PUMALAN PROTOCOL

Technical Specification

70RPLANBSEN.E02

E02 dated 25/02/98

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Changes of the present Edition 02

LOGITRON S.r.l. logos has been added
A reference table about <cp> byte of ending dispense message has been added in **Section 11.6**
Head error list has been updated in section **Section 13.2**

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1. GLOSSARY

Characters used in LAN Protocol messages:

IG Group Identifier: character specifying devices type to which the message is sent ('0' for heads).

<ad> address device: character indicating device number to which the message is sent (30h to 4Fh for pump number 1 to 32).

STX Start TeXt: character indicating transmit data start message (02h ASCII value).

<nmsg> number message: character indicating the sequence of messages

ETX End TeXt: character indicating transmit data end message (03h ASCII value).

<bcc> message checksum obtained with the exclusive OR of all characters except EOT.

ENQ inquiry character: it asks last transmitted answer to Slave (05h ASCII value).

ACK positive message acknowledgment (06h ASCII value).

NAK negative message acknowledgment (15h ASCII value).

ESC message linkage character (1Bh ASCII value).

2. INTERFACE PHISICAL LAYER

PUMALAN is a communication local network (Local Area Network) that connects device members of PUMA series one to each other.

A network controller monitors stations connections to network avoiding conflicts occurring. This device is called "Master".

The only available transmissions are from Master to connected Slave and from connected Slave to Master; it is not possible a direct communication between Slaves.

Transmit settings values are:

Interface	Asynchronous Serial Interface(start/stop);
Baud Rate	4800 Baud;
Data Length	7 Data Bits (ASCII);
Parity	Odd;
Stop Bit	1 Stop Bit;

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Line inverse current-loop a 15-20 mA
mark = logic 1 = no current
space = logic 0 = current
Cable 3-Wire screened cable;

Point-to-Point as well Multi-point connections are available. Multi-Point connections depends on Master output transistor sink capability. However, some mechanical pumps controller are capable of additional connections thank to a local network amplifier. See Multi-Point connection in Figure 1.

Each network Slave device has a unique identifying address. The address consists of 5 bit binary digits. A maximum of 31 devices may be addressed (and so connected to a Master). Each group of devices has a code used to allow multiple network connections. The following description concerns only of PUMA series heads group '0'.

3. MESSAGES LAYER

Transmission from Master to Slave and from Slave to Master consists of messages. Master to Slave message format is:

[EOT][IG][<ad>][STX][<nmsg>][<mess>][ETX][<bcc>]

where:

EOT 04h code;
IG Group Identifier;
<ad> device address 30h to 4Fh (device number 1 to 32);
STX 02h code;
<nmsg> message number cyclically increased form 31h to 39h (for an explanation see in the following pages);
<mess> data message (ASCII codes, different from EOT, ETX, STX and ENQ, only);
ETX 03h code;
<bcc> 7 data bits exclusive OR (bit per bit) from IG character to ETX character included;

There are two types of Master to Slave messages: polling messages and selecting messages. Polling messages require transmission of an answer message from the Slave. Selecting messages require only one acknowledgment character of answer.
When a polling message is received correctly, the Slave answers to it with the following message:

[STX][<nmsg>][<answer mess>][ETX][<bcc>]

where:

STX 02h code;
<nmsg> message number cyclically increased form 31h to 39h;
<answer mess> data message;
ETX 03h code;

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<bcc> 7 data bits exclusive OR (bit per bit) from IG character to ETX character included.

If the answering message is correct, master interrupts communication sending ACK code (06h); otherwise, if the answering message is wrong, it sends NAK code (15h) and the answer is transmitted again.

Slave answers only with ACK code to a selecting message. Slave is able to send a multiple answer to a polling message. In this case the body of answering message is made of bodies of messages linked by ESC character (1Bh). Up to 5 messages may be linked together (sequentially).

[STX][<nmsg>][<mess1>][ESC][<mess2>]...[ESC][<messn>][ETX][<bcc>]

3.1 Polling and Selecting Sequences and "Error Recovery"

LAN Master sends polling and selecting messages cyclically to the connected Slaves. Messages are numbered to avoid duplication or loss of messages in case of wrong transmission. Each Slave has got two different counters. The first one counts the number of received messages, the second one counts the number of transmitted messages.

Master copies message counters data for all Slaves. Thank to proper increase rules, the Master and the Slaves agree on message counters number and the Master is able to clear counters sending a message with number '0' to the station.

In a correct polling sequence, the Master starts the transmission sending a polling message; the slave answers to it with the proper answer message and then the Master sends ACK character to end the sequence.

Master [EOT][IG][<ad>][STX][<nmsgr>][<polling msg>][ETX][<bcc>]

Slave [STX][<nmsgt>][<answer msg>][ETX][<bcc>]

Master [ACK]

If the message received by the Slave is correct, the Slaves updates <nmsgr> and if the answer to the polling message is ACK, it increases <nmsgt>. Master updates <nmsgr> and increases <nmsgt> if the answer message is correct.

In the same way, the Master starts a selecting sequence sending the right message and the Slaves sends ACK character to end the sequence.

Master [EOT][IG][<ad>][STX][<nmsgr>][<selcting mess>][ETX][<bcc>]

Slave [ACK]

The Slave updates <nmsgr> if the message received is correct and the Master increases <nmsgr> if ACK is received.

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When occurring network errors, Slave acts with the following recovery operations:

3.2 Parity Error in Address Device or before Address Device Character

Message is ignored and the Slave sends no answer:

Master [EOT][IG][noise...]

Slave [no answer]

3.3 Parity Error after Address Device Character and/or Checksum Error

The Slaves, that recognizes the address, sends a NAK message as answer. Messages counters are not increased and the Slave does anything else:

Master [EOT][IG][<ad>][STX][<nmsgr>][<mess>][ETX][<bcc>]

Slave [NAK]

3.4 Master sends a NAK to an answer message

The messages is transmitted again with the same message number; next actions depend on the new Master answer. If Master sends ACK, the transmission counter is increased, otherwise a recovery action is done as in the first transmission of answer message:

Master [EOT][IG][<ad>][STX][<nmsgr>][<polling mess>][ETX][<bcc>]

Slave [STX][<nmsgt>][noise...][ETX][<bcc>]

Master [NAK]

Slave [STX][<nmsgt>][<answer msg>][ETX][<bcc>]

Master [ACK]

3.5 Master doesn't send any Acknowledgement Message

Master doesn't send any Acknowledgement Message to an answer message or sends a character different from ACK or NAK character and/or with parity error. The transmission counter is not increased and the Slave waits until next polling message to repeat the transmission.

Master [EOT][IG][<ad>][STX][<nmsgr>][<polling mess>][ETX][<bcc>]

Slave [STX][<nmsgt>][<answer mess>][ETX][<bcc>]

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Master [no answer]

3.6 Message has been Interrupted (received a new EOT character)

If the message has been interrupted and a new selecting or polling message is received by the Slave, the Slave stops message reception and clears reception buffer. The new message is correctly read:

Master [EOT][IG][<ad>][STX][<nmsgr>][...

Master [EOT][IG][<ad>][STX][<nmsgr>][<selecting mess>][ETX][<bcc>]

Slave [ACK]

3.7 Same Message Number of preceding Message

If a selecting message has the same number of the preceding message is discarded ; nevertheless an ACK code is sent.

Master [EOT][IG][<ad>][STX][<nmsgr>][<selecting mess>][ETX][<bcc>]

Slave [ACK]

Master [EOT][IG][<ad>][STX][<nmsgr>][<selecting mess>][ETX][<bcc>]

Slave [ACK]

In case of a polling message any internal action is done, however the right answer message is sent and if Master answers ACK the transmission counter is increased.

Master [EOT][IG][<ad>][STX][<nmsgr>][<selecting mess>][ETX][<bcc>]

Slave [STX][<nmsgt>][<answer mess>][ETX][<bcc>]

Master [EOT][IG][<ad>][STX][<nmsgr>][<selecting mess>][ETX][<bcc>]

Slave [STX][<nmsgt>][<answer mess>][ETX][<bcc>]

Master [ACK]

If Master doesn't answer ACK, the same actions of wrong answer to answer message are applied. Usually it happens when Master doesn't understand Slave answer .

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3.8 Slave answers NAK to a message

Master attempts to transmit again the message with the same message number until ACK is received. Note that between these attempts (or group of attempts), Master must communicate also with the other heads to avoid polling time-out.

```
Master [EOT][IG][<ad>][STX][<nmsgr>][<mess>][ETX][<bcc>]
                Slave [NAK]
Master [EOT][IG][<ad>][STX][<nmsgr>][<mess>][ETX][<bcc>]
                Slave [ACK]
```

3.9 Slave doesn't send any Answer

Master attempts to transmit again the message with the same message number, but, after few attempts, Master sets head absent, and then skips to the other heads and sends the message to the one with greater period (if possible with a different message).

```
Master [EOT][IG][STX][<nmsgr>][<mess>][ETX][<bcc>]
            Slave [no answer]
Master [EOT][IG][STX][<nmsgr>][<mess>][ETX][<bcc>]
            Slave [no answer]
```

Now Master polls the other Slaves.

```
Master [EOT][IG][STX][<nmsgr>][<mess>][ETX][<bcc>]
            Slave [ACK]
```

This happens during polling to absent Slaves. During polling to present Slaves, Master attempts five times. If the Slave doesn't answer Master set it absent, and then skip to another Slave.

3.10 Other general remarks

Master sends ENQ code if the expected ACK or NAK code is not received, that is after the selecting message; in this case Slaves transmits again ACK or NAK code.

If the ENQ code is received in anomalous situations the slave does not transmit any answer.

Master is able to initialize Slave message counters sending a message with the number '0' (30h). Slave sets both counters to '1' (31h).

If the message with number '0' is a polling message, in the answer message there will be a number '1'; otherwise the first answer message transmitted by the Slave after a polling will have

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number '1'. In any case, next received message will have number '1'. Message numbers are increased, as said before, up to '9' (39h), then they will start again from '1' (31h) and so on.

Slave, too, is able to set message number to '0' transmitting an answer with a '0' number, however this has a special meaning in PumaLan Protocol. In fact, it means that Slave devices lost data during a power down.

Finally, Slaves work with a time-out logic based on polling messages to know if a communication has been stopped and activate an error condition if a wrong message number was sent.

To correct these errors special recovery procedures are activated: in fact these errors require the action of a superior logic controller and are not recoverable at protocol layer.

4. HEAD MANAGEMENT

4.1 Standard Command Set

PumaLan Network can be connected to two types of head:

1) monoproduct head (standard set);
2) multiproduct head / mixer (extended set);

A new set of messages has been added to the standard set to manage the second type of head. The Protocol, complete of all messages, is called "extended set". At the moment, monoproduct heads use the standard set and give no answer to any "extended" message.

Master detects the type set used by the head through a special identifier in the status message. Heads using extended set, inform the master by answering to a special identification request. Head sends information about head type and dispensed product. However, a head is allowed to use "extended set" even if it has not a product code.

Product code are:

30h - not specified product;
31h - super;
32h - regular;
33h - diesel;
34h - super unleaded;
35h - G.P.L.;
36h – regular unleaded;
37h - oil;
38h – mixer correction factor (DCBA);

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4.2 Delivery Monitoring

Heads operate in two different modes: automatic and manual. The automatic mode is commonly used when head is connected to PUMALAN Network; manual mode is usually selected in emergencies to allow the use of heads also when network is not working.

In automatic mode, fuel delivery is not directly executed by the head, but follows a master authorisation to deliver.

After the polling, a message of fuel delivery is transmitted as authorization request.

During a delivery request, multiproduct heads send also information about product code and all delivering products types.

LAN Master enables a head to deliver fuel sending a credit message. A credit message consist of this information:

a) *dispense mode*: delivery is authorized by a cash pre-paid device or by other devices (i.e., pre-pay). In the first case, head delivers the exact amount or volume transmitted, and so it will ignore preset key or other local functions that control deliveries. If the device is not able to produce a transfer ticket, delivery will go on until credit depletion, even if the nozzle is inserted again or if non-fatal errors occur during delivery. In the second case, the amount or volume transmitted will be an upper limit to delivery and all deliveries monitoring functions will be active.

b) *amount or volume to deliver*: generally only one value is needed, but if both are present (different from zero) amount is used, because it gives a more exact delivery. Amount is transmitted with four digits, where the most significant one is always zero and the other three are the most significant digits in the display (assuming that display has always six amount digits). In Italy, the amount on the display is without decimal digits and the amount transmitted is in £x1000. In Great Britain, for example, the amount on the display is in Pounds with two decimal digits and so the amount transmitted is in £x10. In Belgium, the amount on the display is in Francs with one decimal digit and the amount transmitted is in Frx100. Volume is measured in 1/10 unit, independently to the head visualization method. For example, if 0100 is transmitted, 10 liters of fuel will be delivered. In the case that amount and volume values transmitted are both zero, credit is null and head doesn't deliver fuel at all.

c) *delivery unit price*: unit price consists of the four digits of the head display. Remember that the transmission of the unit price value depends on currency and that is possible that unit price is shown in a currency different from the amount unit. In Great Britain, for example, amount is in Pounds with two decimal digits, but the unit price is in Penny with one decimal digit. If 0165 is transmitted, head delivers fuel with 16.5 penny unit price.

d) *able to transmit product code*: product code transmission is used for heads that do not have this information (MPD) and so these heads use the product code received in this message in next transmissions. The other heads ignores this datum (and transmit it again in the end delivery message). When delivery is finished, head transmit an end delivery message with delivery data information. Message format is described next.

It was said that in the credit message, amount and volume can be null.

The "null credit" message is usually used by Master to deny delivery authorization. In this case, head doesn't send the end delivery message when the gun is inserted again, however data (i.e., unit price, etc.) are correctly processed by head as happen in case of no null credit.

A network fatal error (polling time-out or wrong message number) occurs when head is waiting for credit. The same happens when power goes down during the waiting for credit.

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The following will occur, if power goes down during delivery or before head transmits the end delivery message:

a) if at startup the head was set to automatic mode, it transmits the end delivery message, that was stored in a special non-volatile memory:

b) if at startup the head was set to manual mode, the end delivery message will be sent the first time head is set in automatic mode.

The same happens for some head versions if a fatal error occurs before the transmission of end delivery message and when head is in manual mode: end delivery message will be transmitted as soon as head is set in automatic mode again.

Manual mode is an emergency operating mode; in this mode head goes on transmitting end delivery data ad pump status, but delivery commands and waiting are ignored.

In particular, manual end delivery data may be lost if a polling isn't sent before next delivery.

Furthermore, if head is in automatic mode Master is able to stop delivery with a special command.

4.3 Unit Price Management (monoproduct)

Head unit price may be changed with a proper serial network message. Note that the change is permanent and so should be used to change price list and not for temporary customer cash discounts.

At startup the automatic unit price is equal to manual unit price (that usually is the official product unit price). Then Master is able to change unit price in different manners.

If a unit price message is sent, the automatic unit price can be changed: standard command change let unit price be set again to manual unit price even if you don't know it. Note that the automatic unit price is lost at power down, and at startup is set to manual unit price again.

Master detects power down and restores automatic head unit price, if necessary.

Format description for the unit price field will agree with the following example of 1535 liras:

Format [UP+][UP][UP][UP-]	Transmission [31h][35h][33h][35h]
Format [UP-][UP][UP][UP+]	Transmission [35h][33h][35h][31h]

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5. MESSAGGES FROM MASTER TO HEAD

5.1 General Format

The general message format used from master to pump is:

[EOT][IG][<ad>][STX][<nmsg>][<mess>][ETX][<bcc>]

where:

EOT	04h code;
IG	Identifier Group '0' = heads;
<ad>	address device 30h to 4Fh;

<nmsg>	number message: Master increases cyclically this number from 31h to 39h for every correct answer to the message;
STX	02h code
<mess>	data message;
ETX	03h code;
<bcc>	message checksum;

Message checksum is calculated as sum module 2, i.e. OR exclusive bit to bit of 7 bits codes from IG to ETX included.

5.2 Polling messages and special requests

Slave answers to all the following messages with a transmission (see polling answers or special requests) or with NAK code if the Slave detects a transmission error.

5.2.1 General Polling

Master sends a polling message to the head to detect its presence and to ask for some data (i.e. status changes, delivery request, end delivery data, etc.).

Message transmission rate has to be fast enough to avoid the new message timeout of the head. An E80/P80 error appears in the main display if a serial network timeout occurs.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['P'][ETX][<bcc>]

where 'P' identifies a general polling message.

5.2.2 Status request

The status request message is sent when the master needs to know head operating status. However, it is better to use this message only if really necessary. For normal communication with the head use polling message instead.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['S'][<cp>][ETX][<bcc>]

where 'S' identifies a status request message and <cp> is the product code assigned to the head (if not used, is 30h).

5.3 Selecting messages

Slave answers to these messages only with ACK or NAK (depending on right or wrong checksum) and activates the assigned action. If <nmsg> shows that a message has been repeated Slave sends the correct answer (ACK or NAK), but it does nothing.

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5.3.1 Credit sending message

Credit sending message contains agreement delivery data for the head (maximum delivery amount and/or maximum delivery volume, unit price, etc.)

If both delivery amount and delivery volume are null values, delivery is denied, on the other hand if both are present (different from zero) amount is used, because it gives a more exact delivery.

If the unit price transmitted is zero ('0000'), the delivery unit price is the same of the preceding automatic unit price.

Only if the head was waiting for delivery data, the message is detected, otherwise it is ignored.
The message has got the following format:

```
[EOT][IG][<ad>][STX][<nmsg>]['E'][<nu>][<importo>][<prezzo>][<volume>]
                         [<cp>][<opz>][ETX][<bcc>]
```

where:

<nu> not used (send 30h);
<amount> delivery amount 4 ASCII digits with this format: L+ L L L-, where the first digit (L+) is always 0 and the others have the weight of 100k, 10k and 1k;
<price> delivery unit price (4 ASCII digits with this format: UP+ UP UP UP-);
<volume> delivery volume (4 ASCII digits with this format: V+ V V V-, with the weight of hundreds, tenths, units and decimals of a liter);
<cp> product code (in the extended protocol is ignored);
<opz> delivery options:
0 bit: if 1 prepaid: ignore preset, stop at round figure, 6 minutes timer;
1 bit: considered only if 0 bit=1; if 0, save credit if less than 4/10 liter was delivered;
if 0 bit=1, save credit till the credit is finished;
3 bit/5bit: always 0 (not used);
6 bit: always 1;

In manual mode the command is ignored..

5.3.2 Stop delivery

This message is used by Master to stop delivery at any moment if the system is in automatic mode (in manual mode the message is ignored). The message has got the following format:

```
[EOT][IG][<ad>][STX][<nmsg>]['T'][ETX][<bcc>]
```

where 'T' identifies the message.

5.3.3 Lamp 1 on

This message turns on lamp 1 (red). The message has got the following format:

```
[EOT][IG][<ad>][STX][<nmsg>]['L'][ETX][<bcc>]
```

where 'L' identifies the message.

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5.3.4 Lamp 2 on

This message turns on lamp 1 (green). The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['A'][ETX][<bcc>]

where 'A' identifies the message.

5.3.5 Lamp 1 off

This message turns off lamp 1 (red). The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['D'][ETX][<bcc>]

where 'D' identifies the message.

5.3.6 Lamp 2 off

This message turns on lamp 1 (green). Message format is:

[EOT][IG][<ad>][STX][<nmsg>]['B'][ETX][<bcc>]

where 'B' identifies the message.

5.3.7 Unit price sending (monoproduct)

Unit price sending message consists of the unit price value that head will have in next automatic deliveries. If unit price transmitted is "0000" head uses manual unit price.

This message is good only if head is in automatic mode and no delivery is on.

When this message is received, in the main display the new unit price will appear. The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['U'][<unit price>][ETX][<bcc>]

where 'U' identifies the message, <unit price> is a field of 4 ASCII digits in format:

[UP+][UP][UP][UP-]

6. MESSAGES FROM HEAD TO MASTER

6.1 General format

Transmission message format from head to master is:

[STX][<nmsg>][<message>][ETX][<bcc>]

where:

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STX 02h ASCII code;
<nmsg> number message (increased every time Master answers ACK). It is increased cyclically from 31h to 39h.
ETX 03h ASCII code;
<bcc> sum module 2 (exclusive OR bit to bit) of 7 bits code from STX to ETX included.

6.1.1 "Nothing to say" answer

When head doesn't need to communicate anything to Master, it answers with a "nothing to say" message. The message has got the following format:

[STX][<nmsg>]['C'][<ad>][ETX][<bcc>]

where 'C' identifies the message.

6.1.2 Delivery request (monoproduct)

When the nozzle is correctly picked up, the head answers to the Master polling message with a delivery request message. This means that head is ready to receive a credit message that authorizes delivery (only in automatic mode). The message has got the following format:

[STX][<nmsg>]['A'][<ad>][ETX][<bcc>]

where 'A' identifies the message.
In manual mode head doesn't send any request.

6.1.3 End delivery in manual mode

In manual mode when a delivery is finished the head sends to the Master delivery data. The message has got the following format:

[STX][<nmsg>]['M'][<ad>][<volume>][<amount>][<price>][<cp>][ETX][<bcc>]

where 'M' identifies the message. The other fields have got the following meanings:

<ad> head address;
<volume> delivered volume in 1/100 of volume unit with format:
[V-][V][V][V][V+]
<amount> delivered amount (the 6 digits in the display) with format:
[I-][I][I][I][I][I+]
<price> unit price (the 4 digits in the display) with format:
[UP-][UP][UP][UP+]
<cp> delivered product code;

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6.1.4 End delivery in automatic mode

In automatic mode when a delivery is finished the head sends to Master delivery data. The message has got the following format:

[STX][<nmsg>]['F'][<ad>][<volume>][<amount>][<price>][<cp>][ETX][<bcc>]

where 'F' identifies the. The other fields mean:

<ad> head address;

<volume> delivered volume in 1/100 of volume unit with the format:
[V-][V][V][V][V+]

<amount> delivered amount (the 6 digits in the display) with the format:
[I-][I][I][I][I][I+]

<price> unit price (the 4 digits in the display) in format:
[UP-][UP][UP][UP+]

<cp> delivered product code. This product code depends upon bit 0 of <opz> character of credit sending message. (bit 4 of <cp> character has got the same value of bit 0 of <opz> character).

6.1.5 Pump status

Pump status message is sent back as answer to a specific master request or to a polling answer, in the following cases:

a) at the first message on head startup;
b) every time the system changes from automatic mode to manual mode and vice versa;
c) every time the head goes into an error condition or goes out of an error condition;

The message has got the following format:

[STX][<nmsg>]['S'][<pk>][<ad>][<stat>][<modf>][<error>][<price>][ETX][<bcc>]

where 'S' identifies the message. The other fields are:

<ad> head address;

<pk> identifies protocol Type:"

1 = Standard head.
2 = Head with extended protocol (MPD).
3 = HT head with extended LAN protocol.
.4 = HT head with extended LAN protocol, counts and totals data control.

<stat> 'F' head in automatic mode, 'G' head in manual mode;

<modf> bit meanings:
bit 0: set to 1 if the gun is virtually picked up;
bit 1: set to 1 if a delivery is occurring and the System is set to automatic mode;
bit 2: lamp 1 on;

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bit 3: lamp 2 on;
bit 4: pump in automatic mode;
bit 5: pump in error condition;
bit 6: always 1;

<error> error code with format [E+][E-] ('00' no error);
<price> unit price with format [UP+][UP][UP][UP-];

7. PUMALAN PROTOCOL TIMERS

7.1 Single character timer

When head is receiving a polling or a selecting message, a 30 ms time-out is active starting from [EOT] till <bcc> character. Timer is initialized every time a character has been received.
If a time-out occurs, communication is interrupted and head waits for next Master message.

A single character time-out of 30 ms is active also when head is sending a polling answer (ACK waiting) to Master. Time-out starts when last character is sent to Master. If a time-out occurs, head act as if ACK has not been received, and so saves the message for next polling and doesn't increase transmission message number.

7.2 Next message timer

In automatic mode, a waiting message timer of 5 seconds is active starting when the last message with its own device address is received. Timer is initialized every time a message with device address is received. If a time-out occurs head goes into E80/P80 error and delivery in automatic mode is stopped.

7.3 Reception-transmission delay

Master waits a delay time of 1 ms up to 30 ms; delay time is the interval between the time when head has finished to receive Master message and the time when head starts to send the answer message.
When delay time is passed, Master considers that head didn't understand the message and acts consequently.

7.4 Polling delay

Master should wait at least 10 ms after the time when a transmission to head is finished before sending a new message transmission, to avoid conflicts during transmission (for example, for a polling message 10 ms after ACK has been transmitted).

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8. INITIALIZING DIALOGUE

Message number '0' (30h) is a special message number condition both for head and for Master.

When head receives message number '0' (30h) from Master, it cancels P20 error condition (received message with a non consecutive message number) and initializes its transmission message number to '1' (31h)

So Master is able to initialize head also if last transmission message number has been lost (i.e., at startup) or Master can cancel P20 error condition without turning off the head.

When Master receives a head message number '0' (30h) sets to '1' (31h) transmission message number, so that head message number is initialized again.

Note that head sends a '0' message number only if all its previous data (suspended deliveries, etc.) have been lost.

If a delivery was in progress, end delivery will never be received and Master would cancel the transaction.

Similarly head sends P33 error code (lost stored data acknowledgment at startup) in the status message, because head wasn't able to send '0' message number due to Master initialization. P33 error code remains until Master has surely received it, then it disappears automatically.

9. LAN PROTOCOL EXTENSION

9.1 Update purpose

Software update purpose is to develop new LAN protocol functions that allow:

- MULTIDISPENSER and MIXER heads management;
- remote service: information management as internal scheduling, hardware status, versions, etc.;
- a new head operating mode that enables remote delivery management (German cash);

9.2 Update description

The new added functions do not alter LAN protocol structure. Only new compatible messages have been added in standard format.

There are three groups of new messages accordingly to their functions:

for MPD and MIX heads control:

- credit data request message (head → master)
- identification device answer message (head →master)
- credit data sending message (master → head)
- identification device request message (master → head)

for remote control:

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- parameters sending message (head → master)
- software version sending message (head → master)
- test result sending message (head → master)
- programming parameter sending message (master → head)
- programming parameter writing message (master → head)
- software device version request message (master → head)
- device internal test request message (master → head)

for new cash management operating mode:

- remote delivery enabling message

9.3 Extended mode head management

Unlike standard mode, extended mode head management is able to use special pump options (multiproduct, mixer). For example, it is possible to have a complete unit price management for multiproduct heads.

9.4 Unit price management (multiproduct)

In multiproduct head there are three unit prices:

- "credit" manual unit price
- "cash" manual unit price
- automatic unit price

In manual mode, "credit" and "cash" manual unit price are used. These head unit prices may be changed with a proper serial network message. Note that the change is permanent and so should be used to change price list and not for temporary customer cash discounts.

At startup the automatic unit price is equal to manual unit price (that usually is the official product unit price). Then Master is able to change unit price in different manners.

A special message is used to change automatic unit price. Standard version lets automatic unit price be set again to manual unit price ("credit" or "cash") even if it is unknown. This feature and the ability of reading unit prices let Master to manage discounts without saving local prices.

For example, if only two discounts types are managed, it is possible to tell the head to use "credit" unit price (full) or "cash" unit price (discounted) depending on customer. In more complex discounts management, it is possible to tell the head to send list unit price and then to send the discounted unit price, which is derived from a mathematical formula. It is easy to manage these features because if unit price sending credit message is zero ('0000'), corrent unit price is used.

Note that automatic unit prices are lost at power down, and at startup are set to manual "credit" unit price again. Master detects power down and restores automatic head unit price, if necessary.

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10. MASTER TO HEAD MESSAGES

10.1 General format

For general format see Section 5.1.

10.2 Polling messages

To all polling messages Slave answers sending a message or NAK code.

10.2.1 Identification request

With this message Master asks the head to send delivering product map identification.
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['I'][ETX][<bcc>]

where 'I' identifies the message.

10.2.2 Totals request (MPD)

With this message Master asks the head total amounts (of all side) and total volume (for each product).
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['V'][<cp>][ETX][<bcc>]

where:
'V' identifies the message
<cp> is total product code requested.

10.2.3 Counts data request (MPD)

With this message Master is able to control head delivery in progress. Head sends delivery data to Master in real time.
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['C'][ETX][<bcc>]

where 'C' è identifies the message. Detecting in progress head delivery is Master work.

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10.2.4 Local unit price request (MPD)

Master asks to head manual local unit prices with this message. Then head sends its manual local unit prices to Master.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['F'][<cp>][ETX][<bcc>]

where:

'F' identifies the message

<cp> is product code of requested unit prices.

10.2.5 Program version request

This message is sent from Master to head to know current program version:

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['v'][ETX][<bcc>]

where **'v'** identifies the message.

10.2.6 Parameter reading

This message is sent from Master to head to know a specific internal programming parameter value.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['r'][np+][np-][ETX][<bcc>]

where:

'r': identifies the message

np: are two digits telling parameter number

10.2.7 Internal check message

This message is sent from Master to request head to perform a specific internal test.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['c'][<test>][ETX][<bcc>]

where:

'c' identifies the message

<test> is a byte telling test type, made of:

0 bit: }

1 bit: }

2 bit: } 6 bits to choose between 64 test types.

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3 bit: }
4 bit: }
5 bit: }
6 bit: ==> always 1

10.3 Selecting messages

Slave answers with ACK or NAK to selecting messages.

10.3.1 Unit price sending (MPD)

Master updates the automatic unit price with this message.
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['X'][UP+][UP][UP][UP-][<cp>][ETX][<bcc>]

where:
'X' identifies the message
<cp> is product code of the automatic changed unit price.

The meaning of UP field is:

- 4 ASCII digits: unit price is updated
- 'CRED' or '0000': manual credit unit price is chosen
- 'CASH': manual cash unit price is chosen

10.3.2 Credit manual unit price (MPD)

Master updates the manual credit unit price of the head with this message.
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['M'][UP+][UP][UP][UP-][<cp>][ETX][<bcc>]

where:
'M' identifies the message
<cp> is the unit price changing product code

Field UP must have four ASCII digits.

10.3.3 Cash manual credit (MPD)

Master updates the manual cash unit price of the head with this message.
The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['N'][UP+][UP][UP][UP-][<cp>][ETX][<bcc>]

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where:
'N' identifies the message
<cp> is the unit price changing product code.

Field UP must have four ASCII digits.

10.3.4 Sending credit message

This message is sent from Master to head after a credit request reception and it informs head about maximum delivery volume and maximum delivery amount, unit price for each product and possible deliveries modes.
The message has got the following format:

```
[EOT][IG][<ad>][STX][<nmsg>]['G'][L+][L][L][L-][V+][V][V][V-]
[<cp1>][UP1+][UP1][UP1][UP1-][<cp2>][UP2+][UP2][UP2][UP2-]
[<cp3>][UP3+][UP3][UP3][UP3-][<cp4>][UP4+][UP4][UP4][UP4-]
[<opz>][ETX][<bcc>]
```

where:
'G': identifies the message
'L': amount 4 ASCII digits where the first digit (L+) is always 0 and the others have respectively 100k, 10k and 1k weight.
'V': volume 4 ASCII digits where the hundreds, tenths, units and decimals weight a liter.
<cpn>: n product code
UPn: 4 unit price digits of n product
If UP = '0000' head uses unit price to the previous automatic unit price or even to manual unit price.
For MPD head only: if UP = 'CRED' head uses credit manual unit price; if UP = 'CASH' head uses cash manual unit price.
<opz>: delivery modes:
0 bit: if set to **0** delivery to be paid;
if set to **1** delivery already paid;
1 bit: if set to **0** , and the nozzle is hang up, head doesn't stop delivery unless 4/10 of a liter has been already delivered;
if set to **1** saves credit until delivery is finished;
2-5 bit: always **0**;
6 bit: always **1**;

This is the case of variable message length that depends on products number sent in credit request; message length variation is of course due to unit price fields.

MPD heads: Master sends to head product codes with their unit prices in the order they were asked by the head; if head receives an answer with code '0', product delivery is disabled, but unit price is updated as well.

MIX heads: head receives three unit prices and derives 8 distinct unit prices from an internal formula, accordingly to the 8 different selected mixture grades.

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10.3.5 Parameter writing

This message is sent from Master to head to change a parameter and consists of parameter number and its new value. If parameter number and/or its new value is wrong, message is ignored.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['w'][np+][np-][vp+][vp-][ETX][<bcc>]

where:

'w' identifies the message
np two digits for parameter number
vp two digits for parameter value

It is possible to set this settings only if head is in idle status, that is not delivering, and it is not in a fatal error condition.

10.3.6 Remote head enabling

After end delivery data sending, head is immediately enabled to a new delivery. It is possible to program the head in a special operating mode so that head is disabled after every end delivery and is enabled again only if a serial network command is sent from Master device.

The message has got the following format:

[EOT][IG][<ad>][STX][<nmsg>]['H'][<disp>][ETX][<bcc>]

where:

'H' identifies the message
<disp> is a "display" field having two different values ('0' and '1')
'0': when head is enabled, display shows previous delivery data;
'1': when head is enabled, display clears previous delivery data (clear main display).

This message is considered only when a delivery is finished: in any other condition this message is ignored.

11. HEAD TO MASTER MESSAGES

11.1 Identification message sending

Head sends this message to Master after an explicit Master request and consists of product internal map with their own error codes.

The message has got the following format:

[STX][<nmsg>]['I'][<ad>][TP][<cp1>][<cp2>][<cp3>][<cp4>]

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[E1+][E1-][E2+][E2-][E3+][E3-][E4+][E4-][ETX][<bcc>]

where:

'I' identifies the message
TP identifies head types accordingly to the following table:

'0' monoproduct
'1' multiproduct
'2' blender
'3' mixer

<cp> are head products codes
E are relative errors ('00' no error).

11.2 Totals message sending

This message is sent from head to Master after an explicit Master request. Message consists of requested total volume product and head total amount.

The message has got the following format:

[STX][<nmsg>]['T'][<ad>][TV+][TV][TV][TV][TV][TV][TV][TV][TV-]
[TI+][TI][TI][TI][TI][TI][TI][TI][TI-][<cp>][ETX][<bcc>]

where:

'T' identifies the message
TV is the volume in liters
TI is total delivered amount
<cp> is the product code for requested data.

11.3 Counts data sending

This message is sent from head to Master after an explicit Master request. Message consists of delivery data (volume and amount) updated at request time. So Master is able to monitor delivery in progress in real time.

The message has got the following format:

[STX][<nmsg>]['D'][<ad>][V-][V][V][V][V+][I-][I][I][I][I][I+][<cp>][ETX][<bcc>]

where:

'D' identifies the message
V is delivered volume in 1/100 of a liter
I is the amount in £iras
<cp> is delivered product code.

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11.4 Manual unit price sending

This message is sent from head to Master after an explicit Master request. Message consists of both manual unit prices (credit and cash) of selected product.

The message has got the following format:

[STX][<nmsg>]['Y'][<ad>][UP1+][UP1][UP1][UP1-]
[UP2+][UP2][UP2][UP2-][<cp>][ETX][<bcc>]

where:

'Y' identifies the message
UP1 is credit manual unit price
UP2 is cash manual unit price
<cp> is the product code for requested unit prices.

11.5 Delivery request

When the nozzle is picked up, credit request message is sent from head to Master to inform Master about all delivering products and to determine which product was selected by the user.

The message has got the following format:

[STX][<nmsg>]['B'][<ad>][<cpx>][<cp1>][<cp2>][<cp3>][<cp4>][ETX][<bcc>]

where:

'B' identifies the message
<cpx> is the selected product
<cp1>..<cp4> are head delivering product.

Message length depends on head products number.

MPD head: products codes are stored in an internal map and are sent in the same sequence of nozzles locations in the active side, that is, cp1 is the product code for gun 1, cp2 is the product code for gun 2, and so on..

In particular operating modes (usually in pre-paid delivery mode) it is possible that delivered product is not equal to initial requested product; head is, in fact, able to change delivering product accordingly to the operating mode described in operator's manual without sending an additional credit request.

MIX head: the three product codes available are: base product, oil and correction factor.

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11.6 Special end delivery data sending

These messages have been introduced to allow end delivery data management with a greater number of significant digits for volume, amount and unit price. Also total volume may be sent and 1 byte is left free for future developments.

In AUTOMATIC mode, the message for special delivery data has got the following format:

[STX][<nmsg>][‘f’][<ad>][<volume>][<amount>][<price>][<cp>][<total liters>]

['0'][ETX][<bcc>]

In MANUAL mode, the message for special delivery data has got the following format:

[STX][<nmsg>]['m'][<ad>][<volume>][<amount >][< price >][<cp>][<total vol.>]
[<'0'>][ETX][<bcc>]

<ad>	head address;
<volume>	delivered volume in liters or gallons; 8 bytes with the following format: [*0.001][*0.01][*0,1][*1][*10][*100][*1000][*10000]
<amount>	delivered amount in £iras or other currencies; 8 bytes with the following format: [*1][*10][*100][*1000][*10000][*100000][*1M][*10M] If different currencies are used, decimal positions may change if necessary .
<price>	unit price in liras or other currencies 6 bytes with the following format: [*1][*10][*100][*1000][*10000][*100000] If different currencies are used, decimal positions may change if necessary.
<cp>	delivered product code. This product code is changed accordingly to bit 0 of sending credit message <opz> character. <cp> character 4th bit has the same value of <opz> character 0th bit.(**)
<total vol.>	total volume (liters or gallons) consist of 9 digits with the following format: [*100M][*10M][*1M][*100K][*10K][*1K][*100][*10][*1]
<'0'>	This field is empty and should be ignored. At the moment it consists of '0' ASCII digits and will be used in future development.

(**) Product code byte has got the following format:

Bit 0, 1, 2	Product code: For standard deliveries is the product number. For mixture deliveries is oil percentage.
Bit 3	Always zero
Bit 4	If 0 POST mode delivery. If 1 prepaid delivery.
Bit 5	Always set to 1 in order to have an ASCII character between 20 hex and 3F hex.
Bit 6	If set to 0, product base delivery. If set to 1, mixture delivery.
Bit 7	Always set to 0 in order to have an ASCII character between 20 hex e and 3F hex.

11.7 Program version transmission

This message is sent by head to Master after a Master program version request.
The message has got the following message:

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[STX][<nmsg>]['v'][<ad>][n][n][t][t][t][e][e][ETX][<bcc>]

where:

'v': identifies the message
n: two characters for device name:
'HT' - monoproduct head
'MD' - multiproduct head
'MX' - mixer head
t: three characters for program version
e: two characters for program edition

11.8 Parameter transmission

This message is sent by head to Master as answer to a special request and informs Master about parameter number and its relative value.

The message has got the following message:

[EOT][<nmsg>]['p'][<ad>][np+][np-][vp+][vp-][ETX][<bcc>]

where:

'p' identifies the message
np two characters indicating parameter number
vp two characters indicating parameter value

If the requested parameter is out of range, head answers to 'r' message with a '*' or ' ' in parameter value field.

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11.9 Internal check answer message

This message is sent from head to master as answer to an internal test result for the head.
The message has got the following format:

[STX][<nmsg>]['c'][<ad>][<test>][<answ>][ETX][<bcc>]

where:

'c' identifies the message
<test> indicates performed test type
<answ> indicates test performance; possible values are:
'0' failure (error)
'1' success (OK)
n datum coming out from test

11.10 Classified tests

Some tests have been classified (at the moment for HT heads only) and should be used to test the System:

<test> = '0'	delivery data flow consistency test
<answ>	0 bit buffer data present after a tx end delivery message
	1 bit buffer data present after a prepared end delivery message
	2 bit last display transmission data
	3 bit BCD internal counter data
	4 bit counts binary data
	5 bit not used
	6 bit always 1

if bit = 0 consistent data, if bit = 1 inconsistent data (cleared after the answer)

<test> = '1'	serial network errors number test
<answ>	0/5 bit errors number
	6 bit always 1

counter is cleared after the answer

<test> = '2'	hardware head status test
<answ>	0 bit preset 1 key
	1 bit preset 2 key
	2 bit preset 3 key
	3 bit preset 4 key
	4 bit dip-switch SW1
	5 bit dip-switch SW2
	6 bit always 1

0 = off, 1 = on

<test> = '3'	hardware head status test
<answ>	0 bit total volume key
	1 bit total amount key
	2 bit manual automatic contact
	3 bit gun contact
	4 bit motor command
	5 bit solenoid valve command
	6 bit always 1

0 = off, 1 = on

<test> = '4'	hardware head status test
<answ>	0 bit U.M. key
	1 bit + key (plus)
	2 bit - key (minus)
	3 bit minimum level contact
	4 bit pulser voltage control
	5 bit not used
	6 bit always 1

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0 = off, 1 = on

12. SOFTWARE COMPATIBILITY

12.1 Multiproduct heads (MPD)

From LAN point of view, multiproduct head (MPD) is divided in two heads. This means that a MPD head answers to two consecutive addresses (one for each side). For example, if side A address is 3 then side B address is 4.

We assume that, if one side have less than four nozzles, assigned nozzle locations are the first free starting from 1, i.e., if both sides have got two nozzles, they will be connected to hydraulic interface 1 and 2 and not to 1 and 3 or 1 and 4, etc.

12.2 Mixer head (MIX)

To maintain compatibility with old Master it is possible to enable/disable extended protocol.

If standard protocol is selected, unit prices management is not active in any case, therefore head uses the eight local unit prices.

13. ERROR CODES

The errors codes description is reported below. Head error codes and some other errors depending on and/or recovered by protocol are listed below too.

13.1 Protocol errors

P20 - Transmission error: this error occurs when some message is lost. To recover this error, it's necessary that Master agrees with head message number.

P33 - Irregular power down: this error occurs when:

a) head has started in irregular way;
b) a checksum error has occurred in unit price memory;
c) a checksum error has occurred in program data memory;

This error is recoverable only (in automatic mode) if head communicate to the Master that it hasn't data to transmit.

P80 - polling time-out: this error occurs when the duration time between two messages addressed to the same pump is longer than polling time-out. This error is recovered only when communication returns normal.

13.2 Other head errors

P10 - RAM error: real-time test of microprocessor RAM memory has detected a fault.

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P11 - ROM error: program memory checksum is wrong.

P14 - Parameters error: parameters checksum, stored in EEPROM at previous power down, is wrong.

P15 - NOVRAM parameters error: this error occurs when head operating parameters memory checksum is wrong. To exit from this condition, it's necessary to check parameters programming.

P16 - EPROM error: program memory checksum is wrong.

P21 - Printer error

P22 - Meters Overflow: increase of total amounts and total volumes is too frequent.

P30 - CPU error: mathematical and logic operation are not correctly executed.

P32 - Overflow error in mathematical routines.

P34 - Conflicts error in stack area.

P35 - Exceeding power respect to requested precision for PULS or CASH signals (multiwire specific).

P40 - Power down: this error occurs when head power goes down.

P41 - Unit price error: this error occurs when unit price value is null (zero).

P42 - Pulser power: this error occurs when control circuit detects pulser power down

P43 - Low level: fuel is under low level in the tank.

P44 - Timer delivery error.

P45 - An incompatible pump types setting was made on protocol converter (specific for protocol converter).

P47 - General system failure due to a bad installation (specific for protocol converter).

E70 - Display error: transmission data error to main display or control error of volume electromechanical meter.

E71 - Pulser error: a pulser channel is interrupted.

E72 - Pulser error: a short circuit occurred between pulser channels.

E73 - Pulser inverse rotation error.

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