RATIOMETRIC VOLTAGE TRANSMITTER AM417

FEATURES

- **Supply Voltage 5V±5% (Ratio Range)**
- **Wide Operating Temperature Range: –40°C...+100°C**
- **Ratiometrical Current Source for Transducer Excitation**
- **Instrumentation Amplifier Input**
- **Voltage Output Driver Open Collector: V_{OUT} = 0.5–4.5V I_{OUT} = +10mA**
- **Adjustable Gain, Offset, and Output Voltage Range**
- **Small Package Dimensions: SO8**
- **Low Cost**

APPLICATIONS

- Industrial Process Control
- Automotive Applications
- Sensor Transmitter

GENERAL DESCRIPTION

The AM417 is a low cost ratiometrical voltage transmitter, designed for flexible bridge input signal conditioning. The IC contains a ratiometric current source for transducer excitation, a high accuracy instrumentation amplifier for differential input signals, and a voltage output driver. Gain, offset, and output voltage range are adjustable by external resistors. The voltage output stage is designed as an open collector stage. The output current is +10mA. A simple current limitation is possible by adding an external resistor. With its functional blocks and possibilities to adjust all important parameters for sensor calibration, the small package dimensions (SO8), and the low costs the AM417 is ideally suited for automotive sensor interface applications.

DELIVERY

- DIL8 packages (samples)
- SOP8 packages
- Dice on 5“ blue foil

BLOCK DIAGRAM

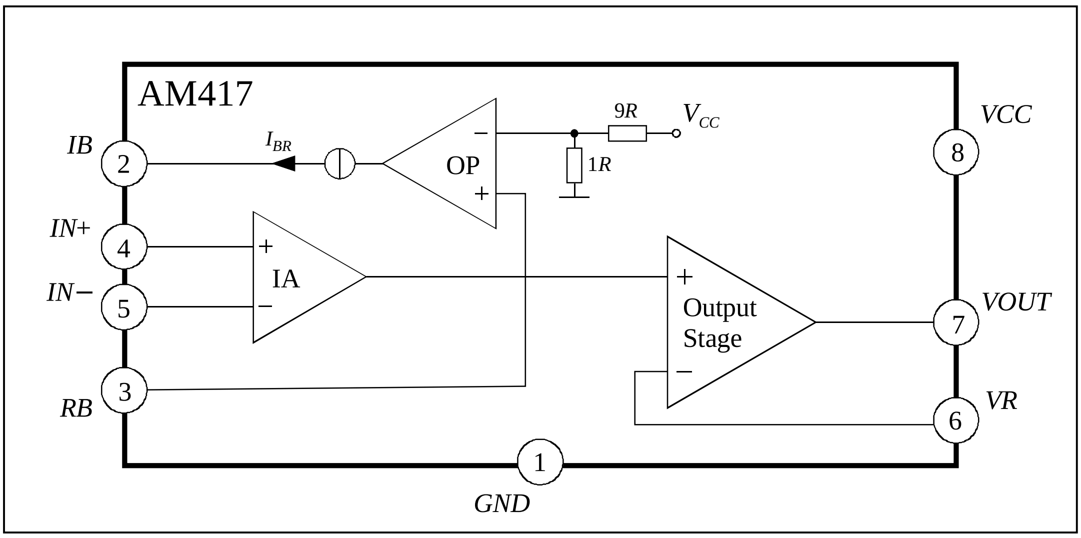

Figure 1

ELECTRICAL SPECIFICATIONS

T_{amb} = 25°C, V_{CC} = 5V (unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Voltage Range (Ratio Range)	V_{CC}		4.75	5	5.25	V
Maximum Supply Voltage	V_{CCmax}				6	V
Quiescent Current	I_{CC}	R_{RB} = 500Ω, I_{IB} = 1mA			6.2	mA
Temperature Specifications						
Operating	T_{amb}		–40		100	°C
Storage	T_{st}		–55		125	°C
Junction	T_J				150	°C
Thermal Resistance	Θ_{ja}	DIL8 plastic package		110		°C/W
	Θ_{ja}	SO8 plastic package		180		°C/W
Ratiometric Current Source – Transducer						
Internal Sense Voltage	V_{RB}	ratiometric with *VCC*, V_{VCC} = 5V		0.5		V
Output Current Range	I_{IB}		0.50		1.25	mA
Output Current	I_{IB}	ratiometric with *VCC*, R_{RB} = 500Ω, V_{VCC} = 5V	0.98	1	1.02	mA
Ratiometric Error	*RAT@IB*	V_{VCC} = 5.25V, *RAT@IB* = 1.05 V_{RB} (V_{VCC} = 5V) – V_{RB} (V_{VCC} = 5.25V)			±1	mV
I_{RB} vs. Temperature	dI_{RB}/dT	I_{IB} = 1mA			±20	ppm/°C
Output Voltage Range	V_{IB}	I_{IB} = 1.25mA	1.5		V_{CC}–0.5	V
Output Resistance	R_{IB}	I_{IB} = 1mA, $R_{IB} = \Delta U_{IB}/\Delta I_{IB}$, V_{VIB} = 5V, I_{IB} = 1mA	1.5	4.5		MΩ
Power Supply Rejection Ratio	ΔI_{IB}	ΔV_{CC} = 4.75V – 5.25V, V_{VIB} = 5V, I_{IB} = 1mA	76	90		dB
Instrumentation Amplifier						
Input Voltage Range	$V_{IN+;-}$		1.5		V_{CC}–2	V
Internal Gain	G_{IA}	V_{IN-} = 2V, ΔV_{IN} = 200mV, $G_{IA} = \Delta V_{VIA}/\Delta V_{IN}$	9.8	10.0	10.2	
Common Mode Rejection Ratio	*CMRR*		80	90		dB
Power Supply Rejection Ratio	*PSRR*		74	80		dB
Offset Voltage	V_{OS}				±3	mV
V_{OS} vs. Temperature	dV_{OS}/dT				±10	µV/°C
Input Bias Current	I_B	V_{IN} = 2V		25	75	nA
Output Voltage Range	V_{VIA}		0		V_{CC}–2	V
Output Resistance	R_{OUT}			20		kΩ
Nonlinearity		ΔV_{IN} = 200mV, ideal input			0.1	% FS
Voltage Output Stage						
Adjustable Gain	G_{OUT}		2		11	
Input Voltage Range	V_{VR}		0		V_{CC}–2.5	V
Power Supply Rejection Ratio	*PSSR*		–72	–90		dB
Offset Voltage	V_{OS}				±3.0	mV
V_{OS} vs. Temperature	dV_{OS}/dT	ΔV_{IN} = 50mV			±15	µV/°C
Input Current	I_{IN}	ΔV_{IN} = 50mV		20	75	nA
Output Voltage Range	V_{OUT}	with transistor BCW68H, I_{OUT} = 10mA (see figure 5)	0.5		4.5	V

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Voltage Output Stage (cont.)						
Output Current	I_{OUT}	with transistor BCW68H			12.5	mA
Output Current Pin *VOUT*	I_{VOUT}	pin *VOUT*	100	200	300	µA
Current Limitation Threshold	V_{THRESH}	$V_{THRESH} = V_{VCC} - V_{VOUTmin}$, $R_2 = 27\Omega$, $I_{OUT} \approx 14mA$	120	150	180	mV
V_{THRESH} vs. Temperature	dV_{THRESH}/dT	–40...+100°C	1.00		1.15	mV
Output Resistance	R_{OUT}	virtual		0.1	0.85	Ω
Linearity		ideal input			0.01	%FS

BOUNDARY CONDITIONS

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resistor Adjustment Current Source (Transducer)	R_1		400		1000	Ω
Gain Resistor Sum	$R_3 + R_4$				2.0	kΩ
Capacitor Power Supply	C_1		100			nF
Capacitor Frequency Compensation (Output Stage)	C_2		4.3		5.8	nF
Capacitor Load (Output Stage)	C_3		1.0		10.0	nF
Resistor Sense Current Limitation	R_2		0		50	Ω

FUNCTIONAL DIAGRAM

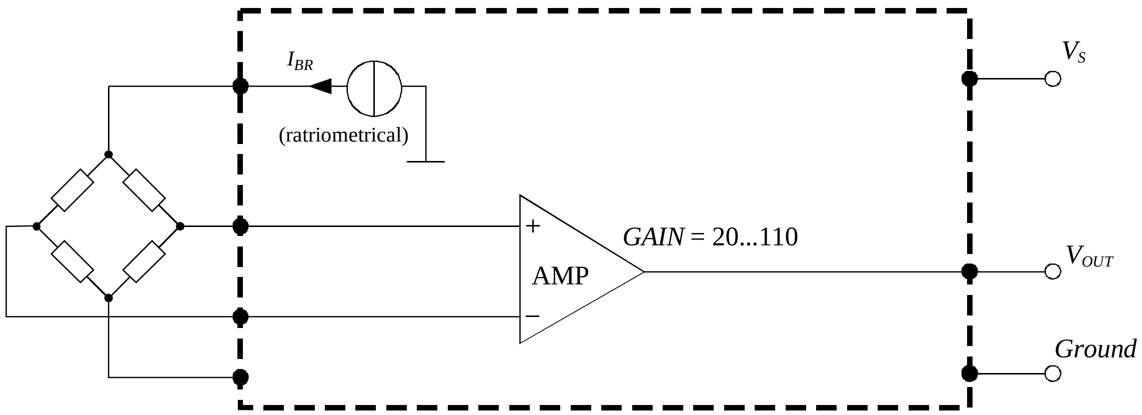

Figure 2

FUNCTIONAL DESCRIPTION

The AM417 is an integrated low cost ratiometric voltage transmitter specially designed for bridge input signals in automotive applications. With its integrated, ratiometrical current source the AM417 is ideally suited for the signal conditioning of piezoresistive pressure transducers and allows an easy temperature compensation and span adjustment of a these kinds of sensors.

The AM417 consists of 3 basic functional blocks:

1. A **Ratiometrical Current Source** for transducer excitation:

The current I_{IB} can be adjusted by the variation of the resistor R_1 by the following relation:

$$I_{IB} = \frac{V_{VCC}}{10\,R_1}$$

2. An **Instrumentation Amplifier Input Stage** with a fixed gain $G_{IA} = 10$ for pre–amplifiing the bridge input signal.

3. An **Open Collector Output Stage** with the following functions:

- **Voltage Output:** As output is used a voltage amplifier which has an external PNP–open collector stage T_1 which is able to push a maximum current of $I_{OUT} = 5\text{mA}$. The gain G_{OUT} is adjustable by the external resistors R_3 and R_4 between $G_{OUT} = 2...11$:

$$G_{OUT} = \frac{R_3}{R_3 + R_4}$$

The gain G of the complete system becomes then $G = G_{IA}\,G_{OUT}$.

- **Current Limitation:** A simple clamp stage for the output pin *VOUT* limits the voltage drop against *VCC* to

$$V_{OUT\max} = V_{VCC} - 1.5\,V_{BE}(T_1)\,.$$

The maximum current can be set by adding a resistor in series to the Emitter of the transistor T_1 at the output stage (see figure 4). For the maximum output current is valid:

$$I_{OUT\max} = \frac{V_{TRESH} - V_{BE}(T_1)}{R_2} \approx \frac{370\text{mV}}{R_2}\,.$$

If no current limitation is required, the Emitter of the transistor T_1 has to be directly connected to *VCC* ($R_2 = 0\Omega$). A proper thermic coupling of the Transistor T_1 (V_{BE}–Drift: –2mV/°C typ.) and the AM417 reduces the resulting temperature drift of I_{OUT} and increases the performance of the current limitation.

Adjustment of Output Voltage Range

The span of the output voltage could be adjusted by the gain G_{OUT} of the output stage. The offset of the output voltage can be adjusted in the same way as the adjustment of the sensor offset using the resistors R_{O1} and R_{O2} (figure 4).

PINOUT

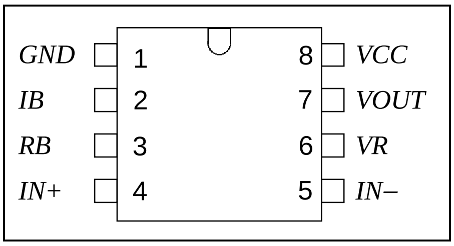

Figure 3

PIN	NAME	DESIGNATION
1	*GND*	IC Ground
2	*IB*	Output Current Source
3	*RB*	Adjustment Current Source
4	*IN+*	Input Positive
5	*IN–*	Input Negative
6	*VR*	Adjustment Gain Output Stage
7	*VOUT*	Out Output Stage
8	*VCC*	Supply Voltage

DELIVERY

The AM417 is available in:

- 8 pin DIL packages (samples)
- SO 8 packages
- Dice on 5“ blue foil

PACKAGE DIMENSIONS SOP8

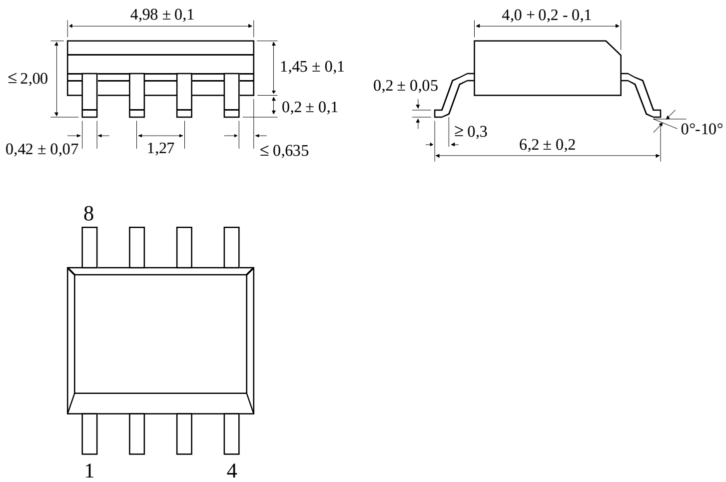

Figure 4

APPLICATION FOR OUTPUT VOLTAGE 0.5...4.5V

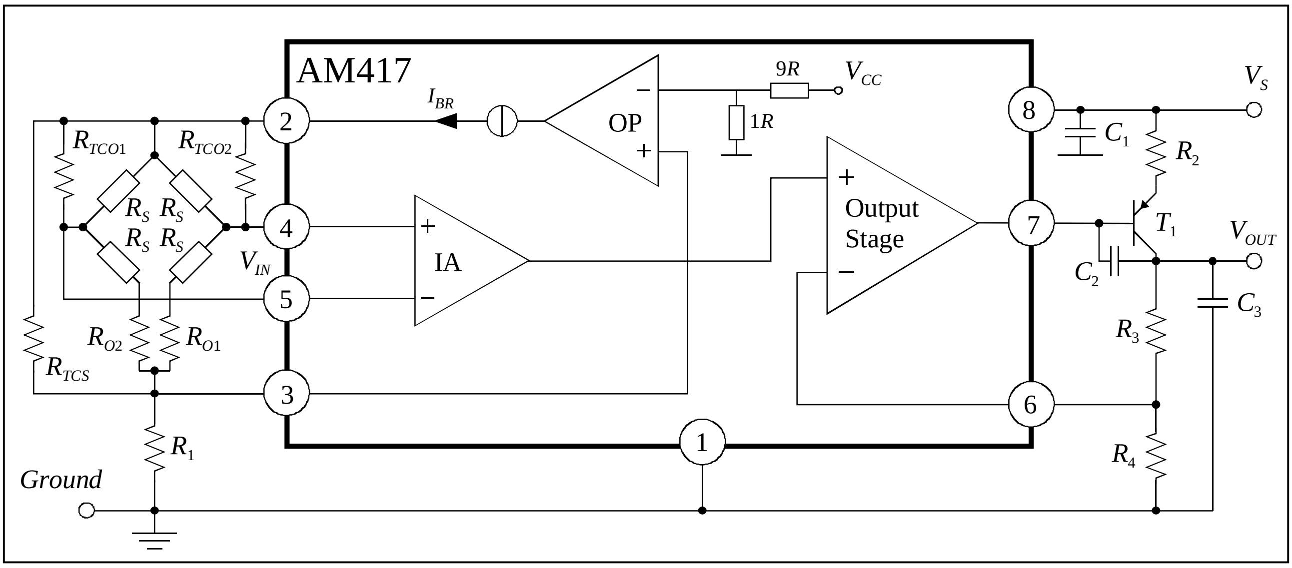

Figure 5

The current application shows the basic functions of the AM417. With the given values of the external components (see *List of External Components*) the following application features are adjusted:

- V_{IN} = 100mV
- $G = G_{IA}\, G_{OUT} = 40$
- V_{OUT} = 0.5 – 4.5V
- I_{OUT} = +10mA – 0.25mA
- I_{BR} = 1mA (ratiometrical supply current for the pressure transducer)

LIST OF EXTERNAL COMPONENTS

Symbol	Description	Value	Unit
T_1	BCW68H, BC557C (or similar)	low drop, high β at10mA	PNP
R_1	I_{BR} = 1 mA	500	Ω
R_2	I_{OUT} = 10mA min (100°C)	15	Ω
R_3	} Span (Gain adjustment)	500	Ω
R_4	$V_{OUT} = R_3 / (R_3 + R_4)\, G$	1.5	kΩ
R_S	typical transducer resistor	3.0 (typ.)	kΩ
R_{TCS}	*TC* span compensation	10 – 120	kΩ
R_{O1}, R_{O2}	Offset adjustment	0 – 500	Ω
R_{TCO1}, R_{TCO2}	*TC* offset adjustment	0.1 – 10.0	MΩ
C_1		330	nF
C_2	± 10%	4.7	nF
C_3	± 10%	1.0	nF