Abbreviations

- DO: Digital Output
- DI: Digital Input
- AI: Analog Input
- AO: Analog Output
- TON: ON Delay Timer
- TOF: OFF Delay Timer
- TP: Pulse Timer
- R: Read
- W: Write
- Int: Integer

Communication Interface

The **iCTRL-20 V1** operates as a Modbus RTU slave device over an RS-485 physical interface, responding to requests from a Modbus master (PLC, HMI, SCADA, or PC via DZVOLT UI).

An additional communication interface is available via micro-USB, implemented through a CP2102 USB-to-UART bridge, enabling Modbus RTU communication over USB. Both RS-485 and USB interfaces share the same Modbus slave ID.

In case of simultaneous connection, the RS-485 interface has communication priority over the USB interface.

1. RS-485 Bus Setup

Protocol	Modbus RTU
Baud Rate	9600 bps
Data Format	8 data bits, No parity, 1 stop bit (8N1)
Max Bus Length	1200 m
Termination	120Ω (enable on first and last device)
Cable	Twisted pair shielded (recommended: Belden 9841 or equivalent)
Topology	Daisy-chain (do NOT use star topology)

> **TIP**
>
> For bus lengths exceeding 500 m, use low-capacitance cable and ensure proper termination at both ends. Ground the cable shield at one point only to avoid ground loops.

2. USB Interface Setup

Protocol	Modbus RTU over USB (Virtual COM Port)
USB Interface	Micro-USB (via CP2102 USB-to-UART bridge)
Baud Rate	9600 bps
Data Format	8 data bits, No parity, 1 stop bit (8N1)
Max Bus Length	5 m (standard USB cable recommended)
Connection	Point-to-point (no multi-drop support)
Priority	Lower priority than RS-485 (RS-485 overrides when active)

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3. Slave ID Configuration (DIP Switches)

The Modbus Slave ID is set using the 3-bit DIP switch located on the front panel (terminal 6). The following table shows all valid combinations:

ID 2	ID 3	ID 4	Slave ID
ON	ON	ON	**1** (default)
OFF	ON	ON	**2**
ON	OFF	ON	**3**
ON	ON	OFF	**4**
OFF	OFF	ON	**23**
ON	OFF	OFF	**34**
OFF	ON	OFF	**24**
OFF	OFF	OFF	**234**

NOTE

The Slave ID is read from the DIP switches at boot time only. Changes require a power cycle or hardware reset to take effect. Each module on the same RS-485 bus must have a unique Slave ID.

4. Modbus Function Codes

Code	Function	Description
FC01	Read Coils	Read DO states and auto-save flag
FC02	Read Discrete Inputs	Read DI, AI alarm, Power OK, interlock status
FC03	Read Holding Registers	Read configuration and command registers
FC04	Read Input Registers	Read Slave ID, AI raw values, serial number
FC05	Write Single Coil	Control individual DO or auto-save
FC06	Write Single Register	Write a single configuration register
FC16	Write Multiple Registers	Write multiple configuration registers at once

5. Type of register

- Coils 0x (Numbers = 00001 to 00009).
- Discrete inputs 1x (Numbers = 10001 to 10018).
- Input registers 3x (Numbers = 30001 to 30018).
- Holding registers 4x (Numbers = 40001 to 40081).

6. Memory map

Coils (0x) — Digital Outputs & Control

Address	Parameter	Data	Value Range	R/W
00001	DO 01	1 bit	0=Inactive / 1=Active	R/W
00002	DO 02	1 bit	0=Inactive / 1=Active	R/W
00003	DO 03	1 bit	0=Inactive / 1=Active	R/W
00004	DO 04	1 bit	0=Inactive / 1=Active	R/W
00005	Auto-Save Configuration	1 bit	0=Disabled / 1=Enabled	R/W
00006	DI1 Counter Enable	1 bit	0=Disabled / 1=Enabled	R/W

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00007	DI2 Counter Enable	1 bit	0=Disabled / 1=Enabled	R/W
00008	DI3 Counter Enable	1 bit	0=Disabled / 1=Enabled	R/W
00009	DI4 Counter Enable	1 bit	0=Disabled / 1=Enabled	R/W

Discrete Inputs (1x) — Read-Only Status

Address	Parameter	Data	Value Range	R/W
10001	DI Power OK	1 bit	0=Power loss / 1= Healthy (OK)	R
10002	DI 01 (after logic)	1 bit	0=Inactive / 1=Active	R
10003	DI 02 (after logic)	1 bit	0=Inactive / 1=Active	R
10004	DI 03 (after logic)	1 bit	0=Inactive / 1=Active	R
10005	DI 04 (after logic)	1 bit	0=Inactive / 1=Active	R
10006	AI 01 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10007	AI 02 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10008	AI 03 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10009	AI 04 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10010	AI 05 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10011	AI 06 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10012	AI 07 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10013	AI 08 Threshold Alarm	1 bit	0=Normal / 1=Alarm	R
10014	DI Interlock (Safety)	1 bit	0=Interlock engaged / 1=Interlock not engaged (normal operation)	R
10015	Raw state of DO1	1 bit	0=Inactive / 1=Active	R
10016	Raw state of DO2	1 bit	0=Inactive / 1=Active	R
10017	Raw state of DO3	1 bit	0=Inactive / 1=Active	R
10018	Raw state of DO4	1 bit	0=Inactive / 1=Active	R

Input Registers (3x) — Read-Only Telemetry

Address	Parameter	Data	Unit	R/W	Notes
30001	Slave ID (Device Address)	Int (2 bytes)	—	R	From DIP switch
30002	Analog Input 01	Int (2 bytes)	—	R	Scaled ×100
30003	Analog Input 02	Int (2 bytes)	—	R	
30004	Analog Input 03	Int (2 bytes)	—	R	
30005	Analog Input 04	Int (2 bytes)	—	R	
30006	Analog Input 05	Int (2 bytes)	—	R	
30007	Analog Input 06	Int (2 bytes)	—	R	
30008	Analog Input 07	Int (2 bytes)	—	R	
30009	Analog Input 08	Int (2 bytes)	—	R	
30010	Serial Number	Int (2 bytes)	—	R	Factory set
30011	DI1 Pulse Counter	Int (2 bytes)	—	R	Rising edge count (0–65535)
30012	DI2 Pulse Counter	Int (2 bytes)	—	R	

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30013	DI3 Pulse Counter	Int (2 bytes)	—	R	
30014	DI4 Pulse Counter	Int (2 bytes)	—	R	
30015	AO1 Actual Voltage	Int (2 bytes)	V	R	Scaled ×100 (e.g., 750 = 7.50V)
30016	AO2 Actual Voltage	Int (2 bytes)	V	R	
30017	AO3 Actual Voltage	Int (2 bytes)	V	R	
30018	AO4 Actual Voltage	Int (2 bytes)	V	R	

Holding Registers (4x) — Configuration & Commands

Address	Parameter	Data	Value Range	Unit	R/W	Notes
40001–40004	Set value AO 01–04	Int (2 bytes)	0–1000	V	R/W	Scaled ×100
40005–40008	Link DI 01–04 to DO	Int (2 bytes)	0: None, 1–4: DO1–DO4	—	R/W	
40009	Link Power OK to DO	Int (2 bytes)	0: None, 1–4: DO1–DO4	—	R/W	
40010–40025	AI 01–08 Thresholds (MAX/MIN)	Int (2 bytes)	Range ±32767	—	R/W	Scaled ×100 Signed
40026–40033	Link AI 01–08 Alarm to DO	Int (2 bytes)	0: None, 1–4: DO1–DO4	—	R/W	
40034–40037	TON (On Delay) DO 01–04	Int (2 bytes)	0–9999	Sec	R/W	
40038–40041	TOF (Off Delay) DO 01–04	Int (2 bytes)	0–9999	Sec	R/W	
40042–40045	TP (Pulse Timer) DO 01–04	Int (2 bytes)	0–9999	Sec	R/W	
40046–40053	Cyclic ON/OFF DO 01–04	Int (2 bytes)	0–9999	Sec	R/W	
40054–40057	Timer Mode DO 01–04	Int (2 bytes)	0=None, 1=TON, 2=TOF, 3=TP, 4=TONOFF	—	R/W	
40058–40065	AI 01–04 Scale (MAX/MIN)	Int (2 bytes), Signed	Range ±32767	—	R/W	Scaled ×100 Signed
40066–40073	AI 05–08 Scale (MAX/MIN)	Int (2 bytes), Signed	Range ±32767	—	R/W	
40074–40077	Logic DI 01–04	Int (2 bytes)	0: Normal / 1: Inverted	—	R/W	
40078–40081	Link AI 01–04 to AO	Int (2 bytes)	0: None, 1–4: AO1–AO4	—	R/W	

IMPORTANT

- Where a register is marked (Scaled ×100), the integer represents the engineering value multiplied by 100, master divided by 100 to display, multiplied by 100 to write (e.g., 500 = 5.00).
- Where a register is marked signed, treat the value as int16_t (range −32768 to +32767).

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