FC-160X Model G3-Hybrid PLC&RF Product Manual

Version：V1.0

Applicability Table

Product	Description
FC-1601	G3-Hybrid PLC&RF Module for Single-phase Meter
FC-1602	G3-Hybrid PLC&RF Module for Three-phase Meter
FC-1603	G3-Hybrid PLC&RF Center Module

Copyright Statement

Note

The product corresponding to this document is FC-160X Model G3-Hybrid PLC&RF Module. The intended users of this document are system engineers, development engineers, and testing engineers.

This manual provides support for customer product design. Customers must design and debug product software in accordance with the specifications and processes in this document. Friendcom is not responsible for any personal injury or property damage caused by improper operation of the customer.

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Document history

Document title	FC-160X Model G3-Hybrid G3-PLC&RF Product Manual		
Document history			
Version	Prepared by	Date	Modified content (terms)
V1.0	Liu Zhiqiang	2023-10-10	First version of new module description

Notice

Due to product version upgrades or other reasons, the content of this document will be updated from time to time. Unless otherwise agreed upon, this document serves as a user guide only, and all statements, information and suggestions in this document do not constitute any express or implied warranty.

Content

FC-160X Model G3-Hybrid PLC&RF Product Manual

1. Overview

This document intends to introduce the FC-160X Model G3-hybrid PLC&RF module which combines G3-PLC and radio frequency (RF) technology, especially its characteristics, features and solutions to practical applications. The G3-hybrid PLC&RF refers to the standards hosted by the International Telecommunication Union (ITU) (ITU-T G.9903) and RF [IEEE 802.15.4] supported by the international association - G3-PLC Appliance.

1.1 Features

The module has the following features:
● Supporting G3-PLC [CENELEC-A/CENELEC-B/FCC/ARIB] and RF [863 ~870/902~928] MHz frequency Band
●Supporting zero-crossing (ZC) detection
●Remote firmware upgrade
●Multi-hops mesh network of maximum 15 hops
●Supporting IPv6 in the network layer

Table 1. PLC Characteristics

Band plan	Frequency(KHz)	No of Carriers	Data Rate(kbps)
CENELEC-A	35.9375~90.625	36	44.34
CENELEC-B	98.4375~121.875	16	22.03
FCC	154.6875~487.5	72	307.53
ARIB	154.6875~403.125	54	163.84

Table 2. RF Characteristics

Freq Band(MHz)	Modulation	No of Carriers	Data Rate(kbps)
863~870	Operation mode #1	69	50
863~870	Operation mode #2	35	100
902~928	Operation mode #1~5	129	50~300

1.2 Application Scenarios and Advantages

The G3-PLC standard supports high-speed, highly reliable IP-based communication across existing power lines, allowing data and control messages to flow in the generation, transmission, and distribution systems that make up the regional smart grid. Its main application directions are intelligent measurement, smart grid, smart home appliances, and industrial applications.

However, due to the shortcomings of individual PLC and RF usage, the fusion of the two modes is a trend.

Advantages of integrating dual modes:
●Channel Complementary

●Same protocol and address
●Improve reliability
●Lower latency
●Shorten networking time
●Reduce on-site support and operation costs

2. Network and Protocol Architecture

The following diagram shows the network architecture of G3-Hybrid PLC&RF. The solid line in the figure represents the PLC link, and the dashed line represents the RF link.

Each device in the mesh network can use PLC as well as RF for the communication. Depending on the actual conditions in the field, messages between two devices are sent over the 'best' available channel. The channel selection for each link in the network is done automatically and adjusted dynamically.
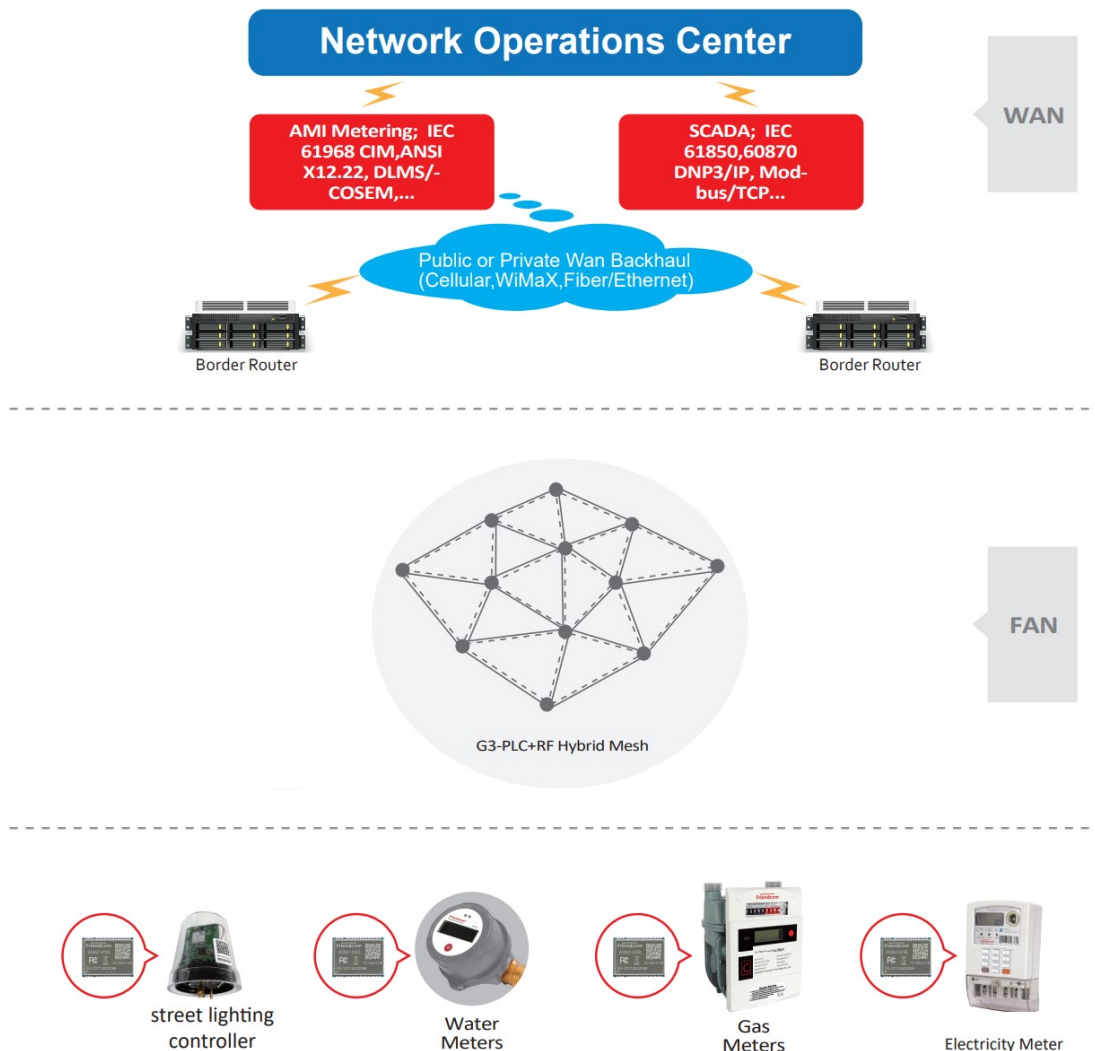
The following figure shows unified G3-Hybrid PLC&RF protocol stack. The hybrid protocol stack is built using open standards IEEE 802.15.4-2015 in addition to the existing G3-ALLIANCE protocol.
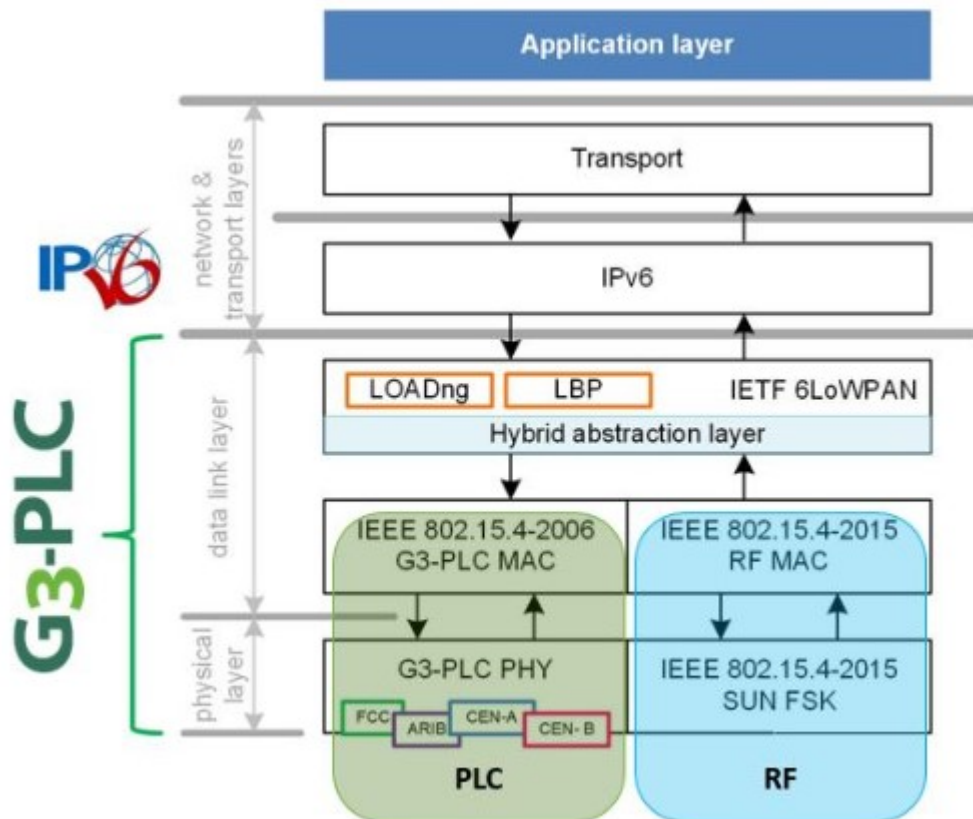
3. Technical Product Spec

STANDARDS
IEEE 802.15.4g
IEEE 1901.2
G3-PLC Alliance certificated

MCU & MEMORY FEATURES
ARM Cortex M4 32-bit MCU
2 MB Flash, 2 MB SDRAM
AES-128/192/256 Crypto Accelerator
SPI x 1, UART x 4, I2C x 1
G3-PLC / IPv6

RF CHARACTERISTICS
Frequency Bands
 ·ISM: 315, 433, 490, 868, 915, 920 MHz
 ·Licensed: 230, 600, 839-847 MHz
Max Data Rate: 400 kbps
 ·Modulation: OOK, (G)FSK, 4(G)FSK and GMSK
Built-in Power Amplifier: Tx Power +20 dBm
Built-in Rx Sensitivity -109dBm/50 Kbps

Frequency Hopping

PLC ANALOG FRONT-END CHARACTERISTICS
Supported frequency Band: 0-500KHz
Modulation: BPSK, QPSK, 8PSK and 16QAM
Integrated patented 4-Amp high current Line Driver

Power Supply
DC 12V (Max 13.5V, Typical 12V, Min 10.5V)

Power Consumption
PLC RX mode: RF 50kbps Data Rates in TX mode, 43.3mA
PLC RX mode: RF 50kbps Data Rates in RX mode, 39.7mA
PLC RX mode: RF 50kbps Data Rates in IDLE mode, 35mA
PLC RX mode: Without RF, 34mA
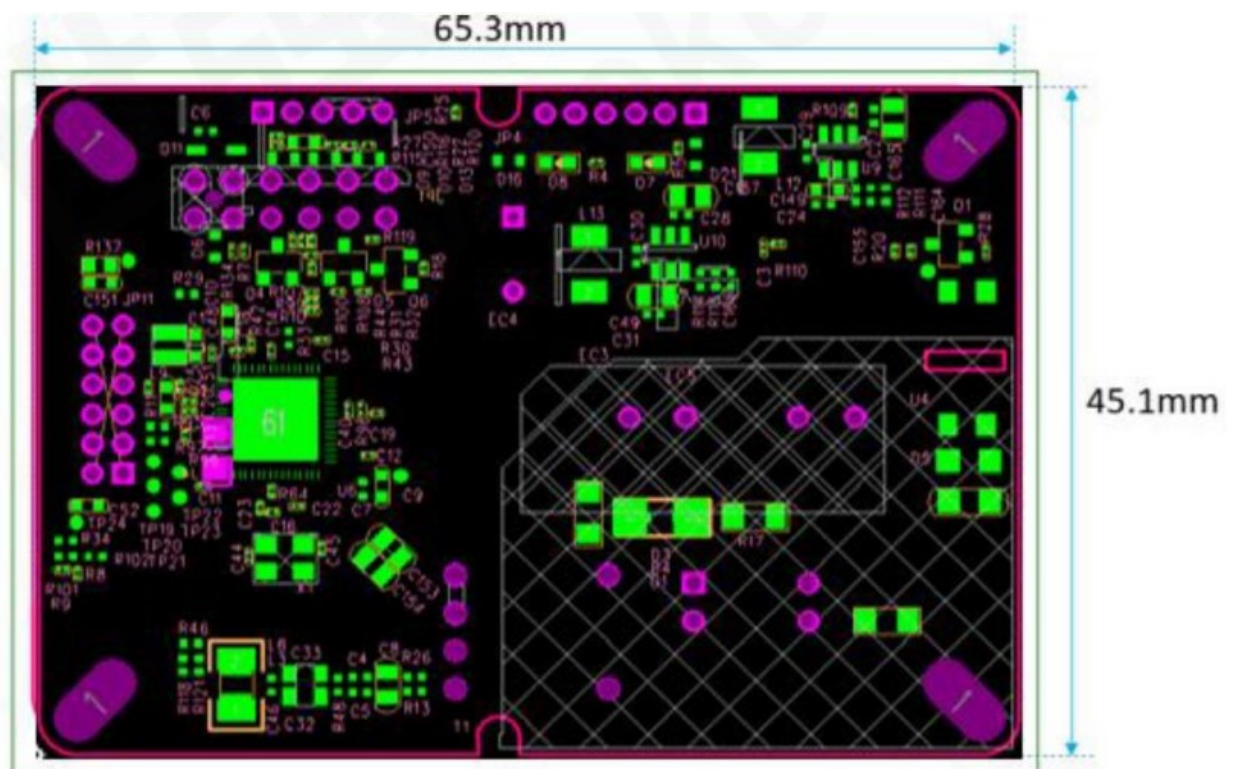PLC TX mode: RF 50kbps Data Rates in TX mode, 373mA
PLC TX mode: RF 50kbps Data Rates in RX mode, 390mA
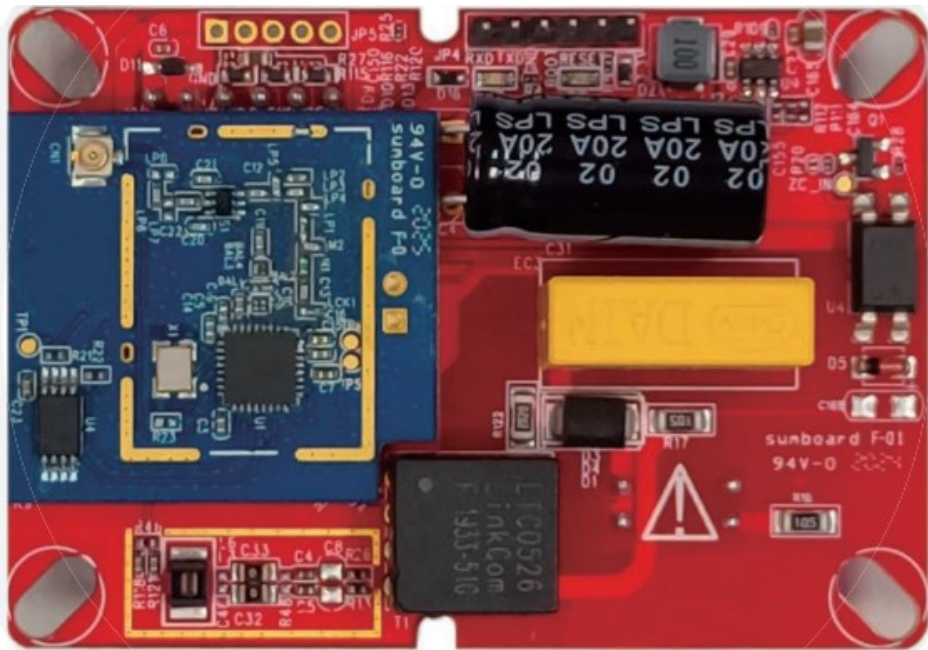PLC TX mode: RF 50kbps Data Rates in IDLE mode, 379mA
PLC TX mode: Without RF, 381m

4. Appearance and installation dimensions

4.1 Board Dimension

4.2 Physical Image

4.3 Interface Definition
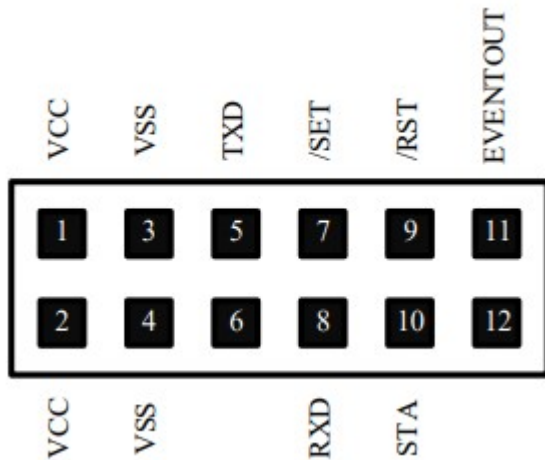
FC-160X board is compliant with the SGCC Standard for the AC connector and digital interface.

4.3.1 Connector of AC Line

Pin#	Type	Mnemonic	Description
1, 2	Neutral	N	Neutral in AC for signal coupling
3, 4, 5, 6	X	NC	Add the empty pins for the safe spaces
7, 8	Line	L	Line in AC for signal coupling

4.3.2 MCU Interface(Digital)

Pin#	Type	Mnemonic	Direction(Module)	Description
1,2	Power	VCC	I	Power supply to VC6322TF module, supplied by external power source
3,4	GND	VSS		Ground of the module
5	Signal	TXD	O	UART TX signal from VC6322TF module; Open-Drain Output pin; default HIGH
6	Reserved			Reserved
7	Signal	/SET	I	It is allowed to set the communication module when this input is at LOW. External source should be Open-Drain mode. Normal: HIGH state
8	Signal	RXD	I	External UART signal to the module. External source should be Open-Drain mode. Normal: HIGH
9	Signal	/RST	I	External Reset to the module. External source should be Open-Drain mode, Normal: HIGH Pules width > 200ms for Reset Signal
10	STATE	STA	O	Showing the state of the PLC module; could be configured in the application layer.
11	STATE	EVENT	I	External event input to the PLC module. External source should be Open-Drain mode. Normal: LOW
12	Reserved			Reserved

5. Transportation and storage

Module transportation and unpacking should not be subjected to severe impact, and should be transported and stored in accordance with GB/T 13384-2008 "General Technical Conditions for Packaging of Mechanical and Electrical Products".

The storage module should be in its original packaging, with an ambient temperature limit of -40℃~70 ℃ and a relative humidity of no more than 85%. There should be no corrosive gases in the air.

6. Warranty

Within 12 months from the date of self-delivery by the end user, and under the conditions that the user complies with the requirements specified in the user manual and the factory lead seal remains intact, our company is responsible for free repairs in case of quality issues. After the initial 12 months, our company ensures continued after-sales service.

Note: The terms of this clause are subject to the contractual agreement in the event of a contract.

Conclusion: Thank you for using our company's products! The manual of this product covers all the designed functions of the product. Please use the manual correctly according to the ordered product functions. This manual is subject to updates without prior notice!

Friendcom America Inc. Warranty Card

Product name		Model	
Product number		Grade	
Fault description			
End user		Post code	
Contact person		Contact number	

Address：3rd Floor, Building 6, Guangqian Industrial Park, 3rd Longzhu Road, Longguang Community, Taoyuan Street, Nanshan District, Shenzhen

Post code：518108

Tel：0755-86026600

Warranty Statement：

To better serve our users, our company provides a warranty card randomly enclosed with the product. Please keep it safe to enjoy the services we provide.

1) From the date of purchase, products that are operated normally without being

disassembled or repaired are eligible for warranty service within one year.

2) The following situations are not covered by free repair services:

   a) Damage to the terminal caused by significant fluctuations in the power grid voltage.

   b) Terminal damage due to misuse or intentional actions.

   c) Terminal damage caused by excessive vibration during user transportation.

3) The software of this product is upgraded for free, and our company provides free training.

4) When the user does not possess a warranty card, charges may apply at the discretion of our company.

5) If repair services are needed, please fill out the warranty card carefully and return it to our company.