5.5 IP161

5.5.1 General Information

Programmable I/O processors are freely programmable I/O modules. Application programs and data modules can be created for all programmable I/O processors using the programming system.

The IP161 module has a CPU section, two interfaces, digital and analog I/O.

The IP161 module features interrupt capable digital inputs/outputs and the fast analog inputs which allow it to be used in both FIFO and comparator modes. The IP161 module can also be used both as a programmable I/O processor and a CPU. The module recognizes the correct operating mode from the slot used (slots 3+4 -> CPU module).

The module is usually used as an I/O processor to reduce the load on the CPU.

All programmable I/O processors have a local processor core with a RISC processor, local system RAM and operating system. The DPR area ("PPdpr" Library) is used as a communication interface between CPU PLC and the programmable I/O processor. A project must be created for each parallel processor in B&R Automation Studio™.

The PLC CPU and the local processor always have access to this data area, which guarantees data consistency for data type UINT. Larger data structures cannot be be used.

The system can be integrated in a CAN bus using the I/O processor's CAN interface. The IF1 RS232 interface is designed for the programming device's connection. The RS232 interface IF3 can be used e.g. for visualization by using the AC961 bus adapter. This ensures that the IF1 is kept free as the online interface.

5.5.2 Order Data

Model Number	Short Description	Image
	Programmable I/O Processor	
3IP161.60-1	2005 programmable I/O processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, max. 12 digital inputs 24 VDC, Sink, max. 12 digital outputs 24 VDC, 0.1 A, 6 analog inputs ±10 V, 14-bit, 6 analog outputs ±10 V, 12-bit, 2 outputs with +10 V and -10 V per terminal block. Order 3 x TB170 terminal blocks separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
7AC911.9	Bus connector, CAN	
0AC912.9	Bus adapter, CAN, 1 CAN interface	
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable	
0AC961.9	Accessories, bus adapter (CAN, RS232)	

Table 70: IP161 order data

5.5.3 Technical Data

Product ID	IP161
C-UL-US Listed	Yes
B&R ID Code	$34
Module Type	B&R 2005 system module
Slot 3 ≥ 4	 CPU operation (slots 3+4 used) Programmable I/O processor operation
Power Consumption 5 V 24 V Total	 Max. 6.5 W Max. 11.5 W, including potentiometer supply (if used externally) Max. 18 W
Processor	
Typical Instruction Cycle Time	0.4 µs
Standard Memory System RAM User RAM System PROM User PROM	 174 KB SRAM 850 KB SRAM 512 KB FlashPROM 1.5 MB FlashPROM
Data Buffering Backup Battery in 2005 Backplane Buffering with AC240 Battery Module Battery Monitoring	 At least 4 years At least 2 years Yes, when operated as main CPU
Peripherals	
Real-time Clock Resolution	Nonvolatile during CPU operation (buffered externally) 1 s
Reset Button	Yes
Status display	4 status LEDs, 4 interface LEDs
Standard Communication Interfaces	
Application Interface IF1 Electrical Isolation Design Distance Baud Rate	RS232 No 9-pin DSUB plug Max. 15 m / 19200 Baud Max. 115.2 kBaud
Application Interface IF2 Electrical Isolation Design Station number Distance Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	CAN Yes 9-pin DSUB plug Can be set using two node number switches Max. 1,000 m 500 kBit/s 250 kBit/s 50 kBit/s
Application Interface IF3 Electrical Isolation Design Distance Baud Rate	RS232 No 9-pin DSUB plug, the AC961 bus adapter is required for operation Max. 15 m / 19200 Baud Max. 115.2 kBaud

Table 71: IP161 technical data

Product ID	IP161
Potentiometer Voltage Outputs	
Static Characteristics	
Number and Type of Potentiometer Voltages	2 outputs with +10 V and -10 V per terminal block
Electrical Isolation to PLC	Yes
Internal Reference Potential	AGND (analog ground for analog input circuit)
Output Current	±80 mA (simultaneously)
Short Circuit Current	Typ. ±100 mA
Continuous Short Circuit Protection	Yes
Basic Accuracy At 25° C At 0 - 60° C	 ±0.25% ±0.5%
Output Power	Max. 1.6 W
Analog Inputs	
Static Characteristics	
Input Type	Differential inputs for voltage measurement
Number of Inputs	6
Input Signal, Nominal	±10 V
Maximum Continuous Overload (without damage) Between +/- Connection Between Analog GND and + or -	 ±25 V ±30 V
Conversion Procedure	Successive approximation
Conversion Time	≤100 µs for all 6 channels (parameters can be set by LTX functions in cyclic operating mode)
Digital Converter Resolution	14-bit
Data Format in Application Program Value Range Raw Values from ADC According to standard software using FUB IP161AIx (x ... 1 - 6) Quantization	INT $8320 - $7CE0 (typically) $8000 - $7FFC 1.22 mV per LSB
Output of the Digital Value during Overload When range is exceeded (pos.) When range is exceeded (neg.)	 $7FFF $8000
Input Impedance in Signal Range Static Dynamic	 2 MΩ 3 kΩ/10 nF
Analog Input Measurement Error Maximum Error at 25° C Temperature Coefficient Offset Drift Gain Drift	 ±0.06% ±0.00122%/°C ±0.00061%/°C
Linearization Method	Scaling conversion using software
Common Mode Voltage	±5 V common mode voltage in contrast to other analog inputs

Table 71: IP161 technical data (cont.)

Product ID	IP161
Wiring	Differential or potentiometer input
External Power Consumption	None (except potentiometer)
Protection	Internal clamp diodes protect against voltage spikes
Dynamic Characteristics	
Input Filter Characteristic Frequency Limit	 Low pass 1st order 5 kHz
Total System Input Transfer Time	≤100 µs for all 6 channels (parameters can be set)
Scan Duration (including response time)	5 µs (response time on the multiplexer + sample time on the ADC)
Scan Repeat Time Minimum Typical	Parameters can be set by LTX functions depending on the operating mode (cyclic, applications driven) 85 µs (cyclic operation) 100 µs
Operating Characteristics	
Operating Modes Operating Mode 1 Operating Mode 2 Operating Mode 3	See Section 5.5.13 "Operating Modes", on page 172 Fast analog value registering Measurement values are recorded in FIFO memory Comparator
Isolations Voltage between Input and Bus Inputs	 ±50 V 0 V (no electrical isolation)
Installation Recommendations	Double-sided twisted cable with 2-pin twisted Cu wires, max. 10 m, Under **no circumstances** should inputs and outputs be mixed in a multi-wire cable
Typical Example for External Connections	Differential input (+/- connection) Potentiometer input (- input pin should be connected with AGND)
Consequences of Incorrect Connection to the Input Terminals	Mixing up the +/- connections: negative result Open inputs: Overrun to $7FFF
Cross-talk between Inputs	>40 dB (DC - 60 Hz)
Non-Linearity	±1 LSB (from ADC)
Continuity Without Missing Codes	No missing codes (in defined value range)
Calibrating or Testing for Maintaining the Accuracy Class	No calibration or testing required
Analog Outputs	
Static Characteristics	
Number of Outputs	6 voltage outputs ±10 V
Digital Converter Resolution	12-bit
Data Format in Application Program	INT ($8000 - $7FF0)
Quantization	1 LSB = 4.88 mV
Output Impedance in Signal Range	0.25 Ω (2.5 mV at load change of 0 to 10 mA at 10 V)
Load Impedance	≥1 kΩ

Table 71: IP161 technical data (cont.)

Product ID	IP161
Analog Output Measurement Error Alignment Precision at 25° C Offset Total Temperature Coefficient Offset Drift Gain Drift	 ±0.0366% ±0.4% ±0.00244%/°C ±0.00122%/°C
Dynamic Characteristics	
Response Time When Changing Using Whole Area	Max. 300 µs from 0.01% of end value (for resistive load)
Overshoot	For resistive load of 1 kΩ max. 3%
Output Response when Power Supply is Switched On/Off	An enable relay is switched on at a defined value of 0 V Default setting = short circuit on the output terminals using relay contact
Output Ripple Factor	≤250 mVpp
Operating Characteristics	
Operating Mode	Cyclic output with approx. 10 kHz
Isolation Voltages between Output and Bus	±50 V
Installation Recommendations	Double-sided twisted cable with 2-pin twisted Cu wires, max. 10 m, Under **no circumstances** should inputs and outputs be mixed in a multi-wire cable
Calibrating or Testing for Maintaining the Accuracy Class	No calibration or testing required
Permitted Load Types	Resistive, inductive
Maximum Capacitive Load	≤100 nF (larger capacity extends the response time)
Typical Example for External Connections	e.g. analog hydraulic valve
Consequences of Incorrect Connection to the Output Terminals	Depends on wiring and voltage size (in worst case scenario all 6 output circuits become defective)
Continuity	±0.5 LSB (DAC value)
Non-Linearity	Max. ±4 LSB (DAC value)
Repeat Precision at a Certain Temperature after a Specified Stabilizing Time	±2 LSB (noise at constant temperature in 24 hours)
Digital inputs	
Static Characteristics	
Number of Inputs	Up to 12 Configuration as input or output takes place in groups of two using software
Maximum Peak Voltage	+35 V
Rated Voltage	+24 VDC
Rated Frequency	Max. 200 kHz (symmetrical square wave)
Wiring	Sink
Limit Values 0-Signal UL 0-Signal IL 1-Signal UH 1-Signal IH	 ≤5 V ≤2 mA ≥11 V ≥5 mA

Table 71: IP161 technical data (cont.)

Product ID	IP161
Delay 0 to 1	≤2.5 µs
Delay 1 to 0	≤2.5 µs
Power Consumption (external) Per Group at 24 V (no load) Per Digital Input at 24 V	 ≤0.48 W 0.24 W
Additional Characteristics	
Status Display	No
Interrupt Capable	Yes Parameters can be set using LTX functions - each digital input can trigger an IRQ **WARNING:** Handling takes place using an exception task
Operating Characteristics	
Consequences of Incorrect Input Connections	At 24 V and COM exchange: internal reverse polarity diode For active inputs without supply: Output driver is not protected
Isolations Voltage between Input and Bus Inputs	 ±50 V Digital group <-> Digital group: ±50 V
Consequences of Removing/Inserting Input Modules with Voltage Applied	Must not be removed/inserted during operation (= system module)
Additional Exterior Load when Inputs and Outputs are Switched Together (if required)	No load required (push/pull)
Explanation of Signal Evaluation	Each digital input is assigned a TPU pin, different types of signal evaluation are possible (edges triggering, counter input) depending on the TPU function, several inputs can be combined (e.g. incremental encoder)
Recommended Length for Cable and Connections Depending on Cable Type and Electromagnetic Compatibility	The recommended cable length and cable type depends on the maximum frequency of use,Shielded cable are recommended for fast signals (>10 kHz)
Typical Example for External Connections	Only sink connection
Different Circuits Possible	Each group is electrically isolated
Digital Outputs	
Static Characteristics	
Number and Type of Outputs	Up to 12 transistor outputs (Push/Pull) Configuration as input or output takes place in groups of two using software
Maximum Switching Voltage	+35 V
Maximum Peak Voltage	+50 V
Rated Current (1-Signal)	±100 mA
Rated Voltage	+24 VDC
Switching Voltage Range	+12 VDC to +35 VDC
Rated Frequency	Max. 100 kHz
Current Range at 1-Signal (continuous at maximum voltage)	±100 mA

Table 71: IP161 technical data (cont.)

Product ID	IP161
Voltage Drop (1-Signal), Internal Resistance	ΔU at 100 mA is ≤1 V
Protected and short circuit outputs	I_K ≤300 mA, continuous
Short Circuit Current Turn-off delay Over-Temperature Cutoff	110 to 300 mA 100 µs ≥ 170° C
Wiring	Sink or source
Power Consumption per Group (external)	≤20 mA + load current for the outputs
Additional Characteristics	
Status Display	No
Protection Characteristics	
For Protected Outputs: Operating characteristics over 1.2 x I_e Including the Current Level, where the Protection Circuit Responds	Internal current limitation from ±110 mA to ±300 mA
For Short Circuit Proof Outputs: Information Concerning Replacement or Removal of the Prescribed Protective Measures	Internal thermal overload protection and internal current limitation
For Non-Protected Outputs: Information Concerning Required Protection Measures which must be Provided by the User	No prescribed protective circuit
Characteristics of the Output Circuit Protection Against Voltage Spikes when Turning Off Inductive Loads	Internal clamping diodes for group supply voltage Short term current of ±1 A, duration ≤10 ms
Type of External Protective Circuit	For inductive loads, clamping diodes can also be connected between the output and the group supply (24 VDC and GND)
Dynamic Characteristics	
Delay 0 to 1	≤2 µs for resistive loads
Delay 1 to 0	≤2 µs for resistive loads
Switch Frequency with Resistive Load	100 kHz with resistive load
Operating Characteristics	
Consequences when Outputs Incorrectly Connected	Depending on the error, the worst case scenario could cause destruction of digital group
Consequences of Multiple Overloads on Multi-Circuit Modules	The entire group is switched off due to internal thermal monitoring
Output Behavior when the Controller Falls Out During Voltage Dips, Interruptions and when the Unit is Switched On-or Off	Output switched to high resistance
Total Output Current	Max. 400 mA/group (static)
Isolation Voltages between Output and Bus	±50 V
Recommended Procedure when Changing Output Modules	Must not be removed/inserted during operation (= system module)

Table 71: IP161 technical data (cont.)

Product ID	IP161
Typical Example for External Connections	Sink or source wiring
Mechanical Characteristics	
Dimensions	B&R 2005 double-width
Pin Assignments	See sections 5.5.4 "Operational and Connection Elements" and 5.5.10 "I/O Connections"

Table 71: IP161 technical data (cont.)

5.5.4 Operational and Connection Elements

Three I/O groups, a reset button, status LEDs, two HEX number switches for the CAN bus station number and the connectors for two RS232 interfaces and a CAN interface are all located behind the module door.

If both RS232 interfaces are used, the AC961 bus adapter is required (see Section 5.5.8 "RS232 Interfaces (IF1 and IF3)", on page 164).

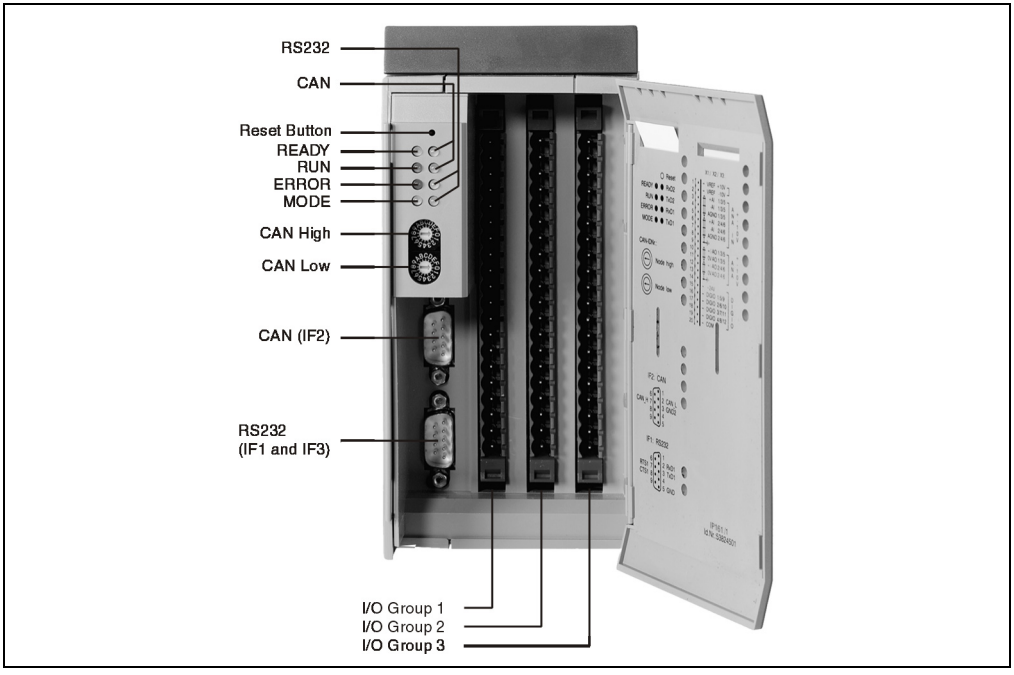


Figure 63: IP161 operational and connection elements

5.5.5 Status LEDs

LED	Description
READY	Lit in Service and diagnostics mode
RUN	Lit in Run, Service and diagnostics mode
ERROR	Lit if error occurs
MODE	Lit when programming FlashPROM
RXD1, TXD1	Lit during data exchange via either of the two RS232 interfaces
RXD2, TXD2	Lit during data exchange via the CAN interface

Table 72: IP161 status LEDs

The LEDs READY, RUN, ERROR and MODE are lit when the reset button is pressed.

5.5.6 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Depending on the operating mode, pressing the reset buttons has different effects.

Operating Mode	Effects
Programmable I/O Processor	Local Reset - All IP161 application programs are stopped - All IP161 outputs are set to zero
CPU	Local reset and global bus reset - All application programs are stopped - All outputs are set to zero

Table 73: IP161 reset button

5.5.7 CAN Node Number Switch

The CAN node number is set with the two hex switches. The switch setting can be evaluated by the application program at any time. If the switch position is changed during operation, a warning can be generated. The operating system only interprets the switch position when switched on.

The settings $00, and $FF are reserved for special functions.

Switch Position	Function
$00	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. The bootstrap loader mode is only required when PCCSW < 2.0 is installed. The procedure is the same as described in Section 5.5.14 "Programming System Flash", on page 174. In an additional dialog box, the baud rate and the interface must only be set, from which a connection to the PLC is created.
$FF	Diagnostics mode

Table 74: IP161 CAN node number switch

5.5.8 RS232 Interfaces (IF1 and IF3)

The IP161 programmable I/O processor is equipped with two RS232 interfaces. The signals are fed through together via a DSUB plug. The interfaces are not electrically isolated (shared GND connection).

The IF1 RS232 interface is designed to be used as an online interface. An AC961 bus adapter is needed to use the IF3. The IF3 can e.g. be used for visualization while the IF1 remains free as the online interface.

An RS232 cable is available from B&R for connecting programmable I/O processors with the PG software (PC).

Model No. 0G0001.00-090

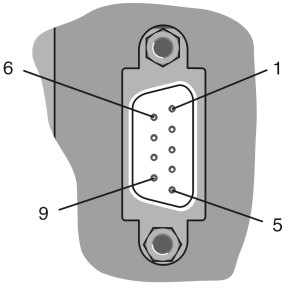
Interface	Description	Pin Assignments		
Application interface RS232  9-pin DSUB plug	The RS232 interfaces are not electrically isolated. Status LEDs RXD1 and TXD1 are lit during data exchange via either of the two RS232 interfaces. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	Pin	IF1	IF3
		1		
		2	RXD1	
		3	TXD1	
		4		TXD3
		5	GND	GND
		6		RXD3
		7	RTS1	
		8	CTS1	
		9		

Table 75: IP161 RS232 interfaces (IF1 and IF3)

AC961 Bus Adapter

An AC961 bus adapter is needed to use both RS232 interfaces. The bus adapter is connected to both DSUB plugs.

The (IF1) online interface is connected to the bus adapter with a 9-pin DSUB plug. Both the RS232 interface IF3 and the CAN interface are connected to one multipoint connector. One 120 Ω terminating resistor is included with the delivery of the AC961. If required, the resistor can be connected between the CAN_L and CAN_H.

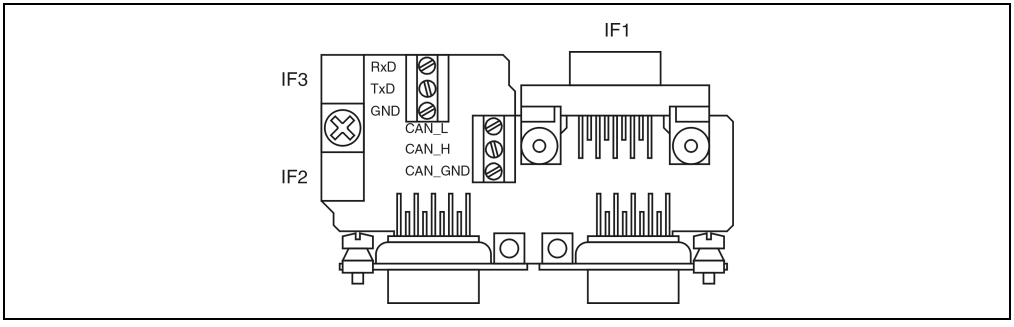


Figure 64: IP161 bus adapter for the AC961

5.5.9 CAN Interface (IF2)

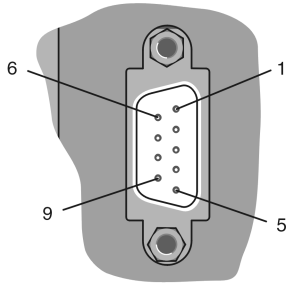
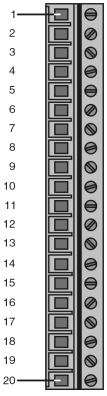
Interface	Description	Pin Assignments	
Application interface CAN  9-pin DSUB plug	The 82527 controller is used as the CAN controller. The interface is electrically isolated. The connection is made using a T-connector (7AC911.9). The status LEDs RXD2 and TXD2 are lit during data transfer via the CAN interface. Max. Baud Rate: 500 kBit/s Bus Length: ≤60 m 250 kBit/s Bus Length: ≤200 m 50 kBit/s Bus Length: ≤1,000 m	**Pin**	**CAN**
		1	
		2	CAN_L
		3	CAN_GND
		4	
		5	
		6	
		7	CAN_H
		8	
		9	

Table 76: IP161 CAN interface (IF2)

5.5.10 I/O Connections

The programmable I/O processor IP161 is equipped with three rows of terminals for analog and digital I/Os. The connection is made using the TB170 20-pin terminal block. The assignments for the three terminal blocks are the same. Only the channel numbers are different.



TB170

Connection	Assignment	Channel number for I/O Group		
		1	2	3
1	VREF +10 V			
2	VREF -10 V			
3	+ Analog input	1	3	5
4	- Analog input	1	3	5
5	Analog GND	1	3	5
6	+ Analog input	2	4	6
7	- Analog input	2	4	6
8	Analog GND	2	4	6
9	Shield analog inputs	1 + 2	3 + 4	5 + 6
10	± Analog output	1	3	5
11	0 V analog outputs	1	3	5
12	± analog output	2	4	6
13	0 V analog outputs	2	4	6
14	Shield Analog Outputs	1 + 2	3 + 4	5 + 6
15	+24 V [1)]	1 - 4	5 - 8	9 - 12
16	Digital input / output 1	1	5	9
17	Digital input / output 1	2	6	10
18	Digital input / output 1	3	7	11
19	Digital input / output 1	4	8	12
20	COM [1)]	1 - 4	5 - 8	9 - 12

Table 77: IP161 I/O connections

1) The digital inputs and digital outputs are arranged in three electrically isolated groups.

Analog Inputs

Signal Cable Connection

Shielded cables must be used for wiring the analog inputs. The shield is grounded on the module using the shield connections provided on the terminal block.

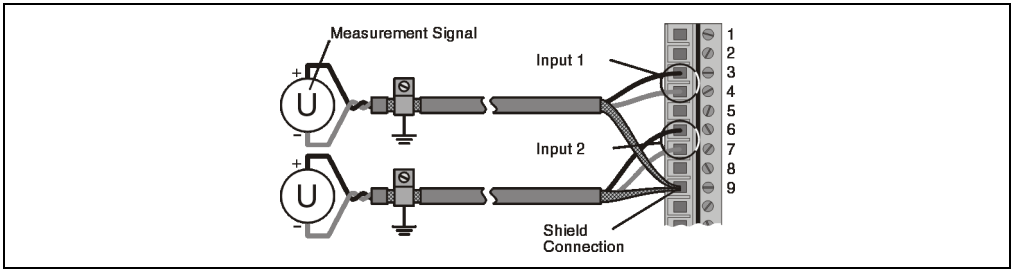


Figure 65: IP161 connections for analog inputs

The shielded connection (pin 9) is connected via an RC element with ground (⏚, i.e. spring contact and mounting rail).

R: 22 kΩ, C: 10 nF / 60 V

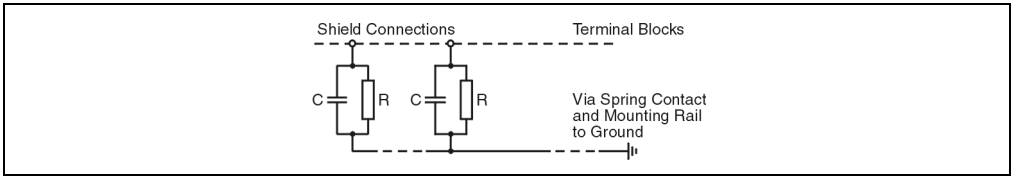


Figure 66: IP161 shielded connection

Potentiometer Connection

The module provides two potentiometer voltages (+10 V and -10 V). The sum of all currents from all three I/O groups amounts to +80 mA or -80 mA. The two voltages are short circuit proof.

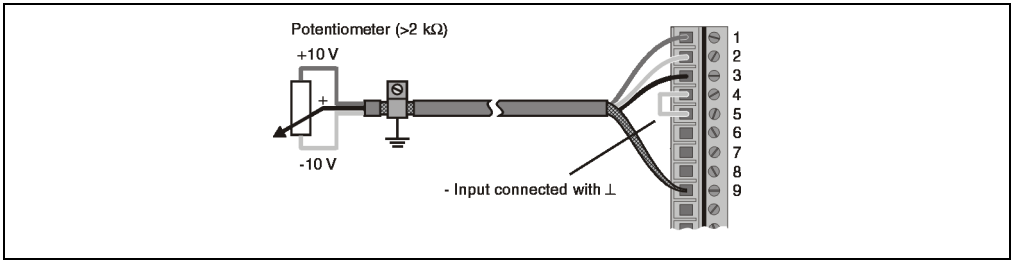


Figure 67: IP161 potentiometer connection

Analog Outputs

Signal Cable Connection

Shielded cables must be used for wiring the analog outputs. The shield is grounded on the module using the shield connections provided on the terminal block.

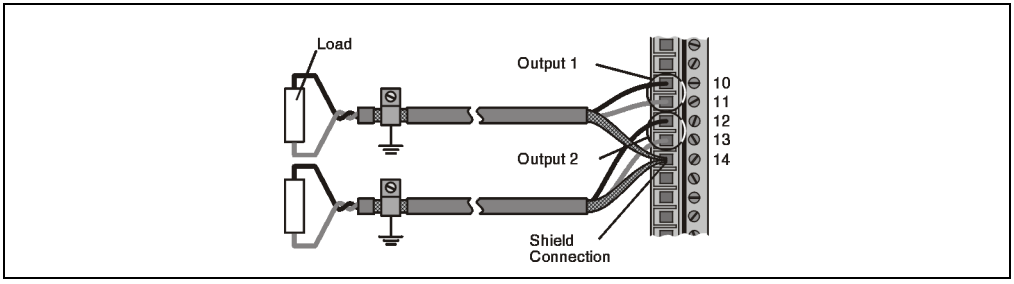


Figure 68: IP161 connection for analog outputs

The shielded connection (pin 14) is connected via an RC element with ground (⏚, i.e. spring contact and mounting rail)

R: 22 kΩ, C: 10 nF / 60 V.

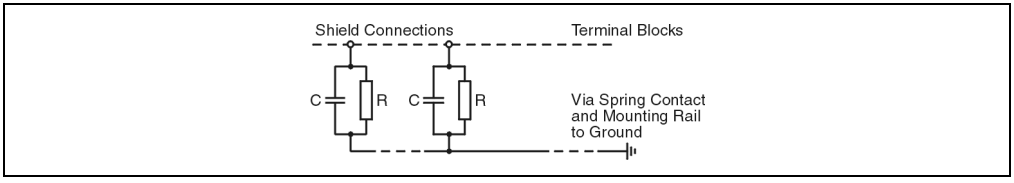


Figure 69: IP161 shielded connection

Digital I/O Group

Each digital I/O group has over four I/Os. As default, they are configured as digital inputs. They can be switched to digital outputs in two groups using software.

Each digital I/O group is supplied externally with +24 VDC (reverse polarity). The groups are electrically isolated by the system.

The digital inputs can be configured as interrupt inputs using the TPU Code Linker in the application program.

Connecting an I/O Group with Four Inputs

The inputs are wired as sink circuits.

Note: Although only inputs are used, the 24 V supply must also be connected to pin 15.

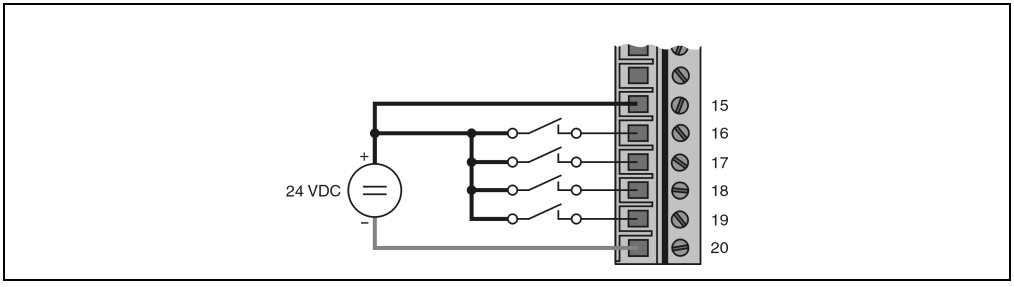


Figure 70: IP161 connecting an I/O group with four inputs

Connecting an I/O Group with Four Outputs

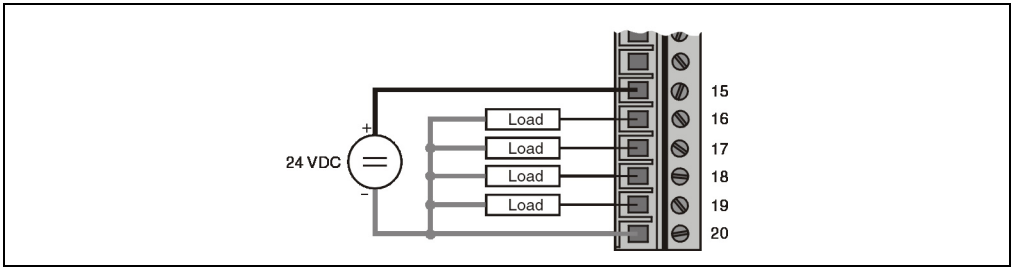


Figure 71: IP161 connecting an I/O group with four outputs

Connecting an I/O Group with Two Inputs and Two Outputs

The inputs are wired as sink circuits.

Note: The digital outputs are push/pull outputs. They can switch the load using a sink or source circuit.

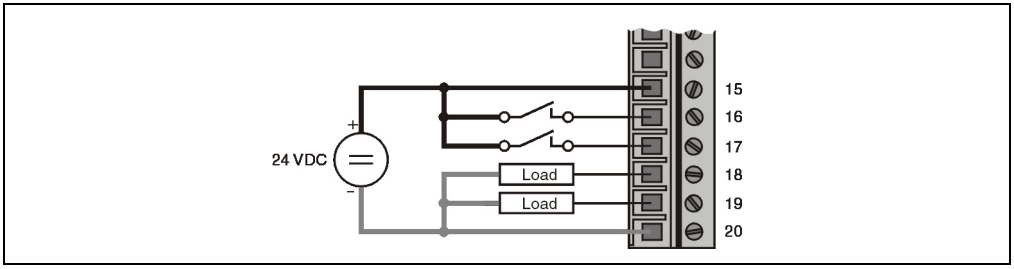


Figure 72: IP161 connecting an I/O group with two inputs and two outputs

5.5.11 Data/Real-time Buffering

The following areas are buffered

- User RAM
- System RAM
- Real-time clock

The backup battery is either in the B&R 2005 rack or in the AC240 battery module

Battery Monitoring

If the IP161 module is operated as the CPU, the I/O processor carries out cyclical monitoring of the battery voltage. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available to the user from the SYS_lib function "SYS_battery".

Battery Change Interval

See section "Backup Battery" in sections 2 "Module Racks" and 17.2 "AC240" (battery module).

5.5.12 Local I/O Bus Expansion

Since the IP161 module does not have its own expansion master, the EX350 I/O master controller is needed for local I/O bus expansion. By using this controller, up to four expansion racks with all I/O modules can be used with the IP161.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU by processing I/O module data on the expansion racks.

5.5.13 Operating Modes

Analog Inputs

The analog inputs are set in all operating modes using LTX functions.

1) Fast Analog Value Registering

a) Cyclic Mode

The six analog inputs are converted as quickly as possible. The conversion time for all six channels is less than 100 µs. When inputs are read with corresponding LTX functions from the application program, the values are a maximum of 100 µs old.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU cyclically using a specified frequency (max. 10 kHz).

2) Measurement Values are Recorded in FIFO Memory

a) Cyclic Mode

The six analog inputs are converted as quickly as possible. The converted analog values are stored in a FIFO memory. The FIFO memory must be allocated by the user.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU cyclically using a specified frequency (max. 10 kHz). The converted analog values are stored in a FIFO memory. The FIFO memory must be allocated by the user.

3) Comparator

a) Cyclic Mode

The six analog inputs are converted as quickly as possible and compared with a comparator value using hardware. The comparator value is evaluated by the TPU. The TPU can handle fast links to digital I/O or trigger an exception to the processor without loading the processor. Depending on the TPU, the reaction time ranges from 50 µs to 150 µs.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU using a specified frequency (max. 10 kHz). Analog values are compared with the comparator value using hardware. The comparator value is evaluated by the TPU. The TPU can handle fast links to digital I/O's or trigger an exception to the processor without loading the processor. Depending on the TPU, the reaction time ranges from 50 µs to 150 µs.

Analog Outputs

The six analog outputs are output cyclically with approximately 10 kHz.

Digital Inputs/Outputs

Digital I/O are set in all operating modes using LTX functions.

Application Example for Digital Inputs/Outputs

- Evaluating digital inputs using link function and exception generation
- Reading digital inputs using a time stamp
- Differential time measurements
- Period or pulse duration measurement using internal or external counter frequency
- Pulse width modulated outputs
- Controlling outputs using the link function
- Operating up to five incremental encoders using the comparator function
- Operating up to five SSI absolute value encoders
- Operating up to six 2 phase stepper motors using the external power supply

5.5.14 Programming System Flash

General Information

CPUs are delivered with a runtime system. The CAN node number switch is set to switch position 00 at delivery i.e. the bootstrap loader mode is set.

A switch position must be set in order to boot the PLC in RUN mode (see Section 5.5.7 "CAN Node Number Switch", on page 163). A runtime system update is only possible in RUN mode.

Runtime System Update when Operated as a Parallel Processor

The runtime system can be updated using the programming system. When updating the runtime system (runtime system update), the following procedure must be carried out:

1) A runtime system update is only possible using the CPU interfaces. This means that updating the runtime system must take place using a CPU interface (also applies to parallel processors).

2) An online runtime system update is only possible if the CPU processor and the parallel processor are in RUN mode. The RUN mode can be set with the operating mode switch.

3) Switch on the supply voltage.

4) Establish online connection (online cable) between programming device (PC or Industrial PC) and the CPU. An online runtime update is possible using the serial RS232 interface.

5) Start B&R Automation Studio™.

6) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

7) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   After pressing **Next >**, a dialog box appears where the user can set the CAN baud rate, CAN ID and the CAN node number (the CAN node number set here is only relevant, if an interface module does not contain a CAN node number switch). Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

8) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

User Flash will be deleted.

9) When the update procedure is complete, the online connection is automatically established again.

10) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.