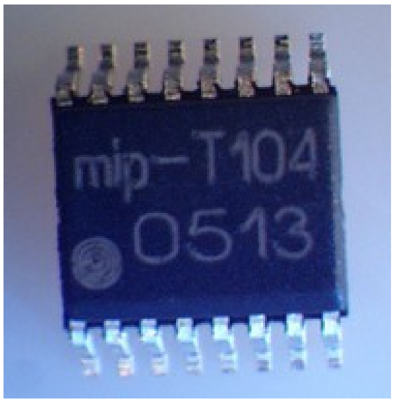
# Double Current/voltage interface circuit




## • Features

- **2 Current outputs for 3-wire or**
- **2 Controllable current sources**
- **2 Protected voltage output interfaces**
- **Adjustable voltage/current regulator**
- **Processor or sensor supply possible**
- **Small package: SSOP16**

## Operating area

- Temperature range: $T_a$ = -40 – 105°C
- Voltage range: $V_{CC}$ = 5 – 28V
- Current output: $I_{Io}$ = 0 – 20mA, 100mA max.
- Regulator current: $I_{VCR}$ = 0 – 25mA

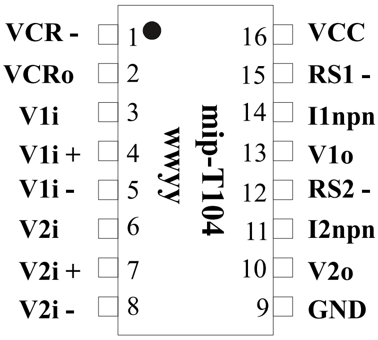
## Applications

- Sensors, voltage/current converter
- Controllable current/voltage sources
- 0 – 5/10V, 0/4 – 20mA-Interface
- Automation, Building, Medicine, ...

## Description

The mip-T104 was developed for the standard 0/4 – 20mA-current 3-wire and voltage (protected) interfaces (replacement for mip-T202) and contains two current and two voltage interfaces. The circuit is also suitable as LED driver (brightness control possible) or as controllable current and voltage sources. With external npn transistors currents up to 100mA are allowed. Additionally the circuit contains an adjustable voltage/current regulator, which can supply and protect the remaining components (sensor, processor, …).

## Anschlüsse




SSOP16

| Pin | Designation |
|---|---|
| VCC | Supply voltage |
| GND | Ground |
| VCRo | Voltage / current regulator |
| VCR - | Regulator input |
| Vi | Current control input |
| RS - | Sense resistor |
| Inpn | npn transistor control |
| Vi +/- | Voltage control inputs |
| Vo | Voltage output |

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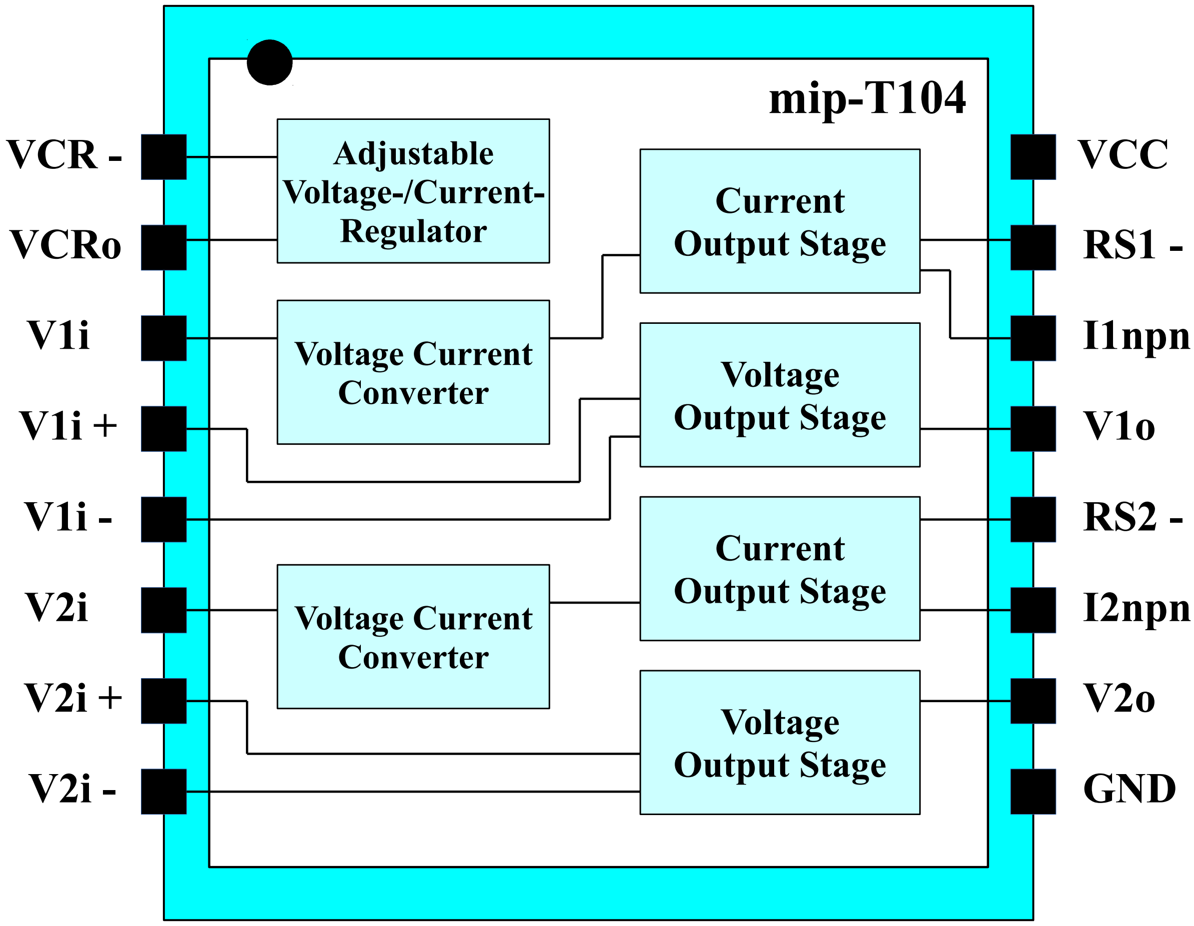
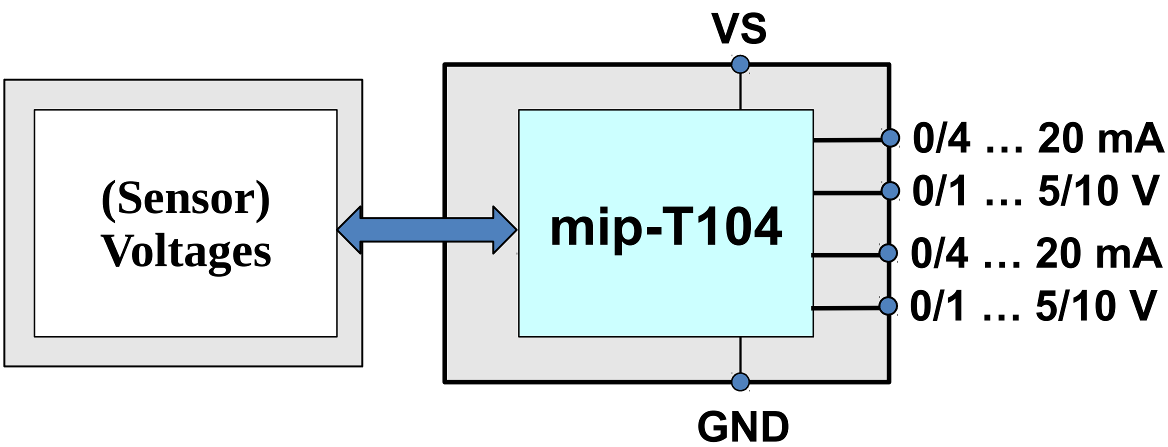
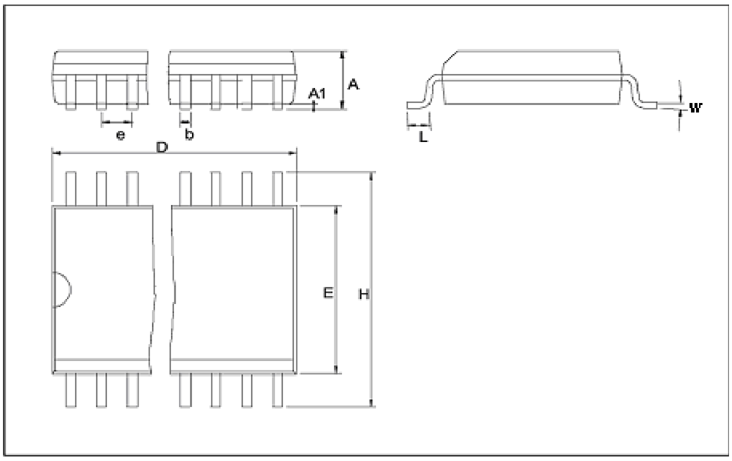
## Block diagram




## Typical application



## Gehäuse




| Shrink Small Outline Package (SSOP) 150 mil – Jedec MO-137, Dimension: mm | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Package-Type** | | **D** | **E** | **H** | **A** | **A1** | **e** | **b** | **L** | **Copl.** | **w** | **Rth(j-a)** |
| **SSOP 16** | nom | 4,90 | 3,90 | 6,00 | 1,75 | 0,15 | 0,635 | 0,26 | 0,72 | | 4° | 140 K/W |
| | max | | | | | | | | | 0,10 | | |

## Boundary conditions

| **Parameter** | **Symbol** | **Description** | **Min.** | **Typ.** | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| Breakdown Voltage | $V_{BR}$ | external (schottky) diode | 35 | | | V |
| Forward Current Gain | $\beta_F$ ($T_N$) | external npn-transistor | 100 | | | |
| **Absolute Maximum Ratings** | | | | | | |
| Supply Voltage Range | $V_{CC}$ | | 0 | | 30 | V |
| Operating Temperature Range | $T_a$ | ambient temperature | –40 | | 105 | °C |
| Storage Temperature Range | $T_s$ | | –55 | | 150 | °C |
| Junction Temperature Range | $T_j$ | | | | 150 | °C |
| Power Dissipation | P | $T_{amax}$ = 85°C (with pcb heat sink) | | | 1.25 | W |
| Lead Temperature | $T_l$ | soldering 10s | | | 300 | °C |

## Electrical specifications

$T_a$ = 25°C, $V_{CC}$ = 10V (unless otherwise noted)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage Range | $V_{CC}$ | | 5 | | 28 | V |
| Supply Current | $I_{CC}$ | no external currents | | 0.8 | | mA |
| **1) Adjustable Voltage- / Current-Regulator:** $V_{VCR} = V_{BG} * (R_{R1} + R_{R2}) / R_{R2}$ or $I_{VCR} = V_{BG} / R_{R2}$ | | | | | | |
| Internal Bandgap Reference | $V_{BG}$ | $V_{CC}$ > 10V | 1.21 | 1.24 | 1.27 | V |
| Bandgap Reference Drift | $dV_{BG}/dT$ | $T_a$ = 0...+50°C | | ±25 | | ppm/°C |
| | $dV_{BG}/dT$ | $T_a$ = – 40...+105°C | | ±40 | | ppm/°C |
| Power Supply Rejection Ratio | PSSR ($V_{BG}$) | | | 80 | | dB |
| Output Voltage Drop | $V_{DR}$ | $V_{CC} – V_{VCRo}$, $I_{VCR} \leq 1mA$ | 1.5 | | | V |
| | $V_{DR}$ | $VCC – VVCRo$, $I_{VCR}$ = 25mA | 3 | | | V |
| Output Voltage Range | $V_{VCR}$ | | $V_{BG}$ | | $V_{CC} – V_{DR}$ | V |
| Output Current | $I_{VCR}$ | respect to power dissipation | | | 25 | mA |
| Load Capacitance | $C_L$ | | 0 | 100 | | nF |
| **2) Protected Voltage Output Stages** | | | | | | |
| Input Voltage Range | $V_{IR}$ | | 0 | | $V_{CC}$ – 1.5 | V |
| Power Supply Rejection Ratio | PSRR | | 80 | | | dB |
| Offset Voltage | $V_{OS}$ | | | ±0.8 | | mV |
| Offset Voltage Drift | $dV_{OS}/dT$ | | | ±2.8 | | µV/°C |
| Input Bias Current | $I_B$ | | | 10 | | nA |
| Output Voltage Range | $V_{OR}$ | $R_L$ = 10kΩ, $V_O \leq 10V$ | 0.01 | | $V_{CC}$ – 3.5 | V3 |
| | $V_{OR}$ | $R_L$ = 2kΩ, $V_O \leq 10V$ | 0.005 | | $V_{CC}$ – 5 | V |
| Output Current Limitation | $I_{LIM}$ | short circuit protection | 5 | 7 | | mA |
| Load Resistance | $R_L$ | $V_O \leq 10V$ | 2 | | | kΩ |
| Load Capacitance | $C_L$ | | 0 | | | nF |
| **3) Current Output Stages:** $IO = VI_I / R_S$ | | | | | | |
| Input Voltage Range | $V_{IR}$ | $V_{CC}$ < 8V | 0 | | $V_{CC}$ – 2.4 | V |
| | $V_{IR}$ | $V_{CC} \geq 8V$ | 0 | | 5 | V |
| Offset Voltage | $V_{OS}$ | | | ±2 | | mV |
| Offset Voltage Drift | $dV_{OS}/dT$ | | | ±8 | | µV/°C |
| Input Bias Current | $I_B$ | | | 15 | | nA |
| Sense Resistor Voltage | $V_{RS}$ | | | $V_{Vi}$ | | V |
| Sense Resistor Voltage Fullscale | $V_{RS}(FS)$ | | | | 5 | V |
| Output Current Range | IO | internal npn | 0 | | 22 | mA |
| | IO | additional external power npn | 0 | 0.2 | 2 | A |
| Output Offset Current | $I_{OS}$ | | | –20 | | µA |
| Stabilization Resistor | $R_Z$ | | $R_S$ / 4 | $R_S$ / 3 | | Ω |
| Output Resistance | $R_{IO}$ | | 1 | | | MΩ |
| Load Resistance | $R_L$ | $V_{IOmax} / I_{IO}$ | 0 | 500 | | Ω |
| Load Capacitance | $C_L$ | | 0 | | 50 | nF |

## Functional description

The mip-T104 is designed for use in sensor systems for the construction of analog interfaces. In addition to the two controllable current sources (current interfaces) the circuit contains two voltage interfaces and an adjustable, controllable voltage/current regulator to supply external components such as a sensor cell or a processor. The regulator delivers up to 25mA output current.

The circuit is applicable in the extended temperature range of -40 – 105°C and in the voltage range of 5 – 28V. It is available in a small SSOP16 package. In addition to the current loop and voltage interface, the device is also particularly suitable for LED applications as well as controllable current and voltage sources.

The regulator as well as the current and voltage outputs can be adjusted by external resistors and controlled by external voltages. In addition to these resistors a capacitor (for microprocessor supply, the capacity is usually specified by the manufacturer), additional npn transistors and for reverse polarity protection diodes are needed.

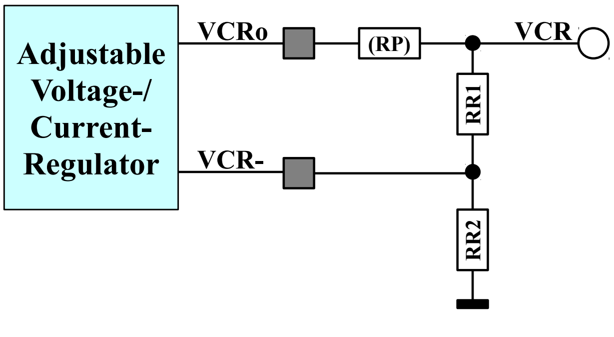
The required minimum supply voltage is defined by the regulator voltage, the maximum voltage on the current and voltage outputs, the minimum internal voltage drops of the mip-T104 and the required external components.

### 1) Adjustable and controllable voltage/current regulator (Pins: VCR+, VCR-, VCRo)

The regulator is set by external resistors ($R_1$, $R_2$). It is infinitely adjustable from the internal reference voltage (bandgap $V_{BG}$) up to the supply voltage $V_{CC}$ minus the internal voltage drop $V_{DR}$. When a sensor is connected in place of $R_1$, its current is controlled.

Voltage regulator: $VCR = V_{BG} * \left(1 + \frac{R_{R1}}{R_{R2}}\right)$ (1)

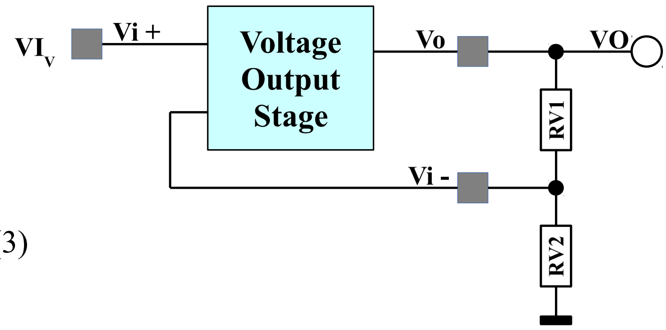
Current regulator: $I_{VCRo} = \frac{V_{BG}}{R_{R2}}$ (2)



**2) Two protected voltage interfaces (Pins: Vi+, Vi-, Vo)**

The voltage outputs are due to his short-circuit and reverse polarity protection and because of their driving performance are suited as a 0 - 10 V interface. Because of the variable gain other output voltages can also be adjusted.

In normal operation, as a non-inverting amplifier, the gain of the resistors $R_{V1}$ and $R_{V2}$ is set, thus allowing the adjustment of the output voltage over a wide range.




Output voltage calculation:

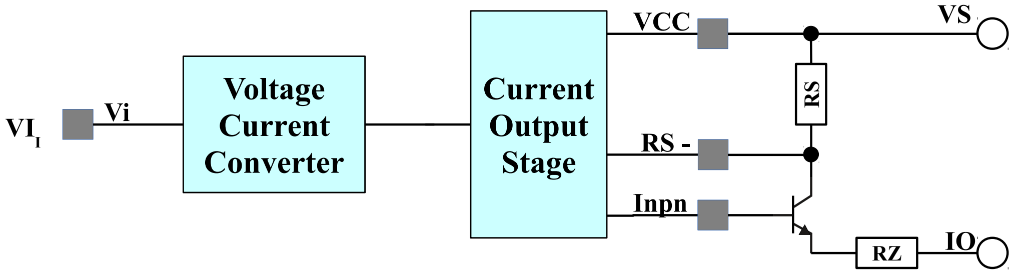
$$VO = VI_V * \left(1 + \frac{R_{V1}}{R_{V2}}\right) \quad (3)$$

**3) Two current interfaces (Pins: Vi, RS-, Inpn)**

The current outputs are voltage controlled current sources and designed for the current loop interface (0/4 – 20mA, 3-wire). The 20mA (100mA) can be delivered with additional external npn transistors (pay attention to the power dissipation). The circuit is also particularly suitable for LED applications (brightness control possible) as well as for controllable current sources.

The voltage across the sense resistor $R_S$ is controlled by the input voltage Vi, thereby the output current is produced. The input is high impedance. The input voltages can therefore be adjusted with resistive voltage dividers.

Output current: $IO = \frac{Vi}{R_S}$ (4)

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