Data Sheet

MTCS - TIAM2

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

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1 INTRODUCTION

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

The True Color 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 Color Filter[1]) for its color range, preferably for the primary color standard CIE (Commission Internationale de l'Eclairage or International Commission on Illumination) color 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 Color detection and measurements
- Consumer appliances
- Portable color detector/reader
- RGB-LCD backlight monitors
- Regulation of RGB-power LEDs
- Detector for various light sources

3 FEATURES

Dielectric filters guaranties the good optical properties of the color 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 color measurement to DIN 5033 (CIE 1931)
- LCC package
- RoHS-conform

Figure 1: TIAM2

[1] The new generation of JENCOLOR 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.

4 BLOCK DIAGRAM

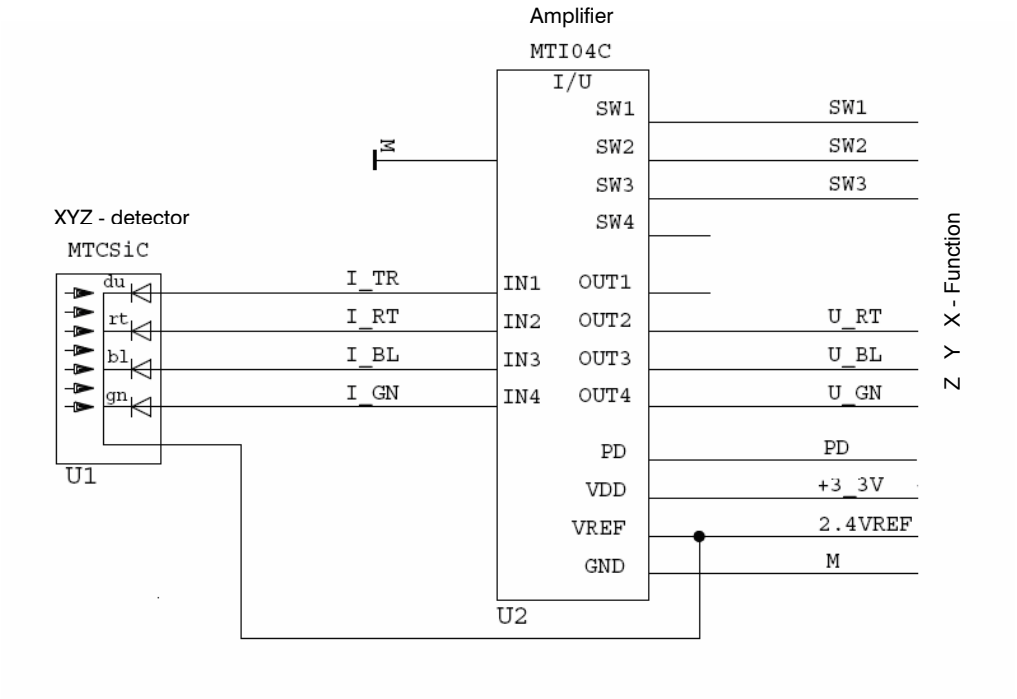


Figure 2: on Chip detector MTCSi and amplifier MTI04C

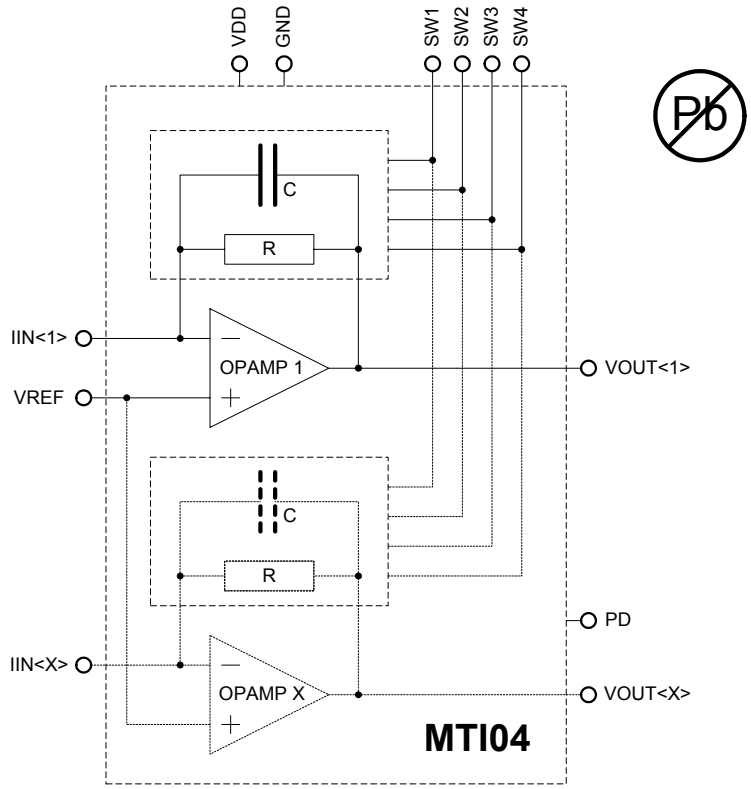


Figure 3: amplifier corresponds the MTI04C

5 SPECTRAL RESPONSE

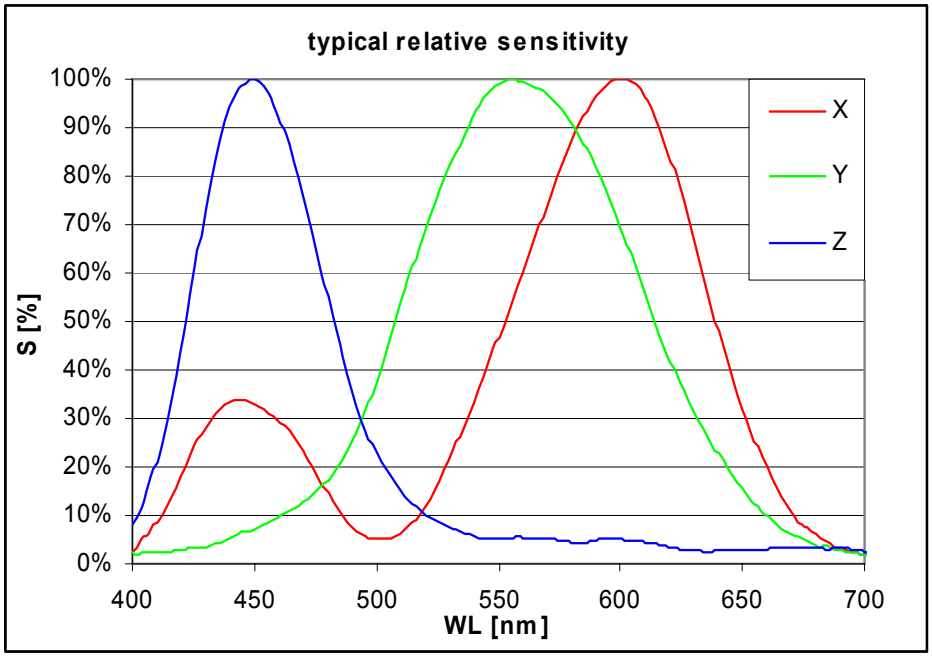


Figure 4: typical (relative) sensitivity (XYZ) of the color sensor2,
scanned by width broadband light (FWHM 30nm)

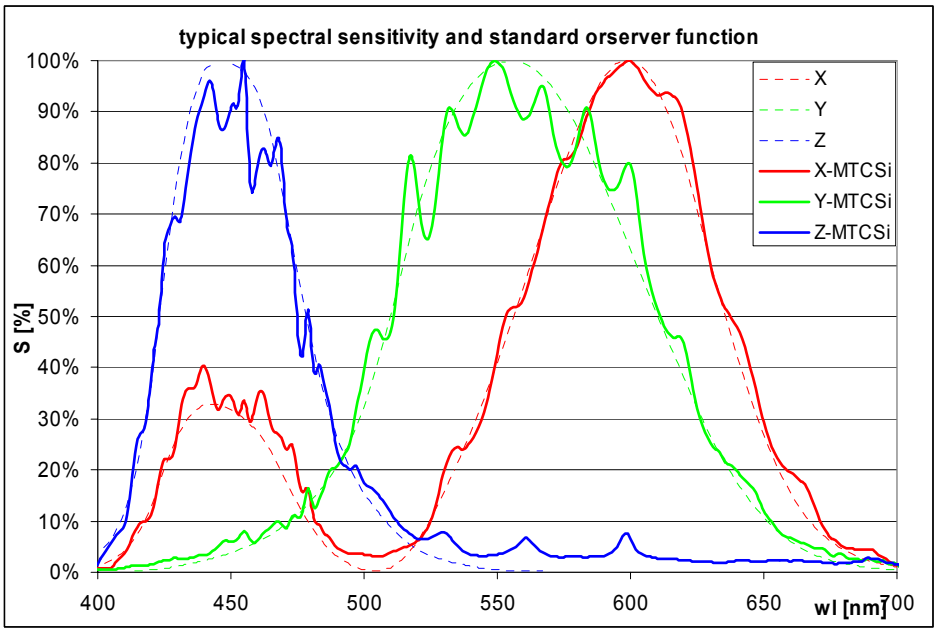


Figure 5: typical (relative) sensitivity (XYZ) of the color sensor3
scanned by narrow-band light (FWHM 3nm)

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

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	20MΩ – **stage 1**
GND	VDD	VDD	10MΩ – **stage 2**
GND	VDD	GND	5MΩ – **stage 3**
VDD	GND	VDD	2MΩ – **stage 4**
GND	GND	VDD	1MΩ – **stage 5**
VDD	GND	GND	500kΩ – **stage 6**
VDD	VDD	GND	100kΩ – **stage 7**
GND	GND	GND	25kΩ[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	< 8μA
GND	typical[c]

c.) default by pull down

7 SPECIFICATION

7.1 ELECTRICAL AND OPTICAL CHARACTERISTICS OF PHOTO DIODE ARRAY

(T_A = 25°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 color array (19 diodes)	A			0,76		mm^2
Typical photo diode sensitivity of color ranges	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 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%*λ	nm
Reverse voltage	V_R		0	2,5	5	V
Dark current	I_R	V_R = 2,5V			10	pA
Noise equivalent power	NEP	f_R = 100 Hz			$<10^{-13}$	W/√Hz
Cross-talk					<1	%
Angle of incidence	φ	$\Delta\lambda_{(Filter)}$ < 1%*λ			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 (power down mode)	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°C and VDD = 5V. All voltages are referenced to GND = 0V.

Parameter	Symbol	Condition	min.	typ.	max.	Unit
feedback resistor	R	stage 20MΩ	14000	20000	26700	kΩ
		stage 10MΩ	7000	10000	13350	kΩ
		stage 5MΩ	3500	5000	6700	kΩ
		stage 2MΩ	1400	2000	2670	kΩ
		stage 1MΩ	700	1000	1335	kΩ
		stage 0,5MΩ	350	500	670	kΩ
		stage 0,1MΩ	70	100	133	kΩ
		stage 0,025MΩ	17	25	34	kΩ
Typical photo sensitivity of color ranges at stage 20MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		34,9 50,1 18,2 53,2		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 10MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		17,5 25,1 9,1 26,6		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 5MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		8,7 12,5 4,5 13,3		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 2MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		3,5 5,0 1,8 5,3		V/ (μW/cm²)

Parameter	Symbol	Condition	min.	typ.	max.	Unit
Typical photo sensitivity of color ranges at stage 1MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		1,75 2,51 0,91 2,66		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 0,5MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		0,874 1,254 0,456 1,330		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 0,1MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		0,175 0,251 0,091 0,266		V/ (μW/cm²)
Typical photo sensitivity of color ranges at stage 0,025MΩ	S_{max}	λ_Z = 445 nm λ_Y = 555 nm λ_{Xk} = 445 nm λ_{Xl} = 600 nm		0,044 0,063 0,023 0,067		V/ (μW/cm²)
signal frequency	f_{3dB}	stage 20MΩ, T_{OP}	4	6	16	kHz
		stage 10MΩ, T_{OP}	7	11	28	kHz
		stage 5MΩ, T_{OP}	11	16	42	kHz
		stage 2MΩ, T_{OP}	18	26	66	kHz
		stage 1MΩ, T_{OP}	25	35	95	kHz
		stage 0,5MΩ, T_{OP}	35	50	130	kHz
		stage 0,1MΩ, T_{OP}	80	120	280	kHz
		stage 0,025MΩ, T_{OP}	160	300	580	kHz
temperature coefficient of the feedback resistor	TC_R			–3300		ppm/K

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	⇒ 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} = VOUT<X> – VREF; results from input offset voltage and input leakage current
[5] up to max. 1% available on request

8 PACKAGE AND OUTLINE DIMENSIONS

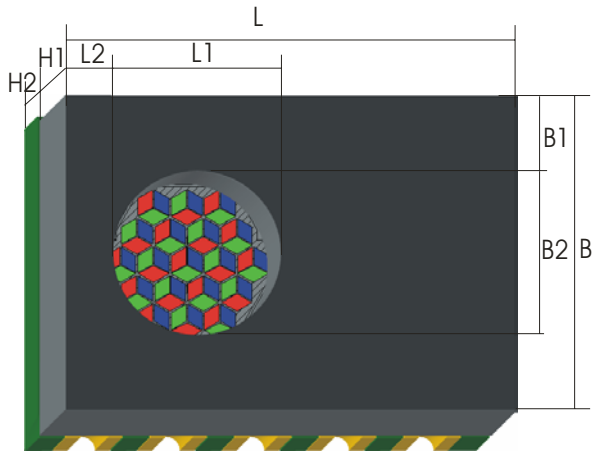


Figure 6: Sizes of packaged TIAM2

	H1+H2	H1	H2	L	L1	L2	B	B1	B2
mm	2,30	1,50[6]	0,80	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

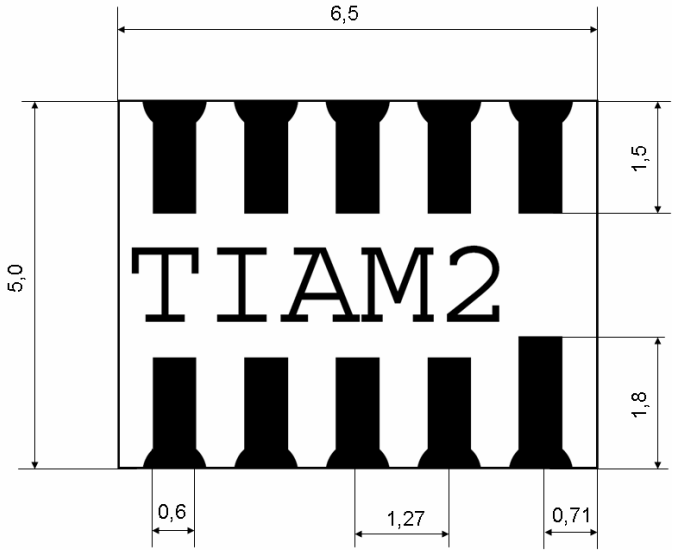


Figure 7: Pad dimensions

[6] standard device for series

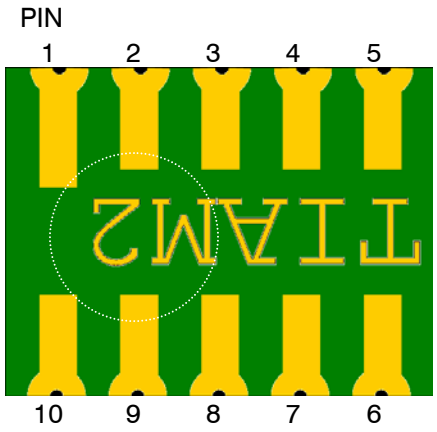


Figure 8: PIN configuration TIAM2 - Bottom view

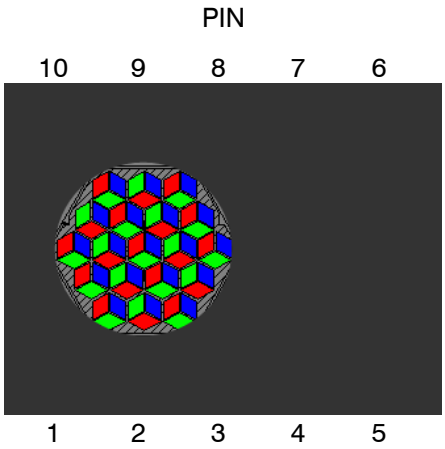


Figure 9: PIN configuration MTCS-TIAM2 Top View

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

10 SOLDERING PROFILE

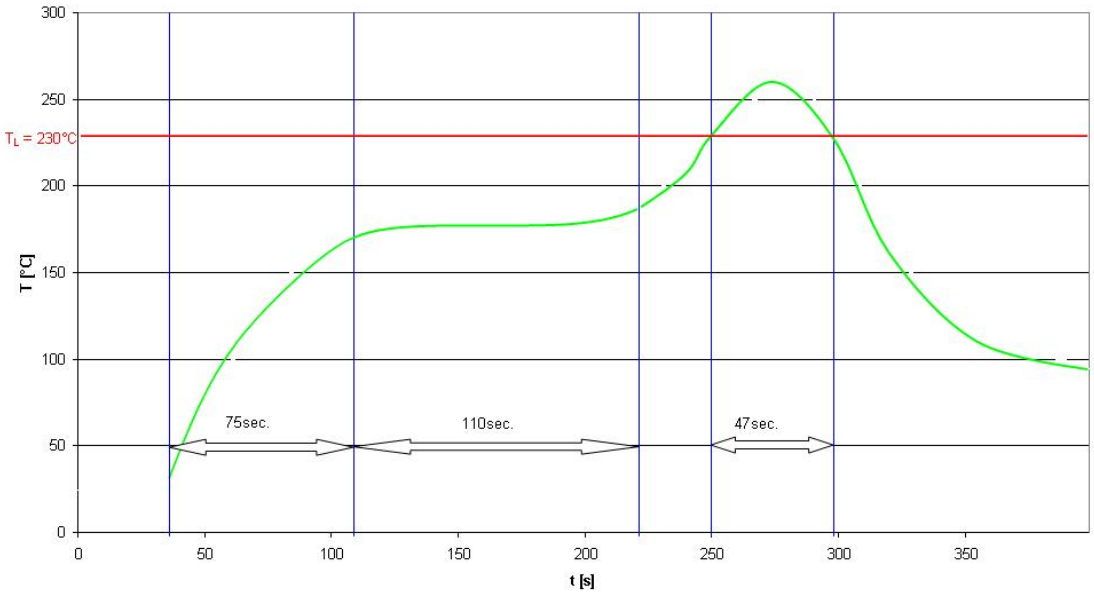
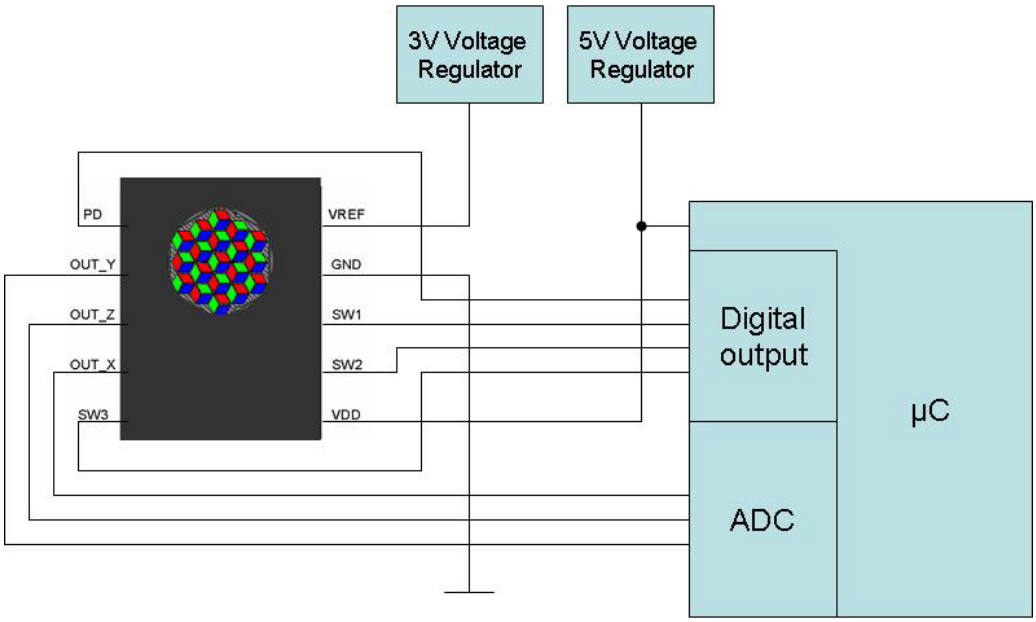


Figure 10: SOLDERING PROFILE

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).



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

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

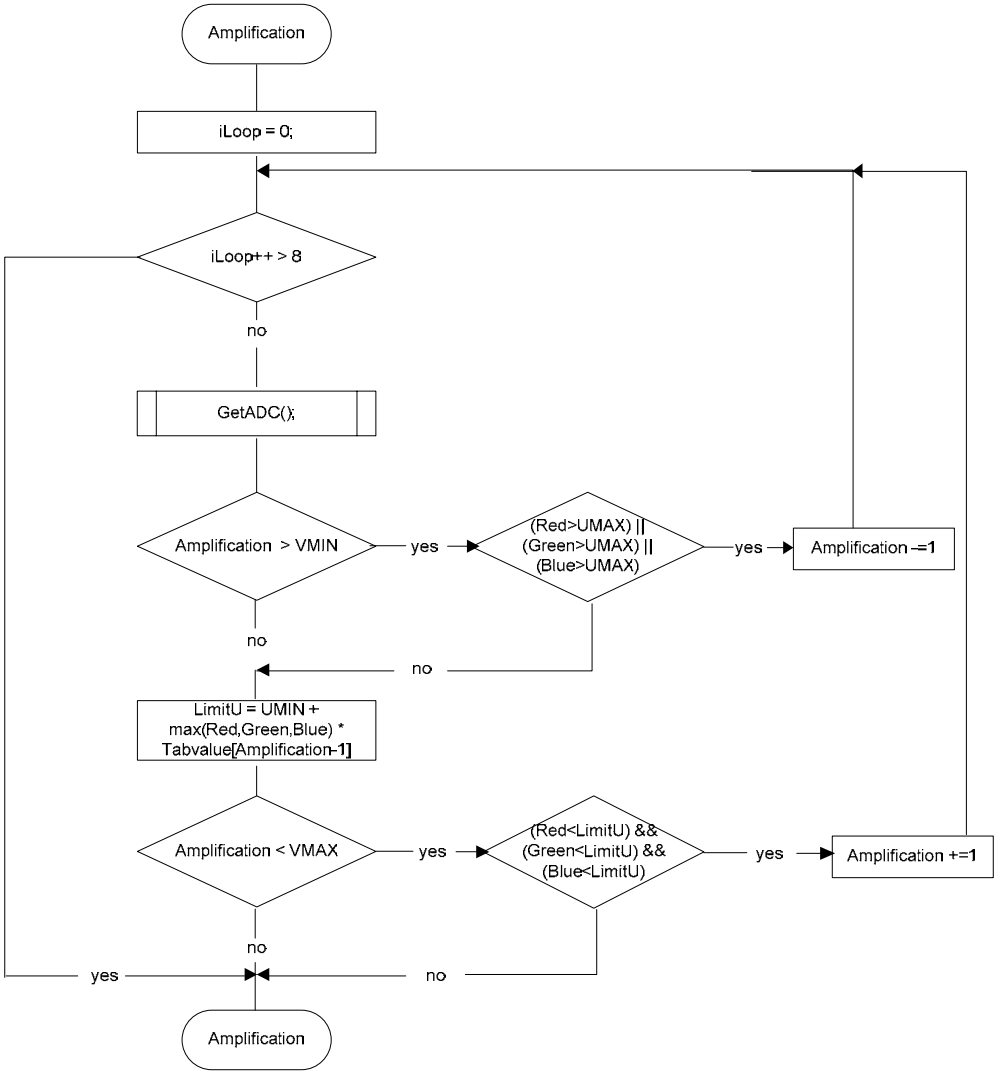


Figure 11: μC-based Algorithm for calculation of an automatic switch of the 8-staged amplification

12 ORDERING INFORMATION

True Color sensor with integrated amplifier **MTCS-TIAM2**

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