**ADMIE S.A.**

# TECHNICAL SPECIFICATION T-2103A

## TECHNICAL SPECIFICATIONS OF DIGITAL PLC (POWER LINE CARRIER) DEVICES TRANSMITTING VIA POWER TRANSMISSION LINES OF 150/400KV WITH TELEPROTECTION MODULE

**14/7/2017**

# Contents

## I. GENERAL CHARACTERISTICS

### 1. USAGE - INSTALLATION

1.1 The specified PLC devices aim at expanding and functionally upgrading the existing PLC network of IPTO.

1.2 The devices will be installed by IPTO personnel.

### 2. APPLICATIONS

2.1. The devices will flexibly use the high frequency spectrum. The user shall be able to use the assigned frequency band only for the digital channel through the broadband modem in order all services to be transmitted digitally. The PLC must be able to allocate, the assigned frequency band in digital and/or analogue channels (frequency usage in standard analogue PLC way).

2.2 The digital PLC will be able to operate in contiguous frequency ranges for the adjacent bands and in separate bands. In addition, superimposed Tx-Rx bands shall be possible through echo canceller.

2.3. Each offered PLC device shall be able to perform the following functions:

2.3.1. Simultaneous bi-directional telephone communication (Full duplex), analogue and digital

2.3.2. Simultaneous and bi-directional transfer of call signalling.

2.3.3. Simultaneous and bi-directional transfer of superimposed signals (data or control signalling). The requirements of IEC60870-5-101 and -104 must be fulfilled.

2.3.4. In the analogue part of the band (whenever used), the data transfer through built-in asynchronous MODEM must comply at speeds of 50 to 1200 baud with FSK modulation (option). In the digital part, the data transfer through the broadband modem must comply at maximum speeds of 300 to 128000bps.

2.3.5. Simultaneous and bi-directional operation of teleprotection device capability: Alternate multipurpose F6 teleprotection system. The offered device must provide the teleprotection functionality by means of built-in or external unit. If the unit is external, must be included in the offer in order the teleprotection functionality to be provided according to the requirements.

2.3.6. If the teleprotection unit is external, it must be certified in the Technical Offer that the offered PLC and teleprotection units are fully compatible. In that case, PLC and teleprotection units are considered as an integrated functional system.

### 3. TECHNOLOGY

### 3.1. GENERALLY

3.1. The offered devices must be latest technology and excellent design and manufacturing.

3.2. The device shall include a broadband modem. Transmission speed must be automatically adjusted in real time (automatic fall-back/restore) depending on the prevailing line conditions (SNR).

3.3. The device shall include an Adaptive Time Division Multiplexer (TDM) to allocate the high speed digital channel to the local and transit connections depending on the current transmission speed (traffic flow control). For data connections, the TDM shall provide drop-insert and point-to-multipoint functions with channel sharing for RTU polling.

3.4. The offered device must fully comply with the latest regulations and IEC-60495 recommendations.

3.5. In the case the requirements of this specification differ from the regulations and recommendations of IEC-60495, the requirements of this specifications shall prevail.

3.6. The certificates of compliance of paragraph 3.4 must be submitted with the Technical Offer.

**3.2. HIGH FREQUENCY (HF)**

3.2.1. The device must be able to operate in the suppressed carrier or reduced carrier transmission system.

3.2.2. AGC

Analogue channel

In the case where the PLC is of suppressed carrier transmission type the receiver sensitivity (A.G.C.) shall be adjusted by means of a control channel (pilot channel) of 50 Baud. The same channel shall also be used as call signalling channel.
The above (pilot) channel must be outside of the area of the overlaid telegraph channels.

In the case where the PLC is of reduced carrier transmission type, the receiver must be able automatically adjust the sensitivity by means of the reduced carrier (A.G.C.). The call signalling will be transferred by means of a 50 baud rate channel. This channel must not be in the frequency band assigned to VF telegraph channels.

Digital channel

AGC functionality is implemented by measuring the received digital signal.

3.2.3. The carrier frequency shall be produced by synthesizer. The synthesizer reference frequency must be produced by a crystal of high stability. The selection of the receiver carrier frequency or the transmitter shall be selected through micro – switches or jumpers and/or the Human Machine Interface (HMI).

3.2.4. The offered PLC devices shall be suitably equipped to support adjacent HF frequency reception and transmission bands.

3.2.5. The operation HF frequency for the receiver and the transmitter shall be selectable in steps of 4 kHz.
The Technical Offer must include:

- the complete frequency allocation scheme extending over the frequency range of 40 kHz to 490 kHz (H.F allocation).
- the recommended frequency allocation combinations for the analogue and digital channels. Especially for digital transmission over adjacent Tx/Rx bands and depending on the digital modulation scheme, the recommended allocations shall be accompanied by graphs of transmission speed in respect of SNR and BER.

3.2.6. The frequency selection of the line filters at transmitter or receiver side shall be implemented through appropriate micro-switches and/or the replacement of a small number of capacitors.
It is pointed out that each offered PLC shall be suitable to operate in any frequency included in the range from 40 KHz - 490 KHz without any intervention from the manufacturer.
Full details about the frequency setting of each filter, at transmitter - receiver side, for the entire frequency range are required. The procedure that shall be followed for the operation frequency changes shall also be provided in the Technical Offer.

3.2.7. The device must be equipped with a high frequency power amplifier preferably hosted with the line filters in a separate module.

3.2.8. Each offered device must have in the front panel LEDs that indicate the operation status.

3.2.9. The HF output at the transceiver side must be able to connect to:

3.2.9.1. Coaxial cable of nominal impedance 75 OHMS

3.2.9.2. Balanced HF cable with a nominal impedance of 150 OHMS

3.2.10. In case that a specific HF transformer is required, (to comply with the requirements stated in §3.2.9), the specifications of the HF transformer shall be provided including all the details of attenuation, return loss, reflection, etc. for the entire range of PLC operation. Also, connection instructions with the PLC shall be provided.

3.2.11. Each device must be offered with a dummy load of 75 or 150 OHM that must be connected to the HF output of the device through jumpers.

3.2.12. The device must be adjusted (without any additional equipment e.g Spectrum analyzer) the line equalizer of the analogue channel through the HMI. For the digital channel, the equalizer must be dynamically adjusted in real time.

3.2.13. A spark gap to protect against surge voltages in the HF connection circuit must be included in the device.

**3.3. ACCESS CONNECTIONS**

3.3.1. Telephony:

3.3.1.1. Each offered PLC device must be equipped with all the required interfaces in order to connect to:

3.3.1.1.1. A pulse and/or DTMF telephone set for extension / CO line (FXS and FXO). The interface must be able to support all the call signalling (ring tone as well as a response – return tone shall be provided). It must be possible to transmit this service over either the analogue (FDM) or the digital (TDM) channel.

3.3.1.1.2. Another PLC device with a 2 or 4 wire connection capability. It shall be possible to transmit this service over either the analogue (FDM) or the digital (TDM) channel.

3.3.1.1.3. A PABX (PAX) with 2 - 4 wire connection. It shall be possible to transmit this service over either the analogue (FDM) or the digital (TDM) channel.

3.3.1.1.4. A local service telephone unit (Service telephone).

3.3.1.1.5. Technical details regarding the interconnection wiring to the PLC, including the required modules, must be provided in the Technical Offer for all the above stated interfaces.

3.3.1.2. Each offered PLC shall be provided with:

3. 3.1.2.1. A telephone hand set with keyboard.
3.3.1.2.2. A service hand set as stated in 3.3.1.1.4 (Service telephone).

3.3.1.3. Each PLC device shall be offered with a dynamic limiter in the voice input.

3.3.2. Low Frequency (LF)

3.3.2.1 One (1) separate 4-wire connections through separate input and output transformers of characteristic impedance of 600 OHM, with corresponding adjustable amplifiers or attenuators in 1dB step at the transmitter (input) and receiver (output) side shall be provided

3.3.2.2 Band pass filters for the superimposed signals at the transmitter and receiver side with a rejection of at least 20db for any undesirable signal.

3.3.3. Asynchronous digital connections

3.3.3.1. Each PLC device must be provided with at least four (4) RS-232 asynchronous digital ports that must be multiplexed to the digital channel through TDM MUX.

3.3.4. 10/100Base-TX LAN Ethernet port

3.3.4.1. Bridge L2 and Router L3 function to the interconnected LAN ports of PLC pair.

**3.4. TELEPROTECTION**

3.4.1. The operation of the teleprotection module/unit must be based on the alternate usage of the assigned frequency band and on the five frequency shift keying ('F6' type modulation) scheme and shall comply with the general requirements and ensure the following:

3.4.1.1. The transmitter shall transmit discrete signals as activated by the interface module that connects to the protection relays

3.4.1.2. A frequency must be permanently transmitted and used as a guard signal. Instead, the PLC pilot frequency could be used as teleprotection guard signal. This signal shall be disconnected only by TRIP commands of the connected protection relays in case of HV line fault and immediately replaced by one of the other four TRIP signals

3.4.1.3. The selection of the TRIP frequency signal is according to the line fault i.e. TRIP A, TRIP B, TRIP C or TRIP D (or any combination, TRIP A+ B or TRIP B+C) in order to protect one or two HV lines.

3.4.1.4. The loss of the guard signal will initiate the trip procedure at the receiver in conjunction with the presence of the appropriate trip frequency.

3.4.1.5. Following the trip transmission, the PLC link re-synchronization time shall be as short as possible. This re-synchronization time shall be provided in the Technical Offer.

3.4.2. The operation of the teleprotection module/unit must be possible with all combinations of frequency spectrum usage according to §2.1.

3.4.3. The guard signal must be constantly monitored and if its level drops below a certain level, an ALARM must be set and teleprotection inhibited.

3.4.4. If the TRIP signal is applied for more than 0.5 sec an ALARM must be set and teleprotection inhibited.

3.4.5. The offered devices must fully comply with the latest regulations and recommendations of IEC-60834-1

3.4.6. Operation indication LEDs must be included in the front panel of the module/unit.

3.4.7. The device must include supervision operations and AUTO TEST functions providing the local and/or remote supervision of the transceivers. These functions shall not induce any undesirable TRIPs in any way.

3.4.8. Event logging shall be part of the management system: the event time of Tx commands and Rx trips will be recorded in a log file.

3.4.10. In case of a separate teleprotection unit, must be suitable for installation in 19'' cabinets/Racks. Dimensions and photos must be submitted with the Technical Offer.

3.4.11. If a PC is required for the configuration of the device or other maintenance works, the necessary software must be submitted / offered. The management / maintenance software must be suitable for Windows operating system (new and old) accompanied by the appropriate interconnection cables. (At least 20 set).

**3.5. POWER SUPPLY**

3.5.1. Each device must be offered with duplicated hot swappable DC power supply (Redundant power supply module) operating at a nominal voltage of 48VDC.

3.5.2. All the relevant information regarding the operation of the DC power supply such as drawings and descriptions of all constituting sub-units must be submitted in the Technical Offer.

3.5.3. The offered power supply as stated in 3.5.1 shall be equipped with :

3.5.3.1 Protection against overvoltage at its inputs (fuses etc).

3.5.3.2. Electronic protection against short circuits at the secondary output voltages.

**3.6. DEVICE MANAGEMENT**

3.6.1. Each device shall be equipped with monitoring circuits (ALARMS) to signal (via free contacts) the failure of the power supply and/or the malfunction of the power amplifier and/or the loss of HF input.

3.6.2. Each device shall be provided with a supervision circuit of the signalling channel at the receiver, such as in the case of malfunction to precede the following:

3.6.2.1. To signal locally through free voltage relay contacts.

3.6.2.2. To transfer the signal through the transmitter to the other side PLC receiver in order to activate a free voltage relay contact at the receiving side.

3.6.3. Setup, activation and configuration of access connections, supervision, maintenance etc. must be performed through the Ethernet port. If the management is not web server based, the necessary software must be offered suitable for Windows operating systems (new and old) accompanied by the appropriate interconnection cables (at least 20 set).

3.6.4. Not only management and supervision of the peer PLC across the HV line shall be possible but also any remote device shall be managed based on its IP address. Two schemes to access to any remote device shall be possible:

3.6.4.1. 'inband' over the digital PLC links and the LAN bridge/router function.

3.6.4.2. 'outband' by means of external network infrastructure.

3.6.5. The management software shall provide the following functions:

3.6.5.1. Automatic frequency response measurement in the assigned frequency band.

3.6.5.2. Automatic analogue channel equalization.

3.6.5.3. Generation and transmission of LF frequencies for adjustments and tests.

3.6.5.4. Channel performance measurement according to G.821.

3.6.5.5. Event logging with time and date.

3.6.6. SNMP v.2 MIB.

3.6.7. Time synchronization by means of IRIG-B port.

3.6.8. As far as management is concerned, in case of external teleprotection unit, PLC device and teleprotection unit are considered as an integrated functional system, and this §3.6. is valid for this system as a whole.

3.6.9. In case of power supply failure no configuration setting will be lost and no logged event will be erased from the memory.

**4. CONSTRUCTION**

4.1 Each device must be constituted of one or more sub-racks fit to be accommodated in 19" cabinets/Racks excluding the offer of any other type.

4.2 Each chassis must be modular constructed by means of plug in cards/boards in a main backplane board.

4.3. The wiring among the different sub-racks shall be implemented through pre-constructed boards or permanent wiring such as no extra wiring work is required during installation.

4.4. All other external connections (power supply, HF connections, LF connections) shall be implemented via connectors, terminal strips or screw type terminals excluding any other type.

4.5. At the front of the PLC or on a separate rack there shall be short circuit jacks of U type or knife connectors for the disconnection of the LF input/output signals such as voice, calls, superimposed, protection signals.

4.6 Each plug-in card shall be of excellent quality well-constructed (epoxy-glass board) and satisfy the following:

4.6.1. To have golden plated ends on the side of connection with the main board.

4.6.2. To have a layer of epoxy resin to be protected against humidity and corrosion.

4.6.3 The front panel must have the required testing point jacks (for measuring purposes) and LEDs indicators for different state of operation conditions.

4.7. The materials used in the device construction and its accessories must be of excellent quality. The integrated circuits I.C. that are used on the board must be appropriate category type for industrial use.

4.8. The cooling of the device shall be implemented through natural air ventilation.

4.9. The offered PLC shall have dimensions not exceeding the 60cm in height. The exact dimensions of the device shall be stated in the Technical Offer.

4.10 The PLC device shall be well designed so all its parts to be easily accessible facilitating the maintenance requirements.

4.11 Each PLC shall be accompanied by an extension card, if required.

4.12 Special measuring cables must be provided if required.

**5. DOCUMENTS AND DRAWINGS**

5.1. Each PLC device must be provided by a complete set of technical documentation in electronic form (e.g pdf, e-book). In addition to the electronic form, two (2) copies in paper form shall be provided.

5.2. The provided technical documentation must be in Greek or in English. Any other language of technical documentation will not be accepted.

5.3. The technical documentation must include the following:

5.3.1. Detailed operational diagrams for each module/unit and block diagrams showing the interconnection among all the modules/units that consist the PLC device.

5.3.2. Initial installation procedures and configuration parameters.

5.3.3. Detailed description of the operation of the device.

5.3.4. Technical information, diagrams-curves, graphical representations of the variables of the operational characteristics of the PLC device.

5.3.5. Detailed circuit diagrams and topological drawings for each unit and sub-units.

5.3.6. Detailed list of all used parts, and elements/components used in each unit and sub unit (electrical - electronic elements) constituting each PLC device stating the exact serial production number and the corresponding commercial number (SKU).

**6. SPARE PARTS**

6.1. The complete spare part list shall be provided (Bill Of Materials) including the relevantpart/ serial numbers, (order number - SKU).

**7. WARRANTY**

The supplier shall provide a warranty of at least two (2) years, starting from the date of equipment delivery.

**8. TRAINING**

Training of fifteen (15) technicians for a week (5 working days) must be included in the offer. The training will take place at the IPTO premises.

**9. PLC PACKING REQUIREMENTS**

9.1. Each PLC device shall be delivered packed in a robust paper box suitable to withstand transfer hazards, accompanied by its accessories.

9.2. It shall be written on each box the type of the device, its serial production number and the number of Contract.

**10. SAMPLE FOR EVALUATION**

A pair of devices (PLC/teleprotection) with all the necessary miscellaneous equipment, cables, software etc must be submitted in order to perform the technical evaluation. The sample must be of the exact type of the offered and must be accompanied with all the relevant type tests and certificates.

**II. TECHNICAL CHARACTERISTICS**

**1. HIGH FREQUENCY (HF)**

1.1. Transmission type:

Single side band with suppressed or reduced carrier transmission.

1.2. High Frequency range:

From 40 KHz to 490KHz continuous band with no frequency gaps.

1.3 Nominal overall High frequency bandwidth, including the digital channel and any analogue channel: 2, 4, 8, 12, 16 kHz per direction.

1.3.1. Digital channel bandwidth (broadband modem) per direction: 4, 8, 16 kHz.

1.3.2. Analogue channel bandwidth per direction: 4 kHz.

1.4. Adjustable output power, measured at the output of the device (antenna), excluding any attenuation inserted by matching transformer:

1.4.1. Z=75Ω (Coaxial): 1- 40W.

1.4.2. Z=150Ω (Balanced): 1- 40W.

1.5. Nominal output impedance (HF side)

1.5.1. Unbalanced (coaxial): 75Ω.

1.5.2. Balanced: 150Ω.

1.5.3. Return loss: ≥10dB.

1.6. Tapping loss

1.6.1. Digital channel: according to IEC60495.

1.6.2. Analogue channel: according to IEC60495.

1.7. Maximum operating attenuation in noise free HV line: ≥40dB.

1.8. HF receiver sensitivity: -30dBm.

1.9. Amplitude modulation in the analogue channel.

**2. BROADBAND MODEM**

2.1. Modulation: OFDM or QAM / TCM

2.2. Transmission speed

2.2.1. Maximum ≥128kbps at 16kHz per direction.

2.2.2. Maximum ≥32kbps at 4kHz per direction.

2.2.3. The Technical Offer shall include the full duplex rate that is attained at 4kHz per direction with BER<$10^{-6}$ for two SNR values: 23dB and 16dB.

**3. ACCESS CONNECTIONS**

**3.1. GENERAL**

3.1.1. AGC performance for the analogue connections: LF output with variation < 0,5dB: >35 dB.

**3.2. TELEPHONY**

3.2.1. Analogue and digital transmission.

3.2.2. Signalling

3.2.2.1. E&M

- Signalling frequency: FSK/2.580 ± 30Hz or equivalent
- Signalling transmission drive by open/closed dry contact
- Signalling reception output: dry changeover contact
- Signalling speed: ≥ 10 pulses / sec (40/60 form)
- Pulse distortion: ≤5ms

3.2.2.2. DTMF

3.2.3. Voice levels:

3.2.3.1. Two wire input: 0dB/600Ω

3.2.3.2. Four wire input: 0dB to -17dB/600Ω

3.2.3.3. Two wire output: - 7dB/600Ω

3.2.3.4. Four wire output: - 7dB to +8dB/600Ω adjustable to 1 dB steps

3.2.4. Frequency band for analogue transmission: 0,3 to 2 kHZ adjustable

3.2.5. Coding speed for digital transmission: 2000bps – 6000bps

**3.3. LOW FREQUENCY**

3.3.1. Total usable frequency range 300 – 3720Hz and for telegraphy 2300 - 3720Hz, adjustable.

3.3.2. Spurious frequencies: according to IEC60495.

3.3.3. Noise level at voice and LF outputs: ≤-55dBm0p according to IEC60495.

3.3.4. LF limiter according to IEC60495.

3.3.5. Telegraphy signal levels:

3.3.5.1. Input: -20dB to -5dB/600Ω adjustable to 1 dB steps

3.3.5.2. Output: -20dB to -5dB/600Ω adjustable to 1 dB steps

3.3.6. Frequency stability between transmitting and receiving LF signals: ≤2Hz

3.3.7. Nominal impendence of LF inputs and outputs and return loss:

3.3.7.1. 600Ω balanced

3.3.7.2. ≥14dB

**3.4. ASYNCHRONOUS DIGITAL CONNECTIONS**

3.4.1. Four (4) data connections V.24/V.28 RS232 with rates from 300 to 14400bps.

**4. TELEPROTECTION**

4.1 The teleprotection unit must be fully compatible with the PLC equipment (internal/external teleprotection device).

4.2 Maximum TRIP delay: ≤15msec

4.3. Transmission input (TRIP COMMAND)

Optoisolated: operation voltage 24, 48, 110, 220 VDC. with surge protection.

4.4 Trip output

Solid state relay two (2) dry contacts Normal Open (NO) 250VDC 0,5A.
With surge protection.

4.5. Trip duration adjustable to 200 ms

4.6. Alarm contact requirements

Double changeover dry contacts 250VDC 0.6 A. With surge protection.

4.7. The operating frequencies shall be stated in the Technical Offer:

4.7.1. Guard

4.7.2. Trip-A

4.7.3. Trip-B

4.7.4. Trip-C

4.7.5. Trip-D(or A+B or B+C)

4.8. Insulation

2KV rms/50Hz/ 1 min per terminal to ground

**5. POWER SUPPLY**

5.1. DC Power supply

5.1.1. Nominal Voltage: 48 VDC +20% to –15%

5.2. Power consumption: < 150VA

**6. ENVIRONMENTAL**

6.1. Insulation

6.1.1. Input to power supply: Each terminal to ground 500Vrms/50HZ/1min

6.1.2. HF side: Each terminal to ground 2KVrms/50HZ/1min

6.1.3. LF side, signalling, alarm outputs, drive circuits: Each terminal to ground 500Vrms/50HZ/1min

6.2. Operating conditions

6.2.1. Operating temperature: $0^{o}$C to +$45^{o}$C (acc. IEC)

6.2.2. Humidity: 0 to 90%

6.3. Storage conditions

6.3.1. Temperature: -$25^{o}$C to +$65^{o}$C

6.3.2. Humidity: 0 to 90%

6.4. Protection: IP20 according to DIN 40050

**III. INSTRUCTIONS FOR TECHNICAL OFFER FORMAT**

1. The technical offer must be typed in Greek or in English and submitted in two (2) copies.

2. Every offer must be accompanied by the following:

2.1. Complete set of technical manuals of the exact type of equipment offered in accordance with I. §5 of technical specification.

2.2. Full compliance list.
In this list must be stated the compliance or noncompliance to all relative specification requirements for each paragraph of chapters I and II. Answers must be clear with references to the technical manuals and/ or other documents accompanying the offer.
E.g. :
Comply and offered. See technical manual ….., page ……, par…….
or :
Not comply, but we offer equivalent. See technical manual …., page….., par……

2.3. Equipment composition list stating:

2.3.1. The exact type of the equipment offered.

2.3.2. Complete and analytic composition list of the equipment offered with description and number of units and subunits used mechanical parts tec. as with their code numbers.
Each set of equipment must be offered complete with all accessories necessary for its independent operation.
2.4. A pair of the offered devices (PLC/Teleprotection) must be offered for technical evaluation.

2.4.1. All bidders within ten (10) working days from the data of their requested department of IPTO with a sample of the exact type of the equipment offered for further technical evaluation, otherwise the offer will be considered as non-acceptable.

2.4.2. In case that the offered equipment is identical to previously supplied to IPTO it is not necessary to provide said sample but must state the number of the relevant contract.

2.4.3. The supplied sample will remain with IPTO for at least the duration of the validity of the financial offer.

2.5. List of spare parts offered. In this list all equipment parts (units, subunits etc) and components must be included with description, manufacturers part number and where possible commercial type number.

2.6. Certificates - attestations as required by specifications.

2.7. The supplier must provide a customer list with company names, addresses, FAX and emails of utility companies where has installed and successful operated.

2.8. If the equipment offered is manufactured under license the relative documents must be supplied.

2.9. Exact and complete photocopy of economic offer without prices and discounts.

3. The following clarifications must be seriously noted:

3.1. Every paragraph of the requirements that has not been answered or has been answered but not clearly will be considered as negative answer.

3.2. Any offer not containing all requirements of par. I. §5 of the technical specifications will be rejected as not technically acceptable.

3.3. The required lists III.§2.3. and III.§2.32.5. above must not include prices otherwise the offer will be rejected. However these list III.2.32.3. and III.2.32.5. must be included in the economic offer with price break – down. The sum of the break – down prices of the units of the composition list 2.3. must equal the total value of the system offered.

3.4. IPTO reserves the right to decide which spare parts and their quantity that will be included in the final contractual agreement.
The price of the spare parts will not be considered in the economic evaluation of the offers.

3.5. For the award of the contract the following will be seriously considered:

3.5.1. The compliance to the technical and other requirements.

3.5.2. The conduct of the supplier and the quality of the material supplied to IPTO in previous contracts if any.

3.5.3. The delivery time of the requested equipment.