Interoperable PLC + RF Hybrid Communication Solution

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AP Region, STMicroelectronics
ST global solutions for smart grid

ST technology solutions covering all smart grid building blocks

Connectivity
- WAN/NAN
- Power Line Communication, Radio Frequency

Processing
- Microcontrollers

Power Management
- Power Conversion
- Metrology ICs

Smart Sensing
- Anti-tamper & Environmental sensors

Actuators
- Relay Drivers
- Motor Drivers

Signal Conditioning
- Operational Amplifiers
ST field-proven PLC solutions covering all standards for Smart Grids

30 years experience in smart grid with key utilities, manufacturers, industrial alliances and standardization bodies

+130 million smart meters with ST inside

Field-proven, integrated, performing flexible and future-proof
Smart grid product platforms

**Connectivity**
- **ST7580**
  - N-PSK transceiver
  - Protocol agnostic

**Metering**
- **STPMS2**
  - 2 ch 24-bit ΣΔ ADC
  - For shunt 3ph-phase solutions

**STCOMET10**
- PRIME/G3 protocols
- M4 app core + Flash
- 3-ch 24-bit ΣΔ + DSP

**ST8500**
- Multi-std modem
- PRIME/G3/others

**STLD1**
- Line Driver
- FCC band

**STPM32,STPM33**
- 2 ch, and 3ch 24-bit ΣΔ ADC
- DSP energy calculator
- For 1ph solutions

**STPM34**
- 4ch 24-bit ΣΔ ADC
- DSP energy calculator
- For split or 3ph solutions

**PLC + RF Hybrid Solution**
ST8500 + STLD1 + S2_LP
Programmable, ultra-low power and compact PLC solution

Certified turn-key multi-standard PLC protocols
- Programmable, certified protocol standards: G3-PLC, PRIME…
- OFDM robust modulations with sophisticated correction coding’s
- Full 500 kHz band coverage for increased performance & reliability
- 6LoWPAN and IPv6 supported

Secure, robust and modular system architecture
- AES 128 / 256-bit engine for secure data encryption and anti-tampering
- Low Distortion, high current capability Power Line Driver for robust communication even in high attenuating, low impedance mains
- STM32 Broad range of external host controllers for whatever application

Low-power and compact solution
- Lowest Power Consumption (<100Mw) in RX mode
- QFN56 7x7 mm package for PCB optimization
- Extended Industrial temperature -40°C to 105°C

Key Applications
Powerline communication for remote management
- Smart Metering / Smart Grid
- Smart Home & Smart Building
- Smart City, Smart Street lighting
- Smart Infrastructure, Smart Railways
- Industrial IoT
# ST8500 PLC protocol stacks

## Multi-standard power line platform

<table>
<thead>
<tr>
<th>Protocols</th>
<th>CENELEC A</th>
<th>CENELEC B</th>
<th>FCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G3-PLC Alliance</strong></td>
<td><strong>Unique HW/FW for Device Node &amp; PAN Coordinator</strong></td>
<td><strong>G3 certification in Cenelec A, B and FCC band</strong></td>
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<tr>
<td><strong>PRIME Alliance</strong></td>
<td><strong>1 FW for Service Node / 1 FW for Base Node</strong></td>
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<td></td>
</tr>
<tr>
<td></td>
<td><strong>Certifications:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PRIME 1.3.6 (CenA)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>PRIME 1.4 : channel 1 (CenA) / ch 2 (Cen BCD) / ch 3 to 8 (FCC)</td>
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New hybrid PLC+RF technology: beyond typical smart grid connectivity

Expanding PLC capabilities

- Challenging network topologies
  - Rural area networks
  - MV/LV transformer bypass
  - Particularly harsh noise/impedance conditions
- Need to extend to other smart grid services (e.g. DER)
- Solution: fully hybrid PLC + RF Network
  - Each node has PLC and RF connectivity
  - The route is built with a hop-by-hop automatic selection of the best between PLC and RF media (dynamically adjusted)
- Boosting KPI to 100%
IPv6 PLC & RF connectivity for cities, buildings, utilities, industrial & commercial areas

Hybrid PLC+RF connectivity for smart infrastructure

Smart street light PLC/RFC
Expandable sensor ecosystem

Environmental & CO₂ sensor
Motion sensors
Microphone arrays

Gateway PLC/RFC

Remote RF sensor

Cloud

Remote control center
Remote monitoring and rapid shut-down

PLC provides the best 2-ways communication for smart solar applications:
- **Lowest system cost:**
  - no dedicated bus wires, no batteries/antennas
- **Highest reliability:**
  - Not subjected to other radio interferences
  - Not subjected by PV panels shielding effects

Hybrid PLC + RF extend the reachability in the very special conditions, like strong environment noise.

**PLC at PV Module Level adds value features:**
- Remote monitoring of PV panel operation and quality, including monitoring of local relevant parameters (V, I, T, ...)
- Remote Rapid Shutdown for safety or maintenance
- ...
Combined powerline and wireless strengths for top performance

The new hybrid connectivity solution for the ST8500 SoC platform

Channel selection and switching according to which link offers better coverage enables highly efficient hybrid mesh networking.
Seamless integration into multiple applications

Protocol stacks fully based on open standards

- G3-PLC Hybrid Profile
  - G3-PLC & IEEE 802.15.4
  - 6LowPAN and IPv6
- Fully backwards compatible and interoperable with any G3-PLC standard-based network
- Full coverage and high resilience
- Solution for the “last 1% connectivity” to meet >99% connectivity requirements in AMI
- Enables low density PLC deployments
- Suitable for integration of RF-only sensor nodes
- ST field proven technology

- Smart Infrastructure
- Smart Industrial
- Smart Metering
- Smart Grid
- Smart City
- Smart Lighting
Hybrid PLC + RF technology: Optimal integration choice

- First approach on G3-PLC technology
  - Already based on IEEE 802.15.4-2007 standard
- Layer 1 extension: added FSK RF PHY from 802.15.4-2015/17
- Layer 2 integration:
  - 2 separate MAC Layers (CSMA, ACK, …)
  - Hybrid abstraction layer to deal with common lower layer procedures
  - Hop-by-hop PLC or RF media selection
ST Hybrid PLC+RF solution
Standardization milestones

- ST pioneered the Hybrid PLC+RF solution with first protocol definitions and implementations
- ST Hybrid solution is already being deployed in specific pilot projects worldwide
- ST solution has been selected by G3-PLC Alliance as provider for the official hybrid conformance test too
- ST successfully passed the first G3-PLC Hybrid interoperability plug-fest tests
Hybrid PLC + RF technology: Performance results

**Internal tests**
- **100%** network discovery
- **100%** success in data exchange

**Hybrid field pilot example**
- Field deployment of ~40k hybrid PLC+RF smart meters
- Results taken in March on 4.7k meters (preliminary PLC+RF version)
  - **100%** network discovery
  - **98%** success in data exchange within 30 days
Explore the many benefits of the new ST G3-PLC Hybrid Solution

**EVLKST8500GH868/915 modular kits**

- Full-feature ST8500/STLD1 PLC module
- X-NUCLEO-S2868A2/S2915A1, for RF evaluation connectivity at 868 or 915 MHz
- NUCLEO-G070RB with STM32G070RB MCU as programmable application controller and PC interface
- Module interconnection board with RS485 and CAN transceivers to develop smart connectivity app
- Application functionality expansion through STM32 Nucleo Open Development Environment

**STSW-ST85000GH** software framework and documentation for EVLKST85000GH
Main Components:
• ST8500
• STLD1
• PM6644
• ST1S12GR
• W25Q16 FLASH
• [S2_LP]

- Turn-key solution HW ready / SW ready
- **Static power < 0.2W**
- HW support both CENELEC & FCC
- MAX line driving **34V/1.5A**.
- HW I/F compatible with **SGCC 1P PLC module**
ST8500 based hybrid reference solution SW

Module

ST8500

- G3 + RF Core Library
- BOOT (with fixed IdP and EUI64)
- Data Comm. (based on IPv6 addr. and Conn#, up to 11)
- PAN node storage (FLASH erase on each modification)
- Fast Restore
- Storage
- UDP Responder
- Keep Alive Slave
- ST8500 Host I/F

STM32

- ST8500 Host I/F (4~6KB RAM)
- BOOT (with customized IdP and EUI64)
- Data Comm. (based on meter address, no #limit)
- Lib. callback
- Handlers (e.g. Pan sort)
- Fast Restore
- Management
- PAN node management
- Remote DFU?
- Phase Detection
- MAC Hook (for CIU)
- Keep Alive Master
- Data frame Buffering
- RF Channel Configuration

Customizable Host I/F (4~6KB RAM)

WIN32

- GUI
- ST DCU demo (G3PanHost.exe)

- ST official binary delivery
- Local reference solution with binary and/or open source

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EVALKITST8500-1

X-NUXLEO-S2xxxx

SLN_MTR17003 + SLN_MTR20001 + SLN_MTR17001
ST8500 smart ecosystem

Design Resources
- G3-PLC Protocol FW packages
  - G3-PLC single binary CEN A/B/FCC + Device/Coordinator
  - Hybrid G3-PLC with RF expansion
  - G3-PLC Application Note
  - Graphical User Interface
  - STM32 driver

G3-PLC SW Package for non-metering applications
- Package to address non-metering connectivity solutions
- Downloadable from st.com:
  - STSW-SGKITGUI: GUI for PC
  - STSW-ST8500G3: G3-PLC images and STM32 FW

Evaluation boards
- EVALKITST8500-1
  - Ready-to-use, full-performance PLC node for AC applications
- EVLKST8500GHexx
  - Modular development kit for hybrid PLC+RF solutions based on NUCLEO

Application-specific SW packages
- ST8500 SmartSolar FW (dual mode SUNSPEC + nPSK)
- Windows PC test tool (command line)
- User Manuals

PRIME PLC Protocol FW packages
- PRIME 1.3.6 and 1.4 (Service Node and Base Node)
- PRIME Application Note
- Graphical User Interface

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STSW-SGKITGUI
STSW-ST8500G3
EVALKITST8500-1
EVLKST8500GHexx
Galvanic Isolation Connectivity
STISO621 - 6KV Isolated Digital Interface

Low Power, high speed Digital I/F

- 6kV galvanic isolation, 100Mbps rate and low pulse distortion (<3ns) for safe and fast data transfer between isolated domains
- 10mA power consumption at max data speed for ultra-low power and high performing operation
- CMTI = 65kV/us typ, Propagation Delay 25 ns typ
- High flexibility with 3.3V and 5V supply ratings and with SO8N and SO8-W package options

Prod. evalution board EVALSTISO62XV1 available


- Available in stock
- Gerber file, FW&SW Package documentation available on st.com
Thank you