Contents

1 Introduction

Our Profinet Interface Board PNET has been developed to be integrated as an internal board that can be plugged in different Serra devices.

Our line of products is composed of welding timers (Alternating Current and Medium Frequency) and motor drivers for spot welding guns. All this products communicate with the PNET board through a dual port RAM mounted on the PNET board.

The development of the PNET interface is based on the Siemens EB-200 board, with Ertec 200, and the Ecos operating system, version 3.2.0.

The board is thought to operate with : Copper interface, Abatron Std. POF interface (AFBR 5978Z) and Abatron POF Diagnosis Enhanced Interface (QFBR 5978Z). Which can be mounted on the same board with the corresponding firmware.

The system is programmed to fulfil Conformance Class B for factory Automation.

The communication functions of the device can be summarised:

- Cyclic IO RT

  Using three different profiles:

  - 10 bytes input / 10 bytes output
  - 8 bytes input / 8 bytes output
  - 6 bytes input / 6 bytes output

- Acyclic Parameter Communications (see section 4.3.2)

  We call this mechanism 'PLC TELEGRAM', through it different communication protocols can be implemented allowing not time critical data to be exchanged between the device and the Profinet Master.

  The master can write the user specific record reserved for this functionality, this record contains an id. code for the function and a 256 bytes buffer, and the PNET board will transmit it to the connected device (this depends on the programm of the master, not supplied by Serra).

  The connected device, at his turn, can transfer a record to the PNET interface to be sent to the master, triggering the following mechanism:

  - The PNET interface generates a Process Alarm, that the master must capture in order to know that there is a record pending for read in the 'mail box'.
  - Then the master can read the record (this part depends on the programm of the master, not supplied by Serra).

- Device diagnostics (see section 4.2)

  - Channel alarms : this is a generic class of device alarms, defined by the standard. As the diagnostic information of our products is dependent on the connected device, only one channel alarm is implemented, this is, the detection of a faulty behaviour of the program in the SERRA device (watchdog alarm).
  - User Diagnostic alarms : in this level all the hardware and functional errors that result in the device blocking its function are grouped together and the additional information generated by the device is passed on to the master.

    - User process alarms : informative an non blocking warnings from the device are grouped in this level, they also contain additional information.

- Device Identification I&M0 and I&M3 (see section 4.4)

  Mandatory information level I&M0 is used to identify the PNET interface and optional level I&M3 is used to identify the attached device through the information contained in the descriptor.

- Neighbourhood detection LLDP

  Link Layer Discovery Protocol is supported. By emission an acceptance of the corresponding frames from other stations, provides received information of connected devices together with port information.

- Port related Network Status PDEV

  Diagnostics and topology information can be called up from the Physical Device Object, using acyclic PROFINET services.

- Network Diagnostics via IT, SNMP

  SNMP (Simple Network Management Protocol) is supported. It is an IT (information technology) protocol for maintenance and monitoring of network components and their functions.

- Shared Device

  The PNET interface can make the cyclic IO data available to a different master than the one directly connected to the interface. This is configured through the master.

- Ring redundancy, MRP

  A MRP (Media Redundancy Protocol) client is supported, allowing the ring topology of the net and its benefits.

- Optic fiber cable diagnostics for POF/HCS

- iParServer Client (see section 4.3.1)

  The iParServer protocol, client side, is implemented. The backup is divided in up to 254 blocks of 480 bytes each, a header block is used, human readable, with the main parameters of the backup copy. Configuration and working programs are stored.

The device also supports our proprietary protocol CPC, on the same communication line, which is based on standard UDP and TCP/IP protocols (see chapter 6).

2 Physical description, cabling and infrastructure

2.1 General

General features of the PNET board are:

- Integrated in the ERTEC200 chip:
  - ARM946E-S CPU.
  - Isochronous Real Time switch with 64 Kbytes RAM for real time Ethernet.
  - External host processor on the LBU interface.
  - Single Channel DMA controller.

  with the following I/O blocks available:

  - External memory interface with SDRAM and SRAM controller.
  - Two Ethernet interfaces with integrated MII PHYs.
  - Input/Output via APB bridge.
    - 45-bit GPIO.
    - UART.
    - SPI.
    - 3 timers.
    - F-timer.
    - Watchdog.
    - Boot ROM.
    - System function register.
- Flash memory 4 Mbytes.
- SRAM 8 Mbytes.
- Debug and trace interface for ARM946ES-uP.
- UART connector (no RS232 drivers) through 2x5 pin 2,54mm PCB connector, for booting, debugging and monitoring.
- 6 GPIO ports externally available through 1x8 pin 2,54mm PCB connector.
- Dual Port 2K SRAM
- Physical interface to mother board through 32pin DIN-Signal 2C032MS-3,0C1-2 male connector.

2.2 Copper Interface

In its copper configuration, the PNET interface mounts two RJ45 IP20 Ethernet sockets with integrated magnetics and activity(amber)/link(green) leds. According to IEEE 802.3 requirements.

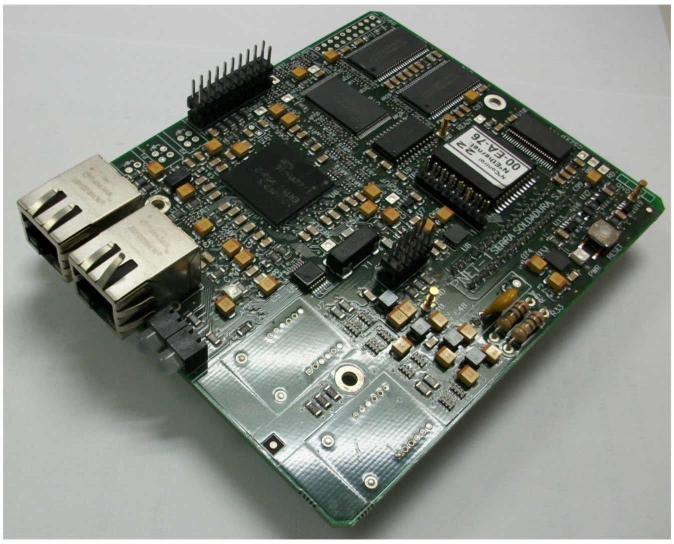

Figure 1: Copper perspective view

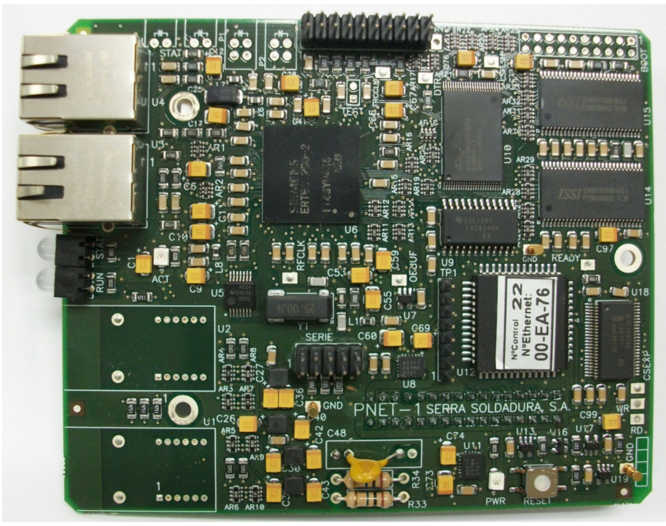

Figure 2: Copper zenithal view

2.3 Plastic Optic Fiber (POF) interface, standard

In its plastic optic fiber configuration standard, the PNET interface mounts two SC-RJ optical fiber connectors. This connector is embedded in a Avago AFBR-5978Z optical fiber transceiver.

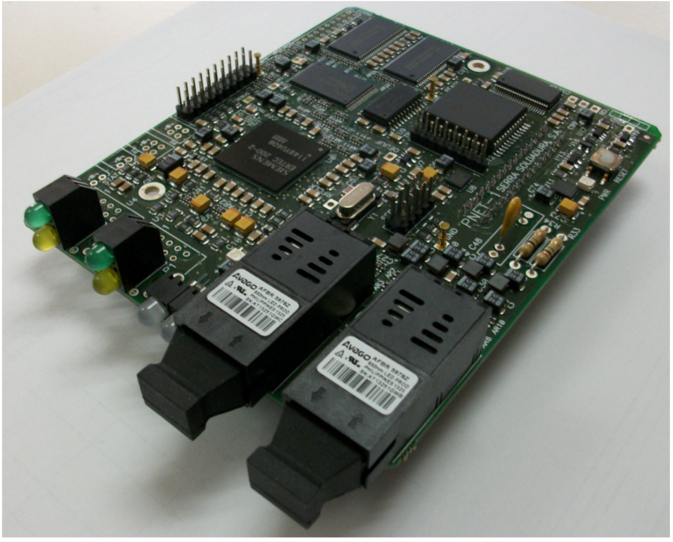

Figure 3: POF-A perspective view

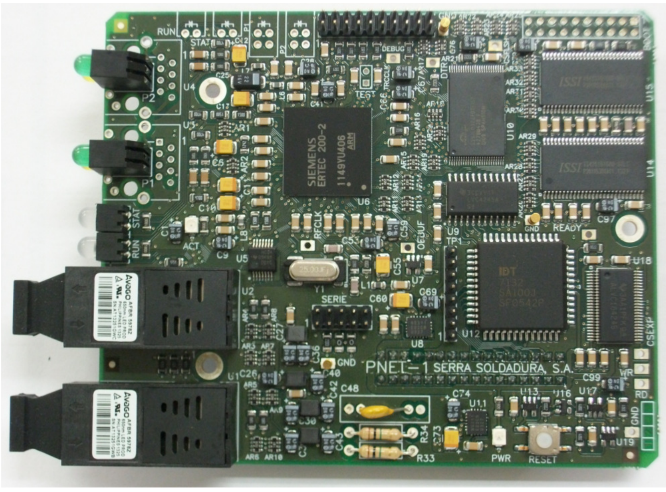

Figure 4: POF-A zenithal view

2.4 Plastic Optic Fiber (POF) interface, enhanced diagnostics

In its plastic optic fiber configuration with enhanced diagnostics, the PNET interface mounts two SC-RJ optical fiber connectors. This connector is embedded in a Avago QFBR-5978Z optical fiber transceiver.

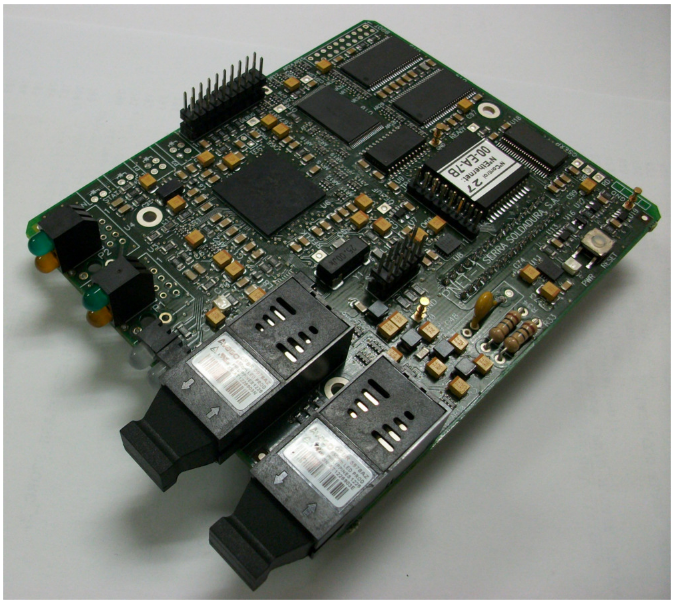

Figure 5: POF-Q perspective view

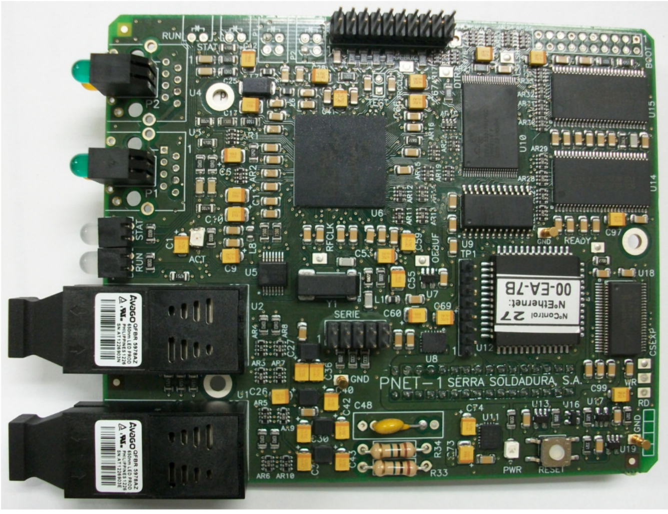

Figure 6: POF-Q zenithal view

2.5 Led description

Externally visible leds are:

Cover ID	Colour	Description	Board ID
BF	bicolour red/green	Bus Failure	STAT
US1	bicolour red/green	Main Power	RUN
P1-LINK	green	Port 1 Data connection	-
P1-ACT	amber	Port 1 Data Activity	-
P2-LINK	green	Port 2 Data connection	-
P2-ACT	amber	Port 2 Data Activity	-

Table 1: Externally visible leds

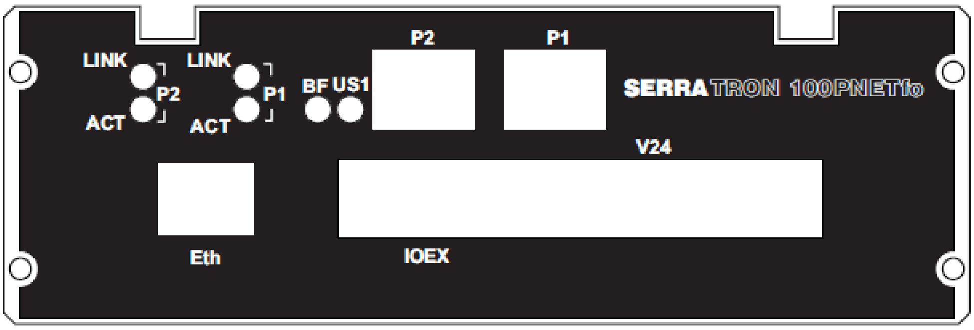

Figure 7: Serratron 100 POF cover

Internal leds, not visible outside de covers used for startup and service, are:

Board ID	Colour	Description
PWR	green	Power feed
ACT	amber	Program status

Table 2: Board internal leds

The description of the different meanings for the colour and blinking are described in paragraph 2.5.2.

2.5.1 Led assembly

Depending on the device and its enclosure, is possible to mount the following leds in an alternative positions as can be seen in figures 2,4 and 6 on the board silk screen .

- STAT
- RUN
- In POF variant (in copper variant this leds are integrated in the socket).
  - Port P1: LINK, ACTIVITY
  - Port P2: LINK, ACTIVITY

2.5.2 Led function

In order to output the status of the PNET interface to the user a number of states are possible for the US1 and BF leds, according to the following table:

US1$_{(RUN)}$	**BF**$_{(STAT)}$	**Description**
OFF	OFF	NOT ACTIVE power down or device booting
GREEN	RED BLINK 0,5s	BOOT waiting for device initialisation
GREEN	RED BLINK 1s	BOOT waiting for first master communication
GREEN	OFF	ACTIVE master connected
GREEN	OFF	ACTIVE communication default
GREEN BLINK 0,5s	RED BLINK 0,5s	NOT ACTIVE wait for firmware update
RED	ANY	ERROR device watchdog error

Table 3: Leds US1,BF function

In order to output the status of the communication lines, for every port, the possible states for the ACTIVITY and LINK leds are:

LINK	**ACTIVITY**	**Description**
OFF	OFF	NOT CONNECTED
ON	OFF	CONNECTED, no communication
ON	BLINK OR CONTINUOUS	CONNECTED, communication active

Table 4: Port leds LINK, ACTIVITY function

PWR	**ACT**	**Description**
ON	ANY	POWER ON
ON	BLINK 0,5s	BOOT waiting for device initialisation
ON	CONTINUOUS	RUN

Table 5: Internal board leds PWR, ACT function

3 Functional Conformance Table (Class B)

The following table resumes the functionalities supported by the PNET-1, in order to achieve conformance Class B.

Requirement	**Technical Function**	**Standard/ Optional**
Cyclic data exchange	PROFINET RT	Standard
Acyclic parameter data	Rd/Wr Record	Standard
Device diagnostics	Alarms	Standard
Device identification	I&M0	Standard
Neighbourhood detection	LLDP	Standard
Port-related network statuses via PROFINET	PDEV	Standard
Network diagnostics via IT	SNMP	Standard
Distribution of functions to various controllers	Shared device	Optional
Extended Device Identification	I&M3	Optional
Higher availability through ring redundancy	MRP	Optional
Optic fiber cable maintenance alarms	PDEV	Optional
Individual Parameter Server Client	Rd/Wr Record	Optional

Table 6: PNET-1 Conformance Table

4 SERRA customized PROFINET functionalities

4.1 Introduction

As the basic functionality of the PNET board, and its hardware design, is inherited from the SIEMENS EB200 development board, only the customized and added functionalities will be explained in the following sections.

4.2 Alarms

4.2.1 Channel Diagnostic Alarms

The following Channel Diagnostic Alarms are generated by the PNET interface, triggering an Event with standard structure ID 0x8000.

Watchdog Error	
Slot Number	0
Sub-slot Number	1
Channel Number	1
Error Number	0x100
Channel Direction	0
Channel Type	0
Description	Watchdog activity of the device not detected

4.2.2 User Alarms

This alarms operate in the range of alarm structures 0x7000-0x70FF reserved for manufacturer specific diagnostics, every different SERRA device uses a different structure which is deduced from its company internal Device Number.

Some examples for this structure numbers:

Serra Device	**Internal ID**	**Alarm structure ID**
Serratron 300C AC Welder (S300C)	0x03	0x7003
Serratron 100C AC Welder (S100C)	0x91	0x7091
Medium Frequency Control (MFC)	0x15	0x7015
Welding Gun Drive (PES)	0x06	0x7006
Welding Gun Drive + Medium Frequency Control (DMF)	0x25	0x7025

All the user alarms generated by the different SERRA devices, generate the same event with a variable structure number as explained above. Its main parameters are described in the following table:

User Alarm Record	
Slot Number	0
Sub-slot Number	1
Channel Number	1
Info Data	(see explanation below)
User Structure Identifier	0x7000 + SERRA Device id
Channel Direction	0
Channel Type	0

The Info Data is structured as follows:

User Alarm Info Structure		
Data Size	**Name**	**Description**
word	Alarm Code	Described in SERRA Device manual
word	Alarm Index	Described in SERRA Device manual
double word	Weld Code	Unique weld point descriptor
word	Weld Program	Alarm related welding program (if needed)
byte	Alarm Level	Described in SERRA Device manual
byte	reserved	

Device alarms are switched to the user alarm mechanism or the process alarm mechanism according to the Alarm Level (blocking, non blocking) contained in the Alarm Info Structure supplied by the connected device. The device alarms and levels are described in the device's manual.

4.2.3 User Process Alarms

Process alarms share the structure identification mechanism and the parameter structure with the user alarms, described in 4.2.2. Device alarms are switched to the user alarm mechanism or the process alarm mechanism according to the Alarm Level (blocking, non blocking) contained in the Alarm Info Structure supplied by the connected device. The device alarms and levels are described in the device's manual.

4.3 Record read/write

Record read/write mechanism has been used to implement the functionalities described below.

4.3.1 IPAR Client

Backups consist of up to 255 blocs of 480 bytes each. The parameters and program information of the device are zipped (not human readable) in this blocks except for index 0, that contains the backup information:

Backup Header, Block 0		
Size	**Parameter**	**Description**
dbl. word	CRC	BACKUP file CRC (uncompressed)
6 byte	SRC_DEST	PNET interface MAC address
word	IM_VENDOR_ID	SERRA Vendor ID (0x1F3)
21 byte	IM_ORDER_ID	PNET board Order ID
byte	RESERVED	
word	IM_HW_REV	PNET board hardware revision
word	IM_SW_REV_1	PNET board software version
word	IM_SW_REV_2	PNET board software subversion
word	IM_SW_REV_3	PNET board Software build index
word	SERRA_DISP	SERRA Device ID
word	SERRA_HW_REV	SERRA Device hardware version
word	SERRA_FW_REV	SERRA Device firmware version
dbl. word	COMP_LENGTH	BACKUP file length (compressed)
dbl. word	UNCOMP_LENGTH	BACKUP file length (uncompressed)
word	NBLOCKS	BACKUP file, number of 480 byte blocks

Block 0 is retrieved at restore and the following actions, number of blocks retrieved, decided based on its information. CRC information is used to check the integrity of the retrieved data.

Further checks are to be implemented in the IPAR master program (not supplied by Serra).

IPAR client Request Record The IPAR functionality is based in an event mechanism, client driven. In this way the server can be told to read a backup block from a device record, or can be told to write a block of data for restore in a device record. Process Alarms are used to trigger the event.

IPAR Request Alarm Record	
Slot Number	1
Sub-slot Number	1
Channel Number	1
Info Data	IPAR Request
User Structure Identifier	0x8201
Channel Direction	0
Channel Type	0

The IPAR Request contents is defined by PROFINET.

4.3.2 PLC Telegram

PLC Telegram is the name for the user structure identifier 0x7100, its contents description:

PLC Telegram		
Size	**Parameter**	**Description**
word	Code	Telegram ID
256 byte	Buffer	Telegram data

Master sending a Telegram The PNET interface Read Record mechanism will capture this event, and the will transfer the arrived information to the connected device.

Master receiving a Telegram To get the master attention, the PNET interface issues a Process Alarm. In reaction to this, the Master program should read the corresponding record (identified by the structure ID), to get the Telegram (this response must be programmed in the master and is not supplied by Serra).

PLC Telegram Request Alarm Record	
Slot Number	0
Sub-slot Number	1
Channel Number	1
Info Data	PLC Telegram
User Structure Identifier	0x7100
Channel Direction	0
Channel Type	0

4.4 Identification and Maintenance I&M

The mandatory information refers to the PNET interface board of the equipment, while I&M3 information is used to indicate information about the Serra device connected to the interface board.

4.4.1 I&M0 Record

Size	Parameter	Value	Comment
2 byte	MANUFACTURER_ID	0x01F3	SERRA
20 byte	ORDER_ID	PNET-1 Cu PNET-1 POF PNET-1 POF Diag	copper interface POF standard POF extended diagnosis
16 byte	SERIAL_NUMBER	PNET board s/n	
2 byte	HARDWARE_VERSION	PNET board hw. ver.	
4 byte	SOFTWARE_REVISION	PNET board sw. ver.	
2 byte	REVISION_COUNTER	0x0100	not used
2 byte	PROFILE_ID	0x0000	Generic Device
2 byte	PROFILE_SPECIFIC_TYPE	0x0001 0x0002 0x0003	8 byte in/ 8 byte out 10 byte in/ 10 byte out 6 byte in/ 6 byte out
2 byte	IM_VERSION	0x0101	v1.1
2 byte	IM_SUPPORTED	0x0800	I&M3 supported

Table 7: PNET-1 I&M0 Record Information

4.4.2 I&M3 Record

Size	**Parameter**	**Value**	**Comment**
54 byte	DESCRIPTOR	SERRA Device information	-

Table 8: PNET-1 I&M3 Record Information

Size	**Parameter**	**Value**	**Comment**
6 byte	TAG1	"Intfc:"	Interface
7 byte 10 byte 10 byte	PROFINET_INTERFACE	"PNET-CU" "PNET-POF A" "PNET-POF Q"	Copper interface POF standard POF extended diag.
1 byte	FIELD_SEPARATOR1	";"	-
4 byte	TAG2	"Dev:"	Device
6 byte 3 byte 8 byte 8 byte 6 byte	SERRA_DEVICE	"S-300C" "PES" "MFC-3000" "DMF-3000 "S-100C"	AC Weld 300C Electric Weld Gun Drive Med. Freq. Weld MF Wld+Wld Gun Drv AC Weld 100C
1 byte	FIELD_SEPARATOR2	";"	-
3 byte	TAG3	"FW:"	Firmware version
1-3 byte	DEV_SOFT_VERSIONHIGH	0-255	-
1 byte	SW_VERSION_SEPARATOR	"."	-
1-3 byte	DEV_SOFT_VERSIONLOW	0-255	-
1 byte	FIELD_SEPARATOR3	";"	-
3 byte	TAG4	"HW:"	Hardware version
1-3 byte	DEV_HARD_VERSION	0-255	-
1 byte	FIELD_SEPARATOR4	";"	-

Table 9: PNET-1 I&M3 Descriptor

5 GSDML file main parameters

5.1 Device Identity

Parameter	**Value**
VendorName	SERRA
VendorID	0x01F3
DeviceID	0x0001
InfoText	Serra Profinet Interface

Table 10: PNET-1 GSDML Device Identity Parameters

5.2 Device Function

Parameter	**Value**
MainFamily	I/O
Product Family	SERRA PRODUCTS

Table 11: PNET-1 GSDML Device Function Parameters

6 SERRA CPC protocol on PROFINET

Serra devices interconnect through Ethernet in order to read and write working parameters and for different surveillance protocols : events, welding results,..

This is an IT service that has been implemented using the BSD sockets alike stack supplied by the ecos operating system. The PNET interface forwards the information to and from the connected device to the programming and logging computer through Ethernet.

Five different threads are used to implement the protocol, with different priorities, described below.

6.1 Device discovery protocol

This protocol is implemented from the master with broadcast packets, these are received and answered to the master address through UDP packets.

Two server threads are implemented in the PNET interface one for listening and the other for listening with priority TASK_PRIO_OS_UDP_SOCKET.

6.2 Device connection protocol

This protocol is implemented using TCP/IP packets.

One listener thread with priority TASK_PRIO_SOCK is intended for accepting incoming connections.

Two Connection Server threads (with the same priority as above) are used for managing already established connections, thus only two PC's can be connected to a Serra device through this protocol.