

MEKATORA CONTROL SYSTEMS

MKT-DXS-180u

Aegis series

UV + Chlorination Skid

Device tag **D-501**

UV + chlorination disinfection skid (defence in depth).

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Precision Through Automation

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1 Overview

The **MKT-DXS-180u** (Aegis series) is a 180 m³/h disinfection skid combining two independent stages:

- a **UV chamber** with four 40 W low-pressure mercury lamps emitting at 254 nm, providing primary pathogen inactivation;
- a **chlorine dosing system** using sodium hypochlorite from a 200 L day tank, providing residual protection in the distribution network.

The two stages are independently controllable. UV alone is effective against most bacteria, viruses and chlorine-resistant cysts (e.g. *Cryptosporidium*, *Giardia*) but provides no residual; chlorine alone is adequate for most pathogens but not for the chlorine-resistant ones. The skid therefore implements **defence in depth**: both stages run in normal operation.

2 Process specifications

Parameter	Value
Design flow	180 m ³ /h
UV chamber holdup	100 L
UV lamps	4 x 40 W low-pressure mercury (254 nm)
UV initial intensity (fresh lamp)	30 mW/cm ²
UV lamp end-of-life model	exp decay, tau = 8000 hours
UV warm-up lag	~120 s first-order (5 min to ~95 %)
UV intensity warning	< 12 mW/cm ² (lamp end-of-life soon)
UV fault threshold	< 8 mW/cm ² while energised
UV dose target	>= 40 mJ/cm ² (4-log inactivation)
Chlorine source	Sodium hypochlorite (NaOCl), 200 L day tank
Chlorine dose setpoint range	0.0–5.0 ppm free chlorine
Chlorine consumption (per tick)	mass = SP x flow x dt

The UV intensity decay model is

$$I_{UV}(t) = 30 \cdot \exp\left(-\frac{t_{lamp}}{8000}\right) \quad [\text{mW}/\text{cm}^2]$$

where t_{lamp} is energised lamp-hours. At 8000 h intensity is at ~50 % of new — typical replacement point.

When the UV lamps are de-energised, intensity decays toward zero with a 5 s first-order lag. The `UV_FAULT` discrete input asserts when the lamps are commanded ON but intensity has fallen below 8 mW/cm².

2.1 UV dose

UV efficacy is **dose**, not intensity alone. Dose is intensity multiplied by residence time in the chamber:

$$D = I_{UV} \cdot \frac{V_{chamber}}{Q}$$

The chamber is sized the way a real reactor is validated: the 40 mJ/cm² target has to be met at the rated 180 m³/h with lamps at 70 % of new output, the usual end-of-life design factor. That takes 100 L, giving a 2 s residence at rated flow.

With fresh lamps there is therefore margin: 60 mJ/cm² at the rated flow. Dose falls in proportion to flow above the rating, and in proportion to lamp output as the lamps age. Both together are what eventually take it below target, which is why the operator watches `UV_DOSE` rather than `UV_INTENSITY` alone.

The 40 mJ/cm² target corresponds to 4-log inactivation of typical pathogens. Below this, primary disinfection is incomplete; the controller raises a critical alarm with water flowing.

3 Network configuration

Item	Value
IP address	172.28.0.163
Subnet	172.28.0.0/24
TCP port	502 (Modbus TCP)
Unit identifier	echoed in the response; not validated
Byte order	big-endian (Modbus standard)
Word order (u32)	high word at register N, low word at N+1

4 Register map

Modbus uses 1-based “register numbers” in narrative; the on-the-wire PDU address is `register_number - 1`. Both columns are shown. All scaled fields are signed 16-bit integers; engineering value = wire / scale.

4.1 Coils (FC 01 read · FC 05 / 0F write)

Reg	Addr	Name	R/W	Description
1	0x000	UV_LAMP_CMD	RW	Energise the four UV lamps. ~5 min warm-up to full.
2	0x001	CL_PUMP_CMD	RW	Master enable for the chlorine dosing pump.
3	0x002	CL_AUTO_REFILL	RW	Day-tank top-up from bulk on low level (25 % -> 95 %).

4.2 Discrete inputs (FC 02 read only)

Reg	Addr	Name	Description
1	0x000	UV_FAULT	1 = lamp end-of-life signal (intensity < 8 mW/cm ² while CMD ON).

4.3 Holding registers (FC 03 read · FC 06 / 10 write · FC 16 mask · FC 17 read+write)

Reg	Addr	Name	Scale	Range	Unit	R/W	Description
1	0x000	CL_DOSE_SP	x10	0..50	0..5 ppm	RW	Free-chlorine setpoint at contactor outlet.

Writes are clamped to 0..5 ppm.

4.4 Input registers (FC 04 read only)

Reg	Addr	Name	Scale	Type	Unit	Description
1	0x000	UV_INTENSITY	x10	int16	mW/cm ²	Lamp output measured in chamber.
2	0x001	UV_LAMP_HOURS1 HI		uint16	h	High word of total lamp-hours counter.
3	0x002	UV_LAMP_HOURS1 LO		uint16	h	Low word of total lamp-hours counter.
4	0x003	CL_TANK_LVL	x10	int16	%	Chlorine day-tank fill (200 L total).
5	0x004	FLOW	x10	int16	m ³ /h	Flow through the skid.
6	0x005	UV_DOSE	x10	int16	mJ/cm ²	UV dose: intensity * residence time. Operator-correct disinfection metric.

5 Supported function codes

FC	Name	Notes
0x01	Read Coils	
0x02	Read Discrete Inputs	UV_FAULT at DI 1.
0x03	Read Holding Registers	
0x04	Read Input Registers	
0x05	Write Single Coil	
0x06	Write Single Register	
0x0F	Write Multiple Coils	
0x10	Write Multiple Registers	
0x16	Mask Write Register	
0x17	Read/Write Multiple Registers	
0x2B/0x0E	Read Device Identification	conformity 0x82

Serial-line / file-record / FIFO function codes return exception **0x01 (illegal function)**.

5.1 Exception codes

Code	Meaning	When the device returns it
0x01	Illegal function	FC not in the table above.
0x02	Illegal data address	Register/coil out of range, or start + count > 0x10000 .
0x03	Illegal data value	Quantity out of range, or coil value not 0x0000 / 0xFF00.
0x04	Server device failure	Internal binding error.

6 Device identification (FC 0x2B / MEI 0x0E)

Conformity level **0x82** (regular).

Object ID	Name	Value
0x00	VendorName	Mekatora Control Systems
0x01	ProductCode	MKT-DXS-180u
0x02	MajorMinorRevision	firmware version (set at build time)
0x03	VendorUrl	https://mekatora.com
0x04	ProductName	UV + Chlorination Skid
0x05	ModelName	Aegis series
0x06	UserApplicationName	D-501 (device tag)

7 Operating notes

In normal operation both stages run continuously. The unit is designed for 24/7 lamp duty — cycling reduces lamp life dramatically. Set `UV_LAMP_CMD` ON, set `CL_PUMP_CMD` ON, then dial `CL_DOSE_SP` to the distribution-network requirement.

Typical free-chlorine setpoints:

Network type	CL_DOSE_SP
Short urban network	0.8–1.0 ppm
Medium municipal	1.0–1.5 ppm
Long rural mains	1.5–2.5 ppm

The aim is ≥ 0.2 ppm residual at the furthest tap. Higher than 3 ppm produces taste/odour complaints and accelerates trihalomethane formation; above 5 ppm exceeds WHO single-event guidelines. Below 0.2 ppm is too low to suppress regrowth in storage. Both upper limits are alarmed on the T-601 residual measurement, at warning and critical priority respectively, so an over-dose shows up on the console rather than only in the laboratory result.

Watch `UV_INTENSITY` trend monthly. Lamps drift down at $\sim 5\%$ per year of continuous operation; replace at the manufacturer's end-of-life signal (`UV_FAULT` = 1) or when intensity falls below 12 mW/cm². Verify `CL_TANK_LVL` daily — silent depletion (the dosing pump runs but pulls air) is the most common disinfection failure.

Interlocks and hazards. Disabling both UV and Cl while public water is flowing is a notifiable event in most jurisdictions. The flow-isolation interlock can be defeated locally — never rely on it as a sole safeguard. Watch the downstream T-601 `FREE_CL` reading for the immediate consequence of any change.

8 Appendix A — Example transactions

8.1 A.1 — Set chlorine dose to 1.2 ppm (FC 06, register 1 = address 0x0000)

Wire value = $1.2 \times 10 = 12 = 0x000C$.

```
0001 0000 0006 01 06 0000 000C
```

8.2 A.2 — Read both coils at once (FC 01)

Request — read 2 coils from address 0x0000:

```
0002 0000 0006 01 01 0000 0002
```

Reply — coil bitmap (LSB-first within each byte):

```
0002 0000 0004 01 01 01 03
      \ / \ / \ /
      FC bc bits (0b000000011 = both coils ON)
```

8.3 A.3 — Read UV_FAULT discrete input (FC 02)

```
0003 0000 0006 01 02 0000 0001
```

Reply:

```
0003 0000 0004 01 02 01 00
```

\ / \ / \ /
FC bc bit (0 = no fault)

8.4 A.4 — Read identification (FC 0x2B / MEI 0x0E)

0004 0000 0005 01 2B 0E 01 00

9 Appendix B — Address convention quick reference

The Modbus PDU carries **register_number** - 1. Tools asking for “Modbus register address” usually want the **0-based PDU value**; tools asking for “register number” want the **1-based** value.