KaaIoT Energy Logger
Communication Module Datasheet

Product Overview

The KaaIoT Energy Logger is a communication module that connects residential energy inverters and battery systems to the Kaa IoT platform. The module reads telemetry and metadata from inverters via MODBUS RTU (RS-485/RS-232), publishes data to the cloud over MQTT with TLS encryption, and enables remote monitoring, configuration, and firmware updates — all without reliance on the inverter manufacturer's cloud infrastructure.

Advantages

- **Vendor-independent monitoring** — works with any MODBUS RTU inverter, not locked to a single manufacturer's ecosystem
- **Secure by design** — TLS 1.2 encryption, per-device authentication, US/EU data jurisdiction options
- **Cloud-configurable** — register maps, polling intervals, and computed fields managed remotely; no on-site reprogramming required
- **OEM-ready** — white-label hardware and cloud platform, available as an integrated module or an external dongle

Features

- MODBUS RTU client with configurable register maps (up to 255 telemetry registers)
- MQTT over TLS 1.2 for secure data transport
- Over-the-air (OTA) firmware updates with automatic rollback
- WiFi AP mode for zero-touch provisioning (no mobile app required)
- Remote MODBUS register read/write commands from the cloud
- Computed fields for cross-register calculations (e.g., net power = export − import)
- Universal energy inverter telemetry schema (PV, Grid, Battery, Load, Device)
- 6 status LEDs for field diagnostics
- Factory reset button
- Hardware watchdog for autonomous recovery

Application Scenarios

Integrated Communication Module

The module is integrated inside the inverter or battery enclosure as an OEM component, providing built-in cloud connectivity with no additional hardware for the end user.

Typical system: Inverter / Battery system → Logger (integrated) → WiFi → KaaIoT Cloud → OEM App
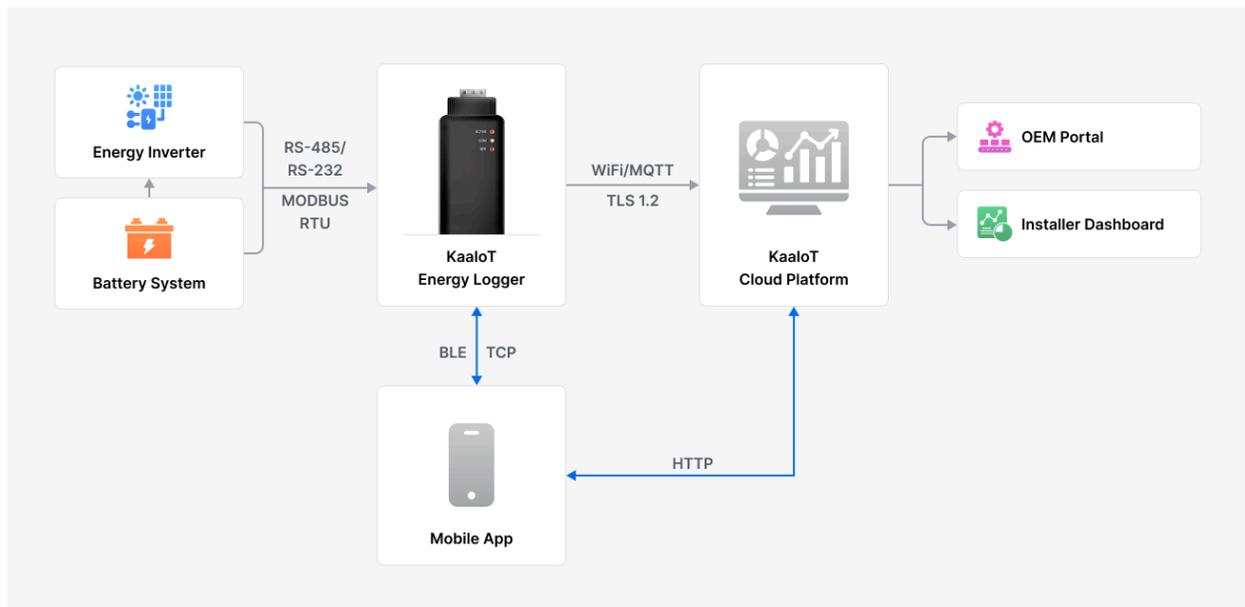
External Dongle

The module is an external dongle connected to the inverter's RS-485/RS-232 port, enabling the system integrator to add cloud monitoring to any compatible inverter regardless of brand.

Typical system: Hybrid inverter → Logger dongle (DB9/RJ45) → WiFi → KaaIoT Cloud → Installer/User App

System Architecture

External Dongle

Integrated Communication Module
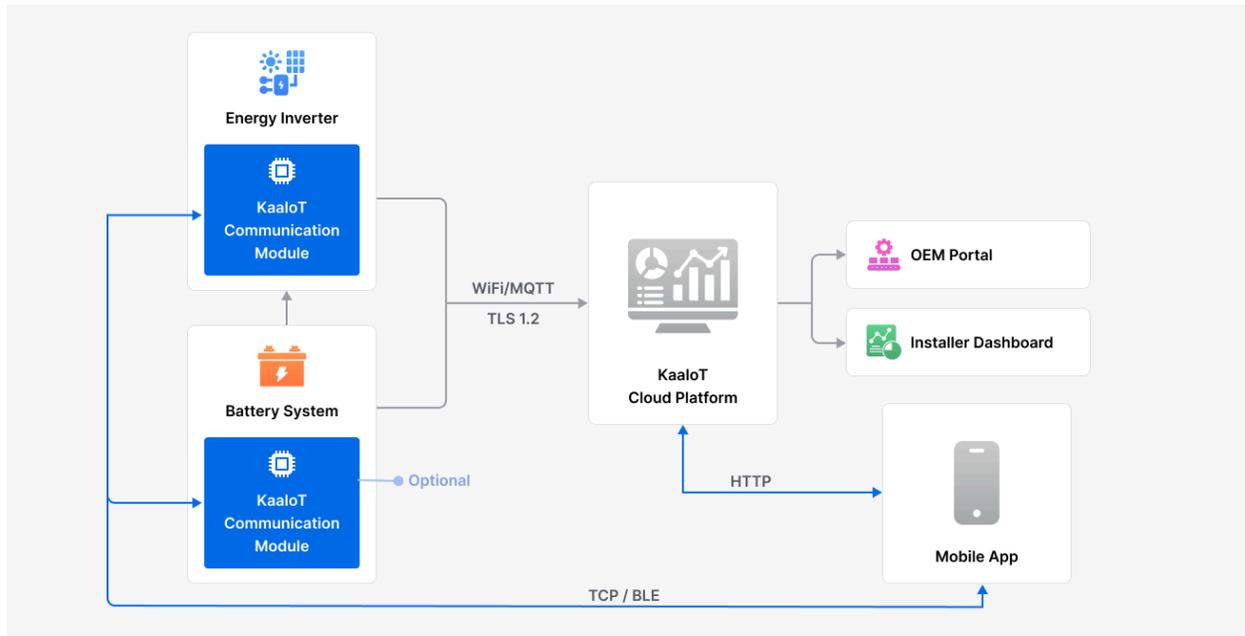
Three user roles:

Role	Access	Use Case
OEM	Fleet management, firmware updates, analytics	Monitor all deployed devices, push OTA updates
Installer	Device provisioning, diagnostics, and configuration	Set up devices on-site, troubleshoot issues
End User	Real-time monitoring, energy dashboard	View solar production, battery status, and grid usage

Technical Specifications

Processor

Parameter	Value
SoC	Espressif ESP32-S3
CPU	Xtensa LX7 dual-core, up to 240 MHz

Flash	8 MB (SPI)
PSRAM	8 MB (Octal SPI)
RTOS	Zephyr 4.x

Communication Interfaces

Interface	Protocol	Details
RS-485	MODBUS RTU	Half-duplex, automatic DE/RE control, 9600 baud default
RS-232	MODBUS RTU	Selectable via hardware configuration
WiFi	802.11 b/g/n	2.4 GHz, station mode (normal) or AP mode (provisioning)
USB	CDC ACM	Diagnostics, configuration, log output
LTE (planned)	MQTT over TLS	Cellular connectivity — Q2 2026

Connectors

Connector	Interface	Notes
DB9	RS-485 / RS-232	Standard serial connector for inverter communication
RJ45	RS-485	Alternative connector option per OEM requirement
USB-C	USB CDC	Diagnostics and local configuration

MODBUS RTU

Parameter	Value
Baud rate	9600 (default, configurable)
Data bits	8
Parity	None
Stop bits	1

Mode	RTU
Role	Client (master)
Function codes	FC01 (Read Coils), FC02 (Read Discrete Inputs), FC03 (Read Holding Registers), FC04 (Read Input Registers), FC06 (Write Single Register), FC16 (Write Multiple Registers)
Data types	uint8, uint16, uint32, int16, int32, string, bool
Max telemetry registers	255
Max metadata registers	30
Computed fields	Up to 20, combining up to 2 source registers each

MQTT / TLS

Parameter	Value
Protocol	MQTT v3.1.1
Security	TLS 1.2
Keepalive	60 seconds
Authentication	Per-device endpoint token
Client ID	`energy-logger-{MAC}`

OTA Updates

Parameter	Value
Bootloader	MCUboot (dual-slot with automatic rollback)
Download	HTTPS from platform-provided URL
Image signing	Required (signed firmware images)
Max firmware size	1.5 MB
Trigger	Cloud-initiated via the Kaa IoT platform

LED Indicators

LED	Function
WiFi OK	WiFi connected to access point
WiFi Error	WiFi connection failed
MQTT OK	MQTT broker connected
MQTT Error	MQTT connection failed
MODBUS	MODBUS slave responding
OTA	OTA firmware download in progress

General

Parameter	Value
Factory reset	Dedicated button
Watchdog	Hardware watchdog with autonomous recovery
Power	— (per OEM hardware design)
Operating temperature	— (per OEM hardware design)
Dimensions	— (per OEM hardware design)

Telemetry Schema

The module uses a universal energy inverter telemetry schema (v1.0) that normalizes data across all supported inverter brands. Schema can be provided by request.

Module	Metrics	Applicability
PV	Voltage, current, power per MPPT (up to 12), total power, daily/lifetime energy	Solar inverters
Grid	Voltage/current/power, frequency, power factor, import/export energy. (3-phase, 1-phase, Split-Phase)	Grid-connected

Battery	Voltage, current, power, SOC, SOH, temperature, cycles, charge/discharge energy	Battery systems
Load	Output voltage/current/power, frequency, daily/lifetime energy (3-phase, 1-phase, Split-Phase)	Off-grid/hybrid
Generator	Connection status, power, voltage, frequency	Optional
Device	Operating state, work mode, fault/warning codes, temperature	All devices

Sign Conventions

Metric	Positive	Negative
Grid power	Export to grid	Import from grid
Battery power	Charging	Discharging
Battery current	Charging	Discharging

Cloud Platform

The module connects to the Kaa IoT platform, which provides:

Capability	Description
Telemetry collection	Real-time and historical energy data with configurable poll intervals
Device metadata	Static device information (model, serial number, firmware version)
Remote configuration	Cloud-managed MODBUS register maps, polling schedules, computed fields
Remote commands	Reboot, firmware version query, MODBUS register read/write
OTA updates	Cloud-initiated firmware updates with version management and rollback
Dashboards	Configurable visualization for OEM, installer, and end-user portals
Alerts & rules	Threshold-based notifications and automated actions

Deployment Options

Option	Description
KaaIoT Cloud	Fully managed SaaS platform
Hosted	Dedicated instance managed by KaaIoT
Self-hosted	On-premise deployment in customer's infrastructure
Custom MQTT	Connect to any MQTT broker (configurable host, port, credentials)

Remote Commands

Command	Description
`reboot`	Reboot the device
`get_version`	Return current firmware version
`regs_read`	Read specified MODBUS holding registers
`regs_write`	Write to MODBUS holding registers (single or multi-register)

Security

Feature	Details
Transport encryption	TLS 1.2 for all MQTT communication
Device authentication	Per-device endpoint token
Firmware signing	MCUboot image signature verification (rejects unsigned/tampered images)
Automatic rollback	Failed OTA updates revert to previous firmware on next boot
Data jurisdiction	US or EU data residency options via the Kaa IoT platform
Factory reset	Physical button for credential wipe
Watchdog	Hardware watchdog prevents permanent hang states

Provisioning & Configuration

Initial Setup (WiFi AP Mode)

When no WiFi credentials are stored, the module automatically enters Access Point mode:

1. Module broadcasts WiFi network: `energy-logger-XXXX` (MAC suffix)
2. Installer connects and opens TCP configuration interface (port 4242)
3. Installer sends WiFi credentials, MQTT broker settings, and KaaIoT endpoint token
4. Module reboots into normal operation mode

No mobile app required — any device with TCP client capability can provision the module.

Runtime Configuration (Cloud-Driven)

Once connected, the Kaa IoT platform pushes MODBUS configuration to the device:

- **Register maps** — which registers to poll, data types, scaling factors
- **Poll interval** — telemetry collection frequency
- **Computed fields** — cross-register calculations (addition, subtraction, multiplication, negation)
- **Value maps** — translate numeric codes to human-readable strings (e.g., `0 → "standby"`)

Configuration changes take effect immediately — no reboot or on-site visit required.

Product Variants & Ordering

SKU	Form Factor	Connectivity	Target Application
EL-INT-WIFI	Integrated module (PCB)	WiFi 2.4 GHz	OEM inverters, battery systems
EL-EXT-WIFI	External dongle (enclosure)	WiFi 2.4 GHz	Retrofit for existing inverters
EL-INT-LTE	Integrated module (PCB)	WiFi + LTE	OEM inverters, battery systems
EL-EXT-LTE	External dongle (enclosure)	WiFi + LTE	Retrofit for existing inverters

All variants share the same firmware and cloud platform. Connector type (DB9, RJ45, USB) or custom configurable per OEM requirement.