LRI®

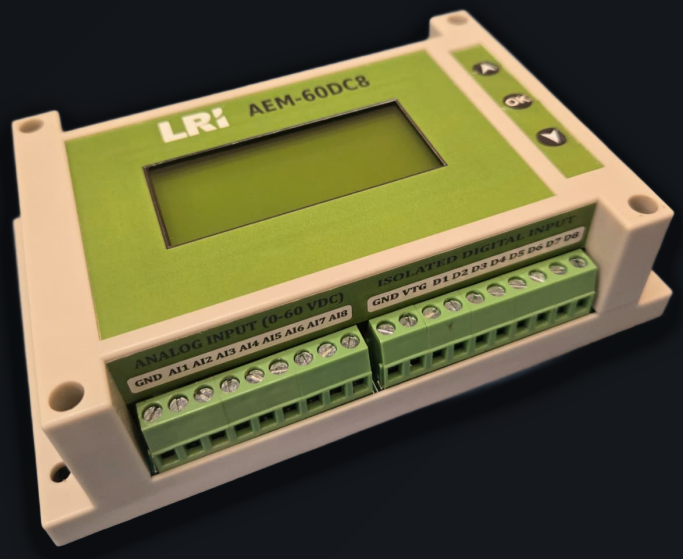
SECURE BY DESIGN · FIRMWARE v1.03

INDUSTRIAL DC MONITORING PLATFORM

AEM-60DC8

Industrial DC Voltage Monitor · 8 Channels · RS-485 Modbus RTU

The AEM-60DC8 is an industrial multi-channel DC voltage monitoring platform for automation, electrical panels, energy management and critical-system supervision. It measures eight independent DC channels, provides a complete local interface and integrates with SCADA supervisors and PLCs over RS-485 Modbus RTU.



8 DC channels	**0–60 V** measuring range	**±1% FS** typical accuracy	**8** digital inputs
5 kV field isolation	**Modbus RTU** RS-485 slave	**16×4 LCD** local interface	**35 mm DIN** rail mounting

DOCUMENTATION · MODBUS MAP · SIMULATOR
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TECHNICAL DATASHEET
8 pg · A4

01 Overview

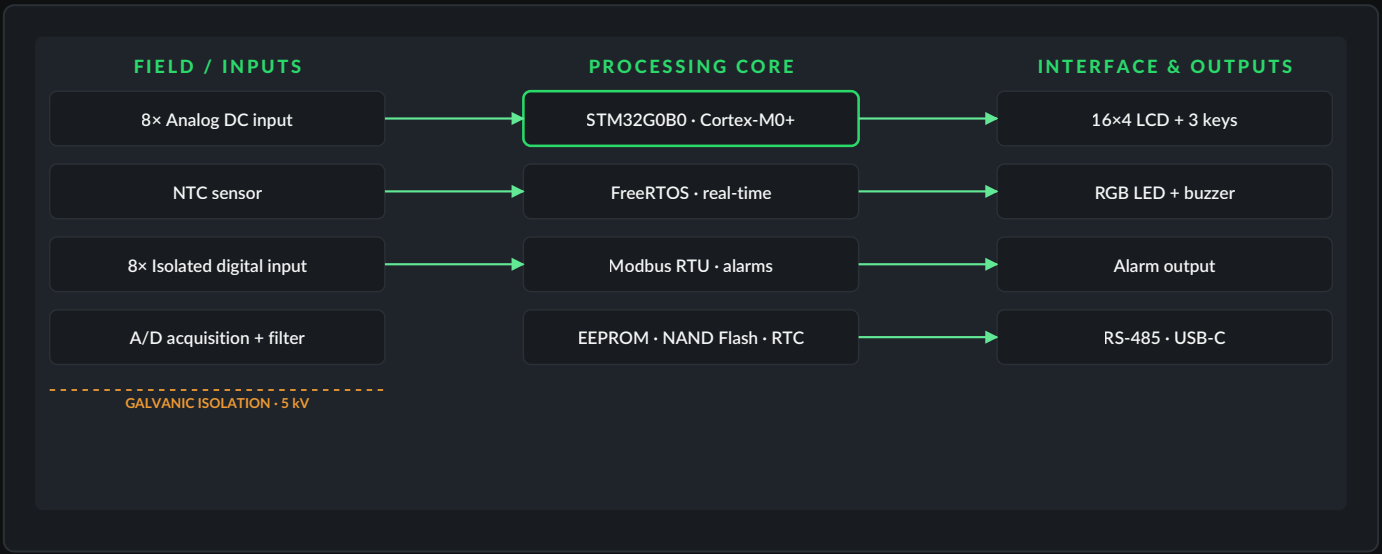
Engineered for industrial environments, the AEM-60DC8 features protected analog inputs, opto-isolated digital inputs, NTC temperature monitoring, configurable alarms and field firmware update. It suits electrical panels, battery banks, rectifiers and critical DC infrastructure.

The integrated LCD display enables local configuration and real-time viewing of operating parameters, reducing the need for external devices for setup and diagnostics. RS-485 Modbus RTU communication ensures direct integration with SCADA systems and PLCs.

Firmware v1.03 is an LRI in-house engineering implementation, with an extended Modbus map, timestamped event logging, multi-point calibration, three firmware-update channels and cybersecurity features based on signed firmware.

02 System architecture

Every functional block is dimensioned for continuous operation inside an industrial panel. The processing core runs a real-time operating system that coordinates acquisition, communication, user interface and security.



03 Product view and identification

Layout optimised for industrial panels with every connection point accessible from the front. 35 mm DIN rail, depth compatible with standard enclosures.

1. **16×4 LCD with green backlight**
   Status, measurements and local configuration.
2. **3 navigation keys (UP/DOWN/OK)**
   Full menu without a PC.
3. **RGB status LEDs + buzzer**
   Visual and audible alarm indication.
4. **8× Analog DC inputs**
   0–60 V, common GND, TVS + RC.
5. **8× Isolated digital inputs**
   Opto-isolated 5 kV AC rms.
6. **RS-485 (A, B, GND)**
   Modbus RTU, ESD ±16 kV, 120 Ω term.
7. **10–30 V DC power**
   Reverse + TVS protection.
8. **USB-C — firmware update**
   Anti-brick bootloader.

04 Electrical specifications

All values refer to operation within the specified environmental range. Auditable engineering, register by register.

Analog inputs

Channels	8 independent
Type	Single-ended DC voltage, non-isolated
Range	0 to 60 V DC
Survivability	Up to 75 V DC
Typical accuracy	±1% FS (≈ ±0.6 V at 60 V)
Modbus resolution	0.01 V (value ×100)
Protection	TVS clamp + RC low-pass filter
Calibration	Offset + multi-point (10/30/60 V), password protected
Connector	Screw terminal, common GND

NTC temperature

Sensor type	NTC 10 kΩ
Wiring	2-wire
Range	−10 °C to +70 °C
Accuracy	±1 °C
Unit	°C or °F (selectable)
Calibration	Offset, password protected

Power supply

Input voltage	10 to 30 V DC
Nominal voltage	12 V / 24 V DC
Protection	Reverse polarity + TVS surge
Typical consumption	< 2 W
Connector	Screw terminal (V+, GND)

Digital inputs

Channels	8
Type	Opto-isolated, field ↔ logic
Voltage range	0 to 30 V DC
Isolation	5000 V AC rms (optocoupler)
Protection	Series resistor + TVS clamp per channel
Polarity	Configurable (global or per channel)
Debounce	Configurable per channel (0–255 ds)
Connector	Screw terminal, common isolated GND

Alarm and indication

Output	1 open-drain MOSFET
Limits	Min/max per channel (voltage and temperature)
Pre-alarm	Independent configurable band
Hysteresis	Configurable (voltage and temperature)
Delay	1 to 30 s
Mode	Manual or automatic
Indication	RGB LED + buzzer (enable-able)

Mechanical and environmental

Dimensions	145 × 90 × 40 mm
Weight	345 g · 35 mm DIN rail mounting
Enclosure	Self-extinguishing thermoplastic UL94 V-0
Temperature	Operating −10 to +70 °C · Storage −20 to +85 °C
Relative humidity	5 % to 95 %, non-condensing

05 RS-485 / Modbus RTU communication

RS-485 half-duplex, two-wire interface, with reinforced ESD protection for industrial buses. Modbus address configurable via DIP switch or Modbus command.

RS-485 / Modbus RTU communication

Interface	RS-485 half-duplex, 2-wire
Protocol	Modbus RTU Slave (Server)
Baud rates	4800 / 9600 / 19200 / 38400 / 57600 / 115200 bps
Frame format	8N1 (8 data, no parity, 1 stop)
Function codes	0x03 (read), 0x10 (write), 0x46 (AEMUP tunnel)
Slave ID	1 to 7 via DIP switch (Modbus-configurable)
Termination	120 Ω selectable via DIP switch
Protection	ESD ±16 kV (HBM) on A/B lines
Connector	Screw terminal (A, B, GND)

Local interface · 16×4 LCD

Display	16×4 character LCD, integrated, green backlight
Keys	3 (UP, DOWN, OK) · short/long press + combos
LEDs	RGB multi-colour status
Buzzer	Integrated
Languages	Portuguese · English · Spanish
Menus	20 items, full local navigation
Fault screens	Auto-rotating every 5 s
Screen saver	Off / 1 / 5 / 10 / 30 min

06 Modbus map · 147 holding registers in 17 blocks

The AEM-60DC8 exposes 147 holding registers organised into functional blocks. The 29 legacy registers (40001–40029) preserve compatibility with existing integrations; the extended blocks (40050+) add identity, diagnostics, telemetry and security. All values are scaled integers (×100 for voltage and temperature).

RANGE	BLOCK	CONTENT	ACCESS
40001–40009	Measurements	8 channel voltages + NTC temperature	R
40010–40027	Fault thresholds	NTC + 8 channels (min/max)	R/W
40028–40029	Communication	Baud rate index · Slave ID	R/W · R
40050–40064	Identity	Version, build, model, HW revision	R
40066	Display	LCD temperature unit	R/W
40070–40089	Diagnostics	Frames, CRC, uptime, reset, HardFault	R
40090–40099	AEMUP / boot	Handler statistics + boot failure	R
40100	Control	Bootloader mode request	W
40101–40119	RTOS health	Heap, stack and HardFault forensics	R
40120–40124	Serial number	Year, month, day, product, sequence	R/W
40130–40143	LCD mirror	LCD state for supervisor	R
40150–40159	Peer update	Channel 3 trigger and state	R/W · R
40160–40163	Security	Security event counters	R
40190–40209	Baud forensics	Baud rate diagnostics	R/W

06.1 Function codes

0x03	Read Holding Registers — read any defined register
0x10	Write Multiple Registers — write to R/W registers
0x46	AEMUP/1 tunnel — firmware update (private)

07 Secure by Design

SECURE BY DESIGN

Secure by Design

Cybersecurity at the heart of engineering

The AEM-60DC8 was born with cybersecurity at the centre of its design. Every architectural decision — from the vector table to the handling of a single Modbus request — went through formal threat analysis. Signed firmware, nine-layer validation, anti-rollback and persistent counters ensure that even an attacker with physical access cannot replace firmware or hide an attempt.

- **9-layer boot validation**
  Header, payload, hardware ID, vectors and Ed25519 signature — any failure keeps the unit in the bootloader.
- **Signed firmware · Ed25519**
  Images signed with Ed25519 (RFC 8032). Four authorised key slots with generation revocation.
- **Persistent anti-rollback**
  Saturating TAMP counters with battery backup. They survive software resets and power cycles.
- **Anti-brick by construction**
  The bootloader lives in a flash region the update channel never touches — a bad image keeps the unit in update mode indefinitely.
- **Mandatory password + strength**
  4-digit password required on first configuration. ~205 trivial passwords (2 % of the total space) are rejected.
- **Forensic telemetry**
  Reset reason, PC/LR/xPSR from the last HardFault, boot failure cause and RTOS health — all over Modbus.

07.1 Compliance and certifications

Achieved · In validation · Planned

UL94 V-0 Self-extinguishing thermoplastic enclosure	Achieved	**5000 V AC rms isolation** Opto-isolated digital inputs	Achieved
ESD ±16 kV RS-485 lines · IEC 61000-4-2 level 4	Achieved	**RoHS** Directive 2011/65/EU	In validation
CE marking EMC and LVD directives	In validation	**FCC Part 15** EMC compliance	Planned
IEC 62443-4-2 SL2 Industrial cybersecurity · target	Planned	**ABNT NBR** Industrial panels	Planned

08 Models and connections

CODE	VOLTAGE RANGE	CHANNELS	DISPLAY
AEM-60DC8	0 – 60 V DC	8	16×4 LCD
AEM-30DC8	0 – 30 V DC	8	16×4 LCD
AEM-150DC8	0 – 150 V DC	8	16×4 LCD
AEM-60DC8-NL	0 – 60 V DC	8	—
AEM-30DC8-NL	0 – 30 V DC	8	—
AEM-150DC8-NL	0 – 150 V DC	8	—

08.1 Connections

Power	V+, GND — 10 to 30 V DC
Analog inputs	A1–A8 + common GND
Digital inputs	D1–D8 + VTG + isolated GND
RS-485	A, B, GND
USB-C	Firmware update
DIP switch SW2	Modbus address (1–3) + termination (TR)

08.2 Documentation and contact

Full documentation, interactive Modbus map and simulator at

aem.lri.com.br

LRI Industrial Automation · sales@lri.com.br · +55 11 4020-2470 · +55 51 2129-3000