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|                                                                                                                                                                                                                                                                                                                                                                                                           | NO        | VERSION | APPROVED   |
|                                                                                                                                                                                                                                                                                                                                                                                                           | 1         | V 1.4   | 2007-08-01 |

## Data Sheet

# MTI04CS/MTI04CQ

## MULTI-CHANNEL PROGRAMMABLE GAIN TRANSIMPEDANCE AMPLIFIER

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|---------------------|-------------|
|                                                                                                                                                                                   | Compiled: | 2007-08-01 | Status: valid       |             |
|                                                                                                                                                                                   | Checked:  | 2007-08-01 |                     |             |
|                                                                                                                                                                                   | Released: | 2007-08-01 | DOC. NO: DB-05-175e | Page 1 of 8 |

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## 1. GENERAL DESCRIPTION

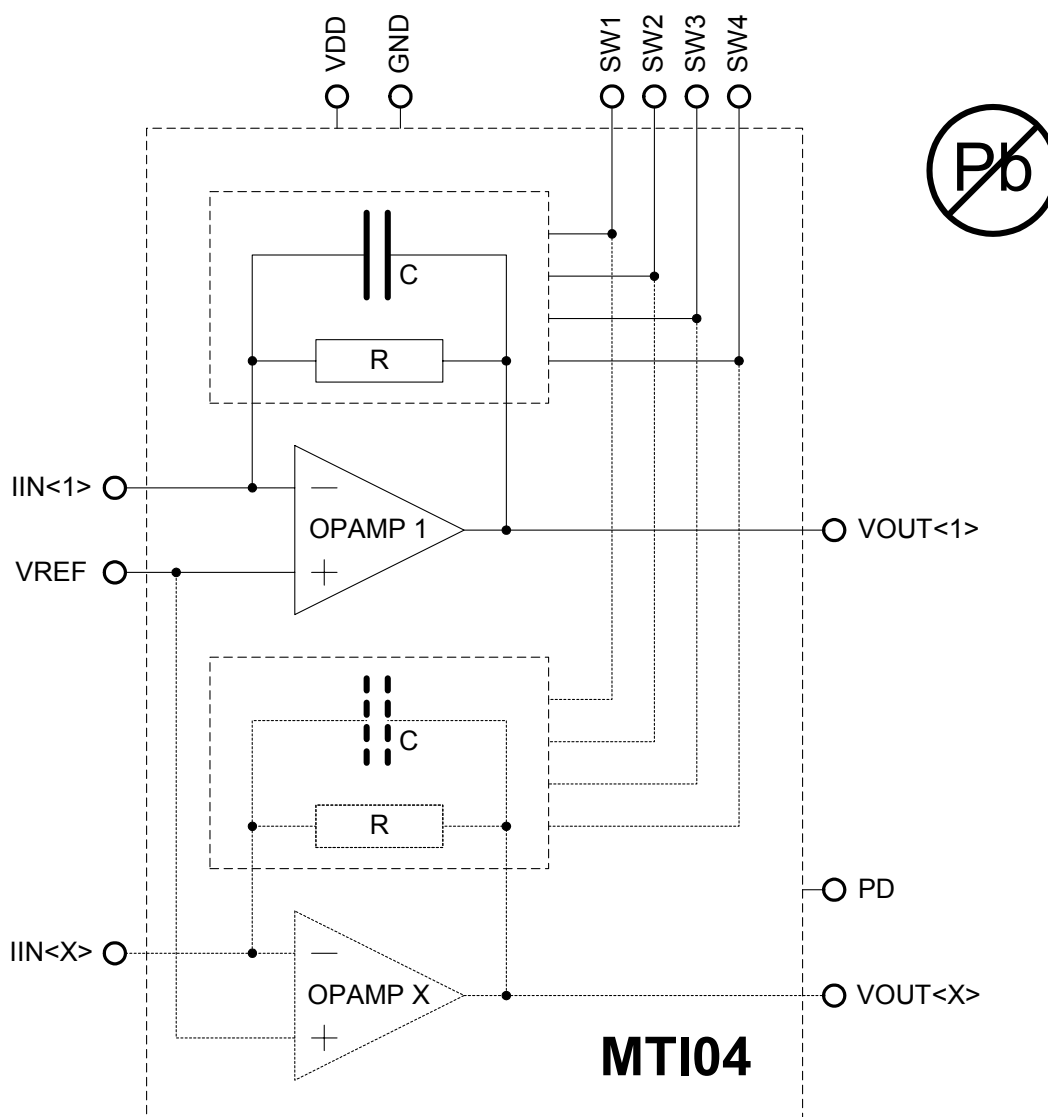
The MTI-devices are a family of integrated circuits of **programmable gain transimpedance amplifiers** with **4 channels** per IC (more custom specific, on request).

The MTI-devices are mainly used for **signal conditioning of sensors with current outputs**. They are especially suitable for connection of photodiodes of **array and row sensors**.

The possibility to **adjust the transimpedance in 8 stages** is a special feature. The adjustment is made by programming three pins and is valid for all channels together.

The device packages (naked chip on request) are ROHS conform and optimized for **COB-mounting and SMD**.

## 2. BLOCK DIAGRAM



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### 3. DESCRIPTION OF INTERFACE

#### 3.1 Pinning

| signal name | typ.   | a/d <sup>a</sup> | 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)                     |
| SW4         | input  | d                | switchable frequency range dependend on input capacitance of the photo-sensor (pull down) |
| PD          | input  | d                | power down modus (pull down)                                                              |
| IIN<X>      | input  | a                | analog current input of amplifier X                                                       |
| VOOUT<X>    | output | a                | analog voltage output of amplifier X                                                      |

a.) analog or digital

#### 3.2 Adjustment of Transimpedance

| settings of digital inputs |     |     | transimpedance R                           |
|----------------------------|-----|-----|--------------------------------------------|
| SW1                        | SW2 | SW3 |                                            |
| VDD                        | VDD | VDD | 20M $\Omega$ – <b>stage 1</b>              |
| GND                        | VDD | VDD | 10M $\Omega$ – <b>stage 2</b>              |
| GND                        | VDD | GND | 5M $\Omega$ – <b>stage 3</b>               |
| VDD                        | GND | VDD | 2M $\Omega$ – <b>stage 4</b>               |
| GND                        | GND | VDD | 1M $\Omega$ – <b>stage 5</b>               |
| VDD                        | GND | GND | 500k $\Omega$ – <b>stage 6</b>             |
| VDD                        | VDD | GND | 100k $\Omega$ – <b>stage 7</b>             |
| GND                        | GND | GND | 25k $\Omega$ <sup>b</sup> – <b>stage 8</b> |

b.) default by pull down

#### 3.3 Switchable Frequency Range

| settings of digital input | allowed capacitance of photo-sensor |
|---------------------------|-------------------------------------|
| SW4                       |                                     |
| VDD                       |                                     |
| GND                       |                                     |
|                           | < 5pF                               |
|                           | < 80pF <sup>c</sup>                 |

c.) default by pull down

#### 3.4 Power Down Modus

| settings of digital input | bias current of the IC |
|---------------------------|------------------------|
| PD                        |                        |
| VDD                       |                        |
| GND                       |                        |
|                           | < 8 $\mu$ A            |
|                           | typical <sup>d</sup>   |

d.) default by pull down

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#### 4. DESCRIPTION OF FUNCTION

The MTI-devices are programmable gain transimpedance amplifiers with different numbers of channels (MTI04 – 4 channels). There is one transimpedance amplifier per channel between a current input IIN<X> and a voltage output VOUT<X>. Its transimpedance is selectable in 8 stages. This adjustment can be effected by setting of digital inputs SW1, SW3 and SW4 and is valid for all channels simultaneously (headline 3.2).

Also simultaneously valid for all channels is a compensation of the input capacitance of photo-sensors for two possible frequency ranges (switchable by SW4, headline 3.3). The pins SW1, SW2, SW3 and SW4 are pull down inputs.

The second input of all transimpedance amplifiers is used for a *common* supply by a reference voltage necessarily fed in through the pin VREF.

All channels are compensated for an external input capacitance of the photo-sensor of smaller than 80pF (SW4 = GND).

The power supply for the MTI-devices is typical 3V to 5V between VDD and GND.

The power down modus is adjusted by PD = VDD and switches off the functionality.

#### 5. ELECTRICAL CHARACTERISTICS

##### 5.1 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                 | name             | 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         | P <sub>OP</sub>  |      | 0.025   | W    |
| operating temperature     | T <sub>OP</sub>  | -40  | 125     | °C   |
| storage temperature       | T <sub>STG</sub> | 55   | 155     | °C   |

##### 5.2 Operating Conditions

All voltages are referenced to GND = 0V.

| parameter             | name            | min.    | typ.   | max.    | unit | condition         |
|-----------------------|-----------------|---------|--------|---------|------|-------------------|
| supply voltage        | VDD             | 2.7     | 3 to 5 | 5.5     | V    |                   |
| bias current MTI04    | I(VDD)          |         | 2.5    | 4.0     | mA   | 27°C,<br>VDD=5.5V |
| bias current MTI04    | I(VDD)          |         |        | 8       | μA   | PD=VDD            |
| operating temperature | T <sub>OP</sub> | -40     | 27     | 125     | °C   |                   |
| input high level      | V <sub>IH</sub> | 0.7*VDD |        | VDD+0.3 | V    |                   |
| input low level       | V <sub>IL</sub> | -0.3    |        | 0.8     | V    |                   |
| reference voltage     | VREF            | 0.4     |        | VDD-0.4 | V    |                   |

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## 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                                                                             | name                      | min.  | typ.  | max.  | unit             | condition                                      |
|---------------------------------------------------------------------------------------|---------------------------|-------|-------|-------|------------------|------------------------------------------------|
| input current                                                                         | $I(IIN<X>)$               |       | 0.025 |       | $\mu\text{A}$    | stage 1                                        |
|                                                                                       |                           |       | 0.05  |       | $\mu\text{A}$    | stage 2                                        |
|                                                                                       |                           |       | 0.1   |       | $\mu\text{A}$    | stage 3                                        |
|                                                                                       |                           |       | 0.25  |       | $\mu\text{A}$    | stage 4                                        |
|                                                                                       |                           |       | 0.5   |       | $\mu\text{A}$    | stage 5                                        |
|                                                                                       |                           |       | 1     |       | $\mu\text{A}$    | stage 6                                        |
|                                                                                       |                           |       | 5     |       | $\mu\text{A}$    | stage 7                                        |
|                                                                                       |                           |       | 20    |       | $\mu\text{A}$    | stage 8                                        |
| feedback resistor                                                                     | R                         | 14000 | 20000 | 26700 | $\text{k}\Omega$ | stage 1                                        |
|                                                                                       |                           | 7000  | 10000 | 13350 | $\text{k}\Omega$ | stage 2                                        |
|                                                                                       |                           | 3500  | 5000  | 6700  | $\text{k}\Omega$ | stage 3                                        |
|                                                                                       |                           | 1400  | 2000  | 2670  | $\text{k}\Omega$ | stage 4                                        |
|                                                                                       |                           | 700   | 1000  | 1335  | $\text{k}\Omega$ | stage 5                                        |
|                                                                                       |                           | 350   | 500   | 670   | $\text{k}\Omega$ | stage 6                                        |
|                                                                                       |                           | 70    | 100   | 133   | $\text{k}\Omega$ | stage 7                                        |
|                                                                                       |                           | 17    | 25    | 34    | $\text{k}\Omega$ | stage 8                                        |
| signal frequency at input<br>SW4 = GND<br>( $C_{\text{PHOTO-SENSOR}} < 80\text{pF}$ ) | $f_{3\text{dB}}$          | 4     | 6     | 16    | $\text{kHz}$     | stage 1, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 7     | 11    | 28    | $\text{kHz}$     | stage 2, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 11    | 16    | 42    | $\text{kHz}$     | stage 3, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 18    | 26    | 66    | $\text{kHz}$     | stage 4, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 25    | 35    | 95    | $\text{kHz}$     | stage 5, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 35    | 50    | 130   | $\text{kHz}$     | stage 6, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 80    | 120   | 280   | $\text{kHz}$     | stage 7, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 160   | 300   | 580   | $\text{kHz}$     | stage 8, $T_{OP} (5.2)$                        |
| signal frequency at input<br>SW4 = VDD<br>( $C_{\text{PHOTO-SENSOR}} < 5\text{pF}$ )  | $f_{3\text{dB}}$          | 4     | 6     | 16    | $\text{kHz}$     | stage 1, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 7     | 11    | 28    | $\text{kHz}$     | stage 2, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 14    | 21    | 45    | $\text{kHz}$     | stage 3, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 35    | 54    | 130   | $\text{kHz}$     | stage 4, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 70    | 110   | 260   | $\text{kHz}$     | stage 5, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 100   | 160   | 360   | $\text{kHz}$     | stage 6, $T_{OP} (5.2)$                        |
|                                                                                       |                           | 260   | 380   | 780   | $\text{kHz}$     | stage 7, $T_{OP} (5.2)$                        |
| temperature coefficient<br>of the feedback resistor                                   | $TC_R$                    |       | -3300 |       | $\text{ppm/K}$   |                                                |
|                                                                                       |                           |       |       |       |                  |                                                |
| offset voltage                                                                        | $V_{\text{OFF}}^1$        | -10   |       | 10    | $\text{mV}$      | $T_{OP} (5.2)$                                 |
| capacitive load at<br>VOUT<X>                                                         | $C_{\text{LOAD}}$         |       |       | 50    | $\text{pF}$      | $I_{\text{LOAD}} < 0.5\text{mA}$ per<br>output |
| pull down current SW1,<br>SW2, SW3, SW4, PD                                           | $I_{\text{PDPAD}}$        |       |       | 200   | $\mu\text{A}$    | digital inputs                                 |
| input capacitance of<br>external connected<br>photo-sensors                           | $C_{\text{PHOTO-SENSOR}}$ |       |       | 80    | $\text{pF}$      | per input<br>SW4 = GND                         |
| input capacitance of<br>external connected<br>photo-sensors                           | $C_{\text{PHOTO-SENSOR}}$ |       |       | 5     | $\text{pF}$      | per input<br>SW4 = VDD                         |
| tolerance of the<br>feedback resistors<br>between the four<br>channels                | $TOL_R^2$                 | 1     |       | 10    | %                | DC input current;<br>for all stages            |

<sup>1</sup>  $V_{\text{OFF}} = V_{\text{OUT}}<X> - V_{\text{REF}}$ ; results from input offset voltage and input leakage current

<sup>2</sup> up to max. 1% available on request

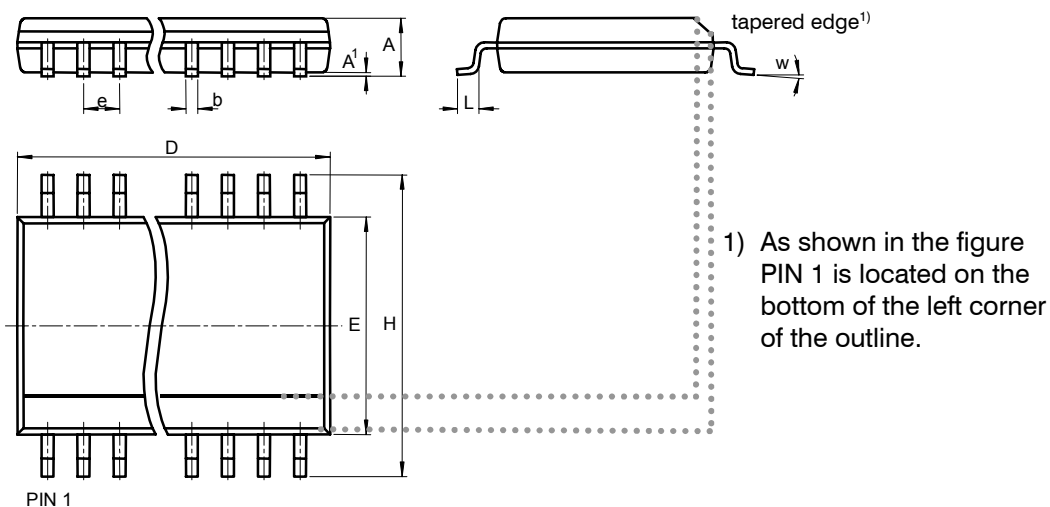
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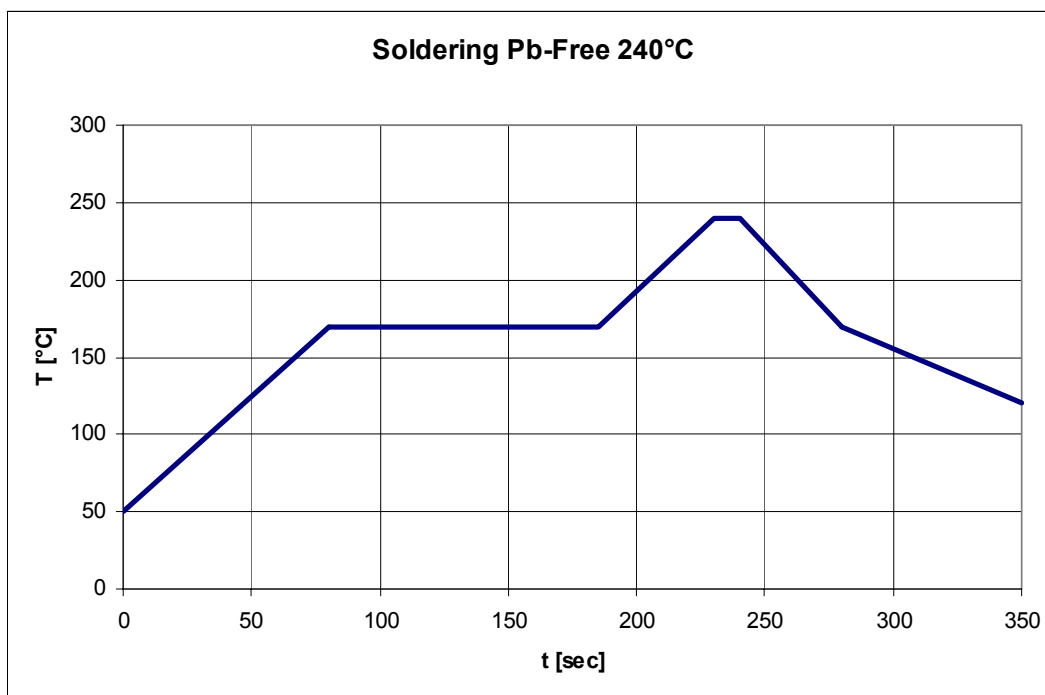
## 6. PACKAGES

## 6.1 Shape And Dimensions



dimensions – mm

| TYP     | PACKAGE | D    | E    | H    | A    | A1   | e     | b    | L    | w  |
|---------|---------|------|------|------|------|------|-------|------|------|----|
| MTI04CS | SOP16   | 9.90 | 3.80 | 6.00 | 1.75 | 0.15 | 1.27  | 0.41 | 0.72 | 4° |
| MTI04CQ | QSOP16  | 4.90 | 3.80 | 6.00 | 1.75 | 0.15 | 0.635 | 0.38 | 0.72 | 4° |



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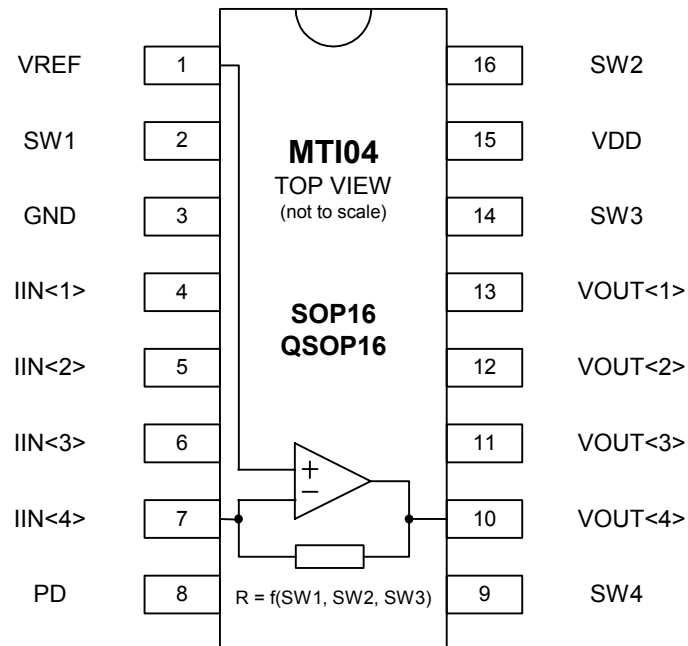
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## 6.2 Pin-Configuration



## 7. ORDERING INFORMATION

| NAME OF PRODUCT | PACKAGE | NUMBER OF CHANNELS |
|-----------------|---------|--------------------|
|-----------------|---------|--------------------|

MTI04CS



SOP16

4

MTI04CQ



QSOP16

4

## 8. CONTACT

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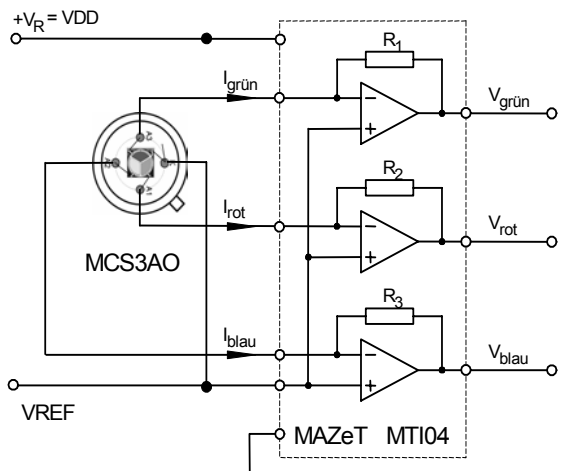
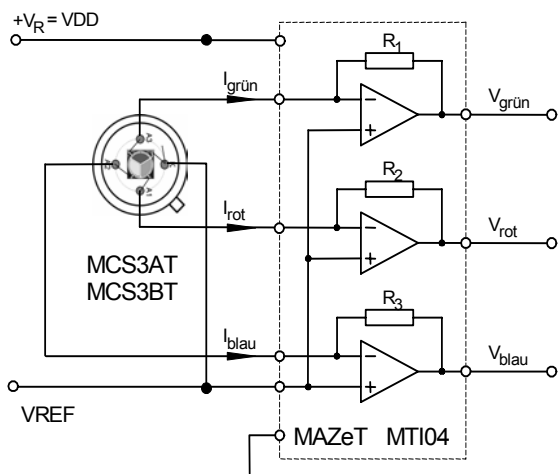
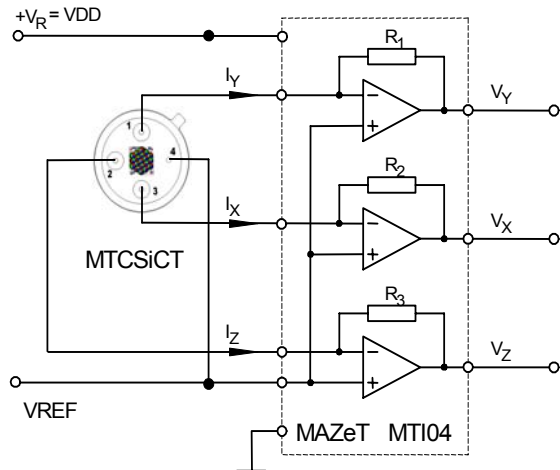
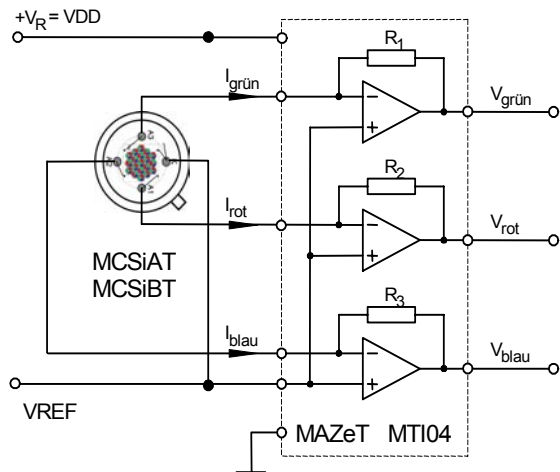
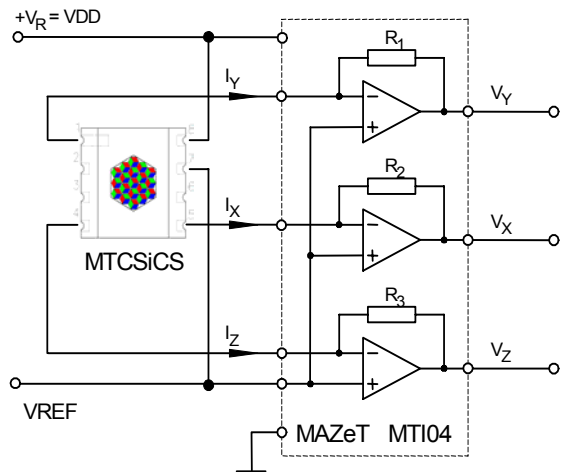
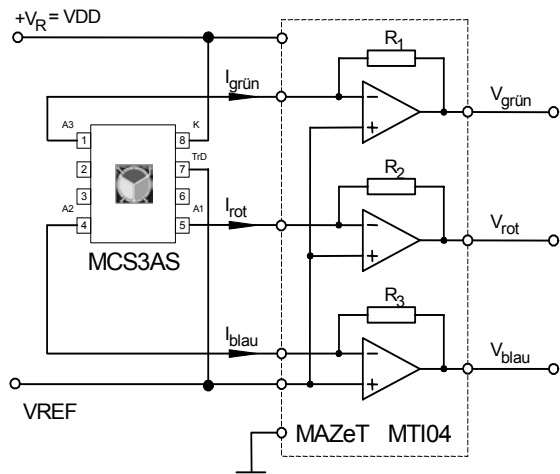
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9. APPLICATIONS

Connection of MAZeT Color Sensor



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