Growbud
elemental insight

# Flo Controller

4-zone irrigation control with Modbus, BACnet, LoRaWAN, and Bluetooth LE

**POCKET MANUAL**


**DOCUMENT** FLO-PM-100
**REVISION** 1.0 · July 2026
**TRIM** 4.25 x 5.5 in
**PAGES** 28

# 1 Safety Information

**WARNING: ELECTRICAL**

Disconnect all power before wiring. The 24 VAC input rectifies to approximately 35 V peak internally. Installation should be performed by qualified personnel.

**WARNING: LOADS**

Valve outputs are for solenoid valve coils only: 0.6 A RMS per AC channel or 1.5 A peak DC pulses. Do not drive motors, pumps, or heaters.

**OUTDOOR SEAL**

All M12/M8 connectors must be mated or capped and both antenna bulkheads torqued. Cap every unused port.

Document FLO-PM-100 · Revision 1.0 · Firmware v5.x · Model GROWBUD013

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**PRINT FORMAT**
Finished size: 4.25 x 5.5 in. The 28-page count is suitable for saddle-stitch booklet production.

# 2 Product Overview

The Flo Controller is a 4-zone irrigation controller for greenhouse, indoor, and field operations. It drives 24 VAC or latching DC solenoids. It connects through LoRaWAN, Bluetooth LE, and RS-485.

**VALVE ZONES**

**4**

AC triac or DC H-bridge

**POWER**

**3 inputs**

USB-C PD, 12 VDC, or 24 VAC

**RS-485**

**3 modes**

Modbus slave, master, BACnet

**SCHEDULES**

**16**

Autonomous on-board slots

## 2.1 Electrical Specifications

| PARAMETER | VALUE |
|---|---|
| USB-C PD | 5-20 V USB Power Delivery, up to 20 W; power only |
| DC supply | 9.0-16.0 VDC, nominal 12 VDC |
| AC supply | 20-26 VAC RMS, nominal 24 VAC |
| Mode selection | Automatic and hardware-latched at boot |
| AC valve output | 0.6 A RMS per channel; 2.4 A total |
| DC valve output | 1.5 A peak per channel; 9-12 V pulses |
| Standby | Up to 250 µA DC or 0.5 VA AC |
| RTC | Supercap-backed |

## 2.2 Environment & Mechanical

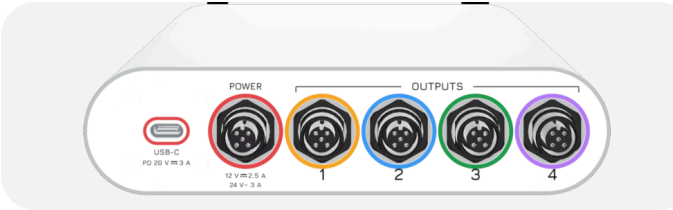
| PARAMETER | VALUE |
|---|---|
| Operating temperature | -20 to +70 °C |
| Enclosure | Obround extruded aluminum, 165 x 40 x 160 mm |
| Panel A | USB-C, M12 POWER, four numbered OUTPUTS |
| Panel B | M12 RS-485, M8 LEAK and SENSE, USER button, two SMA antennas |
| Connectors | M12 A-coded 5-pin and M8 3-pin; IP68 rated |
| Compliance basis | CISPR 22/32 Class B; FCC Part 15; RoHS/REACH |

**SUPPLY MODE**

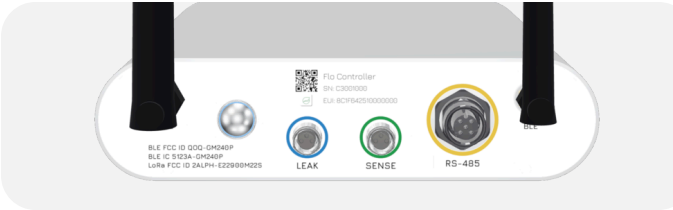
All four valves must use the same AC or DC type because drive mode is global for the current power cycle.

# 3 Panel Reference

**PANEL A · POWER + OUTPUTS**




**PANEL B · DATA + ACCESSORIES**




- Attach the 915 MHz antenna at LoRa.
- Attach the 2.4 GHz antenna at BLE.
- LEAK and SENSE are the two M8 accessory inputs.
- The illuminated USER button handles commissioning and status.

# 3.1 POWER IN

| PIN | SIGNAL | DESCRIPTION |
|---|---|---|
| 1 | +12 VDC | 9.0-16.0 VDC supply |
| 2 | DC return / GND | DC return and chassis ground |
| 3 | 24 VAC hot | 20-26 VAC RMS |
| 4 | 24 VAC return | Floating AC return |
| 5 | Shield | Shield drain to ground |

**DO NOT COMBINE SUPPLIES**

Connect either DC pins 1/2 or AC pins 3/4. Never connect both. The controller detects the powered rail at boot and latches the global drive mode.

# 3.2 Valve Outputs

| PIN | SIGNAL | DESCRIPTION |
|---|---|---|
| 1 | Valve Power A | Switched valve drive |
| 2 | Harness ID | Valve-type identification |
| 3 | Valve Power B | Switched return |
| 4 | Aux I/O | Flow, leak, or auxiliary input |
| 5 | Shield | Shield drain |

## Harness ID Coding

| RESISTOR | VALVE TYPE |
|---|---|
| 2.2 kΩ | 24 VAC solenoid |
| 10 kΩ | Latching DC solenoid |
| Open | Unknown; harness fault |

## 3.3 RS-485 & Accessories

| PIN | SIGNAL |
|---|---|
| 1 | A (D+) |
| 2 | B (D-) |
| 3 | GND |
| 4 | Shield |
| 5 | Shield drain |

The port includes on-board 120 Ω termination and fail-safe bias. It carries no power; externally power third-party sensors.

### M8 Sensor Ports

The ports marked LEAK and SENSE accept Growbud wired flow, leak, and auxiliary accessories.

### USB-C

Power only, up to 20 W USB-C PD. Use when 24 VAC valve drive is not required.

# 4 Installation & Wiring

1. Mount with the valve panel facing the irrigation manifold.
2. Attach both antennas before applying power.
3. Connect each solenoid using a Growbud valve harness. All valve types must match.
4. Optional: daisy-chain RS-485 A/B/GND with shielded twisted pair and terminate the far end.
5. Apply USB-C PD, 12 VDC, or 24 VAC as required.
6. Confirm the USER button illuminates.

**MODE MISMATCH**
A supply/valve mismatch raises fault 12 and interlocks the affected channels off.

# 5 Deployment Configurations

## A · Wireless LoRaWAN


Best for fields, greenhouses, and sites that already use a Growbud LoRaWAN network. On-board schedules continue if connectivity drops.

## B · Wired Automation

The Flo operates as a Modbus slave or BACnet node. It can also aggregate nearby Growbud sensors over Bluetooth. Best for facilities with an existing BMS.

> **COMING SOON**
> Amazon Sidewalk support is planned in a future firmware release. No hardware change is expected.

# 6 Commissioning

1. Get the Growbud app or open www.growbud.app and create an account.
2. Apply power; confirm the USER button illuminates.
3. Press USER once. It blinks while pairing mode is active.
4. Choose Add Device and select the Flo Controller.
5. Name the controller and assign a room or zone.
6. Select the deployment configuration and RS-485 role.
7. Name each valve zone and test each output once.

**CURRENT FIRMWARE**
Protocol configuration tables are held in RAM and re-pushed by the app after a power cycle.

# 7 Modbus Slave Mode

| ITEM | VALUE |
|---|---|
| Register width | 16-bit, big-endian |
| Addressing | 0-based |
| Function codes | 0x03, 0x04, 0x06, 0x10 |
| Slave address | 1-247; broadcast unsupported |
| Layout | Global 0x0000-0x000F; channels at 0x0010 + ch x 0x10; schedule 0x0050-0x005F |

## Global Input Registers · FC 0x04

| REG | NAME | DESCRIPTION |
|---|---|---|
| 0000 | fw_version | Firmware version |
| 0001 | mode_configured | 0 unknown; 1 AC; 2 DC |
| 0002 | mode_detected | 0 unknown; 1 AC; 2 DC; 3 both rails |
| 0003 | device_fault | Device fault code |

# 7.2 Input Registers

| REG | NAME | DESCRIPTION |
|---|---|---|
| 0004 | vboost_mv | VBOOST rail, mV |
| 0005 | vbus_mv | VBUS / 24 V rail, mV |
| 0006 | board_temp_c_x10 | Board temperature, 0.1 °C |
| 0007 | schedule_active | 1 when a schedule is firing |
| 0008-000F | reserved | Reads 0 |

## Per-Channel Inputs · base 0x0010 + ch x 0x10

| OFFSET | NAME | DESCRIPTION |
|---|---|---|
| +0 | state | Output state |
| +1 | fault | Channel fault |
| +2 | level_pct | 0-100% |
| +3 | current_ma | Current, mA |
| +4...+15 | reserved | Reads 0 |

Bases: ch0 0x0010 · ch1 0x0020 · ch2 0x0030 · ch3 0x0040

# 7.4 Holding Registers

## Global · FC 0x03 / 0x06 / 0x10

| REG | NAME | DESCRIPTION |
|---|---|---|
| 0000 | slave_address | 1-247; immediate |
| 0001 | role | 0 MASTER; 1 SLAVE |
| 0002-000F | reserved | Writes rejected |

## Per-Channel Holding Block

| OFFSET | NAME | DESCRIPTION |
|---|---|---|
| +0 | cmd_onoff | 0 off; non-zero on |
| +1 | cmd_level | 0-100% |
| +2 | cmd_pulse | Bits 0-14 duration ms; bit 15 polarity |
| +3...+15 | reserved | Writes rejected |

**INTERLOCK CHAIN**

All external commands pass through the same hardware interlocks. A refused command returns exception 0x04.

# 7.6 Schedule Register Block

Select an entry, stage its fields, then write commit.

| OFF | NAME | DESCRIPTION |
|---|---|---|
| +0 | sel | Entry 0-15 |
| +1 | enabled | 0 or 1 |
| +2 | ch | Channel 0-3 |
| +3 | days_mask | Sun bit 0 through Sat bit 6 |
| +4 | hour | 0-23 |
| +5 | minute | 0-59 |
| +6 | action | 0 ON; 1 OFF; 2 PULSE; 3 LEVEL |
| +7 | duration_s | Seconds |
| +8 | level_pct | 0-100 |
| +9 | polarity | 0 OPEN; 1 CLOSE |
| +10 | commit | Write-only commit |
| +11...+15 | reserved | - |

## 7.7 Exceptions

| CODE | MEANING |
|---|---|
| 0x01 | ILLEGAL_FUNCTION |
| 0x02 | ILLEGAL_DATA_ADDRESS |
| 0x03 | ILLEGAL_DATA_VALUE |
| 0x04 | SLAVE_DEVICE_FAILURE |

# 8 Modbus Master Mode

Flo can poll up to 8 third-party Modbus devices. Each device can have up to 16 register entries. Flo forwards engineering-unit values into Growbud telemetry.

Maps are pushed from the app as a versioned, full-table atomic replacement. A new table must use a greater version number.

# 8.1 Master Device Config

| FIELD | RANGE / VALUE | NOTE |
|---|---|---|
| address | 1-247 | Slave address |
| baud | 9600-115200 | Per poll session |
| parity | none / even / odd | Current firmware uses 8N1 |
| stop_bits | 1 / 2 | Current firmware uses 8N1 |

### Capacity

- Up to 8 devices on the RS-485 bus.
- Up to 16 configured registers per device.
- Externally power every third-party sensor.
- RS-485 role is exclusive: master, slave, or BACnet MS/TP.

## 8.2 Master Register Entries

| FIELD | VALUE |
|---|---|
| reg_addr | uint16 target address |
| func | 0x03 or 0x04 |
| word_count | 1 or 2 |
| dtype | U16, I16, U32, I32, FLOAT |
| word_order | ABCD, CDAB, BADC, DCBA |
| scale, offset | engineering = raw x scale + offset |
| poll_interval_ms | per-register period |

### Behavior

- 3 retries with linear 20 ms backoff on timeout or CRC error.
- Modbus exception responses are terminal.
- t3.5 inter-frame silence is enforced.
- Applied configuration version is reported in telemetry.

# 9 BACnet Integration

Flo exposes valve channels as native BACnet objects on RS-485 using MS/TP, or through a Growbud gateway using BACnet/IP.

> **EXCLUSIVE PORT**
> BACnet MS/TP occupies the RS-485 port and cannot run simultaneously with Modbus modes.

## MS/TP Data Link

| PARAMETER | RANGE | DEFAULT |
|---|---|---|
| MAC address | 0-127 | 1 |
| Baud | 9600 / 19200 / 38400 / 76800 | 38400 |
| Max master | 1-127 | 127 |
| Max info frames | configurable | 1 |

## 9.2 BACnet Object Model

| OBJECT | INSTANCE | ACCESS / FUNCTION |
|---|---|---|
| Device | default 300001 | Who-Is / I-Am |
| Binary Output | BO:0-BO:3 | Commandable on/off; priority array |
| Analog Output | AO:0-AO:3 | Commandable 0-100% |

Supported services include Who-Is / I-Am, ReadProperty for Present_Value, and WriteProperty with priority arrays.

- Max APDU: 1476
- Segmentation: not supported
- ReadPropertyMultiple: planned
- COV subscriptions: planned

## 9.3 BACnet Commissioning

| FIELD | VALUE / RANGE |
|---|---|
| enabled | on / off |
| transport | BACnet/IP or MS/TP |
| device_instance | 0-4194302; default 300001 |
| device_name | up to 32 characters |
| udp_port | default 47808 (0xBAC0) |
| bbmd | disabled by default |
| mstp settings | MAC, baud, max master |
| points | up to 32 AI / AO / AV / BO mappings |

Validation rejects writable flags on non-commandable AI/AV objects and duplicate object type/instance pairs.

# 10 LoRaWAN Configuration

| PARAMETER | VALUE |
|---|---|
| MAC version | LoRaWAN 1.0.3 |
| Activation | OTAA: DevEUI, JoinEUI/AppEUI, AppKey |
| Region | US915 sub-band 2; EU868 configurable |
| Device class | Class C default or Class B |
| Uplink interval | 60 s default; 15 s minimum |
| Uplinks | confirmed or unconfirmed |

DevEUI is printed on the label and shown in the app. Downlinks dispatch valve, schedule, and configuration commands.

# 11 On-Board Scheduling

Sixteen schedule slots run on the supercap-backed real-time clock. Irrigation can continue through network outages.

### Each Entry Defines

- Target channel
- Weekday mask
- Start hour and minute
- Action: ON, OFF, PULSE, or LEVEL
- Duration and level percentage
- Pulse polarity

Manage schedules from the app, Modbus schedule block, or LoRaWAN downlink. Register 0x0007 reports when any schedule is firing.

> **PERSISTENCE**
> Committed schedules persist on the device.

# 12 Troubleshooting

| SYMPTOM | ACTION |
|---|---|
| Fault 12: mode mismatch | Match the supply and valve type; power-cycle to re-latch |
| Fault 11: leak detected | Inspect the zone; clear the condition; re-enable channel |
| mode_detected = 3 | Disconnect one supply pair at POWER IN |
| Harness fault | Check the valve harness pin 2 ID resistor |
| Modbus exception 0x04 | Read device_fault and channel fault registers |

# 12.1 Network Troubleshooting

| SYMPTOM | ACTION |
|---|---|
| No Modbus response | Verify role, address, A/B polarity, and termination |
| MS/TP token loss | Align baud and max_master across the bus |
| No LoRaWAN join | Confirm sub-band and OTAA keys |
| Config lost after power cycle | Keep the app connected so current firmware can re-push RAM-resident protocol tables |

**BEFORE SERVICE**

Record the fault code, supply type, connected valve harness type, firmware version, and recent configuration changes.

# 13 Compliance & Support

- **EMC:** CISPR 22/32 Class B; FCC Part 15.
- **Materials:** RoHS and REACH compliant.
- **Radio:** 902-928 MHz US ISM and 2.4 GHz BLE.
- **Warranty:** 1-year limited warranty.
- **Returns:** 90-day return policy.

**GROWBUD SUPPORT**
support@growbud.io
growbud.io/guides


Document FLO-PM-100 revision 1.0.

### Site Notes