

RL 400 Modular I/O system

Plug-in I/O modules

Suitable for
CANopen/PROFIBUS-DP/MODBUS TCP

Modules for numerous sensors and signals

2, 4 or 8 channels, depending on module version

Flexible plant design

Simple commissioning

2-point measured value adaptation

rail line

PROFILE

The input/output modules with fieldbus communication ports provide a high degree of flexibility when designing new plants. The compact, plug-in modules can be combined into cost-effective, de-centralized I/O islands. Due to the modular concept, type and number of the I/Os can be matched optimally to the requirements. Subsequent system extensions present no problems.

FEATURES

- ✓ **Broad range of available sensor and signal modules**
- ✓ **Standard fieldbus interfaces supported**
- ✓ **Cost-effective module size**
- ✓ **Well defined galvanic isolation concept**
- ✓ **Modules with configurable multi-functions**
- ✓ **Easy module exchange (Hotswap)**
- ✓ **Configuration via BlueControl®**
- ✓ **High signal resolution**
- ✓ **High accuracy**
- ✓ **2-point measured value adaptation**
- ✓ **Small housing size**
- ✓ **Flexible and easy to extend**
- ✓ **Optimized connection to KS108**

APPLICATION

- Data acquisition
- Remote I/O
- I/O extension

DESCRIPTION

CONSTRUCTION

RL 400 consists of a bus coupler for „top hat“ rail mounting and the possibility to connect up to 62 I/O-modules. The I/O modules are interconnected by means of quick-connect plugs. One power supply module must be installed per 16 I/O modules.

Power supply

The system supply of 24 VDC is connected to the bus coupler module. Apart from bus communication, the quick-connect facility also feeds the supply voltage to the I/O modules.

Internal communication

An internal bus connects the I/O modules with the bus coupler module, where the statuses/values of the connected I/Os are continuously updated and stored. The stored data also contains information about the type and diagnostic results of the relevant I/O module. The scanning cycle depends on the type and number of inserted modules and the bus load.

Galvanic isolation

In the bus coupler module, the bus system (CAN / PROFIBUS / RS485), the internal communication circuits are galvanically isolated from each other and from the 24 VDC system supply.

Furthermore, the I/O modules provide galvanic isolation for the internal system bus and for the I/O circuits.

Depending on the module, analog inputs/outputs are either galvanically connected or isolated up to 300 V working voltage. Galvanic isolation between modules is always provided.

The eight digital outputs of the DO-modules are combined into groups with four outputs each. The groups are galvanically isolated from each other and from the remaining electronics.

The eight digital inputs of the DI-modules are grouped together to four inputs each which are galvanically isolated from each other.

Sensor energization

Transmitter supply

The analog input module RL422-0 provides 10V/24V DC for energizing external two-wire transmitters.

Digital inputs

The RL 442 -1 / 442-0 provides 24V DC for operating proximity switches as well as NPN or PNP transistors.

Input circuit monitoring

Analog input signals are monitored for short circuit, open circuit, or polarity. A triggered monitoring circuit is signalled as a status change. Hereby, the status value for the fault signal can be defined in the configuration.

Electrical connections

The signal leads are connected to staggered terminal levels at top and bottom of the module. The screw terminals or spring-clamp connectors are plug-in units, and a connecting diagram is printed on the module front.

Configuration

Available as an accessory, the BlueControl® Engineering Tool not only contains a complete description, but also the EDS or GSD file (max. version with standard mapping of the variables) required for linking into CAN or PROFIBUS systems.

Connection to KS108

If the RL 400 is used as an I/O extension for the multi-function unit KS 108 via CANbus, parameter adjustment and configuration are done by means of additional functions in the Engineering Tool BlueDesign®. In this case, a CAN configurator is not needed!

Fig. 1 : RL400 with different applications

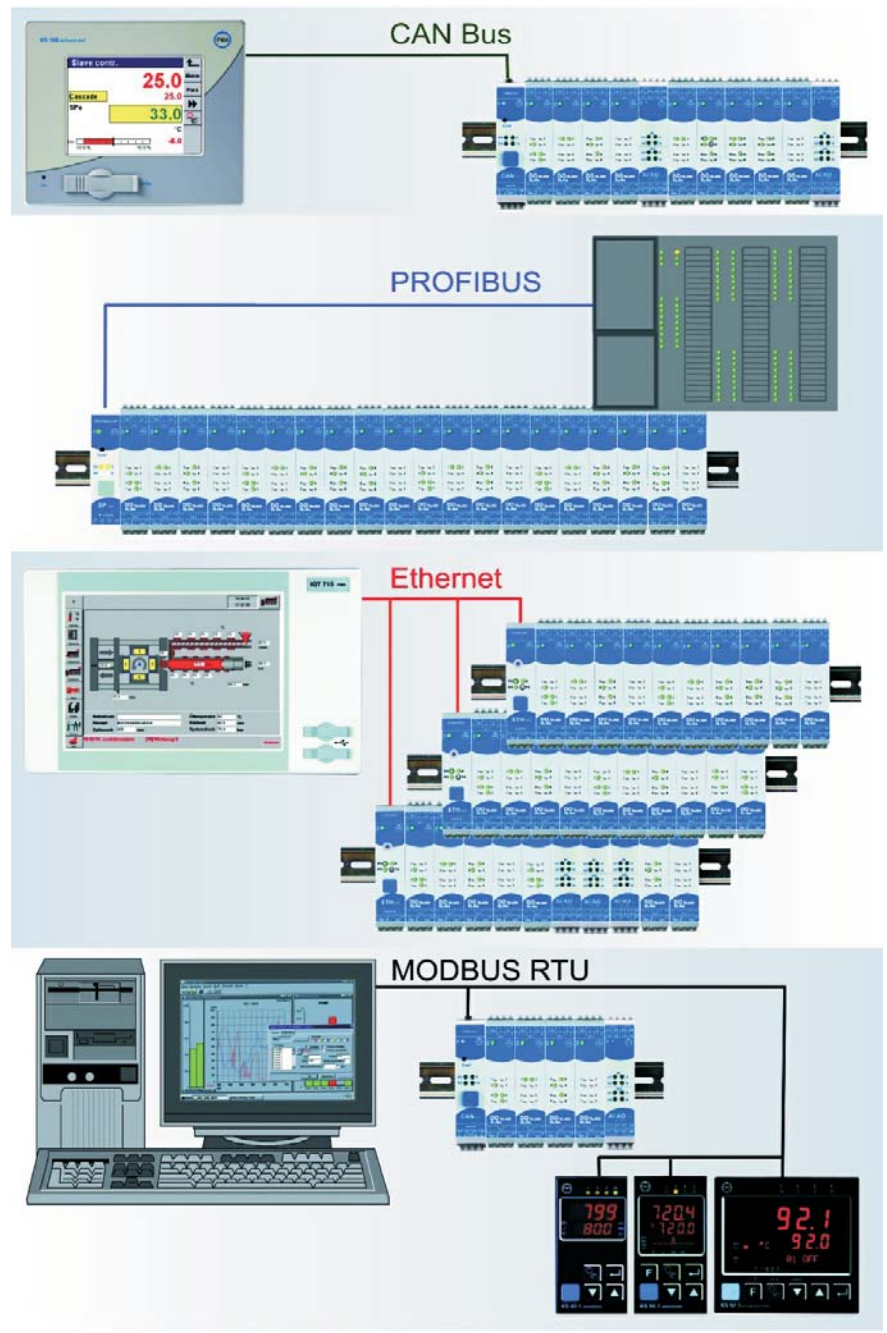
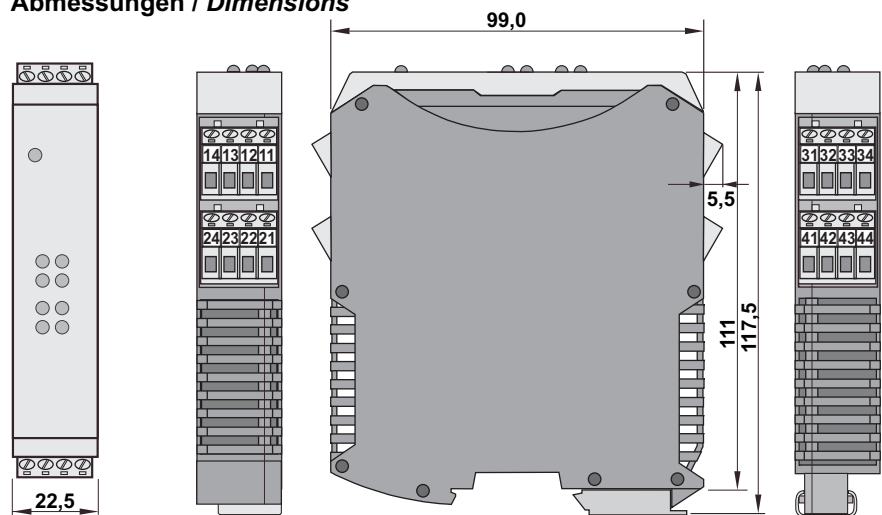


Fig. 2: Dimensions RL400 (Example RL 461)

Abmessungen / Dimensions



TECHNICAL DATA

SYSTEM

Basic module

Internal scanning cycle of the I/O modules:

ts = 10ms (depending on the type and number of connected inserted I/O modules and the bus load).

Restrictions:

Max. 62 modules can be used per coupler module.

One power supply module must be installed per 16 I/O modules.

BUS COUPLER MODULES

Bus coupler module RL 40 CANopen

Full CAN controller according to CAN specification V2.0A; physical coupling according to ISO 11898.

Cycle time on the CANbus:

Depends on the selected transmission speed, and on the number and type of inserted I/O modules (PDOs).

Transmission speed:

10 / 20 / 50 / 100 / 125 / 500 kBd; adjustable with DIP switches or via automatic selection.

Bus cable length

depending on baudrate (10kBd...500kBd):
≤1000/1000/1000/500/250/100/50/25 m

Address configuration:

addresses 1...99, adjustable with DIP switches; ≤42 using the default mapping
With engineering-tool 1...126

Terminating resistor:

external

CAN protocol:

CANopen Slave, supports DS301 V4.02 (communication profile)

Process data objects (PDOs):

1 Multiplex PDO send,
1 Multiplex PDO receive
Receive: ≤5
Transmit: ≤10, of which max. 5 can be requested per RTR (Remote Transmit Request)

EDS file:

Maximum version; component part of the Engineering Set ES/RL 400; not necessary in conjunction with KS98+.

Galvanic isolation:

Supply voltage, CANbus and logic circuits are galvanically isolated from each other.

Indicator LEDs:

Function: State;
1 x State
1 x State of the fieldbus
1 x internal bus
2 x yellow (Transmit, Receive)

Bus coupler RL400DP

PROFIBUS-DP to EN 50 170

Cycle time on the PROFIBUS:

Depends on the selected transmission speed and number of I/O modules.

Fig.3: RL 400 system with I/O-modules



Transmission speed

9600 bit/s up to 12 Mbit/s via automatic selection

Bus cable length:

≤1000 ... 100m, depending on baudrate

Address configuration:

address 1...99, adjustable with DIP switches. With engineering-tool 1...126

Terminating resistor: external

GSD file:

component part of the Engineering Set ES/RL 400

Galvanic isolation:

Supply voltage, PROFIBUS and logic circuits are galvanically isolated from each other.

Indicator LEDs:

Function: State;
1 x green (state);
1 x yellow (data exchange)
1 x yellow (internal bus)
1 x yellow (diagnosis)

Bus cable length:

RS 232: ≤ 3 m
RS 485: ≤ 1200 m

Bus coupler module RL40-ETH

Ethernet interface with TCP/IP - or Ethernet/IP-protocol.

MODBUS/TCP server via TCP port 502

Network connector:

RJ45 10BaseT (socket) according to IEEE 802.3

Bus cable length:

Ethernet segment length: 100m with Cat5 - wire

Address configuration:

Adjusted via bootp or engineering-tool

Galvanic isolation:

Supply voltage, network and logic circuits are galvanically isolated from each other.

Indicator LEDs:

Function: State;
1 x green (state);
1 x yellow (internal bus);
2 x yellow (Transmit/Receive)

Bus coupler module RL40-MOD

Protocol:

MODBUS RTU

Serial interface :

RS 422/485
Transmission speed: 2.400 / 4.800 / 9.600 / 19.200 Baud, adjustable with DIP switch;
Via parameter in addition selectable: 38.400 / 57.600 / 115.200 Baud

Byte format:

Data bits: 8
Stop bits: 1
Parity: even or none (with DIP switch adjustable)

Bus cable length:

≤ 1200 m

Address configuration

With DIP switch adjustable: 1...127
Via parameter selectable: 1 ... 247

MODBUS timeout:

0...600s (adjustable)

Internal bus cycle (HPR):

0,5...10ms (adjustable)
Boot time: 0...25s (adjustable)

Galvanic isolation:

Supply voltage, MODBUS and logic circuits are galvanically isolated from each other.

Indicator LEDs

Function, status:
1 x Green: Power;
2 x Yellow: Tx, Rx activ (Transmit, Receive)
1 x Yellow: internal system bus (HPR) activ
1 x Yellow: MODBUS interface OK

ANALOG INPUT MODULES

General

Measurement cycle:

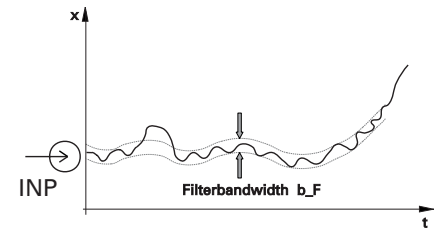
≤160 ms for all channels of a module

RL 422-1: ≤ 80 ms

Digital filter:

Every input is fitted with a 1st-order filter that is adjustable for time constant or bandwidth.

Fig.4: Filterfunction



A/D converter:

Successive approximation, 16 bits. Sigma-delta modulation.

Input span monitoring:

Error message in case the upper limit is exceeded by more than > 160 digits (resolution 16 bit)

Temperature drift: ≤0,08%/10K

Analog inputs/outputs RL 422-0 to RL 461-0

Indicator LEDs:

Status per channel

Galvanic isolation

RL 422-0: Inputs only separated from logic circuit; **not** from internal supply. Inputs are connected galvanically.
RL 461-0: Inputs are separated from logic circuit and from internal supply. Inputs are galvanically connected.

Measuring range: selectable per channel

RL 422-0: Single-ended inputs
4 x -20...20 mA/ -10...10V/
-5... 5V / -1...1V

RL 461-0: Difference inputs
2 x -20...20 mA and/or
2 x -10...10 V
-5... 5V / -1...1V

Resolution: 16 bits

Temperature influence: ≤ 0,1 %/10K

Characteristic: linear

deviation: ≤0,15%

Input resistance:

Current: approx. 47Ω; Voltage: >730 kΩ (with ground reference)

Sensor monitoring:

Exceeded limit: "out of range" >22mA

Fig. 5: Blockdiagram RL 422

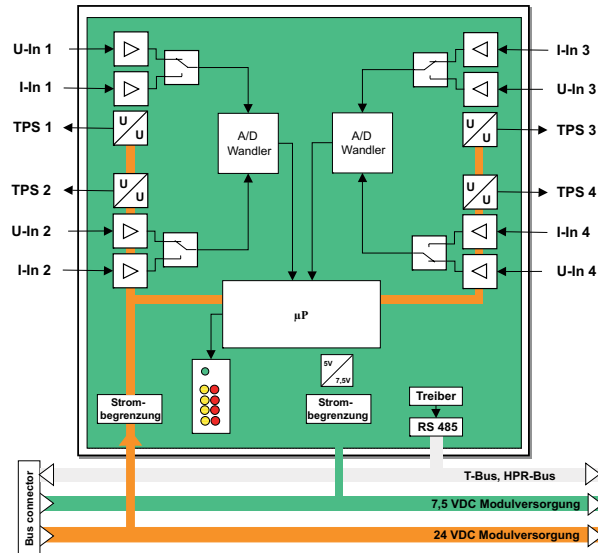


Table 1:

RL 422-0 /1			
Type of input	single-ended		
Cycle time	160 ms		
Measuring range	Input resistance	Error	Resolution
-10...+10 V	> 1MΩ	= 0,1%	0,4 mV
-5...+5 V	> 1MΩ	= 0,1%	0,2 mV
-1...+1 V	> 1MΩ	= 0,1%	0,05 mV
-20...+20 mA	45 Ω	= 0,1%	0,8 µA

Fig. 6: Blockdiagram 461

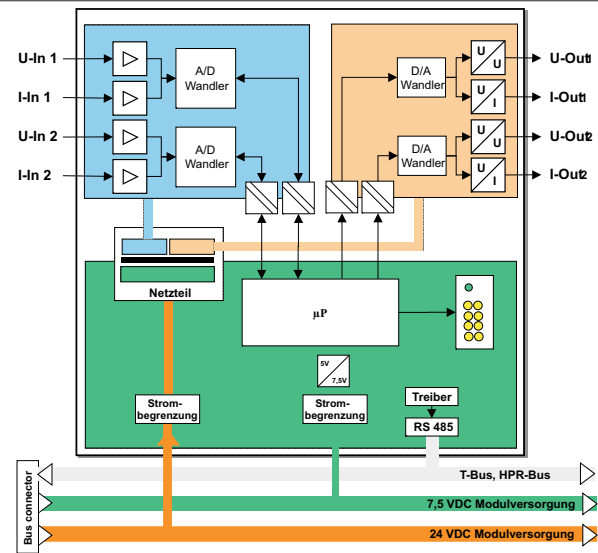


Table 2:

RL 461			
Type of input	difference		
Cycle time	80 ms		
Measuring range	Input resistance	Error	Resolution
-10...+10 V	> 1,2 MΩ	= 0,1%	0,4 mV
-5...+5 V	> 1,2 MΩ	= 0,1%	0,2 mV
-1...+1 V	> 1,2 MΩ	= 0,1%	0,05 mV
-20...+20 mA	50 Ω	= 0,1%	0,8 µA

Interface:

- integer 16 (fixpoint)
- float

Two-wire transmitter supply(TPS) only RL 422-0

One supply voltage "+24V OUT" for energizing a two-wire transmitter. Voltage: $U_s = 10/24 \text{ VDC} \pm 10\%$ (short-circuit proof)

Max. load: 20 mA at 10 V,
25 mA at 24 V

Potentiometer measurement:

(voltage-divider circuit)

Channels intended for voltage input can be configured in pairs for potentiometer measurement.

Uconst: $U_s = 10 \text{ VDC}$ (output instead of +24V OUT); short-circuit proof
Current limiting: 20mA

Temperature input Pt100 /PT1000 /Ni100/ Ni 1000 / KTY

RL 423-0 /-1 /-2 /-3

Sensor current: < 0.5 mA

Sensors: selectable per channel for RL 423-0/RL 423-2/RL 423-3

- Pt100/Ni 100
RL423-0/-1/-2: 2- and 3-wire configuration (selectable)
RL423-3: 4-wire configuration
Measuring range:
Pt 100: -200...850°C
Ni100: -60...300°C

RL 423-1/RL 423-2

Pt 1000 / Ni 1000 / KTY 11-6

Characteristic: temperature-linear

Conformity error: negligible

Sensor monitoring:

Break and short circuit. Permissible voltage difference between inputs: = 4 VAC rms

Error

see table for RL 423

Resolution: 16 Bit

2-point measured value adaptation or zero offset (selectable)

Temperature influence: $\leq 0,05 \text{ \%}/10\text{K}$

Interface:

Data format:

- integer 16 (fixpoint)
- float

Galvanic isolation:

RL423-0/-1/-2: Inputs against logic and power supply; inputs are interconnected.

RL423-3: inputs among each other, against logic and power supply, up to 300 VAC operating voltage.

Fig. 7: Blockdiagram RL423-0 /-1 /-2

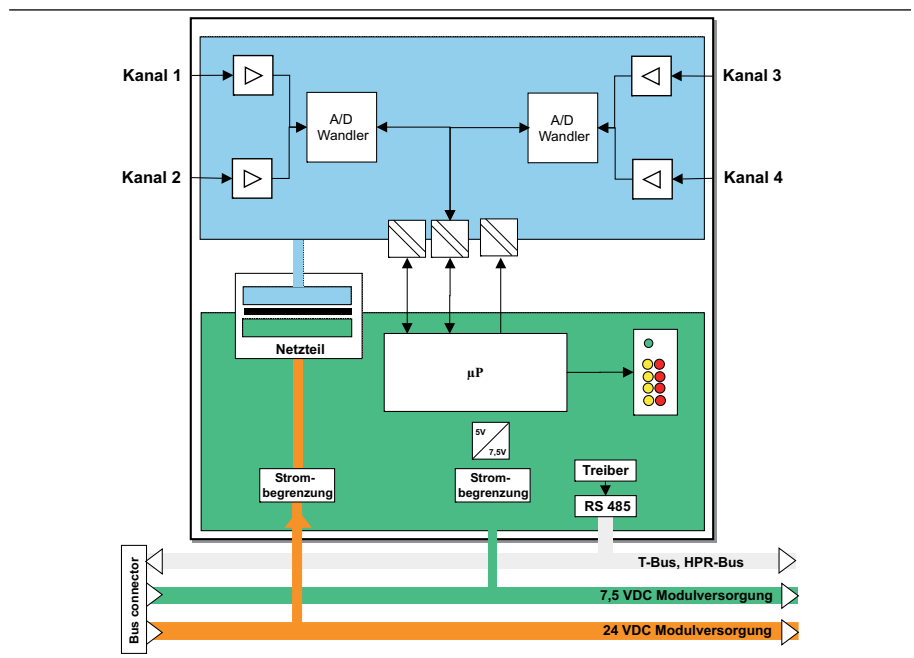


Table 3:

RL 423-x			
Type of input	3-wire (RL423-3: 4-wire)		
Cycle time	160 ms (RL423-3: 80ms)		
Type	Measuring range	Error	Resolution
Pt100/1000	-200...850°C	= 1K	0,04 K
Ni100/1000	-60...300°C	= 1K	0,04 K
KTY	-50...125°C	= 1K	0,04 K

Thermocouple input TC (RL 424-0/-1/-2)

Sensors: selectable per channel

- Thermocouples: to DIN IEC 584
Types see table RL 424

Characteristic: temperature-linear
Conformity error: negligible

Resolution: 16 bits

TC type E, J, K, L, T, N: $\leq 0,01$ K/digit
TC type S, R, B: $\leq 0,01$ K/digit
TC type W: $\leq 0,01$ K/digit

Error

see table for RL 424

2-point measured value adaptation or zero offset (selectable)

Sensor monitoring:

For break and shortcut
Permissible voltage difference between inputs: ≤ 380 VAC / 50Hz, 500 VDC

Interface:

Data format:
-integer 16 (fixpoint)
-float

Galvanische Trennung:

Eingänge gegen Logik und interne Versorgung RL 424-0 Kanal gegen Kanal (300 Volt Arbeitsspannung).
RL 424-1 und RL 424-2 Kanäle in Gruppen à 2 getrennt.

Millivolt-/O₂ (RL 424-1)/thermocouple input

Number of channels: 4; galvanic isolated

2 Kanäle mV/O₂
2 Kanäle TC

Channel 1: Millivolt input

Measuring range: $1 \times \pm 2000$ mV, ± 1000 mV, ± 500 mV, ± 250 mV.
Input resistance: approx: $200M\Omega$ diff.
Connection with screened sensor leads.

Resolution: 16 bits

Characteristic: linear

Error:

With 100 k Ω sensor output resistance:
linearity: $\leq 0.05\%$
temperature: $\leq 0.05\%$
with 1 M Ω ensor output resistance:
linearity: $\leq 0.5\%$
temperature: $\leq 0.4\%$

Internal calculation

- O₂ content at measured temperature
- O₂ content with heated sensor and a constant

2-point measurement adaptation

Interface:

Data format:
-integer 16 (fixpoint)
-float

Fig. 8: Blockdiagram RL424-0 and 423-3

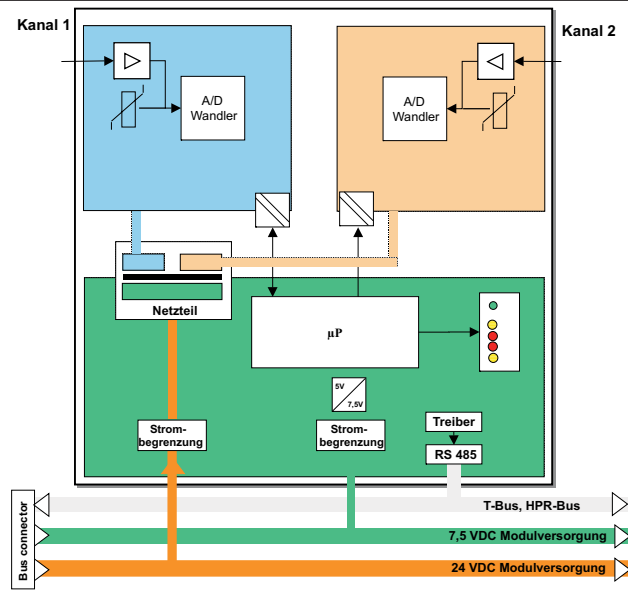


Fig. 9: Blockdiagram 424-1

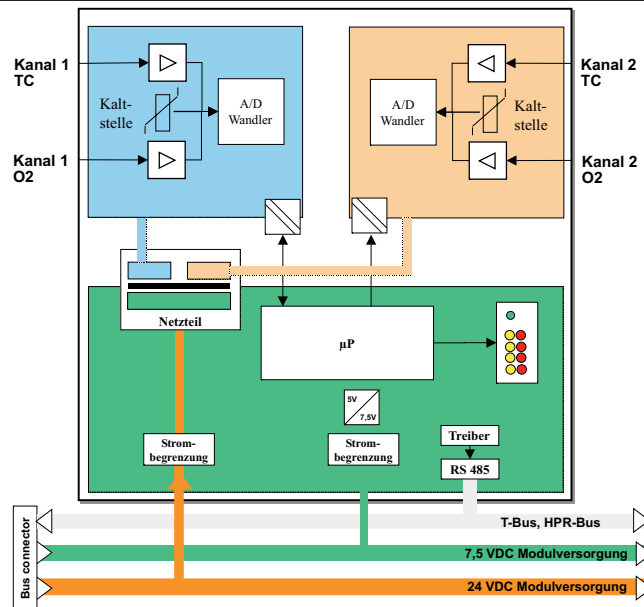


Table 4:

RL 424				
Type of input	difference			
Cycle time	160(240)** ms			
Measuring range	Input resistance	Measuring range	Error	Resolution
L	$> 1M\Omega$	$-200 \dots 900^\circ\text{C}$	$= 2K$	0,05 K
J	$> 1M\Omega$	$-210 \dots 1200^\circ\text{C}$	$= 2K$	0,05 K
K	$> 1M\Omega$	$-270 \dots 1370^\circ\text{C}$	$= 2K$	0,08 K
N	$> 1M\Omega$	$-196 \dots 1299^\circ\text{C}$	$= 2K$	0,08 K
S	$> 1M\Omega$	$-50 \dots 1760^\circ\text{C}$	$= 2K$	0,07 K
R	$> 1M\Omega$	$-50 \dots 1760^\circ\text{C}$	$= 2K$	0,07 K
T	$> 1M\Omega$	$-270 \dots 400^\circ\text{C}$	$= 2K$	0,02 K
E	$> 1M\Omega$	$-270 \dots 1000^\circ\text{C}$	$= 2K$	0,04 K
B	$> 1M\Omega$	$25 \dots 1820^\circ\text{C}$	$= 3K$	0,1 K
W	$> 1M\Omega$	$0 \dots 2299^\circ\text{C}$	$= 3K$	0,1 K
80mV	$> 1M\Omega$	$-80 \dots 80\text{mV}$	$= 0,1\%$	3 μV

* *) 4-channel and TC/O₂ version

ANALOG OUTPUT MODULES

Standard signals I,U (RL 461-0)

Number of channels: 4 (2AI, 2AO)

For technical data of analog inputs, see "Analog Input Modules".
Signal ranges: selectable per channel
All outputs are short-circuit proof.

Resolution: 12 bits

±20mA
-10...10V / -5...5V / -1...1V

Node guarding

Behaviour at communication failure: configurable

- Fail safe: output is set to 0V/0mA
- Hold: retain last value
- vault value

Characteristic: linear

overall error: ≤0,25% (0...10V);
≤0,6% (-10...10V); ≤0,63% (0...20mA)
of measurement range.

Permissible load:

Current output: ≤ 500 Ω
Voltage output: ≥ 1000 Ω
Load effect: 0,1%/100Ω
Temperature drift: ≤0,01%/10K

Interface:

Data format:
-integer 16 (fixpoint)
-float

Galvanic isolation:

Outputs are separated from logic circuit and from internal supply, but are galvanically connected.

Indicator LEDs:

Function: Display of the selected signal range (U or I) 4 x 2 x yellow

DIGITAL INPUT MODULES

RL 442-X, RL 443-0

24 VDC logic

Number of channels: 8

Input: Logic signals, contacts or 3-wire sensors (NPN or PNP transistors); according to module

Signal level: according to IEC 61131

„Low“: -3...5 VDC
„High“: 15...30 VDC

Messzyklus: ≤10 ms für alle Kanäle
(Zykluszeit auf dem Systembus
10ms/Modul)

Operating sense: configurable

Input resistance: 6,8kΩ

Filter: analog, $f_g = 1$ kHz
Surge voltage protection: fitted

Galvanic isolation:

Between inputs and logic circuits.
Groups of 4 separated from each other, from logic circuits, and internal supply.

Indicator LEDs:

Function: signal status
8 x yellow

115V/230V AC-logic (RL 443-0)

Number of channels: 4

Signal level:

„Low“: 0...50 VAC
„High“: 90...250 VAC

Measurement cycle:

≤10 ms for all channels
(cycle time on the system bus: 10
ms/module)

Operating sense: configurable

Input resistance: 240 kΩ
Filter: input delay ≤10 ms/ channel
Surge voltage protection: fitted

Galvanic isolation

Inputs from logic, between inputs

Indicator LEDs:

Function: signal status
4 x yellow

DIGITAL OUTPUT MODULES

RL 451-X, RL 452-0

Node guarding

Behaviour at communication failure configurable:

- Fail safe: outputs 0/1 (selectable)
- Hold: retain last value
- Fault value

24 VDC logic (RL 451-0)

Number of channels: 8 (2 groups of 4 channels); suitable for switching loads with 12 and 24 VDC.

Control voltage:

$U_c = 2 \times 24$ VDC; separated according to groups.

Permissible range: 8...34 VDC

Forward resistance: ≤140 mΩ
(≤200 mΩ typical); voltage drop ≤1,2V

Leakage current:

approx. 30 μA (non-conducting)

Load current:

Depends on ambient temperature:

At 25°C: ≤2A / output

At 50°C: ≤1,5A / output

Lead break and short circuit

detected and made available as a status signal on the bus.

- function can be switched off.

Protective circuits:

Fitted as standard against short circuit, and surge voltage; thermal current limiting. No reversed-polarity protection.

Free-wheel diode for inductive loads:

at RL 451-1 included

Cycle time: ≤10 ms for all channels

(cycle time on the system bus: 10
ms/module)

Operating sense: configurable

Galvanic isolation

Logic from output group, groups among each other

Indicator LEDs:

8 x yellow (signal status)

Relays (RL 452-0)

Number of channels: 4 relays

Contacts: potential-free change-over

Contact rating:

AC: ≤ 1250 W, 250 V, 5A

RC suppressor circuit:

must be provided externally

Cycle time: ≤10 ms for all channels

(cycle time on the system bus: 10
ms/module)

Operating sense: configurable

Galvanic isolation:

Relays from logic circuits and internal supply

Indicator LEDs:

4 x yellow (signal status)

POWER SUPPLY

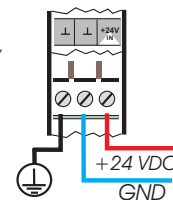
The basic module is energized via its bus coupler module.

Supply voltage: 24 V DC (20...30VDC)

Current consumption: ≤1,5A

Influence power supply: negligible

- The GND of the 24V power supply has to be connected to protective earth (PE).



ENVIRONMENTAL CONDITIONS

Permissible temperature:

Operation: -10...55 °C (32...122 °F)

Storage and transport: -20...70 °C
(-4...158 °F)

Climatic category:

KUF according to DIN 40 040

Relative humidity: ≤75% yearly average,
no condensation

Electrical safety:

DIN EN 61010-1

Contamination class 2,
Overvoltage category II

Electromagnetic compatibility:

DIN EN 61000-6-3

DIN EN 61000-6-2

Shock and vibration:

To DIN 40046 IEC 60068-2-6

GENERAL

Electrical connection:

Screw terminals and spring-clamp connectors for leads with max. 2,5 mm² cross-section.

Mode of protection:

IP20

Housing:

Material: polyamide PA 6.6

Flammability class: V0 to UL 94

Mounting:

on 35 mm „top hat“ rails to DIN EN 50022

Mounting position: vertical

Overall dimensions (W x H x D):

RL 400 22,5 x 99,0 x 117,5 mm

Weight:

All modules: approx. 100 g (3,53 oz.)

ACCESSORIES

BlueControl®

Type	RL 400		RL 40 - 1 x x - 00000 - x 00
Fieldbus coupler			
CAN	RL40-CANopen		1
DP	RL40-DP PROFIBUS DP V1		2
MOD	RL40-MOD* MODBUS RTU		3
ETH	RL40-ETH Ethernet MODBUS/TCP		4
ETH	RL40-ETH /IP		4-1
Power module			
PWR	RL40-PWR Power module PWR		9
Analog inputs AI			
AI	RL 422-0	Analog inputs, 4 x I / U / TPS / Potentiometer	4 2 2 0
AI	RL 422-1	Analog inputs 2 x I/U galv. isolated	4 2 2 1
AI	RL 423-0	RTD 4 x Pt100 galvanic isolated	4 2 3 0
AI	RL 423-1	RTD 4 x Pt1000 galvanic isolated	4 2 3 1
AI	RL 423-2	RTD 4 x Pt100/Pt1000	4 2 3 2
AI	RL 423-3	RTD 2 x Pt100 galvanic isolated	4 2 3 3
AI	RL 424-0	2 x TC galvanic isolated	4 2 4 0
AI	RL 424-1	2 x TC / O2 (mV)	4 2 4 1
AI	RL 424-2	4 x TC galvanic isolation 2/2	4 2 4 2
AIO	RL 461-0	Combi module, 2 x AI (±U / ±I, 16 Bit) differential inputs; 2 x AO (±U / ±I, 12 Bit)	4 6 1 0
Analog outputs AO			
AO	RL 431-0	4 x I / U (±10V / ±20mA, 12 Bit)	4 3 1 0
AIO	RL 461-0	Combi module, 2 x AI (±U / ±I, 16 Bit) differential inputs; 2 x AO (±U / ±I, 12 Bit)	4 6 1 0
Digital inputs DI			
DI	RL 442-0	Digital inputs 2 x 4 24 VDC (pnp /contact, potential-free)	4 4 2 0
DI	RL 442-1	Digital inputs 2 x 4 24 VDC (npn /contact, potential-free)	4 4 2 1
DI	RL 442-2	Digital inputs 8 x 1 24 VDC (individual supply)	4 4 2 2
DI	RL 443-0	4 x Relay (115/230V AC)	4 4 3 0
Digital outputs DO			
DO	RL 451-0	Digital outputs 2 x 4 24 VDC/2A	4 5 1 0
DO	RL 451-1	Digital outputs 2 x 4 24 VDC/2A (free wheeling diode)	4 5 1 1
REL	RL 452-0	Relay outputs 4 x 230 VDC/5A	4 5 2 0
Terminations			
		Without terminal blocks	0
		Screw terminal	1
		Spring-clamp terminal	2
Approvals			
		CE	0
		UL/cUL	U

RL Accessories

4 x Screw terminal blocks	9407-998-07101
4 x Spring-clamp terminal blocks	9407-998-07111
1 x Top-hat rail bus-connector	9407-998-07121
1 x Plug for busconnection left(for bus coupler)	9407-998-07131
1 x Plug for busconnection right (bus extension)	9407-998-07141



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