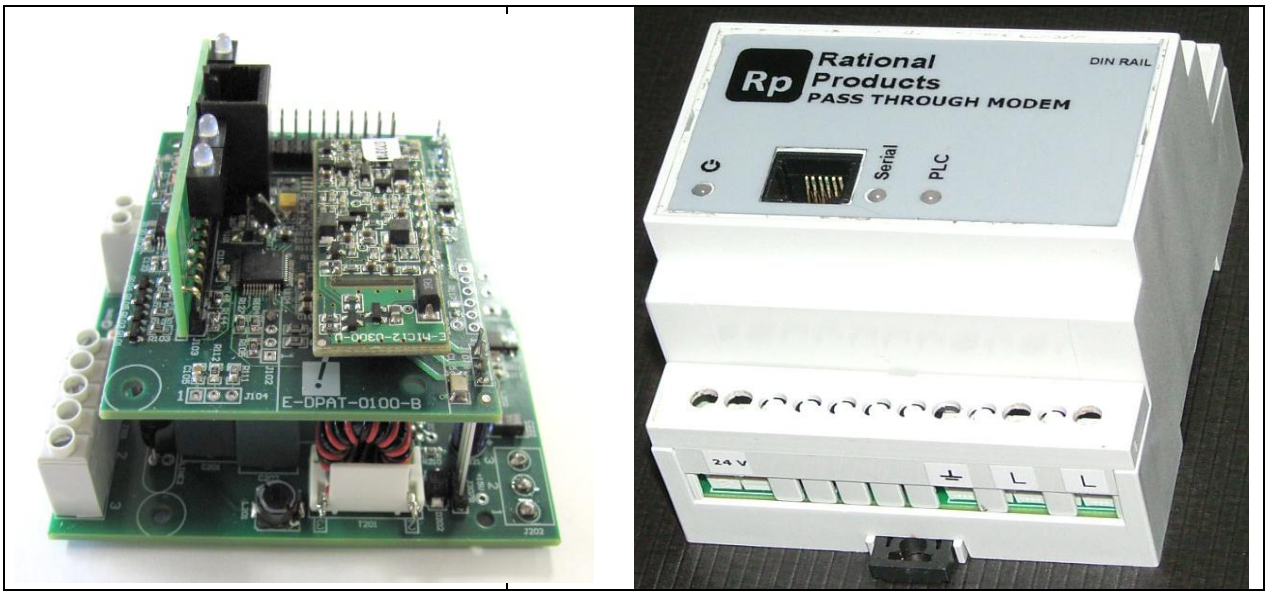
DIN Pass through Modem Unit (DPAT) User's Manual

UM-DPAT-3_1b41



Rational Products

Control Networking Solutions

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Chapter 1 Overview

1.1 Document

This document describes the PLC Modbus pass-through. It describes installation and operation of the device.

1.2 Product

The PLC Modbus pass-through (DPAT) is powered by a 24VAC power supply. It connects to a RJ-11, RS232 connector and to power line (380VAC). The product is a bridge between the serial port and the power line: messages received from the serial port are sent on power line and messages received from the power line are sent on the serial port.

In addition to manage multi-drop communication, the DPAT has a small user interface. It accepts a very limited set of Modbus commands and drives three LEDs.

1.3 System

The DPAT receive messages from a ModBus Master and sends the messages on the power line. When an answer is received, the DPAT forwards the answer to the Modbus Master.

The DPAT also forwards requests from the power line to the Modbus Slave on its serial port. The answer from the Modbus Slave is than retransmitted on the power line.

The figure below illustrates the physical communication system:

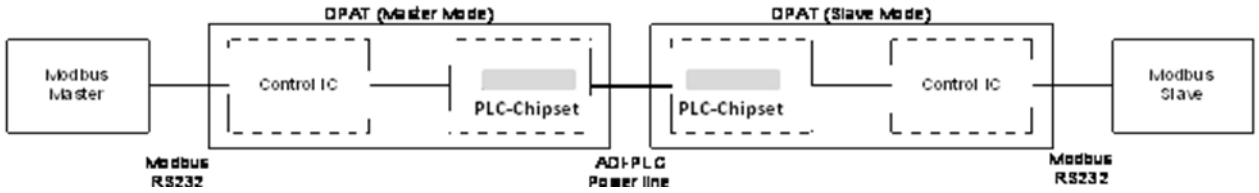


Figure 1 – Physical Interconnections

The figure below illustrates the logical communication system:

Figure 2 – Logical Interconnections

Chapter 2 Specifications

2.1 Electrical Specifications

Table 2-1: Electrical specifications

Parameter	Min.	Typ.	Max.	Units	Notes
Supply AC/DC Input Voltage	18Vac 24Vdc	24Vac 32Vdc	28Vac 40Vdc	V	For connection details, refer below
Supply AC/DC Input Power	1.1 2	1.2 2.5	1.3 4	W	Receiving mode Transmitting mode
Main AC Input Voltage	185	220 380	418	VAC	For connection details, refer below
Main AC Input Power	0	0.1		W	
AC Power Line Frequency	49.5 59.5	50 60	50.5 60.5	Hz	AC frequency must drift slowly as it is usually controlled by the main utility
PLC Signal Amplitude	4	6		Vpp	Power line impedance (Z) = 8 Ω
PLC Carrier Frequency		105.5 118.7		kHz	
Operating Temperature	-25	-	70	°C	
Storage Temperature	-40	-	85	°C	
Humidity Non-Condensing	10	-	95	%	
RS232C	-12	±8V	+12	V	As per RS232 Standard
RS485	-8V	-	+13	V	Absolute maximum rating conditions for extended periods of time may affect reliability

2.2 Mechanical Specifications

- **Length**: 2.8 inches;
- **Width:** 3.55 inches;
- **Height:** 2.3 inches (including DIN rail brackets);
- **Gross weight:** 0.11 kg / 0.242 lb

Chapter 3 System Operation

3.1 Modes of Operation

The DPAT operates in two modes: power line Master and power line Slave. In Master mode, the DPAT is responsible to get data from its serial port to the end-destination. To do so, the Master may try various communication routes or baud rate. In Slave mode, the DPAT gets messages from the power line and forwards the messages to the Modbus Slave. The slave manages answers from the Modbus slave, message duplicates and may route messages to other slaves.

By default, the DPAT is in power line slave mode. When a message is received on its serial port, the DPAT automatically switch in Master mode. It will revert to slave mode automatically if it gets an answer from a Modbus slave. It will also revert to slave mode if it does not reach the Modbus slave or does not receive a new request from the Modbus Master within 3 minutes.

3.2 Data Communication

To use the Data, you have to install the DPAT and configure your serial port with the following settings: 9600bps, 8 bits, no parity, 1 stop bit, no handshake. Then, any serial byte sent to the DPAT will be forwarded on power line.

The DPAT, in master mode, operates as follow:

- Bytes received from the serial port are concatenated together into a message until no byte is received for 10ms
    - If the message is longer than 61 bytes, the DPAT sends a data loss indication (0xFA 0x8F 0x06 0xB5 0xC3) and discards extra bytes.
- When a new message is ready, the DPAT sends and resends the message on the power line until an answer is received, a timeout occurs (3 minutes) or until the Modbus Master sends another message to the DPAT.
    - When an answer is received from the power line, the DPAT sends the answer to the Modbus Master and stops power line communication.
    - Upon timeout, the DPAT stops power line communication
    - If a new message is received from the Modbus Master before reception of the answer from the Modbus Slave, the DPAT reinitializes its transmission state machine and restarts power line communication
    - If a new message is received from the Modbus Master before the first transmission of the previous message on power line, the Modbus Master discards a message and a data loss indication is sent (0xFA 0x8F 0x06 0xB5 0xC3).

The DPAT, in slave mode operates as follow:

- When message is received from the power line, the slave forward the message on its serial port unless the message is routed or a duplicate.
    - The slave waits 660ms for an answer from the Modbus Slave. If an answer is received the answer is put into a temporary answer buffer and sent on power line
    - The slave waits 1minute for a possible answer from the Modbus Slave. If an answer is received during that minute, the answer is put into the temporary answer buffer, but not sent on power line
- When a duplicate is received from the power line, the slave discards the duplicate or sends the data in the temporary answer buffer if there is any data in the temporary answer buffer matching the duplicate identification.
- When a routed message is received from the power line, the slave discards the message unless the message needs to be routed by the slave. In that case, the DPAT-Slave forwards the massage.

3.3 Inputs/Outputs

The DPAT uses three Leds to operate. Power, Serial communication and power line communication afftect leds behaviour. All three leds are red and green bicolour.

*** Having both RED and GREEN led Lit will give a YELLOW LIGHT.**

POWER LED

OPERATION	RED	GREEN
BOOT UP	ON	ON
POWER	ON	OFF
MODBUS	0FF	ON
ERROR	FAST BLINK	OFF
MONITOR	OFF	SLOW BLINK

Serial Communication LED

OPERATION	RED	GREEN
BOOT UP	ON	ON
TX	ON	OFF
RX	0FF	ON
ERROR	OFF	OFF

Power Line Communication LED

OPERATION	RED	GREEN
BOOT UP	ON	ON
TX	ON	OFF
RX	0FF	ON
ERROR	OFF	FAST BLINK

3.4 Local Requests to DPAT

The DPAT supports local queries (valid Modbus messages with addresses value up to 0xFA).

FUNCTION CODE	DESCRIPTION	ANSWER	Description
0x14	Send data to ADE8155	According to data from ADE8155	TX >> FA 14 43 1F RX << FA 94 04 3E F2 (No data sent!) (No response from ADE8155)
0x15	Get firmware version	Major, Minor, 6-bytes built #	TX >> FA 15 82 DF RX << FA 15 30 31 00 00 00 00 00 35 Version : 3.1 Build
0x16	Get Signal Quality	3 bytes Baud Rate, Signal Strength, Signal Correlation	TX >> FA 16 C2 DE RX << FA 16 00 00 00 F8 5C BaudRate : 00 = 50bps 04 = 800bps Signal Str : 00 -> 0xFF dBuV Correlation : 00 = 100% 0xFF = 0%
0x17	Reset Modem	No Answer	TX >> FA 17 03 1E

FUNCTION CODE	DESCRIPTION	ANSWER	Description
0x18	Monitor Mode	All data received on PowerLine	Send no data to activate the monitor: TX >> FA 18 43 1A RX << FA 98 05 FA 32 Send 0x00 to desactivate the monitor: TX >> FA 18 00 5B F1 RX << FA 98 05 FA 32
0x19	RCT Mode(RCT) Timeout Send Packet on PL at all speed	Send ACK	Send the following string to activate the RCT TX >> FA 19 82 DA RX << FA 99 05 FB A2 Send 0x00 as data to stop the RCT TX >> FA 19 82 DA RX << FA 99 05 FB A2

FUNCTION CODE	DESCRIPTION	ANSWER	Description
0x1A	Maximum BaudRate	Send ACK	Set baud rate with one of these value : (50Hz or 60Hz Power Line) 0x00 : 50bps/60bps: TX >> FA 1A 00 5A 91 RX << FA 9A 05 FB 52 0x01 : 100 bps/120bps: TX >> FA 1A 01 9B 51 RX << FA 9A 05 FB 52 0x02 : 200 bps/240bps: TX >> FA 1A 02 DB 50 RX << FA 9A 05 FB 52 0x03 : 400 bps/480bps: TX >> FA 1A 03 1A 90 RX << FA 9A 05 FB 52 0x04 : 800 bps/960bps: TX >> FA 1A 04 5B 52 RX << FA 9A 05 FB 52

3.5 Error Code Returned by the DPAT

ERROR CODES	DESCRIPTION	ANSWER
Data Lost indication	When the system is unable to send data on power line	0xFA, 0x8F, 0x06, 0xB5, 0xC3

Chapter 4 DPAT Connection

4.1 Main Input connector (J201):

This connector is used to send and receive communication signal. It should be connected close to the main cable to maximize the quality of the power line communication.

This connector is also used to provide the communication synchronization to the unit. The RHINO technology needs a line synchronization to communicate on the power line. It is important to guarantee a stable input frequency to maximize the PLC performance.

Table 4-1: J8 pin description

Pin Number	Name	Description	Note
1	EARTH	EARTH of the input main	Connect the earth to the low voltage GROUND to improve security.
2	LINE 1	LINE of the main	Must be connected to power line network
3	NEUTRAL/LINE 2	NEUTRAL/LINE of the main	Must be connected to power line network

4.1.1 Serial Connectors (RS232 and RS485)

The DPAT features serial connectors: a DB9 connector for the RS-232 interface and a 3-terminal connector for the RS-485

4.1.1.1 RS-232 Connector RJ-11 (J4)

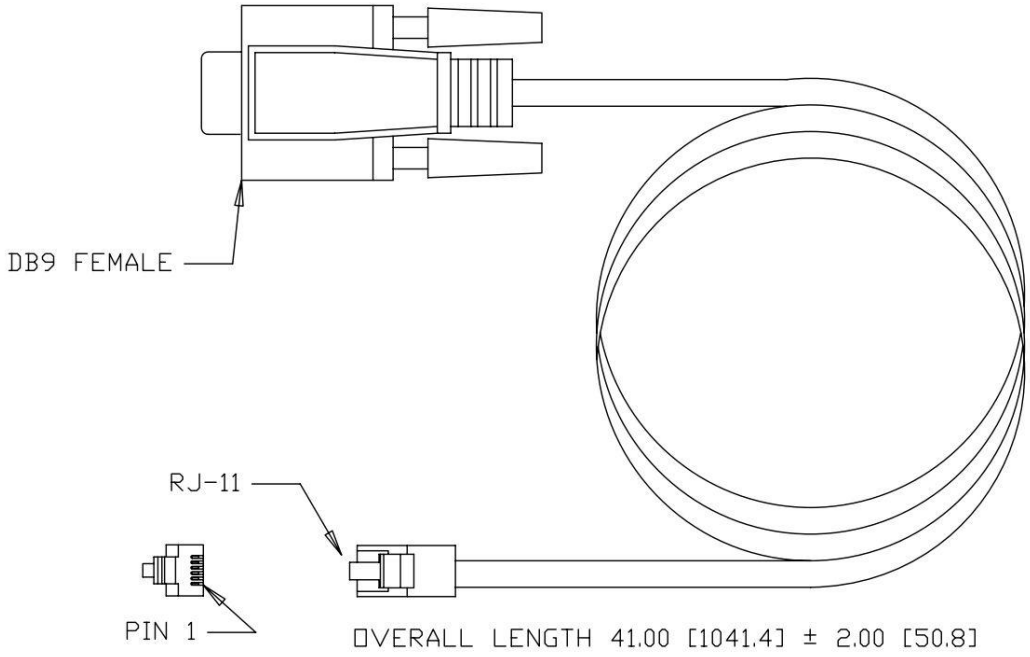
A RJ-11 connector is used for RS-232 serial communication between a host and the DPAT.

Table 4-2: RS-232 connector pin description

Pin Number	Signal Name	Description	Direction
5	GND	Reference Ground	NA
2	TX	Transmit data.	Output for DPAT
3	RX	Receive data.	Input for DPAT

Figure 4-1: RJ-11 to DB9 Cable Specification

RJ-11	DB9
1	7
2	2
3	3
4	4
5	5
6	6



4.1.1.2 RS-485/RS-422 Connector (J204)

A connector with three connection terminals is used for the RS-485 interface between a host and the DPAT.

Communication is half-duplex.

Table 4-3: RS-485 connector pin description

Pin Number	Signal Name	Description
1	A+	Data Receive/Transmit (+)
2	B-	Data Receive/Transmit (-)
3	GND	Signal ground

4.1.2 DIN Rail Clips

Two DIN rail clips are located on the back side of the DPAT. They can be used to hook up the DPAT on a DIN rail.

Appendix A, Power Line Communication

Power Line Communication Protocol

Physical and data link layer of the ADI chipset as been used for Power line transmission:

Datalink Layer

- Up to 63 byte packet support
- Automatic Baud Rate Negotiation (800bps to 50bps) per phase

Physical Layer

- CPFSK modulation :
    - CENELEC B Carrier Frequencies : 105.5kHh and 118.7kHz
    - Line synchronized receive/transmit

**** Please refer to the IC datasheet for details:***

Pass Through vs Modbus Protocol

The DPAT-slave acquires a new address when a valid Modbus primitive is received from the Modbus device connected on its serial port. The DPAT-master and the DPAT-slave-router update their routing tables when a valid Modbus primitive is received as an answer from the power line.

Power Line Network protocol

Master vs Slave Communication

When a new message from the Modbus master is sent on power line, the power line master tries to reach the target by the last successful communication route. It tries at maximum baud rate first. If this fails, the minimum baud rate is tried. Then, the power line master tries new route to reach the target (determined by the Modbus address) until the target answers or until a new message is received from the Modbus Master or until 60 seconds are elapsed.

The system must behave as a pass through system. When the Modbus master sends a single message, the Modbus slave must receive a single message and nothing else. When the master tries different paths to reach a target, another power line slave may hear the same message several times. The default behaviour of the power line slave is to send messages from the power line to their serial port. However, retries on power line must not be sent more than one time on the serial port.

To avoid duplication of serial packets to the Modbus slave upon power line communication retries, the Master attributes a new message ID on every requests made by Modbus Master unit. If a power line slave receives the same message ID twice, the second message is discarded.

Slave vs Slave Communication

When the power line master cannot reach a power line slave, it asks a power line slave to reach the target device. In that case, the power line slave routes the message toward the destination and routes the Modbus response from the destination toward the power line master.

When a slave receives a request to route a message, the slave sends a receipt ack and parses the request. The routing request is encapsulated in the power line protocol with few parameters:

- Router address
- Destination address
- Route count
- Max route count

The router determines which slave is going to route the message toward the destination. The route count is used to associate routed request with routed answer. It is incremented toward the destination and decremented from the destination to the master. Finally, the max route count is the maximum number of router that can be used by the slave/router to reach the target.

With this information, the slave computes a route towards the target or sends the Modbus packet to the destination directly. The slave uses the same algorithm as the power line master to determine the next router. When the message is routed again, the Slave issues a routing request and decrement the max route count for that request.

Upon reception of a response, a router updates its routing information. After that, it forwards the response toward the power line master after decrementation of the route count.