B2 |
|------|-------|-------------------|-------|-------|-------|-------|-------|-------|-------|
| A | 6,50 | 6,00 ⁶ | 0,50 | 6,50 | 2,00 | 0,95 | 5,00 | 1,50 | 2,00 |
| B | 2,00 | 1,50 ⁷ | 0,50 | 6,50 | 2,00 | 0,95 | 5,00 | 1,50 | 2,00 |
| Tol. | ±0,20 | ±0,10 | ±0,10 | ±0,05 | ±0,05 | ±0,05 | ±0,05 | ±0,05 | ±0,05 |

All dimensions in mm

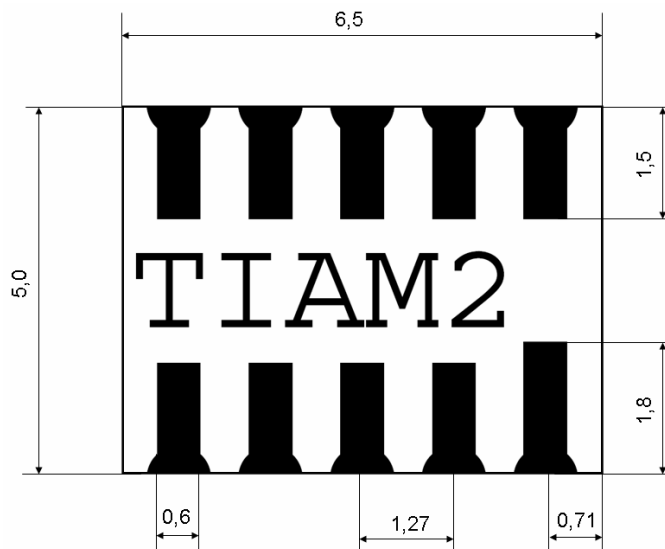


Figure 8: Pad dimensions

⁶ specific variant for prototypes (only with 4,0 mm thickness of windows cap) or custom specific on request

⁷ standard device for series

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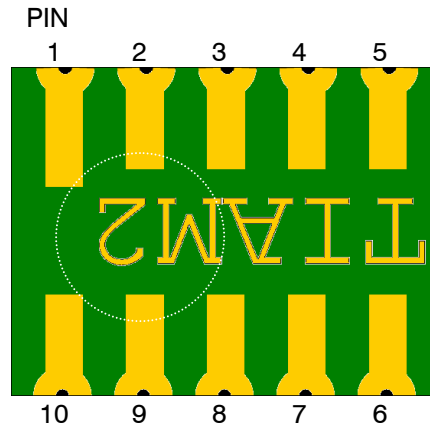


Figure 9: PIN configuration TIAM2 - Bottom view

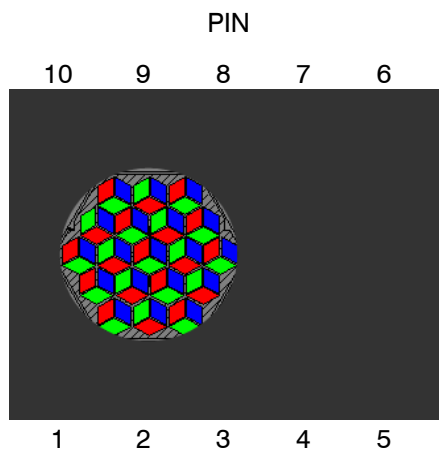


Figure 10: PIN configuration MTCS-TIAM2 Top View

9 PIN-CONFIGURATION

| Pin | Name | IN-/OUTPUT | A/D | Description |
|-----|--------|------------|-----|---|
| 1 | PD | INPUT | D | power down modus (pull down) |
| 2 | VOUT Y | OUTPUT | A | analogue voltage output Y |
| 3 | VOUT Z | OUTPUT | A | analogue voltage output Z |
| 4 | VOUT X | OUTPUT | A | analogue voltage output X |
| 5 | SW3 | INPUT | D | input 3 for adjustment of transimpedance of MTI-amplifier (pull down) |
| 6 | VDD | INPUT | D/A | power supply |
| 7 | SW2 | INPUT | D | input 2 for adjustment of transimpedance of MTI-amplifier (pull down) |
| 8 | SW1 | INPUT | D | input 1 for adjustment of transimpedance of MTI-amplifier (pull down) |
| 9 | GND | INPUT | D/A | ground |
| 10 | VREF | INPUT | A | reference voltage |

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10 SOLDERING PROFILE

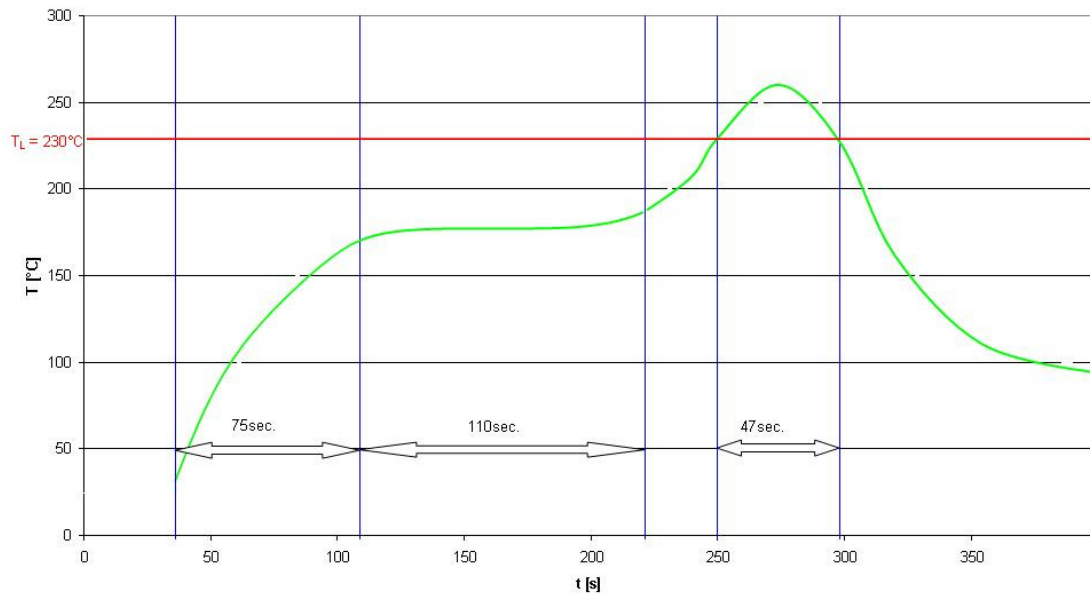
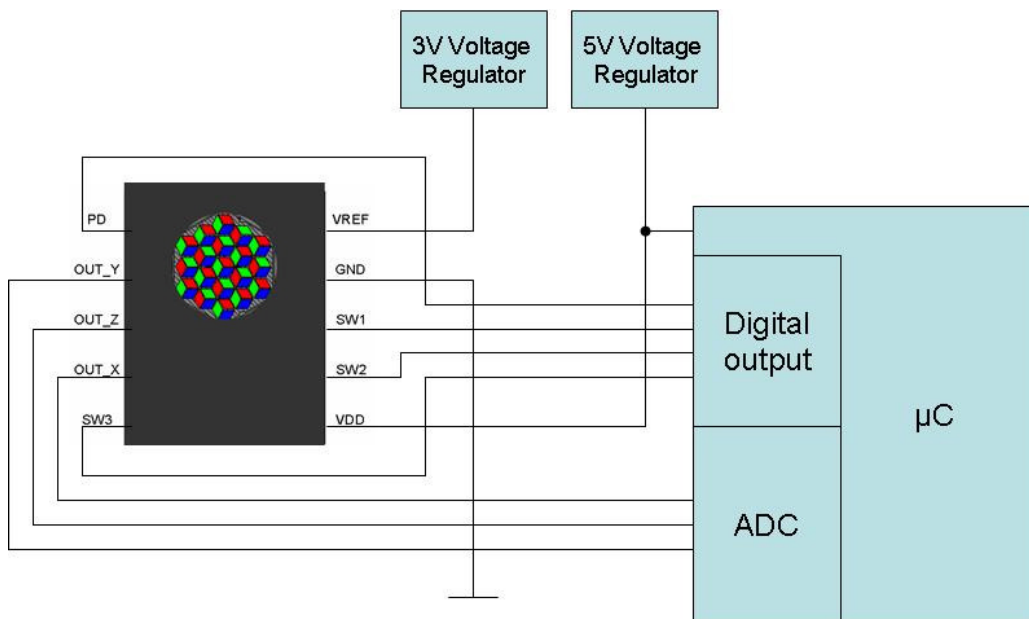


Figure 11: SOLDERING PROFILE

11 APPLICATION NOTE

In the following there is an example for connection of TIAM 2 to a μC -based measurement system. Please note the necessary connection of Vref (e.g. 3V, depend on the used ADC) and Vdd (e.g. 5V). Alternatives are possible within the settings (see chapter 7).



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The TIAM2 includes an multichannel amplifier of MAZeT. The amplifier can be switched smoothly to the required amplification stage via μC programming, e.g. if input variables fail to reach or exceed a set threshold. Transimpedance programming is carried out via three inputs and affects all channels simultaneously (see also chapter 6.1). In the following there is a preposition for an algorithm to switch automatically the required amplification via μC .

defines: $V_{\text{MIN}} = 1$, $V_{\text{MAX}} = 8$ $U_{\text{MAX}} = 0x3ff$, $U_{\text{MIN}} = 0x1ff$
 Values for calculation LimitO and LimitU: $\text{Tabvalue}[8] = \{ 4, 5, 2, 2, 3, 2, 2, 1 \}$

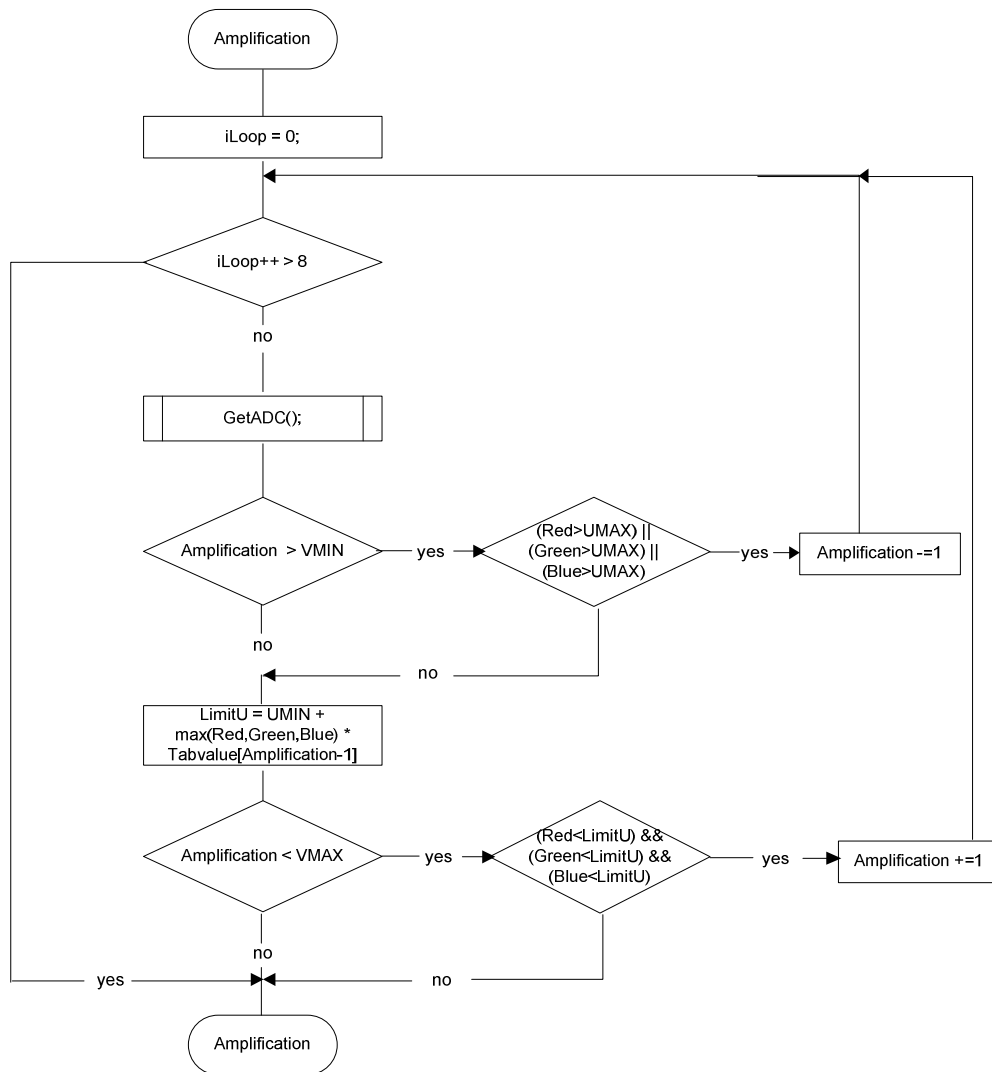


Figure 12: μC -based Algorithm for calculation of an automatic switch of the 8-staged amplification

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12 ORDERING INFORMATION

True Colour sensor with integrated amplifier

MTCS-TIAM2

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