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	NO.	ISSUE	APPROVED
	1	V 1.3	2007-01-10

Data Sheet

MTCS - TIAM2

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

Table of Contents

1 INTRODUCTION	2
2 APPLICATION	2
3 FEATURES	2
4 BLOCK DIAGRAM	3
5 SPECTRAL RESPONSE	4
6 DESCRIPTION OF INTERFACE	5
6.1 Adjustment of Transimpedance	5
6.2 Power Down Modus	5
7 SPECIFICATION	6
7.1 ELECTRICAL AND OPTICAL CHARACTERISTICS OF PHOTO DIODE ARRAY	6
7.2 ELECTRICAL CHARACTERISTICS	6
7.3 AC/DC-Characteristics	7
7.4 Maximum Conditions	9
8 PACKAGE AND OUTLINE DIMENSIONS	10
9 PIN-CONFIGURATION	11
10 SOLDERING PROFILE	12
11 APPLICATION NOTE	12
12 ORDERING INFORMATION	14

MAZeT GmbH Sales Göschwitzer Straße 32 07745 JENA / GERMANY Phone: +49 3641 2809-0 Fax: +49 3641 2809-12 E-Mail: sales@MAZeT.de Url: http://www.MAZeT.de	Approvals	Date	MAZeT GmbH	
	Compiled:	2007-01-10	Status: valid	
	Checked:	2007-01-10		
	Released:	2007-01-10	DOC. NO.: DB-06-202	Page 1 of 14

VERSION		
NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

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 sensitised 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

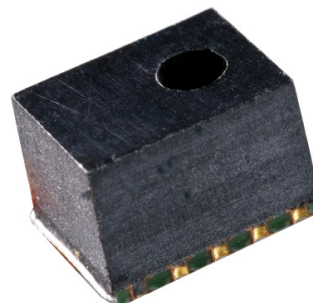


Figure 1: TIAM2 - Var. A

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

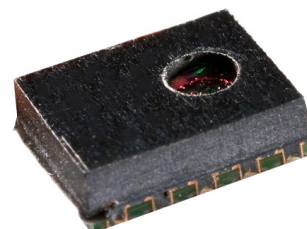


Figure 2: TIAM2 - Var. B

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.

VERSION		
NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

4 BLOCK DIAGRAM

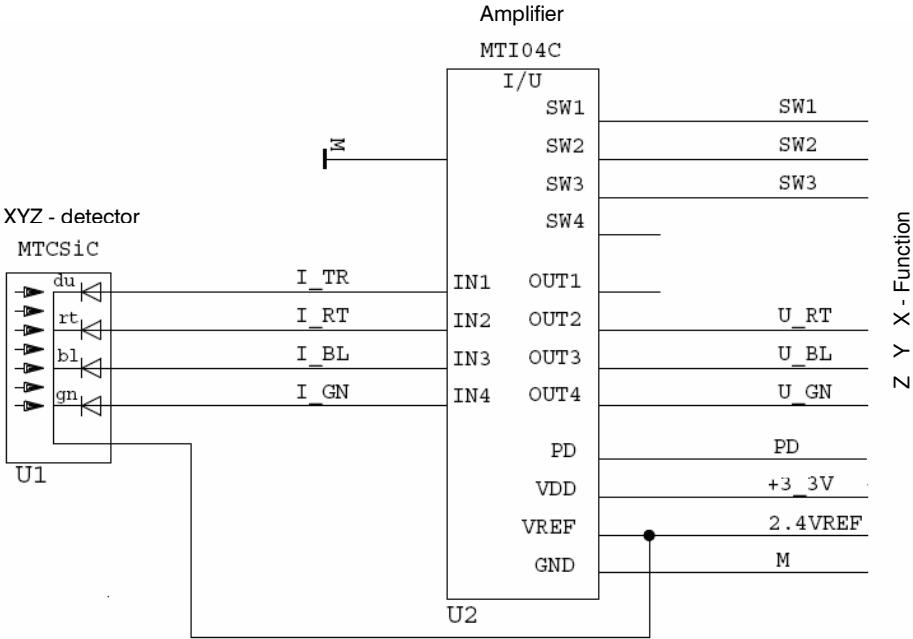


Figure 3: on Chip detector MTCSi and amplifier MTI04C

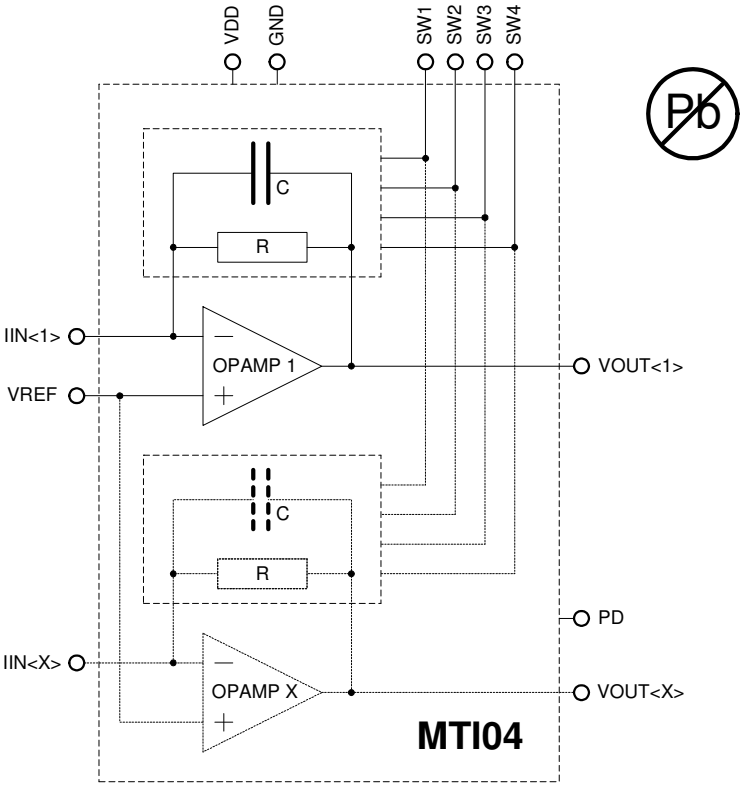


Figure 4: amplifier corresponds the MTI04C

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NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

5 SPECTRAL RESPONSE

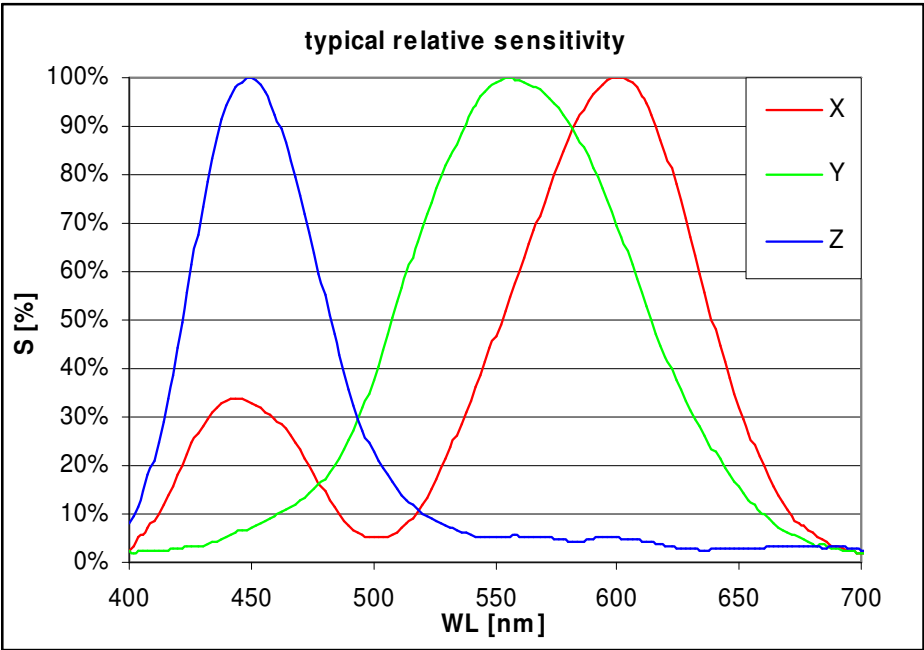


Figure 5: typical (relative) sensitivity (XYZ) of the colour sensor2, scanned by width broadband light (FWHM 30nm)

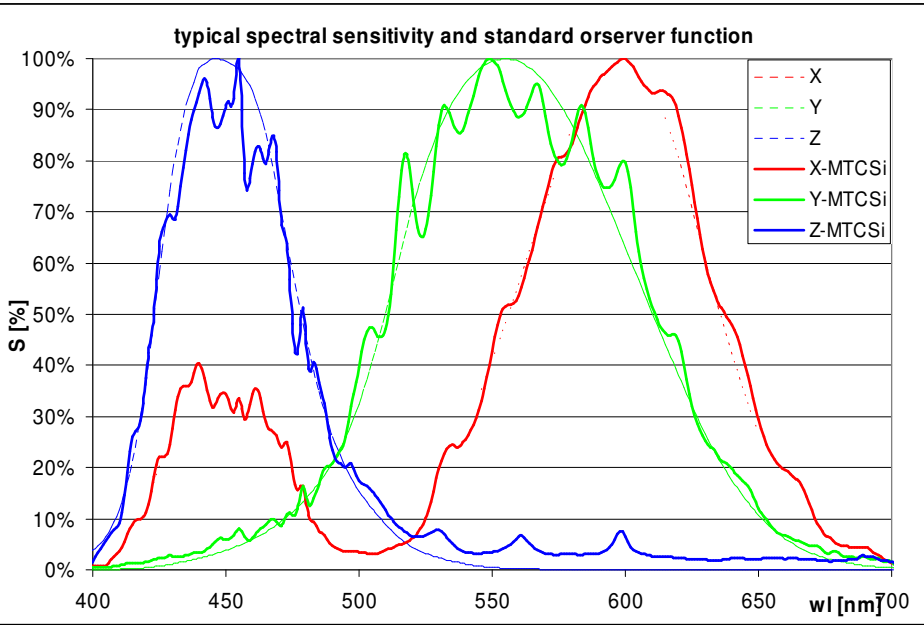


Figure 6: typical (relative) sensitivity (XYZ) of the colour sensor3 scanned by narrow-band light (FWHM 3nm)

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

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

NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

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	
GND	

c.) default by pull down

NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

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 , $VDD=5.5\text{V}$		2.5	4.0	mA
bias current MTI04	I(VDD)	PD=VDD			8	μA
reference voltage	VREF		0.4		VDD-0.4	V

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/ ($\mu\text{W}/\text{cm}^2$)

DATA SHEET MTCS – TIAM2				VERSION		
				NO.	ISSUE	APPROVED
				1	V 1.3	2007-01-10
Parameter	Symbol	Condition	min.	typ.	max.	Unit
Typical photo sensitivity of colour ranges at stage 1M Ω	S_{max}	$\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$		1,75 2,51 0,91 2,66		V/ ($\mu\text{W}/\text{cm}^2$)
Typical photo sensitivity of colour ranges at stage 0,5M Ω	S_{max}	$\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$		0,874 1,254 0,456 1,330		V/ ($\mu\text{W}/\text{cm}^2$)
Typical photo sensitivity of colour ranges at stage 0,1M Ω	S_{max}	$\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$		0,175 0,251 0,091 0,266		V/ ($\mu\text{W}/\text{cm}^2$)
Typical photo sensitivity of colour ranges at stage 0,025M Ω	S_{max}	$\lambda_z = 445 \text{ nm}$ $\lambda_y = 555 \text{ nm}$ $\lambda_{xk} = 445 \text{ nm}$ $\lambda_{xl} = 600 \text{ nm}$		0,044 0,063 0,023 0,067		V/ ($\mu\text{W}/\text{cm}^2$)
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 $V_{OUT<X>}$	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	°C
storage temperature	TSTG	-40	+ 100	°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

VERSION		
NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

8 PACKAGE AND OUTLINE DIMENSIONS

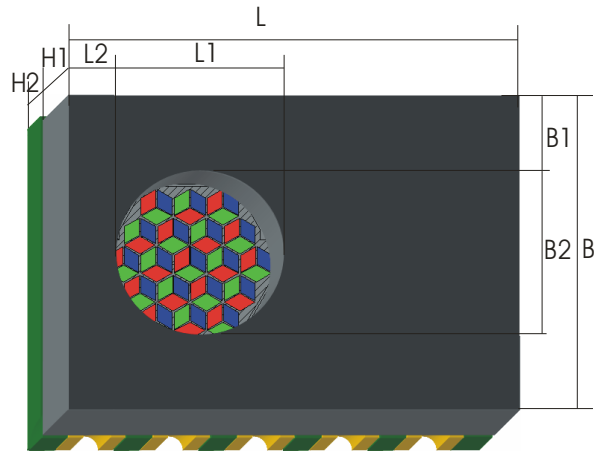


Figure 7: Sizes of packaged TIAM2

Type	H1 + H2	H1	H2	L	L1	L2	B	B1	B2
A	6,5	6,0 ⁶	0,5	6,5	2,0	0,95	5,0	1,5	2,0
B	2,0	1,5 ⁷	0,5	6,5	2,0	0,95	5,0	1,5	2,0

All dimensions in mm

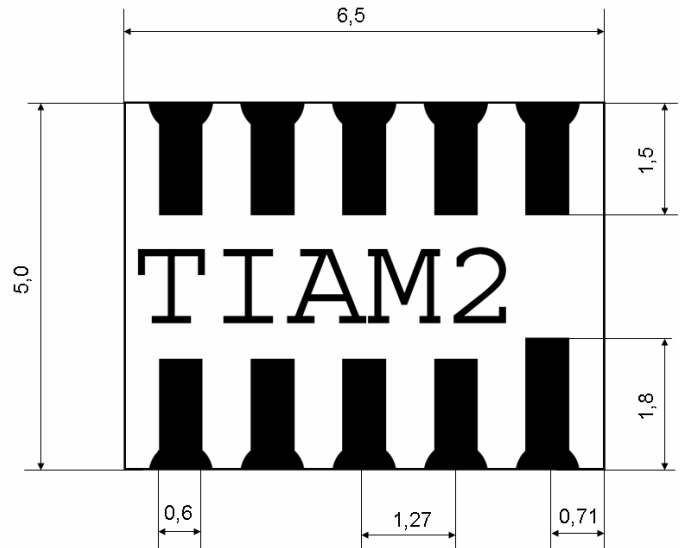


Figure 8: Pad dimensions

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

⁷ standard device for series

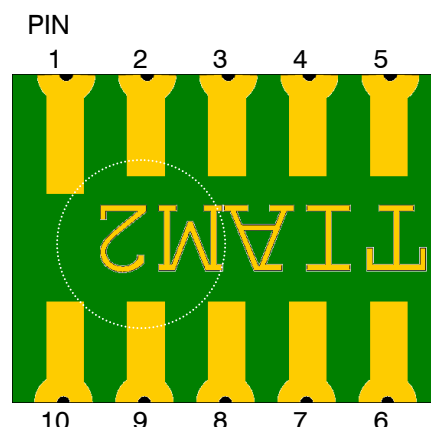


Figure 9: PIN configuration TIAM2 - Bottom view

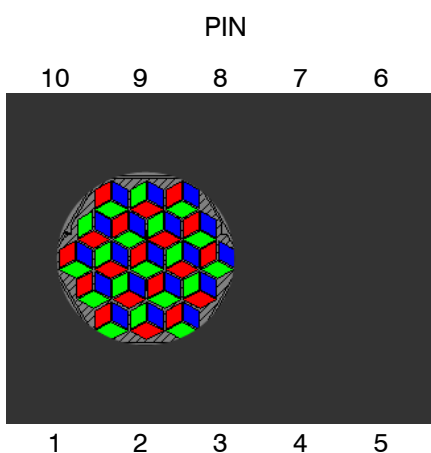


Figure 10: PIN configuration MTCS-TIAM2 Top View

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

VERSION		
NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

10 SOLDERING PROFILE

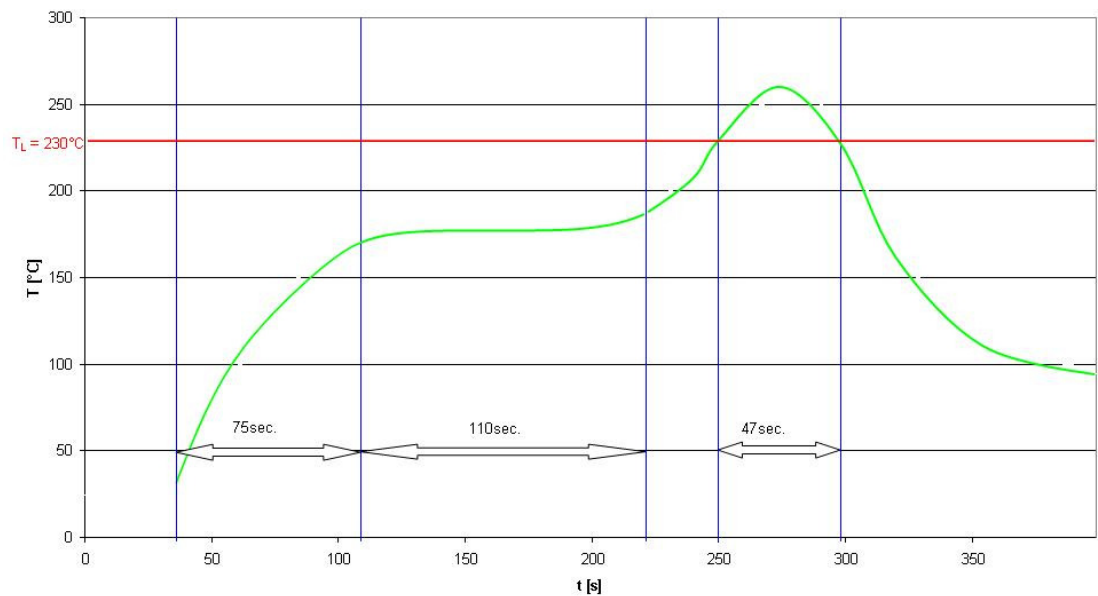
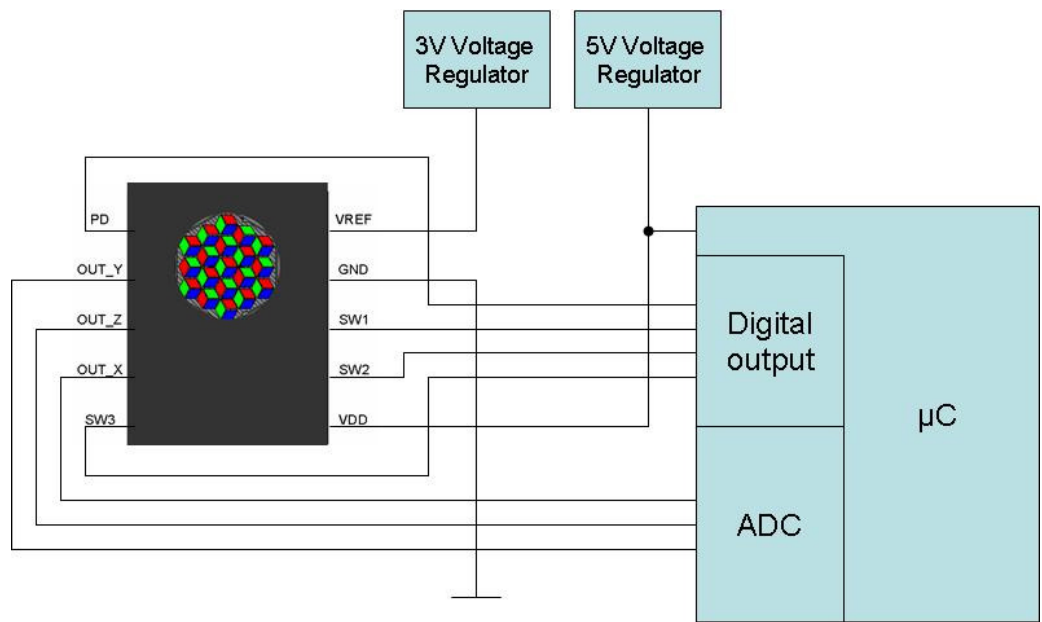


Figure 11: SOLDERING PROFILE

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).



VERSION		
NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

The TIAM2 includes an multichannel amplifier of MAZeT. The amplifier can be switched smoothly to the required amplification stage via μ C 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 μ C.

defines: VMIN = 1, VMAX = 8 UMAX = 0x3ff, UMIN = 0x1ff

Values for calculation LimitO and LimitU: Tabvalue[8] = { 4, 5, 2, 2, 3, 2, 2, 1 }

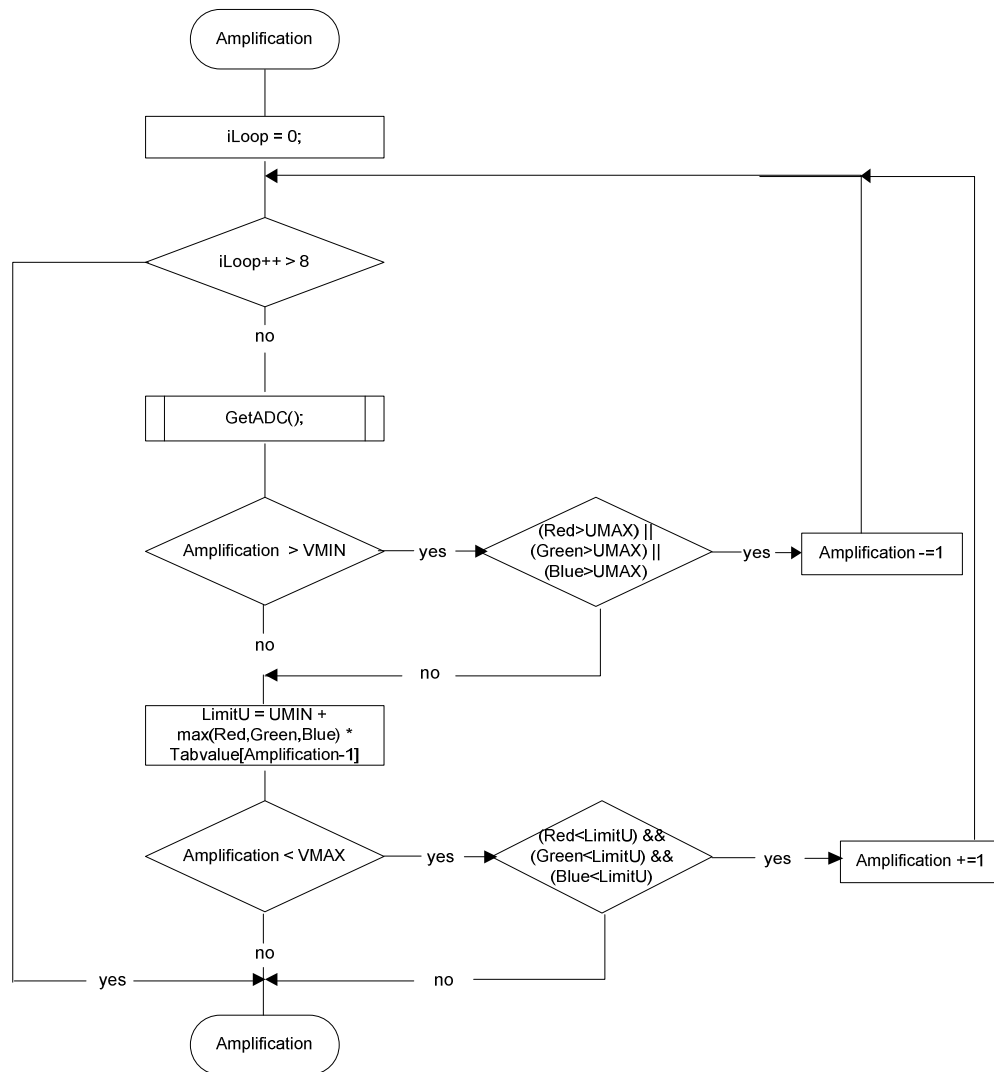


Figure 12: μ C-based Algorithm for calculation of an automatic switch of the 8-staged amplification

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NO.	ISSUE	APPROVED
1	V 1.3	2007-01-10

12 ORDERING INFORMATION

True Colour sensor with integrated amplifier

MTCS-TIAM2

For further information please contact:

MAZeT GmbH

Sales office:

Göschwitzer Straße 32

07745 JENA

GERMANY

Phone: +49 3641 2809-0

Fax: +49 3641 2809-12

E-Mail: sales@MAZeT.de

URL: <http://www.MAZeT.de>

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