ANALOGNI MODULI

Splošno

Na voljo imamo več tipov analognih modulov, izmed katerih izberemo za naše potrebe najustreznejšega. Moduli se med seboj razlikujejo po številu analognih vhodov in analognih izhodov (lahko so tudi samo vhodi ali samo izhodi), resoluciji A/D oz. D/A pretvorbe, hitrosti pretvorbe in namembnosti posameznih vhodnih in izhodnih kanalov.

Nekateri moduli omogočajo, da si posamezne vhodne ali izhodne kanale konfiguriramo oziroma izberemo eno izmed ponujenih opcij. Tako je lahko npr. neki kanal uporabljen kot navadni napetostni vhod za merjenje napetosti, lahko je to merilnik toka 4-20 mA, ali pa merilnik upornosti in tudi merilnik temperature; vse je pač odvisno od tega, kakšne merilne signale želimo digitalizirati, oziroma kakšne dajalnike signalov imamo na razpolago. Pozorni moramo biti tudi na možno izbiro merilnega obsega. Vhodi ali izhodi na modulu so lahko med seboj združeni v skupine, za katere veljajo določene omejitve glede možnosti njihovega konfiguriranja.

Nekatere module konfiguriramo hardversko, nekatere pa tudi programsko preko STEP 7. Sicer so moduli nastavljeni za neko privzeto (default) konfiguracijo.

Pri priključitvi analognih vhodnih kanalov na senzorje oziroma izhodnih kanalov na aktuatorje moramo upoštevati značilnosti konkretnega modula in senzorja oz. aktuatorja (galvansko izoliran ali ne, še druge konkretne lastnosti). Ob tem se trudimo zagotoviti čimmanjšo elektromagnetno interferenco.

Preglednica digitalnih in normiranih analognih vrednosti za unipolarni vhodni obseg:

Units	Measured Value in %	Data Word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	≥ 118.515	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Over-
27649	≥ 100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	range
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Rated range
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
–1	–0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Under-
–4864	–17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	range
–32768	≤ –17.596	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Preglednica digitalnih in analognih vrednosti za merilna obsega 1-5 V in 0-10 V (unipolarni):

System			Voltage Measuring Range		
	Dec.	Hex.	1 to 5 V	0 to 10 V	
118.515 %	32767	7FFF	5.741 V	11.852 V	Overflow
117.593%	32512	7F00			
117.589%	32511	7EFF	5.704 V	11.759 V	Overrange
	27649	6C01			
100.000%	27648	6C00	5 V	10 V	Rated range
75%	20736	5100	3.75 V	7.5 V	
0.003617%	1	1	1 V + 144.7 µV	0 V + 361.7 µV	
0 %	0	0	1 V	0 V	
	–1	FFFF		Negative values not possible	Underrange
–17.593%	–4864	ED00	0.296 V		
	–4865	ECFF			Underflow
≤ –17.596 %	–32768	8000			

Preglednica digitalnih in analognih vrednosti za dva tokovna merilna obsega:

System			Current Measuring Range		
	Dec.	**Hex.**	**0 to 20 mA**	**4 to 20 mA**	
118.515 %	32767	7FFF	23.70 mA	22.96 mA	Overflow
117.593%	32512	7F00			
117.589%	32511	7EFF	23.52 mA	22.81 mA	Overrange
	27649	6C01			
100.000%	27648	6C00	20 mA	20 mA	Rated range
75%	20736	5100	15 mA	15 mA	
0.003617%	1	1	723.4 nA	4 mA + 578.7 nA	
0 %	0	0	0 mA	4 mA	
	–1	FFFF			Underrange
–17.593%	–4864	ED00	–3.52 mA	1.185 mA	
	–4865	ECFF			Underflow
≤ –17.596 %	–32768	8000			

Preglednica digitalnih in analognih vrednosti za temperaturno sondo Pt 100:

Pt x00 climate in °C (1 digit = 0.01°C)	Units		Pt x00 climate in °F (1 digit = 0.01 °F)	Units		Range
	decimal	**hexadecimal**		**decimal**	**hexadecimal**	
>155.00	32767	$7FFF_H$	>311.00	32767	$7FFF_H$	Overflow
155.00 : 130.01	15500 : 13001	$3C8C_H$: $32C9_H$	311.00 : 266.01	31100 : 26601	$797C_H$: $67E9_H$	Overrange
130.00 : –120.00	13000 : –12000	$32C8_H$: $D120_H$	266.00 : –184.00	26600 : –18400	$67E8_H$: $B820_H$	Rated range
–120.01 : –145.00	–12001 : –14500	$D11F_H$: $C75C_H$	–184.01 : –229.00	–18401 : –22900	$B81F_H$: $A68C_H$	Underrange
< –145.00	–32768	8000_H	< –229.00	–32768	8000_H	Underflow

Preglednica digitalnih in normiranih analognih vrednosti za unipolarni izhodni obseg:

Units	Output Value in %	Data Word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
≥32512	0 %	0	1	1	1	1	1	1	1	x	x	x	x	x	x	x	x	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	≥100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Rated range
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
–1	0.000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Limited to rated range lower limit 0 V and 0 mA
–32512		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
≤32513	0 %	1	0	0	0	0	0	0	0	x	x	x	x	x	x	x	x	Underflow

Preglednica digitalnih in analognih vrednosti za izhodna obsega 1-5 V in 0-10 V (unipolarni):

System			Voltage Output Range		
	Dec.	**hex.**	**0 to 10 V**	**1 to 5 V**	
118.5149%	32767	7FFF	0.00 V	0.00 V	Overflow, off circuit and de-energized
	32512	7F00			
117.589%	32511	7EFF	11.76 V	5.70 V	Overrange
	27649	6C01			
100 %	27648	6C00	10 V	5 V	Rated range
75%	20736	5100	7.5 V	3.75 V	
0.003617%	1	1	361.7µV	1V+144.7µV	
0 %	0	0	0 V	1 V	
	–1	FFFF			Underrange
–25 %	–6912	E500		0 V	
	–6913	E4FF			Not possible. The output value is limited to 0 V.
–117.593%	–32512	8100			
	–32513	80FF			Underflow, off circuit and de-energized
–118.519%	–32768	8000	0.00 V	0.00 V	

Parametri analognih vhodno/izhodnih modulov:

Parameter	Value Range	Default Settings	Parameter Type	Scope
Input				
Measurement				
• Measuring method	Deactivated U Voltage R-4L Resistance (four-conductor connection) RTD-4L Bulb resistor (linear, four-conductor connection)	RTD-4L	Dynamic	Channel
• Measuring range	0 to 10 V 10000 Ω Pt 100 climate	Pt 100 climate		
• Integration time	20 ms; 16.6 ms	20 ms		
Output				
• Output type	Deactivated Voltage	U	Dynamic	Channel
• Output range	0 to 10 V	0 to 10 V		

Analogni vhodno/izhodni modul SM334; AI 4/AO 2X12 bits

Ta analogni vhodno/izhodni modul ima naslednje lastnosti:

- 4 analogni vhodi v dveh skupinah
- 2 analogna izhoda (napetostna izhoda)
- resolucija 12 bitov + predznak
- možnost izbire meritve: napetost, upornost, temperatura
- galvanska ločitev od krmilnikovega vmesniškega vodila
- galvanska ločitev od bremenske napetosti

Analogna vhoda 0 in 1 ("kanala") sta v svoji skupini. Na obeh hkrati lahko merimo ali temperaturo ali upornost. Na teh kanalih ne moremo meriti napetosti. Prav tako ne moremo na enem izmed njiju meriti upornosti, hkrati pa temperature na drugem, ker uporabljata skupen tokovni vir.
V svoji (ločeni) skupini sta tudi analogna vhoda 2 in 3. Na obeh hkrati lahko merimo napetost, upornost ali temperaturo, ali pa na enem napetost in na drugem temperaturo, ter na enem napetost in na drugem upornost. Ne moremo pa hkrati na enem meriti temperature in na drugem upornosti, ker oba kanala prav tako uporabljata skupen tokovni vir.

Preglednica vhodnega/izhodnega obsega za različne nastavitve:

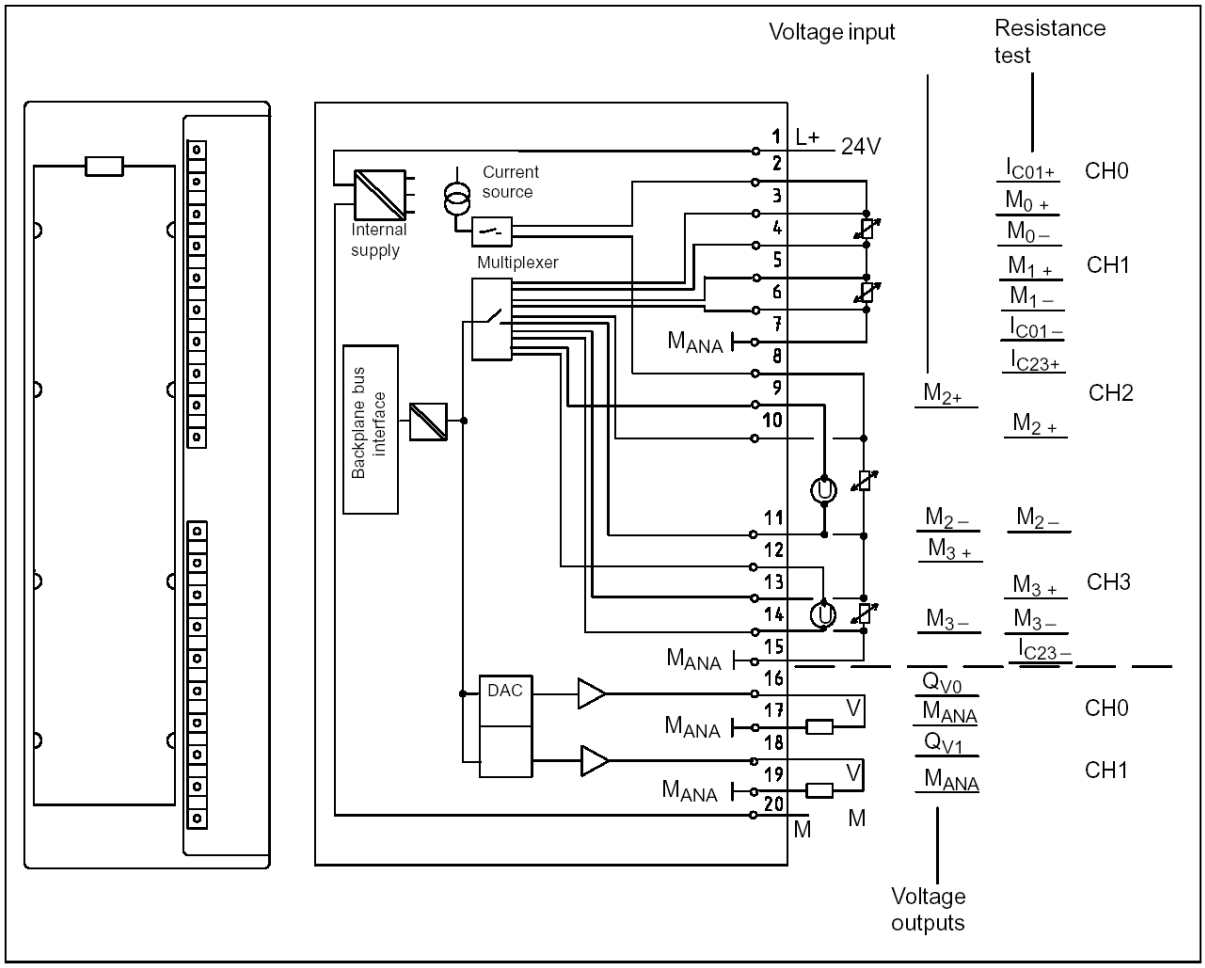
Vhodna veličina	**Obseg**	**Opis**
U: vhodna napetost	0 - 10 V	10 V = 27648 (DEC) = 6C00 (HEX)
R-4L: upornost (4-žična priključitev)	0-10 kΩ	10 kΩ = 27648 (DEC) = 6C00 (HEX)
RTD-4L: temperatura (linearna upornost, 4-žična priključitev)	Pt 100	130°C = 13000 (DEC) = 32C8 (HEX)
Izhodna veličina		
U: izhodna napetost	0 - 10 V	10 V = 27648 (DEC) = 6C00 (HEX)

Privzete (default) nastavitve so:

- merjenje temperature s sondo Pt 100 na vseh štirih vhodnih kanalih,
- izhodna napetost na obeh izhodnih kanalih.

Modul konfiguriramo preko programske opreme. Neuporabljene vhodne kanale pri tem izključimo (disabled), kar skrajša čas čitanja modula. Neuporabljene vhodne kanale med seboj kratko vežemo in jih povežemo z analogno maso (M_{ANA}), s čimer dosežemo optimalno zaščito pred interferenco. Neuporabljene izhodne kanale prav tako pri konfiguriranju izključimo, njihove sponke pa pustimo odprte.

Priključitvena shema za modul SM334; AI 4/AO 2X12 bits:



Tehnični podatki za modul SM334; AI 4/AO 2X12 bits:

Dimensions and Weight	
Dimensions W × H × D (in millimeters)	40 × 125 × 117
Weight	Approx. 200 g
Data for Specific Module	
Supports clocked operation	No
Number of inputs	4
• For resistance-type sensor	4
Number of outputs	2
Shielded line length	max. 100 m
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Supply voltage of the rated electronics voltage and rated load voltage L+	24 VDC
Power supply of the transmitters	
• Short-circuit-proof	Yes
Constant measured current for resistance-type sensor	
• For PT 100	typ. 490 μA
• At 10 kΩ	at 105 μA
Isolation	
• Between channels and backplane bus	Yes
• Between channels and power supply of the electronics	Yes
Between the channels	No
Permitted potential difference	
• Between inputs and M_{ANA} (U_{CM})	1 V
• Between the inputs (ECM)	1 V
• Between M_{ANA} and $M_{internal}$-(U_{ISO})	75 VDC / 60 VAC
Insulation tested with	500 VDC
Current consumption	
• From the backplane bus	max. 60 mA
• From power supply and load voltage L+ (no load)	max. 80 mA
Power dissipation of the module	typ. 2 W

Analog Value Generation for the Inputs		
Measuring principle	Integrating	
Integration/conversion time (per channel)		
• Parameters can be assigned	Yes	
• Integration time in milliseconds	$16^2/_3$	20
• Basic conversion time including Integration time in milliseconds	72	85
• Additional conversion time for measuring resistance, in ms	72	85
• Resolution in bits (incl.) overrange)	12 bits	12 bits
• Suppression of interference voltage for interference frequency f1 in Hertz	60	50
Smoothing of the measured values	Programmable, in 2 stages	
Time constant of the input filter	0.9 ms	
Basic response time of module (all channels enabled)	350 ms	
Analog Value Generation for the Outputs		
Resolution (incl. Overrange	12 bits	
Conversion time (per channel)	500 μs	
Settling time		
• For resistive load	max. 0.8 ms	
• For capacitive load	max. 0.8 ms	

Tehnični podatki za modul SM334; AI 4/AO 2X12 bits (nadaljevanje):

Suppression of Interference, Limits of Error for the Inputs		
Noise suppression for f = n × (f1 ± 1 %) (f1 = interference frequency)		
• Common-mode interference (U_{pp} < 1 V)	> 38 dB	
• Series-mode interference (peak value of interference < rated value of input range)	> 36 dB	
Crosstalk between the inputs	> 88 dB	
Operational limit (in the entire temperature range, with reference to the input range)		
• Voltage input	0 to 10 V	±0.7 %
• Resistor input	10 k Ω	±3.5 %
• Temperature input	Pt 100	± 1 %
Basic error (operational limit at 25 °C, referred to input range)		
• Voltage input	0 to 10 V	±0.5 %
• Resistor input	10 k Ω	±2.8 %
• Temperature input	Pt 100	±0.8 %
Temperature error (with reference to the input range)	±0.01 %/K	
Linearity error (with reference to the input range)	±0.05 %	
Repeat accuracy (in the steady state at 25 °C, referred to the input range)	± 0.05 %	

Suppression of interference, Limits of Error for the Outputs	
Crosstalk between the outputs	> 88 dB
Operational limit (in the entire temperature range, with reference to the output range)	
• Voltage outputs	±1.0 %
Basic error (operational limit at 25 °C, referred to output range)	
• Voltage outputs	±0.85 %
Temperature error (with reference to the output range)	±0.01 %/K
Linearity error (with reference to the output range)	± 0.01 %
Repeat accuracy (in the steady state at 25°C, referred to the output range)	± 0.01 %
Output ripple; band width 0 to 50 kHz (with reference to the output range)	± 0.1 %

Status, Interrupts, Diagnostics	
Interrupts	None
Diagnostic functions	None

Data for Selecting a Sensor		
Input range (rated values)/Input resistance		
• Voltage	0 to 10 V	100 k Ω
• Resistors	10 kΩ	10 mΩ
• Temperature	PT 100	10 mΩ
Maximum input voltage for voltage input (destruction limit)	max. 20 V continuous; 75 V for max. 1 s (duty factor 1:20)	
Connection of the sensor		
• For measuring voltage	Possible	
• For measuring resistance		
With two-conductor connection	Possible	
With three-conductor connection	Possible	
With four-conductor connection	Possible	
Characteristic linearization	Parameters can be assigned	
• For RTD	PT 100 (climate range)	
User data in engineering format	Degrees Celsius	

Data for Selecting an Actuator		
Output range (rated value)		
• Voltage	0 to 10 V	
Impedance (in the nominal output range)		
• For voltage outputs	min. 2.5 kΩ	
– Capacitive load	max. 1.0 µF	
Voltage outputs		
• Short-circuit protection	Yes	
• Short-circuit current	max. 10 mA	
Destruction limit for voltages/ currents connected from outside		
• Voltage at outputs to M_{ANA}	max. 15 V continuous;	
Connection of actuators		
• For voltage output		
Two-Conductor Connection	Possible	
Four-conductor connection (measuring circuit)	Not possible	