REVISIONS		
NO	VERSION	APPROVED
1	V 1.7	2008-08-22

Data Sheet

MTI04CS/MTI04CQ

MULTI-CHANNEL PROGRAMMABLE GAIN TRANSIMPEDANCE AMPLIFIER

Table of contents

1. GENERAL DESCRIPTION 2
2. BLOCK DIAGRAM 2
3. DESCRIPTION OF INTERFACE 3
3.1 Pin Assignment 3
3.2 Adjustment of Transimpedance 3
3.3 Switchable Frequency Range 3
3.4 Power Down Mode 3
4. DESCRIPTION OF FUNCTION 4
5. ELECTRICAL CHARACTERISTICS 4
5.1 Maximum Conditions 4
5.2 Operating Conditions 4
5.3 AC/DC-Characteristics 5
6. PACKAGES 6
6.1 Shape And Dimensions 6
6.2 Pin Configuration 7
7. ORDERING INFORMATION 7
8. CONTACT 7
9. APPLICATIONS 8
9.1 Connection of MAZeT Colour Sensor 8
9.2 Temperature compensation of MTI04 via reference method 9
9.3 Output Signals V_{OUT} 10

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

1. GENERAL DESCRIPTION

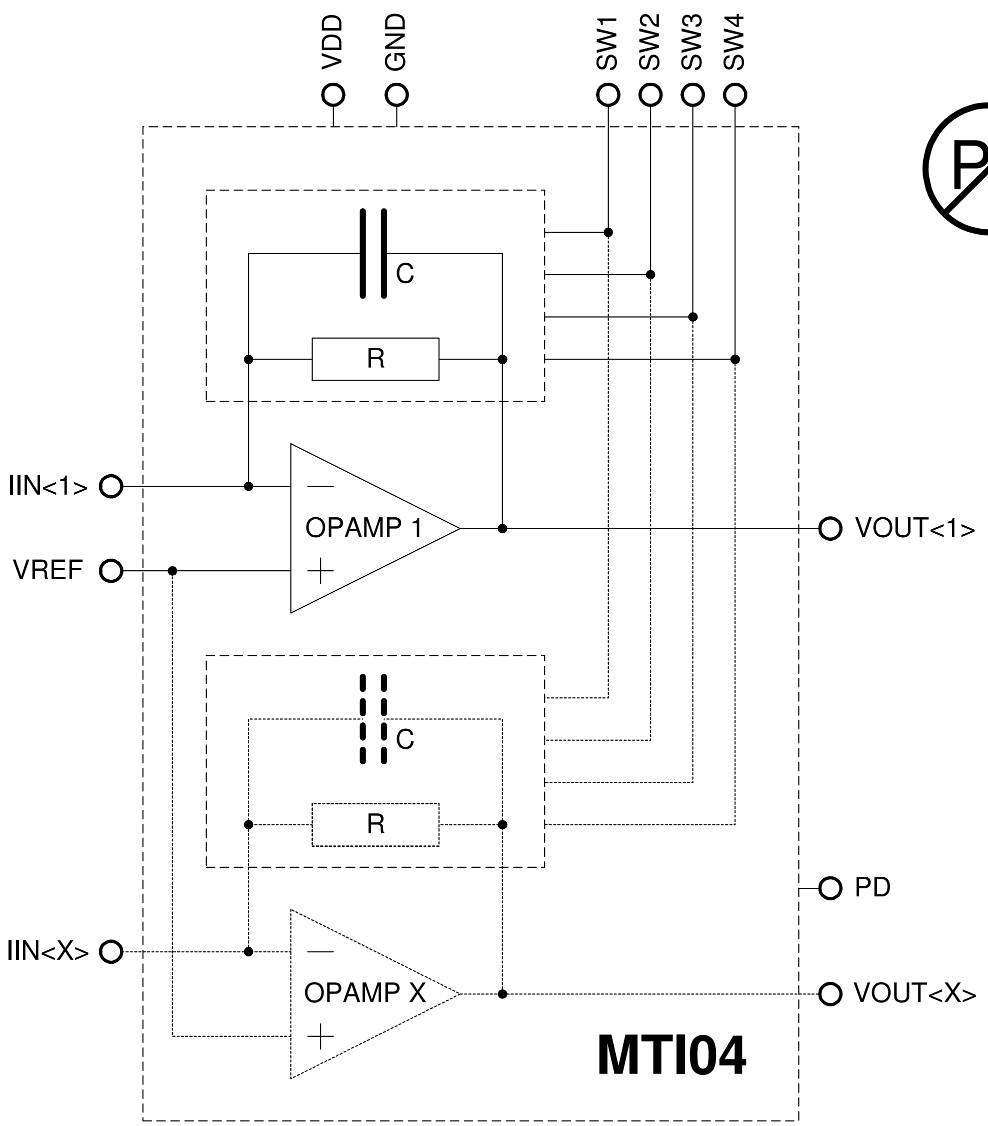
The MTI-devices are a family of integrated circuits of **programmable gain transimpedance amplifiers** with **4 channels** per IC (more custom specific, on request).

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



3. DESCRIPTION OF INTERFACE

3.1 Pin Assignment

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)
SW4	input	d	switchable frequency range dependend on input capacitance of the photo-sensor (pull down)
PD	input	d	power down mode (pull down)
IIN<X>	input	a	analog current input of amplifier X
VOUT<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	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

3.3 Switchable Frequency Range

settings of digital input	allowed capacitance of photo-sensor
SW4	
VDD	< 5pF
GND	< 80pF[c]

c.) default by pull down

3.4 Power Down Mode

settings of digital input	bias current of the IC
PD	
VDD	< 8μA
GND	typical[d]

d.) default by pull down

4. DESCRIPTION OF FUNCTION

The MTI-devices are programmable gain transimpedance amplifiers[1] 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[2] 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 mode is adjusted by PD = VDD and switches off the functionality. In that case it must be pointed out that the transimpedance resistor of stage 8 is between the particular inputs and outputs. The amplifiers are switched off (tristate).

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_{OP}		0.025	W
operating temperature	T_{OP}	–40	125	°C
storage temperature	T_{STG}	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, VDD=5.5V
bias current MTI04	I(VDD)			8	µA	PD=VDD
operating temperature	T_{OP}	–40	27	125	°C	
input high level	V_{IH}	0.7-VDD		VDD+0.3	V	
input low level	V_{IL}	–0.3		0.8	V	
reference voltage	VREF	0.4		VDD-0.4	V	

[1] work as inverted amplifiers
[2] $V_{OUT} = V_{REF} - I_{In} * R$

5.3 AC/DC-Characteristics

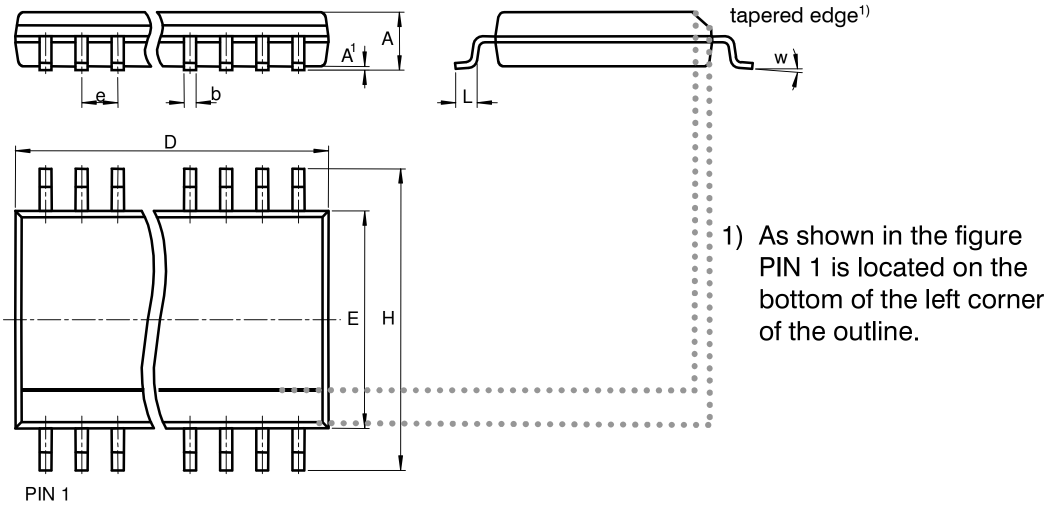
Unless otherwise specified the data in this table is valid for T_{OP} = 27°C and VDD = 5V.
All voltages are referenced to GND = 0V.

parameter	Name	min.	typ.	max.	unit	condition
input current	I(IIN<X>)		0.025		µA	stage 1
			0.05		µA	stage 2
			0.1		µA	stage 3
			0.25		µA	stage 4
			0.5		µA	stage 5
			1		µA	stage 6
			5		µA	stage 7
			20		µA	stage 8
feedback resistor	R	14000	20000	26700	kΩ	stage 1
		7000	10000	13350	kΩ	stage 2
		3500	5000	6700	kΩ	stage 3
		1400	2000	2670	kΩ	stage 4
		700	1000	1335	kΩ	stage 5
		350	500	670	kΩ	stage 6
		70	100	133	kΩ	stage 7
		17	25	34	kΩ	stage 8
signal frequency at input SW4 = GND ($C_{PHOTO-SENSOR}$ < 80pF)	f_{3dB}	4	6	16	kHz	stage 1, T_{OP} (5.2)
		7	11	28	kHz	stage 2, T_{OP} (5.2)
		11	16	42	kHz	stage 3, T_{OP} (5.2)
		18	26	66	kHz	stage 4, T_{OP} (5.2)
		25	35	95	kHz	stage 5, T_{OP} (5.2)
		35	50	130	kHz	stage 6, T_{OP} (5.2)
		80	120	280	kHz	stage 7, T_{OP} (5.2)
		160	300	580	kHz	stage 8, T_{OP} (5.2)
signal frequency at input SW4 = VDD ($C_{PHOTO-SESNOR}$ < 5pF)	f_{3dB}	4	6	16	kHz	stage 1, T_{OP} (5.2)
		7	11	28	kHz	stage 2, T_{OP} (5.2)
		14	21	45	kHz	stage 3, T_{OP} (5.2)
		35	54	130	kHz	stage 4, T_{OP} (5.2)
		70	110	260	kHz	stage 5, T_{OP} (5.2)
		100	160	360	kHz	stage 6, T_{OP} (5.2)
		260	380	780	kHz	stage 7, T_{OP} (5.2)
		500	800	1700	kHz	stage 8, T_{OP} (5.2)
temperature coefficient of the feedback resistor[3]	TC_R		-3300		ppm/K	
offset voltage	V_{OFF}[4]	-10		10	mV	T_{OP} (5.2)
capacitive load at VOUT<X>	C_{LOAD}			50	pF	I_{LOAD} < 0.5mA per output
pull down current SW1, SW2, SW3, SW4, PD	I_{PDPAD}			200	µA	digital inputs
input capacitance of external connected photo-sensors	$C_{PHOTO-SENSOR}$			80	pF	per input SW4 = GND
input capacitance of external connected photo-sensors	$C_{PHOTO-SENSOR}$			5	pF	per input SW4 = VDD
tolerance of the feed-back resistors between the four channels	TOL_R[5]	1		10	%	DC input current; for all stages

[3] see also chapter 9.2
[4] V_{OFF} = VOUT<X> – VREF; results from input offset voltage and input leakage current
[5] up to max. 1% available on request

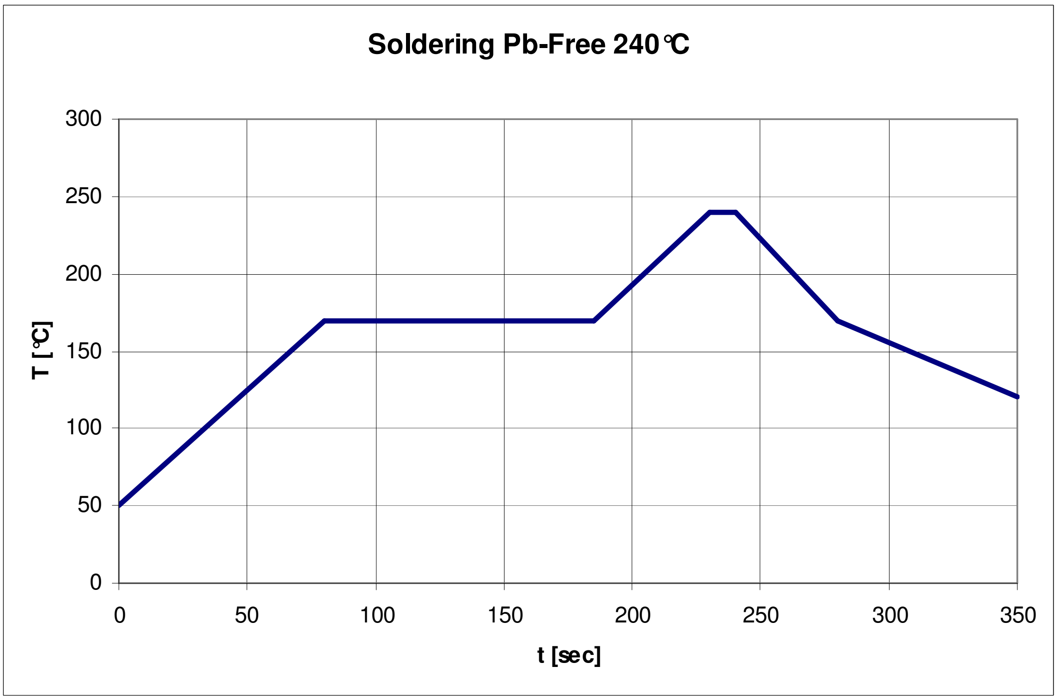
6. PACKAGES

6.1 Shape And Dimensions

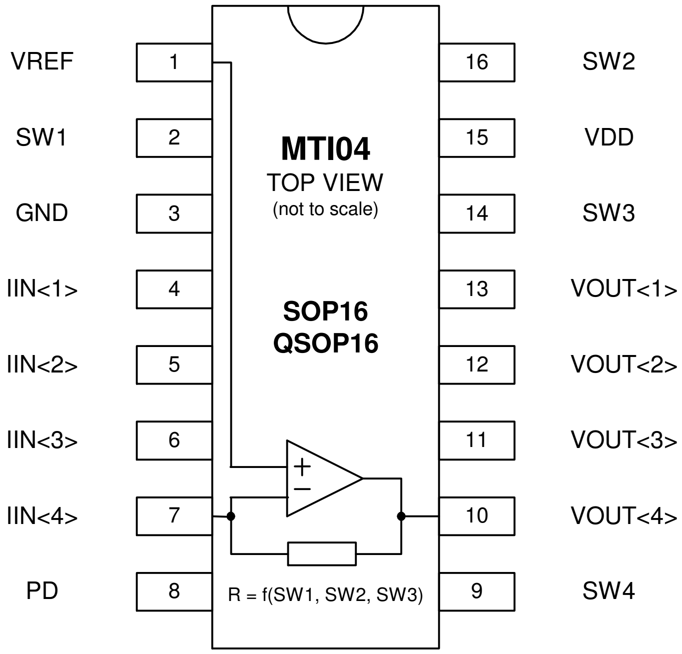


dimensions – mm

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°



6.2 Pin Configuration



7. ORDERING INFORMATION

NAME OF PRODUCT	PACKAGE	NUMBER OF CHANNELS
MTI04CS	SOP16	4
MTI04CQ	QSOP16	4

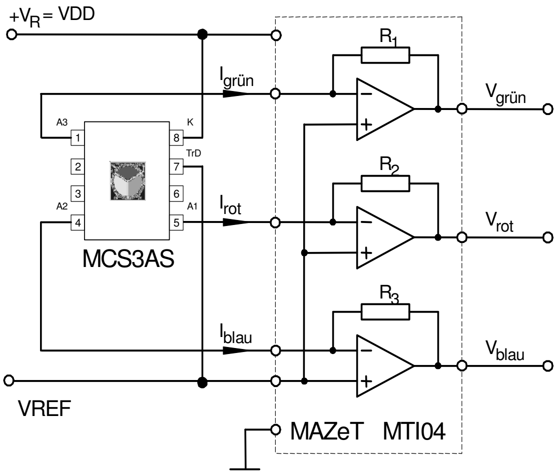
8. CONTACT

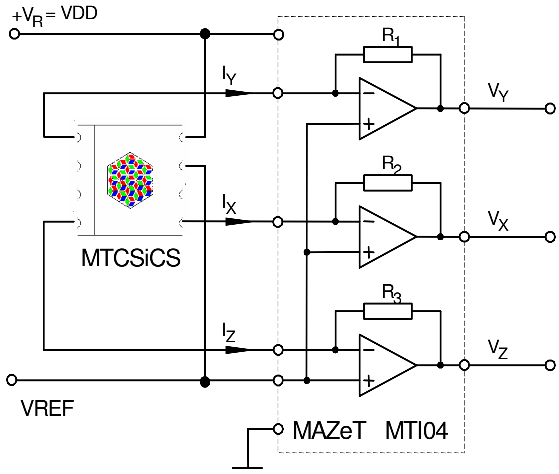
For further information, please feel free to contact:

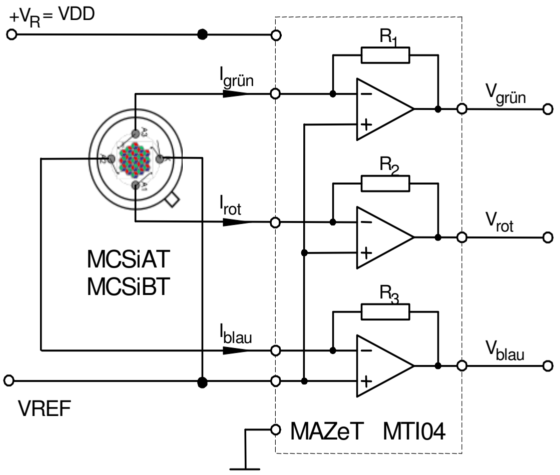
MAZeT GmbH
Sales office:
Göschwitzer Straße 32
07745 JENA
GERMANY
Phone: +49 3641 2809-0
Fax: +49 3641 2809-12
E-Mail: sales@MAZeT.de
Url: http://www.MAZeT.de

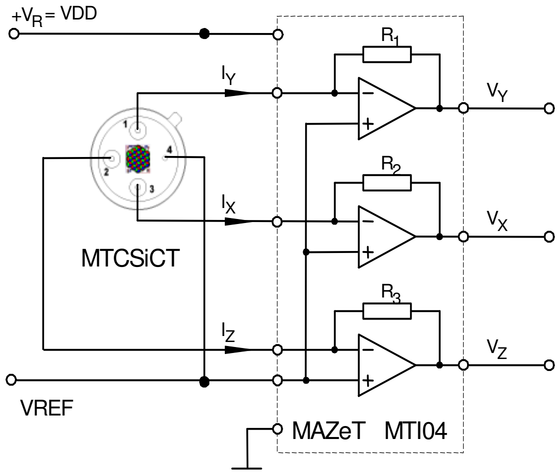
9. APPLICATIONS

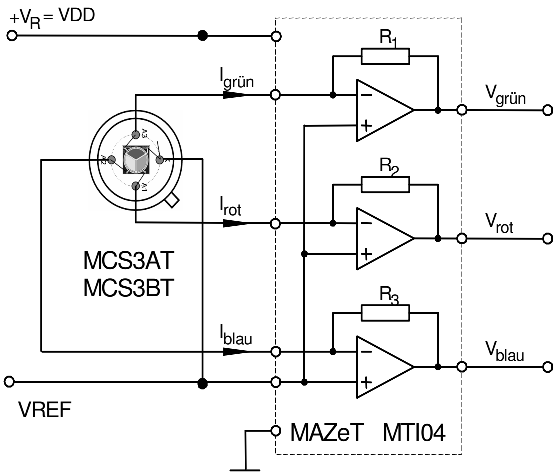
9.1 Connection of MAZeT Colour Sensor

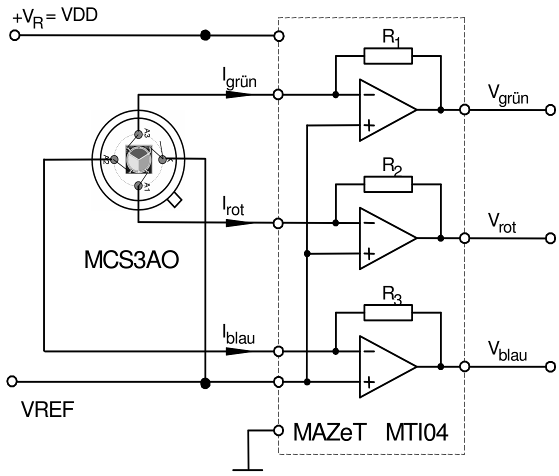






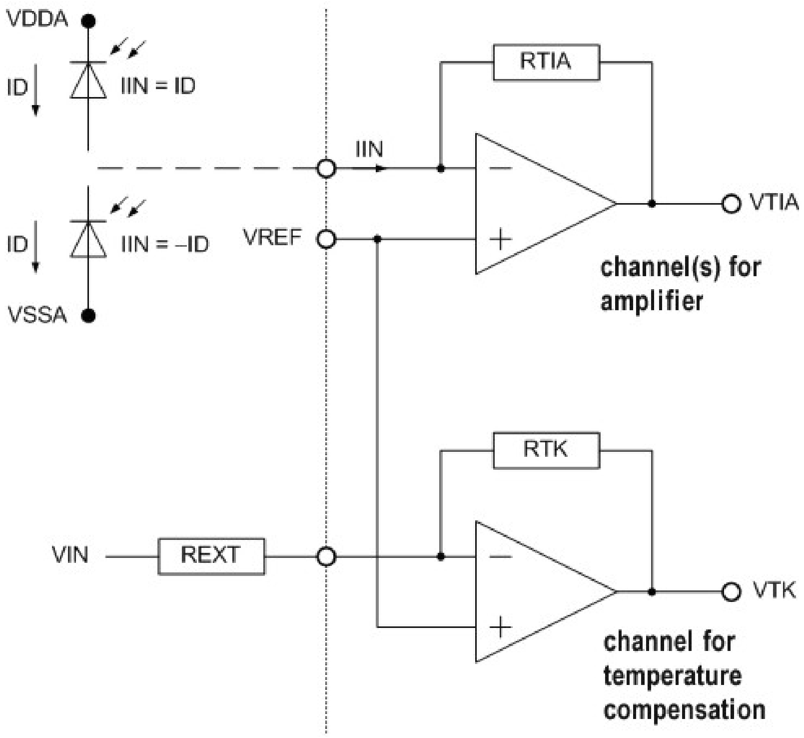






9.2 Temperature compensation of MTI04 via reference method

The following description shows a possible approach for reduction the temperature dependency of amplifier via reference channel (use the 4th channel of MTI04).



The input of the reference channel is connected with an external resistor that will load with an input voltage which is different to VREF.

The output voltage of the measuring channel is explained in the coming formula:

$$(1)\quad VTIA(T) = VREF(T) - IIN * RTIA(T)$$

IIN is the input current, which is supplied by the external sensor. The output voltage of the channel for the temperature compensation is defined:

$$(2)\quad VTK(T) = VREF(T) - \frac{VIN(T) - VREF(T)}{REXT(T)} * RTK(T)$$

The following voltages will calculate for temperature compensation with a resistor.

$$(3)\quad \Delta VTIA(T) = VREF(T) - VTIA(T)$$
$$(4)\quad \Delta VTK(T) = VREF(T) - VTK(T)$$

For example the voltage ΔVTK(T0) will detect during the initialization of the system. The value is equivalent to a constant for the temperature T0, which prevailed at the time of initialization. All further measurements will calibrate by this value.

(5) $\Delta VTIAkorrigiert(T) = \Delta VTIA(T) * \frac{\Delta VTK(T0)}{\Delta VTK(T)}$

All variables of the channel for temperature compensation are affected by temperature effects. Therefore there is an additional coefficient necessary. That coefficient should be highly reduced opposite to the named above value of the RTIA (typical -3300ppm/K).

(6)

$$TK = TK(REXT) - \frac{VIN}{VIN - VREF} * TK(VIN) + \frac{VREF}{VIN - VREF} * TK(VREF)$$

„TK(REXT)“ is the temperature coefficient of the external resistor, „TK(VIN)“ is the temperature coefficient of the input voltage and „TK(VREF)“ is the temperature coefficient of the reference voltage.

Please consider the following interrelationship by the choice of resistors REXT and RTK in term of the selected voltages VIN and VREF(values from (2) and (4)).

(7) $\frac{REXT}{RTK} > \left| \frac{VIN}{VREF} - 1 \right|$

The adherence of this non-equation ensures, that the voltage VTK is located in the working range. That means the amplifier of the channel for temperature compensation doesn't go into saturation.

Furthermore you can calculate the absolute value of the transimpedance resistor RTK for a certain actual existing temperature.

(8) $RTK(T) = REXT(T) * \frac{VREF(T) - VTK(T)}{VIN(T) - VREF(T)}$

9.3 Output Signals V_{OUT}

MTI04 works by the principle of a connected op-amp:

$V_{OUT} = V_{REF} - I_{In} * R$ {limited by GROUND …VREF}

a. $I_{IN} = 0$ ➔ $V_{OUT} = V_{REF}$
b. $I_{IN} =$ max. ➔ $V_{OUT} = 0$