UM0934
User manual

ST7570 S-FSK power line networking System-on-Chip

Description

This user manual targets application developers and provides complete information on how to use the ST7570 in applications by describing the embedded functions and protocol layers, with a focus on the commands and parameters available to the user to control and operate the device through its host interface.

For ordering information and mechanical and electrical device characteristics please refer to the ST7570; *S-FSK power line networking system-on-chip,* datasheet.

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1 Documentation conventions

1.1 List of abbreviations

The following abbreviations are used:

Table 1. List of abbreviations

Abbreviation	Description
PRE	Preamble
SSD	Start of subframe delimitation
MIB	Management information base
PGA	Programmable gain amplifier
ZC	Zero-crossing
PHY	Physical layer
MAC	Medium access layer
DA	Destination address
SA	Source address
NS	Number of subframes
FCS	Frame check sequence
CRC	Cyclic redundancy check
M_sdu	MAC service data unit
M_pdu	MAC protocol data unit
IC	Initial credit
CC	Current credit
DC	Delta credit
TIC	Inter-character timeout
FIMA	First initiator MAC address
LIMA	Last initiator MAC address

2 Functional overview

The ST7570 embeds full S-FSK PHY and MAC protocol layers and services compliant with the IEC 61334-5-1 standard ([2]), mainly developed for smart metering applications in CENELEC A band, but suitable also for other command and control applications and remote load management in CENELEC B and C bands.

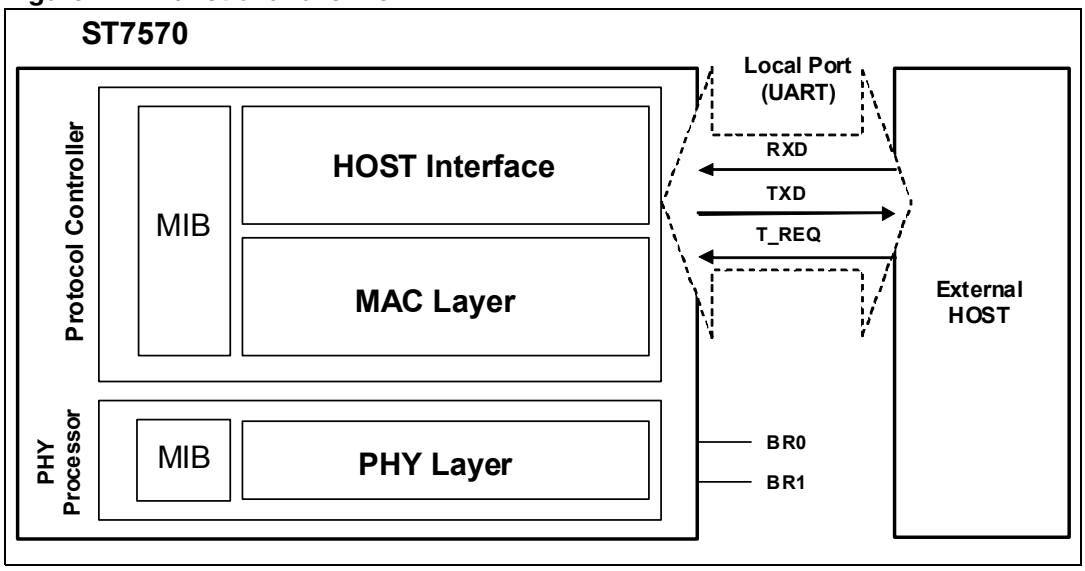
A local port (UART) is available for communication with an external host, exporting all the functions and services required to configure and control the device and its protocol stack.

2.1 Protocol stack

Below is a list of the protocol layers and functions embedded in the ST7570:

- **Physical layer:** implemented in the PHY processor and exporting all the primitive functions listed in [2], plus additional services for configuration, alarm management, signal and noise amplitude estimation, phase detection, and statistical information
- **MAC layer:** implemented on the protocol controller and exporting all the primitive functions listed in [2], plus additional services for configuration
- **Management information base (MIB):** an information database with all the data required for proper configuration of the system (at both PHY and MAC layers)
- **Host interface:** all the services of the PHY, MAC, and MIB are exported to an external host through the local UART port.

Figure 1. Functional overview



2.2 Access points

The external host can access the protocol stack at two points:

- MAC access (or MAC mode): the external host operates and controls the ST7570 through its embedded MAC. The host interface exports all the MAC functions and services on the local port
- PHY access (or PHY mode): the embedded MAC layer is bypassed and the external host can directly access the PHY layer. The host interface exports all the PHY functions and services on the local port.

3 Physical layer

3.1 Overview

The ST7570 embeds a PHY layer compliant with [2], with additional functions for alarm management and electrical delta-phase detection.

In order to meet the application's functions and physical channel characteristics, many parameters involved at this layer can be programmed by the user.

3.2 Frame structure

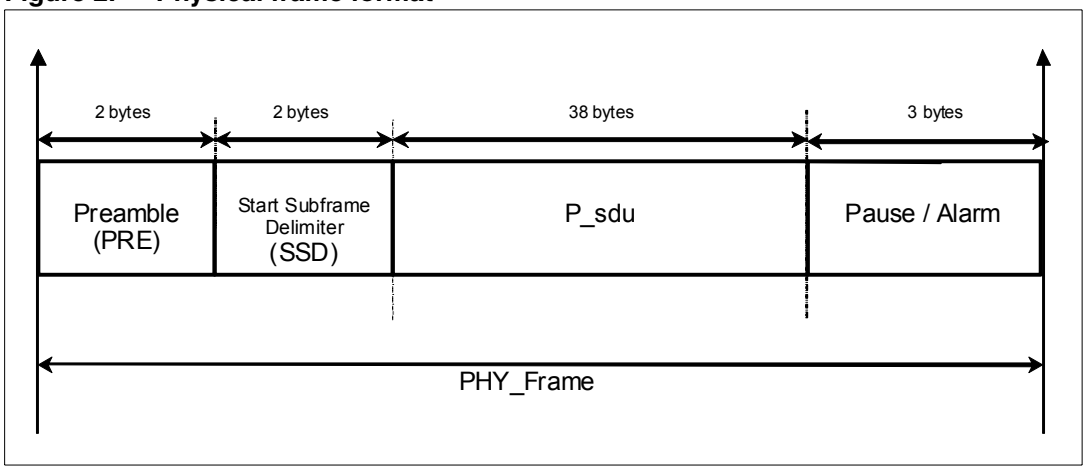
The frame at the physical level (PHY_Frame) is made up of 45 bytes (360 bits), as follows:

- 2 bytes - preamble (PRE) (AAAAh)
- 2 bytes - start subframe delimiter (SSD) (54C7h)
- 38 bytes - physical service data unit (P_sdu), i.e. the payload transmitted by the MAC layer
- 3 bytes - pause or alarm

The bytes are sent from the most significant byte (MSB) to the least significant byte (LSB).

Bits within the byte are packed with the same order.

Figure 2. Physical frame format



3.3 Frame timing and time-slot synchronization

The time domain in the network is divided into recurrent "time-slots", with a fixed length equal to the length of a physical frame PHY_Frame, (45 bytes). The start of each time-slot is usually aligned with the mains zero-crossing and the bit time is automatically adapted to the mains frequency and can be chosen from two values:

- 24 bits/mains period
- 48 bits/mains period.

Therefore, the effective baud rate of the data communication depends on the mains frequency, in accordance with *Table 2*:

Table 2. Baud rate vs. mains frequency

Baud rate		50 Hz	60 Hz
24 bits/mains period	15 mains cycle/time-slot	1200 bps	1440 bps
48 bits/mains period	7.5 mains cycle/time-slot	2400 bps	2880 bps

All the nodes belonging to the network must use the same time-slot division in order to be able to communicate. The achievement of a common time division is the so-called “time-slot synchronization” process. Time-slot synchronization is first achieved by the master (Client) of the network by choosing an arbitrary time-slot start, usually aligned with the zero-crossing event of one of the three phases of the mains. All the other nodes in the network are slaves (Server) and they acquire the master’s time-slot synchronization as soon as a sequence composed by PRE+SSD is received.

3.4 Operating modes

The following operating modes are supported, as defined by [2]:

- Client: is the master of the communication.
- Server: is the slave of the communication. Before being allowed to transmit, the ST7570 modem needs to achieve the “slot synchronization”.

3.4.1 Additional operating modes for the physical layer

In addition to the operating modes defined by [2], the ST7570 adds operating modes for specific tasks (monitor and test):

- Monitor: similar to the Server, being able, in addition, to provide extended information on physical events. This mode is also called the SPY or SNIFFER mode, and is used to ease the debugging of a PLC network. It is normally not used in operating conditions
- Test: embedded test modes to generate test tones, useful to check EMI compliance of the output S-FSK signal.

3.5 Services

The following services are available:

- Data services: to transmit and receive data on the power line
- Alarm services: to transmit and receive alarms on the power line
- Synchronization services: to notify or reject a time-slot synchronization.

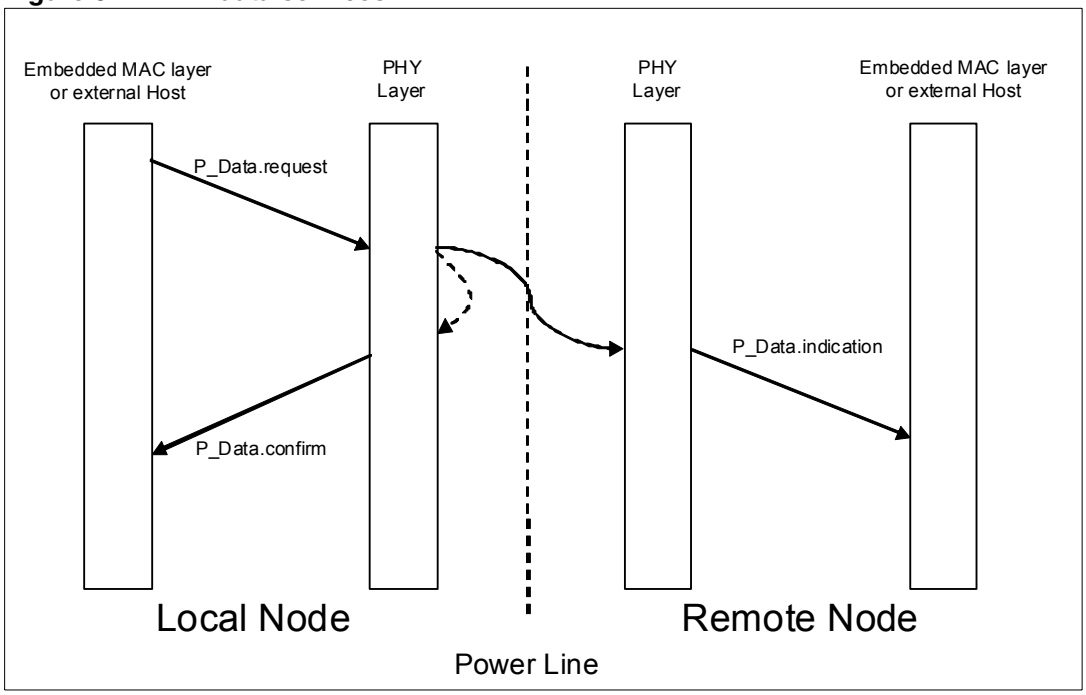
3.5.1 Data services

The data services provided by the physical layer allow the embedded MAC layer (in the case of a MAC access point) or the external host (in the case of a PHY access point) to manage data transfer on the power line.

Three primitives are available:

- P_Data.Request(P_sdu): to ask the PHY layer for the transmission of data P_sdu
- P_Data.Confirm(T_result): generated by the PHY layer as a response to a previous P_Data.Request with the result of transmission (T_result)
- P_Data.Indication(P_sdu): generated by the PHY layer as soon as data P_sdu coming from the power line has been received.

Figure 3. PHY data services



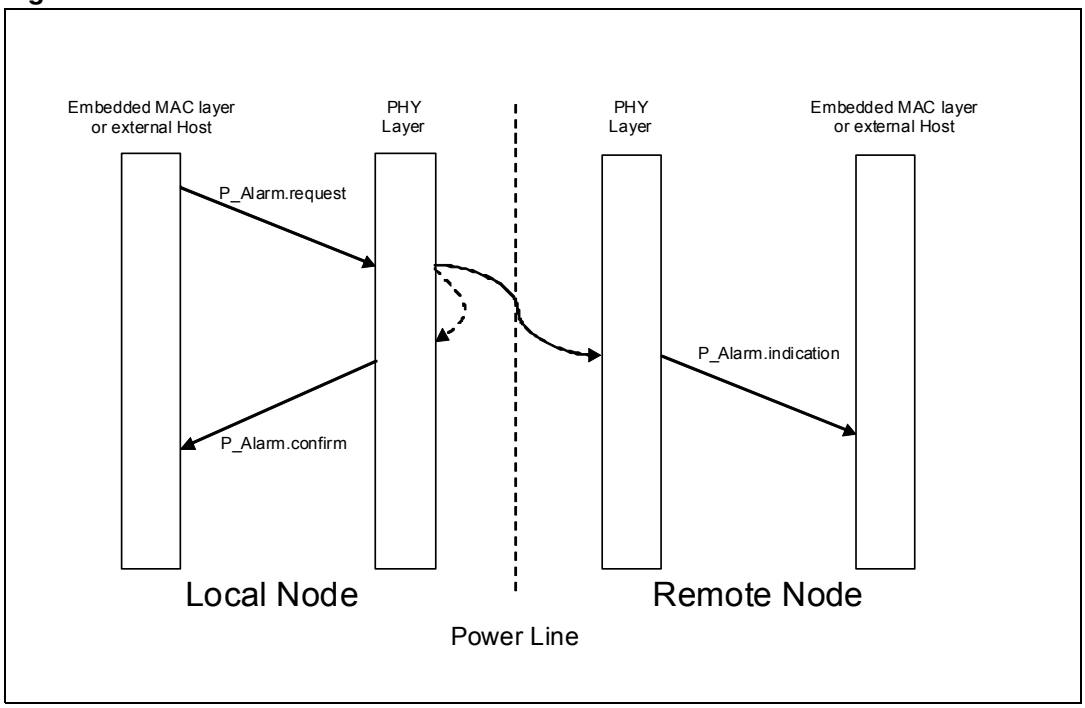
3.5.2 Alarm services

The alarm services provided by the physical layer allow the embedded MAC layer (in the case of a MAC access point) or the external host (in the case of a PHY access point) to manage alarm transfer on the power line.

Three primitives are available:

- P_Alarm.Request(): to ask the PHY layer for the transmission of an alarm
- P_Alarm.Confirm(T_result): generated by the PHY layer as a response to a previous P_Data.Request with the result of transmission (T_result)
- P_Alarm.Indication(): generated by the PHY layer as soon as an alarm coming from the power line has been received.

Figure 4. PHY alarm services



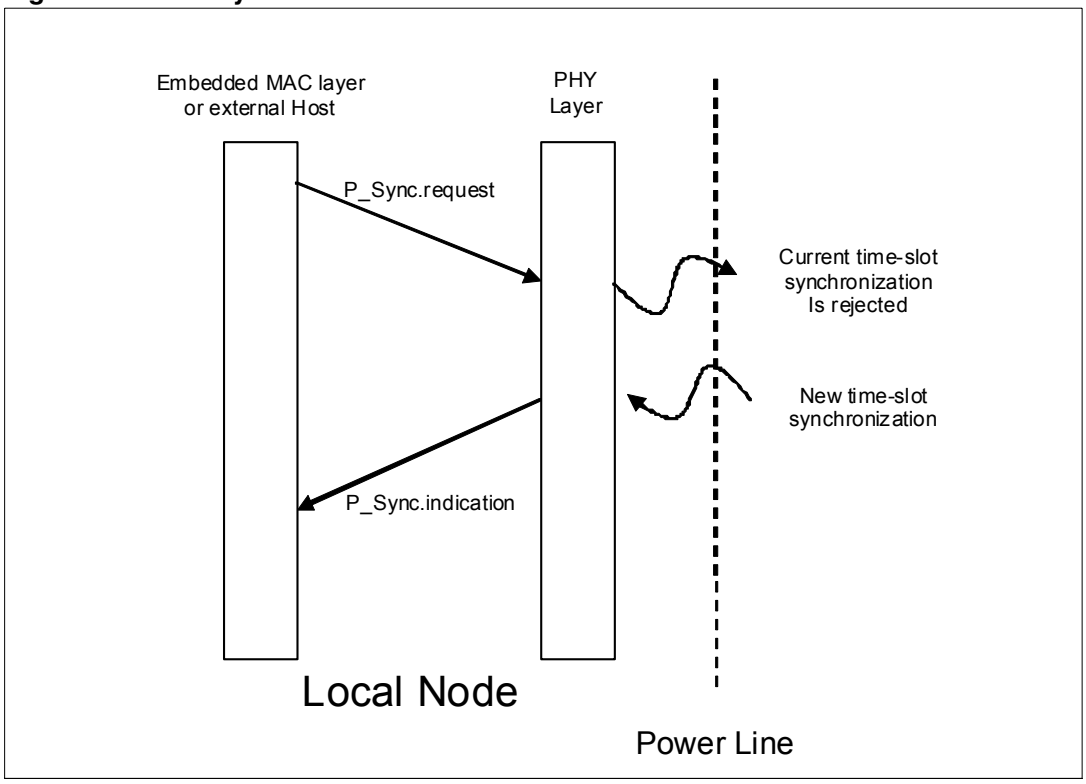
3.5.3 Synchronization services

The synchronization services provided by the physical layer allow the embedded MAC layer (in the case of a MAC access point) or the external host (in the case of a PHY access point) to manage the time-slot synchronization.

Two primitives are available:

- P_Synch.Request(): to ask the PHY layer for the rejection of the current time-slot synchronization (if any)
- P_Synch.Indication(): generated by the PHY layer as soon as a new time-slot synchronization is achieved.

Figure 5. PHY synchronization services



3.6 Additional features

The ST7570 embeds additional features in the PHY layer to collect or estimate additional information useful for MAC and upper layers.

3.6.1 Signal and noise estimation

The ST7570 performs an estimation of signal and noise on every received physical frame.

Two estimations are provided, with different accuracy:

- Raw estimation: performed on PRE+SSD sequence
- Fine estimation: performed on P_sdu.

Raw estimation

This function provides an estimation of signal and noise amplitudes, as detected by the ST7570 at the RX_IN pin. Signal and noise amplitudes are estimated separately on channel 0 and channel 1 during the preamble (PRE) and SSD sequence (4 bytes). The estimated amplitudes are stored in the MIB objects 000Dh (S0, N0, PGA, *Section 6.5.14*) and 000Eh (S1, N1, phase, *Section 6.5.15*) and provided through unsolicited indications (CMD_SynchroIndication, *Section 5.3.1*, and SPY_SynchroFoundIndication, *Section 5.3.20*).

In order to convert from a raw number (“value” as stored in the MIB) to an RMS voltage value expressed in dBµV, use *Equation 1:*

Equation 1

$$V_{RMS}[dB\mu V] = value / 100$$

Table 3 shows some conversion examples:

Table 3. SNR estimator values conversion

Values provided by the ST7570		RMS amplitude [dBµV]
Name	Value	
S0	002C8Fh	114.07
N0	002359h	90.49
S1	002B0Ch	110.20
N1	0023F6h	92.06

Fine estimation

This function provides an estimation of the signal-to-noise ratio for both channels 0 and 1, as detected by the ST7570 at the RX_IN pin. The estimation is performed on the P_sdu payload (304 bits). The estimated ratios are automatically provided through unsolicited indications (CMD_DataIndication, *Section 5.3.11*).

In order to convert from a raw number (“value” as stored in the MIB) to an RMS voltage value expressed in dB, use *Equation 2:*

Equation 2

$$SNR[dB] = 10 \cdot 64 \cdot value \cdot \log_{10}(2) \cdot 2^{-19}$$

3.6.2 Demodulation method count

For each received PHY frame, the ST7570 provides a statistic of the ways used to demodulate each single bit of the P_SDU payload (304 bits), based on the signal quality.

During each bit time, the demodulator returns the received binary symbol on the basis of numerical processing performed on measured data for both tones. If these data are processed independently and a binary symbol is chosen without combining them, an “ASK” counter (“ASK0” if the demodulated bit value is equal to 0, “ASK1” otherwise) is incremented; however, if the bit is returned after a combination of measured data, the “SFSK” counter is incremented.

The values of the counters are automatically provided by means of unsolicited indications (CMD_DataIndication, *Section 5.3.11*).

3.6.3 Receiving gain (PGA) estimation

The internal PGA block (refer to [*1*]) is driven by an automatic control algorithm to find the best gain maximizing the dynamic range of the input signal. The found PGA gain is then written into the MIB object 000Dh (S0, N0, PGA, *Section 5.3.14*), and automatically provided through unsolicited indications (CMD_DataIndication, *Section 5.3.11*,

SPY_SubframeIndication, *Section 5.3.18*, SPY_No_SubframeIndication, *Section 5.3.17*). Such gain value is useful to estimate the input signal amplitude.

3.6.4 Electrical delta-phase detection

During the reception of a valid sequence of preamble and SSD bytes, the ST7570 automatically performs a measurement of the mains phase difference between the local zero-crossing reference and the received sequence. The result is then written into the MIB object 000Eh (S1, N1, phase, *Section 6.5.15*) and automatically provided through unsolicited indications (CMD_DataIndication, *Section 5.3.11*, SPY_SubframeIndication,*Section 5.3.18*, SPY_No_SubframeIndication, *Section 5.3.17*).

The meaning of each code is described in *Table 4*:

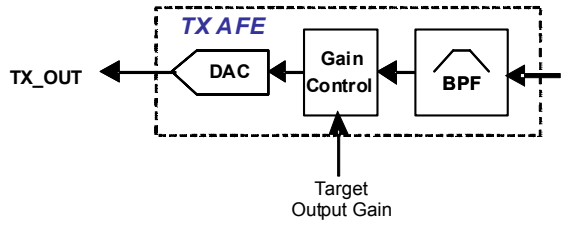
Table 4. Electrical delta-phase coding

Value returned by the ST7570	Delta-phase [degree °]	
	1200 bps	2400 bps
0	Not valid	Not valid
1	0	0 or +180
2	+60	+60 or -120
3	+120	+120 or -60
4	+180	+180 or 0
5	-120	-120 or +60
6	-60	-60 or +120

3.6.5 Transmitting digital gain

The level of the output signal can be digitally adjusted by accessing the MIB object 0082h (TX output gain and current limiting, *Section 6.5.24*), controlling the gain control block depicted in *Figure 6*.

Figure 6. ST7570 transmission path block diagram



The amplitude of the transmitted signal can be set on a 32-step logarithmic scale through the target output gain parameter of the MIB object 0082h, introducing an attenuation ranging from 0 dB (typ.), down to -31 dB (typ.).

For further details refer to [*1*].

3.6.6 Soft Start

When the ST7570 modem starts transmitting, the soft start feature allows to linearly increase the power amplifier output gain from zero to the target value in a given time. This option can be used to reduce the EM emissions. The duration of the soft start is programmable by steps of 13 µs through the MIB object 00ACh (soft start, *Section 6.5.33*).

3.6.7 Programmable digital output

Pin PRESLOT/ZC/TS/BIT (refer to [*1*]) can be programmed to output the following information:

- PRESLOT: as soon as time-slot synchronization is achieved, it is low when the device is able to accept a P_Data.Request (or M_Data.Request) and high otherwise
- ZC: square wave toggling on every positive zero-crossing event. Its period is equal to double the mains period
- TS: square wave synchronous to the time-slot reference generated by the internal PLL. Its period is equal to time-slot
- BIT: square wave toggling at every bit time start, generated by the internal PLL. Its period is 2*bit time.
- TX_P: it is high when a transmission is in progress, low otherwise
- RX_P: it is high when a reception is in progress, low otherwise
- TXRX_P: it is high when the device is involved in a communication (transmission or reception) through powerline

The desired information to be output can be selected through the MIB object 00A4h (PRESLOT/ZC/TS/BIT and ZC_IN_D configuration, *Section 6.5.31*).

3.6.8 Zero-crossing signal fault detection

This feature, always active, is used to detect fault conditions on the external zero-crossing signal causing loss of proper synchronization.

If no falling edges are detected on the input ZC signal within a given timeout (1.3 s as the default value), no time-slot events are generated. After this fault condition, a reset is required.

4 MAC layer

4.1 Overview

The ST7570 embeds a MAC layer compliant with [2], with additional functions for the electrical delta-phase measurement.

In order to meet the application's functions and physical channel characteristics, many parameters involved at this layer can be programmed by the user.

4.2 Operating modes

The following operating modes are supported, as defined by [2]:

- Client: is the master of the communication.
- Server: is the slave of the communication. Before being allowed to transmit, the ST7570 modem needs to achieve the "slot synchronization".

4.2.1 Additional operating mode

In addition to the operating modes (Client and Server), defined by [2], the MAC layer of the ST7570 also embeds a Monitor mode for specific tasks.

Monitor mode

When the node is running as "Monitor":

- All the time-outs (*Section 4.7*) are disabled to allow the reception of frames, even if they are not valid (i.e. invalid FCS) or after a long silence period
- Every received frame causes an CMD_SynchroIndication (*Section 5.3.1*) to be sent to the host
- All the valid frames (i.e. valid FCS) are notified through an CMD_DataIndication (*Section 5.3.11*), whatever the source address and destination address
- Each repetition is notified through an CMD_DataIndication (*Section 5.3.11*) independently, if the modem is set as well as a REPEATER (*Section 4.8.5*).

Special MIB objects (disable frame type check and disable CRC check, 0008h *Section 6.5.9*, and auto synchro reject 0015h, *Section 6.5.22*) let the Monitor be configured as a sniffer capable of receiving and notifying all the frames:

- Disable frame type check and disable CRC check: these flags allow the long MAC frame type and frame CRC check to be disabled so that the wrong MAC frames are notified
- Auto synchro reject: this parameter makes the Monitor able to automatically reject the synchronism at the end of each received MAC frame.

4.3 Services

The following services are available:

- Data services: to transmit and receive data on the power line
- Alarm services: to transmit and receive alarms on the power line
- Synchronization services: to notify or reject a time-slot synchronization.

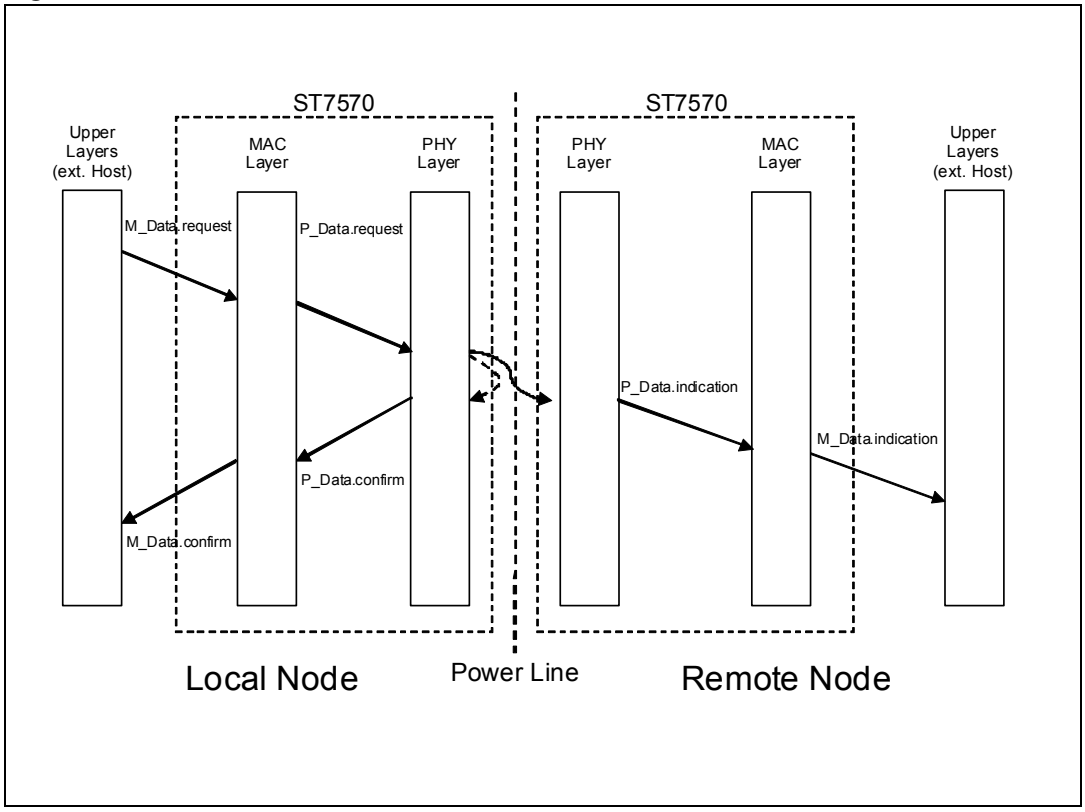
4.3.1 Data services

The data services provided by the MAC layer allow the upper protocol layers (embedded in the external host) to manage data transfer on the power line.

Three primitives are available:

- M_Data.Request(DA, M_sdu, IC, CC, DC): to ask the MAC layer for the transmission of data M_sdu on the power line to a destination node whose local MAC address is DA with credit values IC, CC and DC, (see *Section 4.8*)
- M_Data.Confirm(T_status): generated by the MAC layer as a response to a previous M_Data.Request with the result of the transmission (T_status)
- M_Data.Indication(DA, SA, M_sdu, IC, CC, DC): generated by the MAC layer as soon as data M_sdu coming from the power line has been received. The local MAC address of the sender is SA, the destination address is DA while credit values are IC, CC and DC.

Figure 7. MAC data services



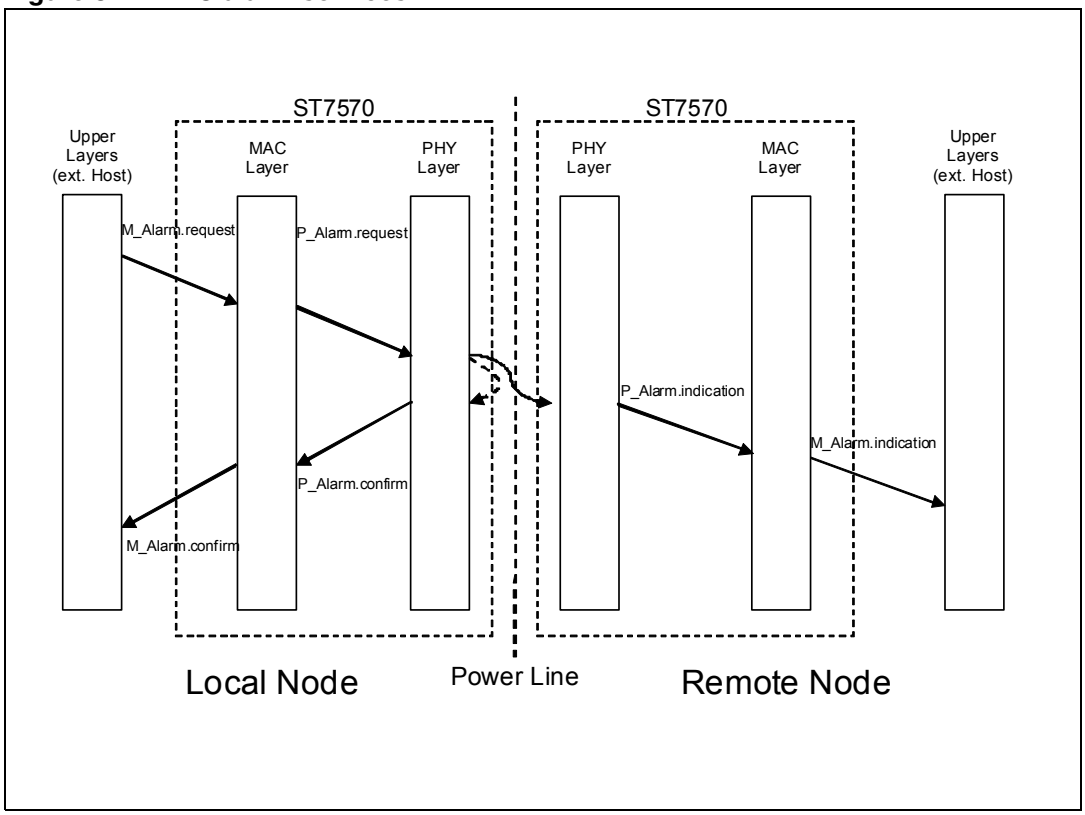
4.3.2 Alarm services

The alarm services provided by the MAC layer allow the upper protocol layers (embedded in the external host) to manage alarm transfer on the power line.

Three primitives are available:

- M_Alarm.Request(): to ask the MAC layer for the transmission of an alarm
- M_Alarm.Confirm(T_result): generated by the MAC layer as a response to a previous M_Alarm.Request with the result of transmission (T_result)
- M_Alarm.Indication(): generated by the MAC layer as soon as an alarm coming from the power line has been received.

Figure 8. MAC alarm services



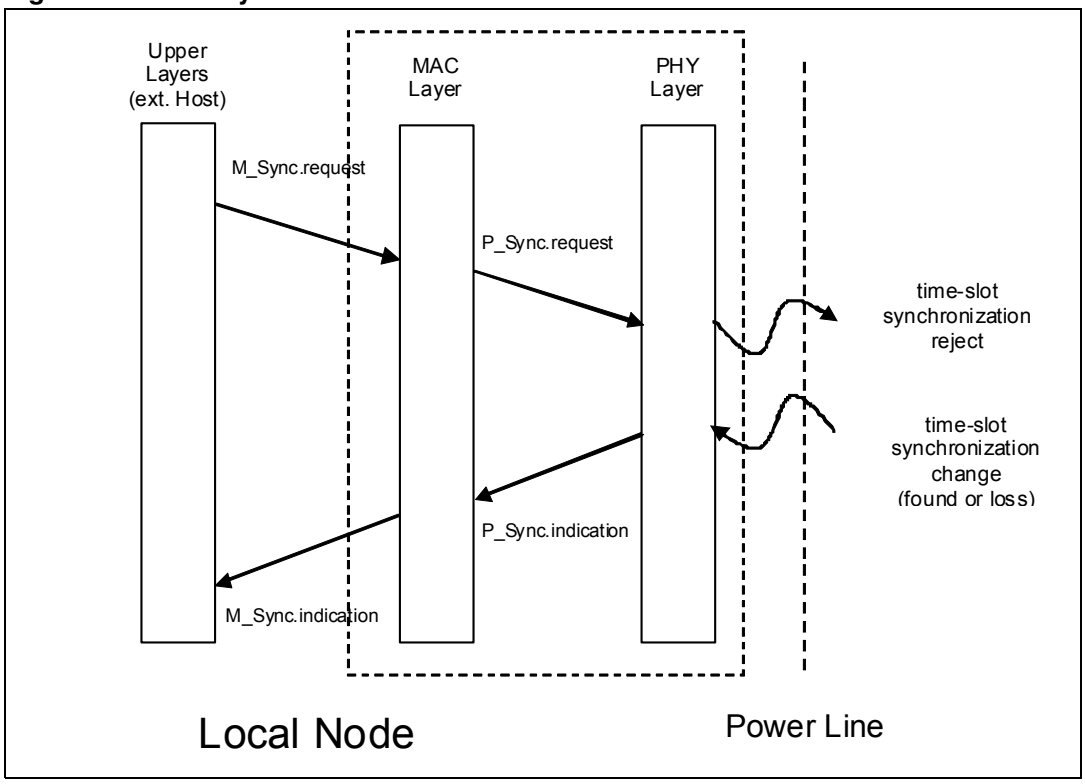
4.3.3 Synchronization services

The synchronization services provided by the MAC layer allow the upper protocol layers (embedded in the external host) to manage the time-slot synchronization.

Two primitives are available:

- M_Sync.Request(): to ask the MAC layer for the rejection of the current time-slot synchronization (if any)
- M_Sync.Indication(S_state): generated by the MAC layer as soon as a change in the time-slot synchronization has happened, with a description of the status (S_state).

Figure 9. MAC synchronization services



4.4 Framing

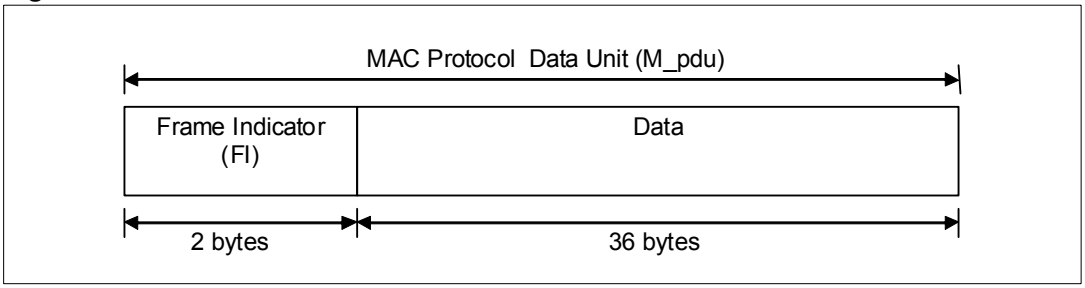
The framing process performed by the MAC layer is depicted in *Figure 11*.

Upper layers (running in the external host) request a transmission through the primitive M_Data.Request(), passing to the MAC the service data unit M_sdu to be transmitted and additional information regarding addresses and repetition credits. Such information is used by the MAC to build the “long MAC frame” made up of the following fields:

- Header:
  - NS: number of subframes building the long frame
  - SA: source address (12-bit)
  - DA: destination address (12-bit)
  - Repetition credits (information used for repetition management, 8 bits)
- M_sdu (from 1 up to 242 bytes)
- FCS (24 bit CRC).

The “long MAC frame” is then divided into several 38-byte fixed-length protocol data units (M_pdu) called “MAC subframes”, the structure is depicted in *Figure 10*. The frame indicator (FI) is always equal to 0000h to mark it as a subframe of a long MAC frame.

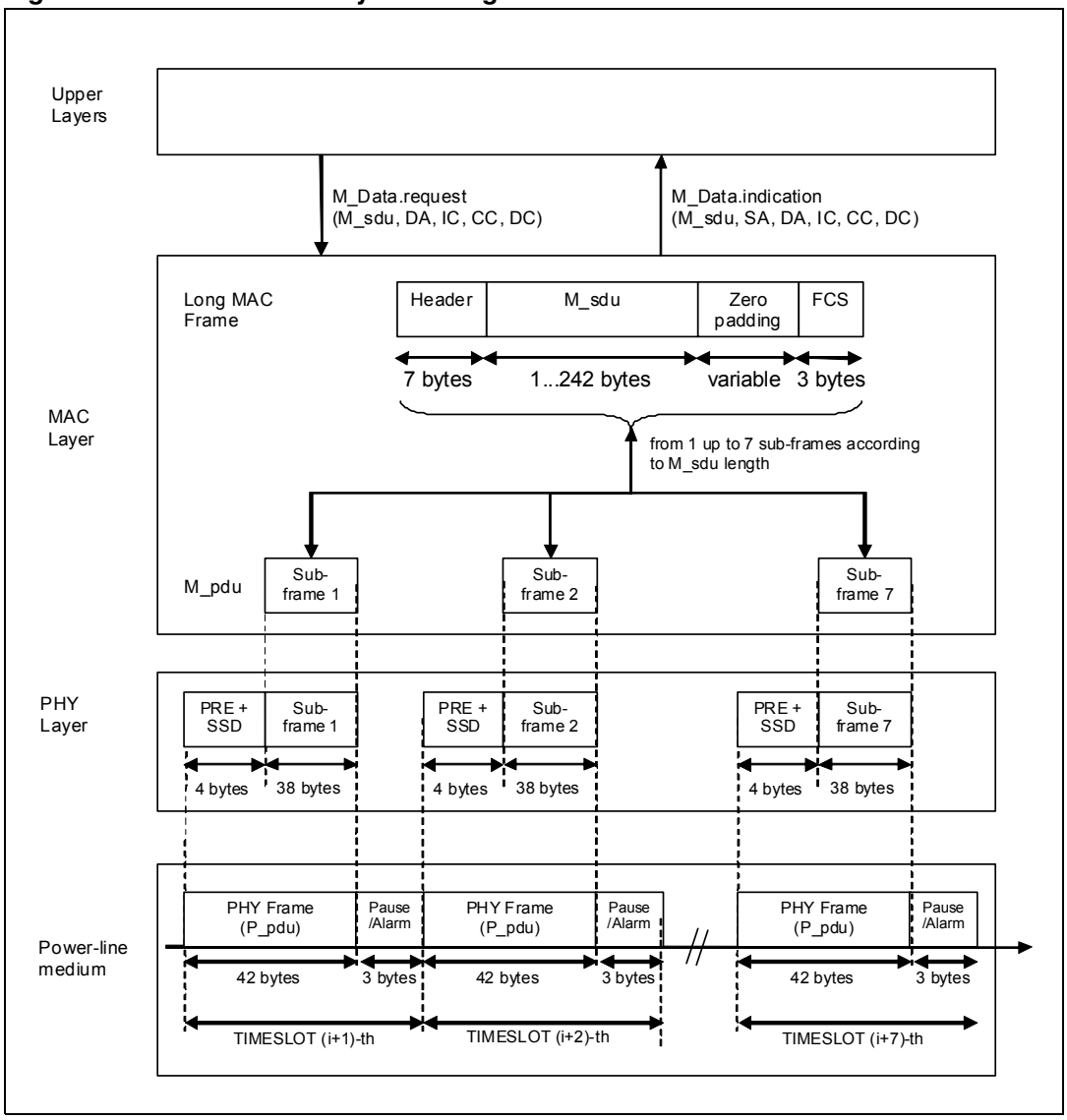
Figure 10. MAC subframe structure



MAC subframes are then presented to the underlaying PHY layer for encapsulation and transmission on the medium. According to the length of the M_sdu to be transferred (from 1 up to 242 bytes), the MAC could use from 1 up to 7 subframes (corresponding to 1 up to 7 consecutive time-slots on the medium).

During reception, the PHY layer presents all the received P_pdu frames to the MAC for further processing. If the P_pdu frames are recognized as being part of one long MAC frame (checking information NS), the MAC assembles them in order to rebuild the original long frame. The long frame is then presented to upper layers through M_Data.Indication() according to the result of the FCS and address checks.

Figure 11. MAC and PHY layer framing



4.5 Address management

Each long MAC frame contains two address fields:

- source address (SA), identifying the station the frame has been transmitted from
- destination address (DA), identifying the station the frame has been transmitted to.

Both SA and DA fields are 12 bits long.

There are three types of destination addresses:

- individual address, used for point-to-point (unicast) communication
- group addresses, used for multipoint (multicast)
- broadcasting address.

4.5.1 Local MAC address

Each station in the network is identified through a unique local MAC address, stored in the MIB object 0001h (local MAC address, *Section 6.5.2*). When the node has been configured as Server or Monitor, by default, the initial value for the local MAC address is NEW (FFEh). When the node has been configured as Client, the local MAC address is automatically set equal to FIMA address. It is then the responsibility of the upper layers to assign a unique address to each station within the range address space (000h-FFFh).

4.5.2 Address space

The available address space, ranging from 000h up to FFFh, is allocated to nodes belonging to the network according to:

- The node type (Client or Server)
- Application related parameters, programmable through MIB objects:
  - First initiator MAC address (FIMA) is the first address available for Clients
  - Last initiator MAC address (LIMA) is the last address available for Clients

Refer to *Table 5* for local MAC address fixed values.

Table 5. Local MAC address

Value	Description
000h	Reserved
001h	Server
...	
FIMA-1	
FIMA	Client
...	
LIMA	
FFCh	Reserved
FFEh	New
FFFh	Reserved

4.5.3 Reception

When a valid long MAC frame is received by a server, the MAC compares the destination address (DA) and the local MAC address and generates an M_Data.Indication(DA, SA, M_sdu) if at least one of the following cases is verified:

- DA matches the local MAC address
- DA matches one of the group addresses
- DA is the broadcast address.

In the case of a Client receiving the long frame, it generates an M_Data.Indication(DA, SA, M_sdu) regardless of the originator and destination of the frame.

4.5.4 Transmission

When upper layers request a transmission through an M_Data.Request(DA, M_sdu), the MAC builds the long frame header by copying the DA value into the destination address field and by copying the local MAC address value into the source address field.

4.5.5 Group addresses

The MAC supports pre-defined group addresses (*Table 6*).

Further custom group addresses (up to 5) can be specified through MIB object 0005h (MAC Group Addresses, *Section 6.5.6*).

Table 6. Pre-defined group addresses

Name	Value	Description
NO-BODY	000h	Reserved value, it can't be assigned to any node in the network. If a frame with DA equal to NO-BODY is received, a Client always generates a M_Data.Indication, while a Server generates a M_Data.Indication only if at least one MAC group addresses is equal to 0x000.
NEW	FFEh	Nodes with local MAC address equal to NEW.
NOT-NEW	FFCh	Nodes with local MAC address different from NEW.
BROADCAST	FFFh	Broadcast address. All the network nodes generate an M_Data.Indication if the DA field in the received MAC frame is equal to BROADCAST.

4.6 Time-slot synchronization

As explained in *Section 3.3*, all the nodes belonging to the network must use the same time-slot division in order to be able to communicate. The time-slot synchronization is first achieved by the Client, by choosing an arbitrary time-slot start, while all the other nodes (Server) acquire the Client's time-slot division as described in following sections.

4.6.1 PHY layer

At PHY layer, the time-slot synchronization is acquired by a Server as soon as it receives the PRE+SSD sequence. As the PHY layer does not perform any check on frame CRC and addresses, the reception of any physical frame sent over the network, whatever the source address and even if corrupted by noise, causes the Server to acquire the time-slot synchronization (if not already synchronized).

Upon receipt of the PRE+SSD sequence, the PHY notifies to the MAC a P_Sync.Indication.

4.6.2 MAC layer

At MAC layer, two further checks are performed in order to confirm or reject the time-slot synchronization acquired by the PHY:

1. Frame integrity: a valid MAC frame (i.e. with a valid CRC) must be received within “synchronization-confirmation-timeout” (*Section 4.7*) from the reception of the PRE+SSD causing the synchronization. This condition is aimed at avoiding the acquisition of a fake synchronization, caused by the reception of a PRE+SSD simulated by the noise on the line.
2. Address check: two operating modes are available:
   – unlocked mode: no checks on addresses are performed. Only condition 1 is used to accept or refuse the synchronization;
   – locked mode: both source (SA) and destination (DA) addresses are checked and compared against a local MIB object called “Initiator MAC address”, programmed by upper layers (usually with the address of the network’s Client, also called “initiator”). If at least one SA or DA matches with the “Initiator MAC address” value, the synchronization is confirmed or otherwise rejected. This condition is aimed at forcing a Server to accept only the time-slot synchronization coming from a specific node (usually the network’s Client), by confirming the time-slot synchronization only on frames originating from, or addressed to, that node.

After having confirmed the time-slot synchronization according to the conditions mentioned above, the MAC layer keeps on monitoring the validity of the synchronization through the “timeout-frame-not-OK”. At least one valid MAC frame must be received within this timeout. The timeout counter is reset at any valid MAC frame reception. If no valid MAC frame is received within this time interval, time-slot synchronization is rejected.

4.6.3 Initiator MAC address

The field “Initiator MAC address” in the MIB object 0001h can be used by upper layers to force a Server to accept the time-slot synchronization coming only from a specific node, as described in *Section 4.6.2*.

Valid values for the initiator MAC address are shown in *Table 7*.

Table 7. Initiator MAC address

Initiator MAC address value	Mode	Description
NO-BODY (default value)	unlocked	Any time-slot synchronization is confirmed.
Any value between FIMA and LIMA	locked	Only time-slot synchronization coming from the specified node is confirmed.

4.7 Timeouts

The MAC layers of a Server node handle 3 timeouts aimed at:

- Managing the time-slot synchronization, as described in *Section 4.7.1*, through the “synchronization-confirmation-timeout” and “timeout-frame-not-OK”
- Checking the validity of the local MAC address through the “timeout-not-addressed”.

The time-outs can be programmed with the desired values through dedicated MIB objects 0002h (Timeout Synchro Confirmation, *Section 6.5.3*), 0003h (Timeout Frame Not OK, *Section 6.5.4*), and 0004h (Timeout Frame Not Addressed, *Section 6.5.5*).

4.7.1 Synchronization-confirmation-timeout

Refer to *Section 4.6.2*.

4.7.2 Timeout-frame-not-OK

Refer to *Section 4.6.2*.

4.7.3 Timeout-not-addressed

This timeout is aimed at periodically checking the validity of the local MAC address and, if necessary, at releasing it.

Once the Server has achieved the time-slot synchronization, it expects to receive at least one valid MAC frame addressed to it (i.e. a frame with field DA equal to the local MAC address of the node) within “timeout-not-addressed”. The timeout counter is refreshed at any valid MAC frame with DA equal to MAC local address reception.

If the timeout-not-addressed has elapsed, the local MAC address is automatically reset to the default value NEW (FFEh) and the time-slot synchronization is rejected.

4.8 Credit management and repetitions

In a real power line network several undesired electrical phenomena such as signal attenuation, noise, and narrow band interferers may impact on communication performance, preventing a message being delivered to a destination node. In order to overcome this problem, in accordance with [*2*], the MAC layer provides a repetition mechanism based on “credits” (IC, CC and DC) and on specific Server nodes called REPEATERs, behaving exactly as a Server but being able, in addition, to perform repetitions according to IC and CC values. Credit information is embedded in the header of each long MAC frame, with the meaning described in the following sections.

4.8.1 Initial credit (IC)

The initial credit (IC) is a 3-bit long field (with a maximum value equal to 7) and counts how many times the frame must be repeated.

When receiving, the field IC is extracted and notified to the upper layers through the M_Data.Indication upon receipt of the first valid MAC frame within the repetition burst. Such information is not used by the MAC layer.

When upper layers request a transmission through an M_Data.Request, according to the node type:

- Client and REPEATER: the node originates (IC+1) consecutive transmissions of the same MAC frame
- Server: whatever the value of the IC, the node performs only 1 transmission of the MAC frame.

4.8.2 Current credit (CC)

The current credit (CC) is a 3-bit long field with an initial value equal to IC and automatically decremented by the MAC layer after each repetition.

When receiving, the CC field is extracted and notified to the upper layers through the M_Data.Indication upon receipt of the first valid MAC frame within the repetition burst. Moreover, only in the case of REPEATER, does the node join the repetition by transmitting CC frames in the next time-slots. CC field is automatically decremented by the MAC layer after each repetition.

4.8.3 Delta credit (DC)

Delta credit (DC) is 2 bits long and used by the system management application entity (SMAE) of the Client for credit management, while it has no meaning for a Server or a REPEATER. It represents the difference (IC-CC) of the last communication originated by the system identified by the DA address to the system identified by the SA address.

When the MAC builds a long MAC frame, it receives the IC and DC credit values from the SMAE and they are usually specific to the destination address DA. The MAC fills the MAC frame header with the passed IC and DC values, while CC is equal to IC for the first transmitted frame.

When a MAC frame is received, the MAC automatically decodes the IC, CC, DC values and notifies them to the upper layers (SMAE).

4.8.4 Repeater

The REPEATER is basically a Server being able, in addition, to perform repetitions.

A dedicated MIB object 000Bh (TIC selector and repeater state, 6.5.12) can be used to configure a Server as a REPEATER.

4.8.5 Example

Figure 12 shows a repetition example.

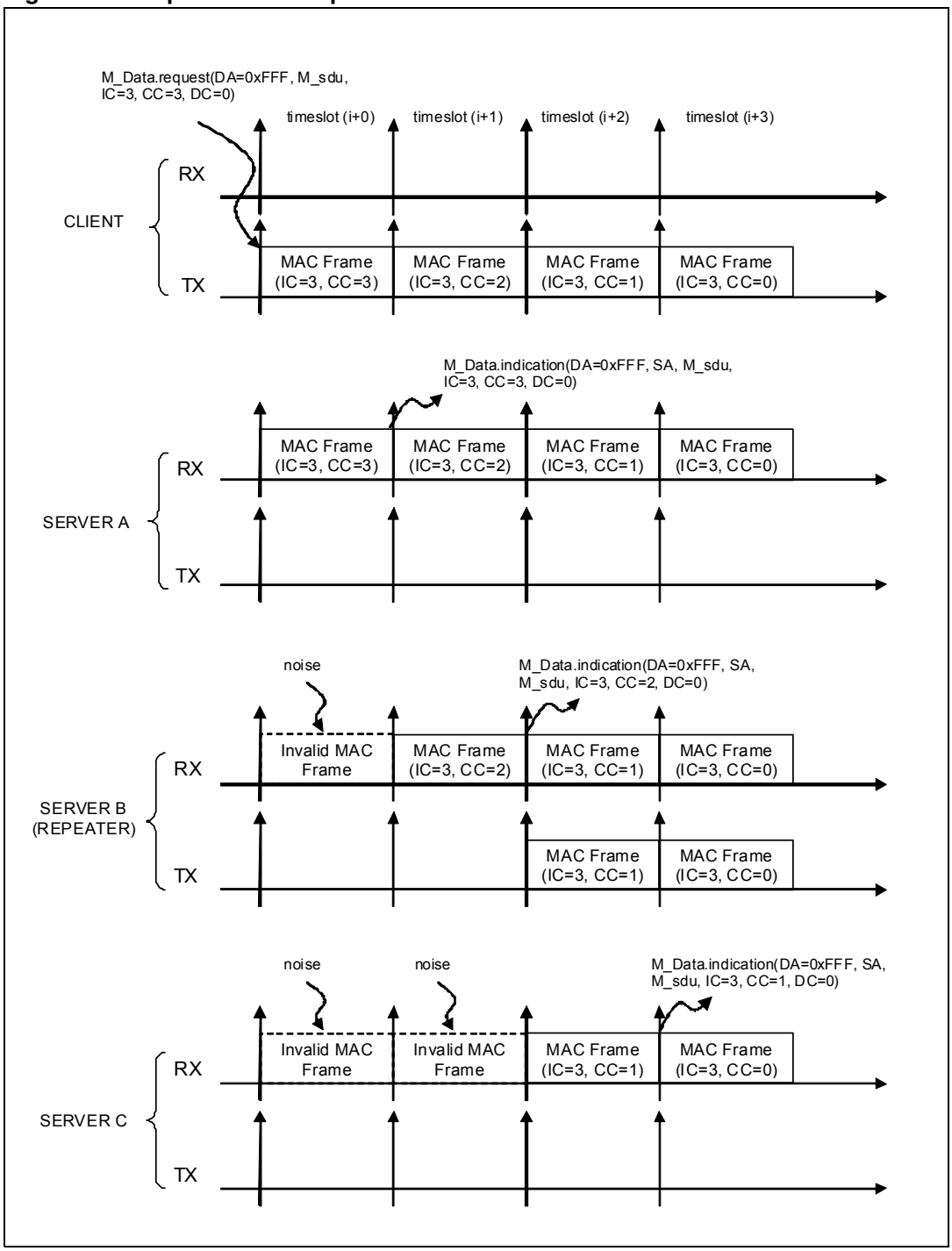
Upper layers of the Client station requests a broadcast (DA=FFFh) transmission of a MAC frame (made of a single subframe) with IC=CC=3. The Client performs the transmission of the original frame (IC=CC=3) followed by 3 repetitions, for a total amount of 4 transmissions.

All the other nodes in the network (both Server and REPEATER) receive the transmissions and provide an M_Data.Indication to the local host upon receipt of the first valid MAC frame (i.e. with valid FCS), while the following transmissions are neglected (as they are detected as being repetitions).

Below is the expected behavior of the nodes:

- Server A: as the link between the Client and this node is assumed to be good in this example, the node receives the 4 valid frames (i.e. with valid FCS). It provides an M_Data.Indication upon receipt of MAC frame CC=3. The following repetitions (CC=2, CC=1, CC=0) are neglected.
- REPEATER B: the link between the Client and this node is assumed to be noisy, with the noise corrupting the reception of MAC frames marked with CC=3. This node provides an M_Data.Indication upon receipt of MAC frame CC=2. The node joins the repetitions by transmitting 2 frames with CC=1 and CC=0.
- Server C: the link between the Client and this node is assumed to be noisy, with the noise corrupting the reception of MAC frames marked with CC=3 and CC=2. This node provides an M_Data.Indication upon receipt of MAC frame CC=1 coming from Server B. The following repetition (CC=0) is neglected.

Figure 12. Repetitions example



4.9 Additional features

4.9.1 Delta-phase detection at 2400 bps baud rate

When the ST7570 is running at 2400 bps, the delta-phase detection is affected by ±180° ambiguity, due to the fact that time-slots start alternatively on positive zero-crossing or negative zero-crossing.

In order to remove such ambiguity, the transmitter can be forced to start the transmission of a new frame on a positive zero-crossing only. The detection algorithm in the receiver can be adapted in the same way.

MIB object 0013h (smart-phase detection) can be used to configure this special feature. Admitted values and corresponding behavior during transmission and reception are shown in *Table 8*:

Table 8. Delta-phase detection

Value	Name	Behavior	
		Transmission	Delta-phase detection (reception)
0	DISABLED	The transmission of a new PHY frame starts on a positive or negative zero-crossing.	Normal.
1	TX	The transmission of a new PHY frame starts on a positive zero-crossing only.	Normal.
2	RX	The transmission of a new PHY frame starts on a positive or negative zero-crossing.	Delta-phase detection is calculated taking into account all MAC frame fields.
3	TXRX	The transmission of a new PHY frame starts on a positive zero-crossing only.	Delta-phase detection is calculated taking into account all MAC frame fields.

The typical configuration is TX for a Client and RX for a Server.

If enabled, the phase estimated by the smart-phase detection is written in the MIB object 0014h (Phase). This object is updated only when the sender of the frame was an initiator (i.e. the source MAC address is in the range FIMA – LIMA of the receiver).

5 Host interface

The host interface is a communication port used by the external host to exchange data with the ST7570.

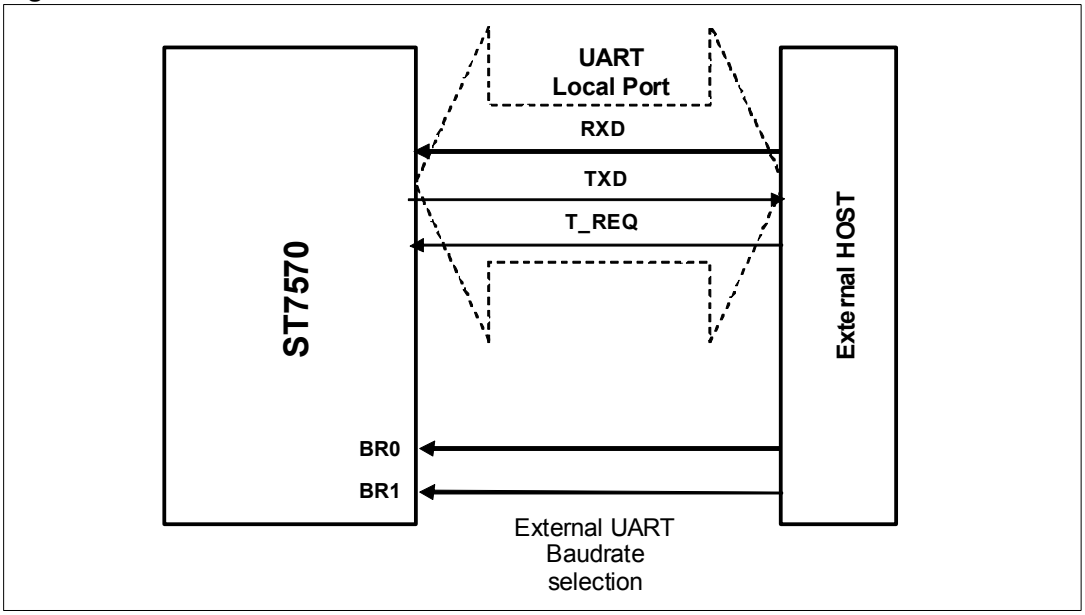
The host interface consists of a local port (a standard UART), a communication protocol, and a set of commands exchanged between ST7570 and the external host. It manages the communication and arbitration on the local port, and provides access to all the ST7570 internal services.

5.1 UART

The local communication is a half duplex asynchronous serial link (UART) using a receiving input (RXD), a transmitting output (TXD), and a T_REQ signal to manage the communication.

The connection diagram of the ST7570 using UART as the host interface port is shown in *Figure 13*:

Figure 13. ST7570 and external host: UART connections



The communication baud rate is selected after the ST7570 reset, in accordance with the status of local input ports BR0 and BR1 listed in *Table 9*:

Table 9. UART baud rate

BR1	BR0	Baud rate (b/s)
0	0	9600
0	1	19200
1	0	38400
1	1	57600

The UART interface has two data channels:

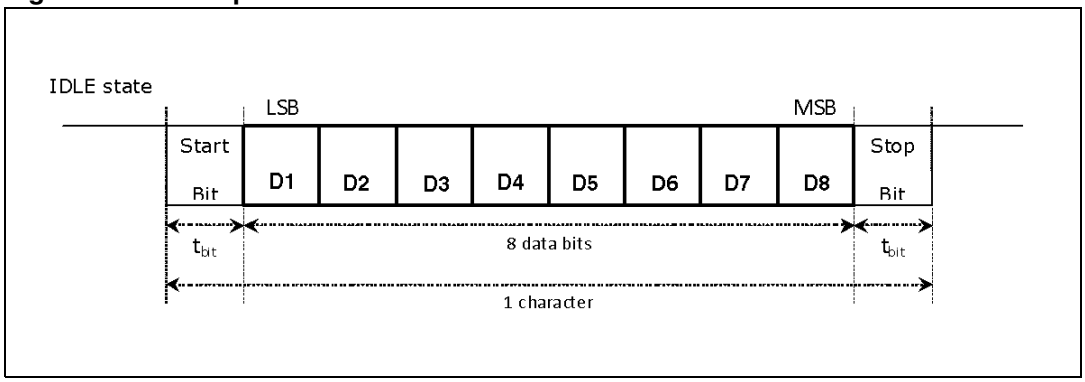
- TXD carries data from the ST7570 to the host
- RXD carries data from the host to the ST7570.

The UART communication has the following settings:

- Half duplex mode
- Standard NRZ bit coding
- LSBit first transmission: the bits within each byte are sent LSBit to MSBit
- The exchanged frames are composed of characters
- A single character is composed of 1 start bit, 8 data bits, and 1 stop bit
- 0-5 V or 0-3.3 V levels on TXD, RXD, T_REQ signals.

Figure 14 shows the character format:

Figure 14. Local port character format



5.2 Communication protocol

The host interface process implemented in the ST7570 device performs the following tasks:

- Frame format definition
- Reception mechanism: the UART standard on the half duplex data channel is implemented and collisions are avoided
- Acknowledgement to received frames
- Timeout management
- Error checking: length, syntax, and checksum field of a received frame are controlled and a repetition is requested in case of error.

5.2.1 Frame types

A frame is a sequence of one or more characters encapsulating data exchanged between the ST7570 and the external host. The communication protocol defines several frame formats for the different steps of the communication protocol (access to ST7570 services, acknowledgement, device status).

All the ST7570 resources and services (PHY layer, MAC layer, and MIB management) are available through local commands and they can be handled by the external host using the local communication serial interface and the commands defined in the next paragraphs.

As described in *Section 2.2*, the ST7570 protocol stack implemented in compliance with [2] can be accessed at the physical layer (PHY mode) or at the MAC layer (MAC mode). Several commands of the host interface may present a different format and behavior according to the selected mode.

Local frames

The format of the frame used in the local communication between the ST7570 and the external host is graphically represented in *Figure 15*:

Figure 15. Local frame format

The frame fields are described in *Table 10*:

Table 10. Local frame format

Field	Byte length	Value	Description
STX	1	02h	Start of text delimiter
Length	1	3..250	Byte length of fields: command + data + checksum
Command code	1	0..FFh	Command code
Data	0..247		Data field (247 byte max)
Checksum	2		The checksum of the local frame is the result of the addition of the elements of the frame, from length up to the last data byte, or up to the command byte if there is no data byte.

Byte endianness for fields (data and checksum) with a length greater than one byte is:

- Data field: structured in sub-fields in accordance with command code specifications described in *5.3*. Sub-fields with a length greater than one byte are sent LSByte first unless otherwise specified
- Checksum field: is sent LSByte first.

Status message

The status message is composed of 4 bytes, filled according to the operating mode selected.

The first byte (byte index 0) is always the character “?” (ASCII code 3Fh). Other bytes are set as in *Table 11*:

Table 11. Status message composition

Byte index	MSBit	6	5	4	3	2	1	LSBit
0	? (ASCII code 3Fh)							
Not set (PHY and MAC mode)								
1	OVERCURRENT	THERMAL STOP	MODE		0	0	LAYER	0
2	0	0	0	RESET	FW_RELEASE = 1		0	ZC_FAIL
3	0	0	0	0	0	0	0	0
Client (PHY mode)								
1	OVERCURRENT	THERMAL STOP	MODE		0	SYNC	LAYER	BUSY
2	0	0	0	RESET	FW_RELEASE = 1		ALARM	ZC_FAIL
3	0	0	0	0	0	0	0	0
Client (MAC mode)								
1	OVERCURRENT	THERMAL STOP	MODE		0	SYNC	LAYER	BUSY
2	TS_COUNTER[2..0]			RESET	FW_RELEASE = 1		ALARM	ZC_FAIL
3	INVALID_FRAME[7..0]							
Server (PHY mode)								
1	OVERCURRENT	THERMAL STOP	MODE		0	SYNC	LAYER	BUSY
2	0	0	0	RESET	FW_RELEASE = 1		ALARM	ZC_FAIL
3	DELTA_PHASE[2..0]			0	0	0	0	0
Server (MAC mode)								
1	OVERCURRENT	THERMAL STOP	MODE		NEW	SYNC	LAYER	BUSY
2	TS_COUNTER[2..0]			RESET	FW_RELEASE = 1		ALARM	ZC_FAIL
3	DELTA_PHASE[2..0]			MIN_CREDIT[3..0]				REPEATER
Monitor (only PHY mode)								
1	OVERCURRENT	THERMAL STOP	MODE		0	SYNC	LAYER	BUSY
2	0	0	0	RESET	FW_RELEASE = 1		ALARM	ZC_FAIL
3	DELTA_PHASE[2..0]			0	0	0	0	0

The status fields mentioned in *Table 11* are coded as follows:

OVERCURRENT: at least one frame previously transmitted by the device has been current limited

0: no overcurrent

1: overcurrent

THERMAL STOP: a thermal shutdown (see ST7570 power line networking system on chip datasheet) previously occurred

0: no thermal shutdown

1: thermal shutdown

MODE: operating mode

0: Idle mode, Test modes

1: Client

2: Server

3: Monitor

SYNC: Synchronization status

0: modem synchronized

1: modem not synchronized

LAYER: access point

0: PHY layer

1: MAC layer

BUSY: Physical layer is busy (a transmission or reception is in progress, or a transmission has been requested but not yet started)

0: not busy

1: busy

RESET: last Reset event cause

0: Hardware Reset (boot or RESETn low)

1: Software Reset (through CMD_ResetRequest)

FW_RELEASE: embedded firmware version

ALARM: alarm reception notification (if the bit is active one time only, at the next status message sent by the ST7570 after receiving an alarm only)

0: No alarm reception after the previous Status Message

1: Alarm reception after the previous Status Message

ZC_FAILURE: notification of Zero Crossing loss

0: the internal ZC PLL is properly locked at the frequency set (50 Hz or 60 Hz)

1: the internal ZC PLL is not locked at the frequency set

TS_COUNTER[2..0]: Time-slot counter

Possible values from 0 to 7

DELTA_PHASE[2..0]: Electrical delta-phase

Table 12. Delta-phase

Delta_Phase value	Phase [°]
0	Not measured
1	0
2	+60
3	+120
4	±180
5	-120
6	-60

INVALID_FRAME[7..0]: Invalid frames

LSByte of MIB object 0006h (invalid frame counter).

MIN_CREDIT [3..0]: Minimum delta credit

Possible values from 0 to 7

REPEATER: Repeater status

0: not a repeater

1: repeater

Acknowledgement messages

After receiving a local frame on the host interface, both the external host and ST7570 must send an acknowledgement or not acknowledgement message through either TXD (ST7570) or RXD (external host).

The two messages have the same format for both ST7570 and the external host and they are 1 byte long.

Table 13 lists their fixed codes.

Table 13. ACK and NAK message codes

Symbol	Definition	Code
ACK	Acknowledgement	06h
NAK	Not acknowledgement	15h

5.2.2 Local port arbitration rules

The ST7570 modem is always the communication master. In the case of no local transfer, the ST7570 can initiate a local communication without taking into account the external host status. On the other hand, when the external host wants to send data (using a local frame), it must first send a request through the T_REQ (transmitting request) input port. Then, the ST7570 answers with a status message allowing or not the reception of a frame (or any other command).

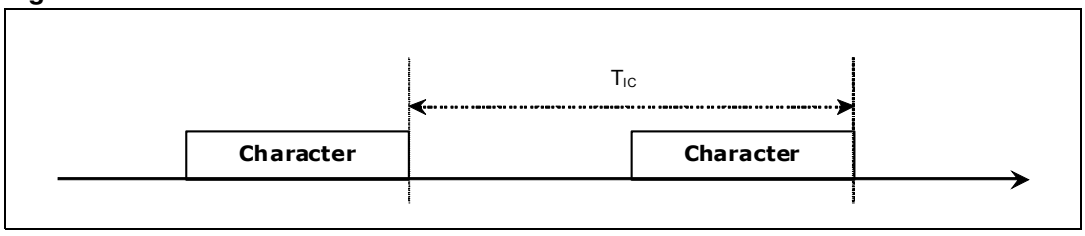
Frame delimitation

Data coming from the UART serial port are an asynchronous flow of bytes. In order to divide the byte flow into a frame flow, the ST7570 communication protocol uses two methods: length and timeout.

When the number of bytes received reaches the expected frame length, in accordance with the frame type characteristics, the frame reception ends.

The time interval between two consecutive characters (two local frames including start and stop bits) in a local frame must not exceed T_{IC} (timeout inter-character): the receiving part (ST7570 host interface or external host) no longer accepts any character after this delay expiration.

Figure 16. Timeout inter-character TIC



The timeout inter-character (T_{IC}) is set by default at 10 ms after a reset and can be modified by writing a dedicated MIB object (*Section 6.5.12*).

If the length and the checksum are both correct, the received frame is accepted, otherwise all previous characters are discarded.

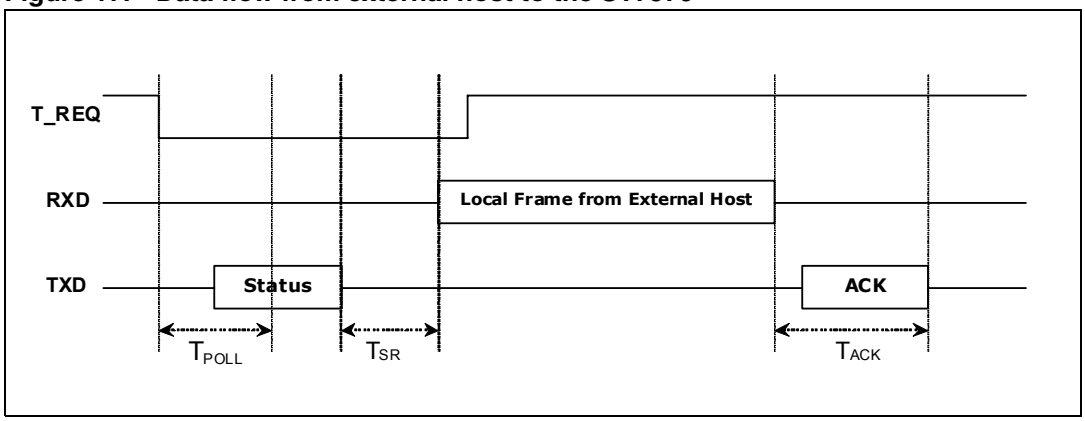
Data communication from the external host to the ST7570

When the external host needs to initiate a data transfer to the ST7570, it must set the T_REQ signal at low level. The ST7570 answers within the T_{POLL} delay with the status message confirming or not the data channel availability.

If the communication is possible, the external host can start sending a local frame within the T_{SR} delay. The T_REQ signal is set to a high logic value as soon as the first character (STX) of the local frame (*Section 5.2.1*) has been sent. If the first byte of the local frame is not received before the T_{SR} delay, the ST7570 ignores it.

At the end of the data reception on the RXD line, the ST7570 sends an acknowledgement message on the TXD line to inform the status of the transmission (ACK or NAK).

Figure 17. Data flow from external host to the ST7570



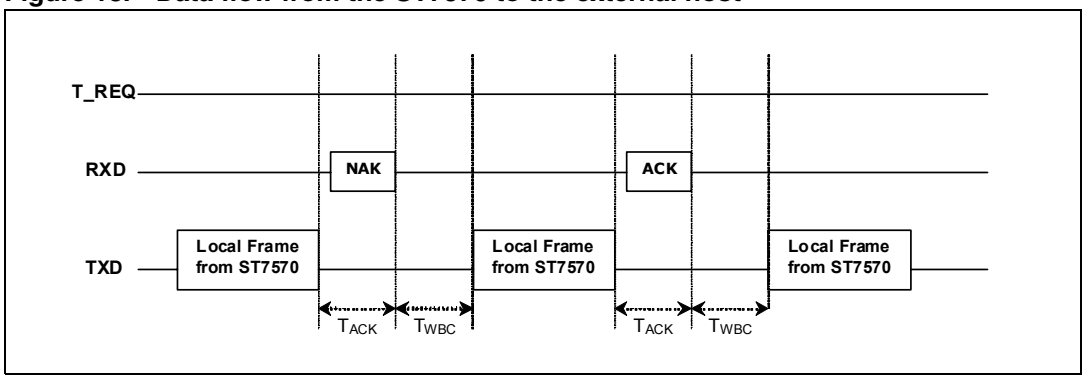
If the length and the checksum of the local frame are both correct, the ST7570 acknowledges with an ACK character. In other cases, it answers with an NAK character.

In the case of an NAK response or no acknowledgement from the ST7570 within the T_{ACK} timeout, a complete sequence must be restarted to repeat the frame.

Data communication from the ST7570 to the external host

When the ST7570 needs to transmit a frame to the host, it can directly send it without any previous request.

Figure 18. Data flow from the ST7570 to the external host



If the length and the checksum of the local frame are both correct, the external host micro acknowledges with an ACK character. In other cases, it answers with an NAK character.

In the case of an NAK response from the external host, the ST7570 repeats the frame only once after a delay corresponding to T_{WBC} (wait before continue).

A missed response from the external host or a framing error when an ACK character is awaited is considered as an acknowledgment.

5.2.3 Host interface timeouts

All the default values of host interface time-outs are reported in *Table 14*.

Table 14. Host interface timeout values

Timeout	Default value [ms]
T_{ACK}	40
T_{POLL}	20
T_{SR}	200
T_{WBC}	5
T_{IC}	10

5.3 Command codes

Each command frame exchanged between the host controller and the ST7570 carries a command, identified by a unique command code (declared in the command code field as in *Figure 15*).

It is possible to distinguish three different commands types:

- Request commands sent by the external host to use an ST7570 service
- Confirm/Error commands sent by the ST7570 to answer a previous request command
- Indication commands sent by the ST7570 to inform the external host of a change on its services; these are unsolicited commands not following any request.

Table 15 lists all the available commands, grouped according to the different types of services offered by the ST7570.

Table 15. List of available command codes

Group	Command	Code
Synchronization	CMD_SynchroIndication	10h
	CMD_DesynchroRequest	11h
	CMD_SynchroStatus	85h
Reset	CMD_ResetRequest	21h
MIB	CMD_WriteDBRequest	41h
	CMD_WriteDBConfirm	42h
	CMD_WriteDBError	43h
	CMD_ReadDBRequest	90h
	CMD_ReadDBConfirm	91h
	CMD_ReadDBError	92h

Table 15. List of available command codes (continued)

Group	Command	Code
Data	CMD_DataIndication	50h
	CMD_DataRequest	51h
	CMD_DataConfirm	52h
Alarm	CMD_AlarmRequest	88h
	CMD_AlarmConfirm	89h
	CMD_AlarmIndication	8Ah
Spy	SPY_No_SubframeIndication	A0h
	SPY_SubframeIndication	B0h
	SPY_SearchSynchroIndication	C0h
	SPY_SynchroFoundIndication	D0h
	SPY_No_AlarmIndication	E0h
	SPY_AlarmIndication	F0h
Repeater Call	CMD_RC_Request	61h
	CMD_RC_Confirm	62h
Intelligent Synchronization	CMD_IS_Indication	15h
Error	CMD_SyntaxError	20h

5.3.1 CMD_SynchroIndication (10h)

This command exports the following services to the external host:

- PHY mode: P_Sync.Indication
- MAC mode: M_Sync.Indication.

This command is generated by the ST7570 itself to indicate to the host a change in the synchronization status (*Section 3.3*). Its meaning is different in accordance with the operating mode:

- PHY mode: this indication is generated every time a valid PRE+SSD sequence is found
- MAC mode: this indication is generated every time a change in the synchronization state occurs.

Table 16. CMD_SynchroIndication: Syntax

Source	Command (Data)	Possible response
ST7570	CMD_SynchroIndication(SyncData)	None

Table 17. CMD_SynchroIndication: SyncData (PHY mode):

Byte index	Label	Description
0..2	S0	Amplitude of signal on channel 0. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*).
3..5	N0	Amplitude of noise on channel 0. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*).
6..8	S1	Amplitude of signal on channel 1. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*)
9..11	N1	Amplitude of noise on channel 1. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*)
12	PGA	Gain of the reception PGA.
13	PHASE	Electrical delta-phase

Table 18. CMD_SynchroIndication: SyncData (MAC mode)

Byte index	Label	Description
0	SYNC	Status of synchronization change: 1: Synchronization FOUND 2: Synchronization CONFIRMED 4: Synchronization LOST 5: Synchronization INTELLIGENT (0x05)
Other bytes differ according to the SYNC byte status If SYNC = 1 (Synchronization FOUND)		
1..3	S0	Amplitude of signal on channel 0. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*).
4..6	N0	Amplitude of noise on channel 0. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*)
7..9	S1	Amplitude of signal on channel 1. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*).
10..12	N1	Amplitude of noise on channel 1. Raw estimation performed on received preamble + SSD sequence (*Section : Raw estimation*)
13	PGA	Gain of the reception PGA.
14	PHASE	Electrical delta-phase
If SYNC = 2 (Synchronization CONFIRMED)		
1	PAD	Padding byte. Not used.
2..3	SA	Source address
4..5	DA	Destination address
If SYNC = 4 (Synchronization LOST)		
1	CAUSE	1: Timeout not addressed expired 2: Timeout frame not OK expired 3: Timeout synchronization confirm expired 4: Addressed by a wrong initiator 5: Desynchronization request from host (by accessing MIB object 00A0h, *Section 6.5.29*)
2..3	ADD1	Local MAC address (if CAUSE = 1, 2, 3, 5, 6, 7, 8) Source MAC address (if CAUSE = 4)
4..5	ADD2	Initiator MAC address (if CAUSE = 1, 2, 3, 5, 6, 7, 8) Destination MAC address (if CAUSE = 4)
If SYNC = 5 (Synchronization INTELLIGENT)		
1	CAUSE	LM_IS_INIT (06h): Synchronization AutoReject after the reception of a valid MAC frame by an Initiator (MAC address within FIMA, LIMA interval) during Intelligent Synchronization first phase LM_IS_SYNC_FAST (07h): Fast Synchronization achieved LM_IS_NOT_INIT (08h): Synchronization AutoReject after the reception of a valid MAC frame by a node not configured as Initiator (MAC address not within FIMA, LIMA interval) during Intelligent Synchronization first phase
2..3	ADD	Initiator MAC Address
4..5	S	Max Received Signal level (between S0, S1), expressed as 100*dBµV

5.3.2 CMD_SynchroStatus (85h)

Only in PHY mode can the host retrieve the synchronization status at any time.

Table 19. CMD_SynchroStatus: Syntax

Source	Command(Data field)	Possible response
Ext. host	CMD_SynchroStatus(none)	CMD_SynchroStatus (SyncStatus)

Where the SyncStatus parameter can be equal to the following values:

Table 20. CMD_SynchroStatus: SyncStatus (PHY mode)

Byte index	Label	Description
0	STATUS	1: LP_SYNC_FOUND: Synchronization found (valid preamble + SSD sequence detected) 2: LP_SYNC_LOSS: Synchronization lost or not found

5.3.3 CMD_DesynchroRequest (11h)

This command exports the following services to the external host:

- PHY mode: P_Sync.Request
- MAC mode: M_Sync.Request.

This command is used by the external host to force the ST7570 to discard the current synchronization.

Table 21. CMD_DesynchroRequest: Syntax

Source	Command(Data field)	Possible response
Ext. host	CMD_DesynchroRequest(Reset)	PHY mode: none MAC mode: CMD_SynchroIndication(SyncData)

Table 22. CMD_DesynchroRequest: Reset

Byte index	Label	Description
0	RESET	1: Rejects current synchronization

The SyncData field returned by the CMD_SynchroIndication() is filled, as listed in *Section 5.3.1*, with SYNC parameter equal to 4 and CAUSE equal to 5.

Note: In the case of MAC mode, this command has the same effect of setting the MIB object 00A0h (New synchronization, Section 6.5.29) to a high logic value, by using the CMD_WriteDBRequest (Section 5.3.5) function.

5.3.4 CMD_ResetRequest (21h)

This command is used by the external host to force a software reset in the ST7570.

The host can decide to keep the current configuration (automatically refreshed through the auto-reconfiguration procedure) or to reload the factory default settings.

After the reset, the ST7570 sends a confirmation with the same command code.

Table 23. CMD_ResetRequest: Syntax

Source	Command(Args)	Possible response
Ext. host	CMD_ResetRequest(ResetData)	CMD_ResetRequest(ResetConfirm)

Table 24. CMD_ResetRequest: ResetData

Byte index	Label	Description
0	RESET	Auto-reconfiguration bypass 0 = OFF: The system performs an auto-reconfiguration. All the registers are refreshed with the previous configuration, if no corruption occurred (*Section 7.2*) 1 = ON: The auto-reconfiguration is by-passed. All the registers are loaded with the factory default values.

Table 25. CMD_ResetRequest: ResetConfirm

Byte index	Label	Description
0	RESET	0: The reset request has been taken into account

5.3.5 CMD_WriteDBRequest (41h)

This command is used by the external host to access an object of the MIB.

The ST7570 checks the parameters for validation:

- If the check is valid, the object is updated in the database and ST7570 replies with a CMD_WriteDBConfirm (*Section 5.3.6*)
- If the check is not valid, the request is rejected and the ST7570 replies with a CMD_WriteDBError (*Section 5.3.7*).

Table 26. CMD_WriteDBRequest: Syntax

Source	Command(Args)	Possible response
Ext. host	CMD_WriteDBRequest(RequestData)	Request accepted: CMD_WriteDBConfirm(RequestData) Request rejected: CMD_WriteDBError(ErrorData)

Table 27. CMD_WriteDBRequest: RequestData

Byte index	Label	Description
0..1	INDEX	Database entry index. Refer to the MIB table for available objects. LSByte sent first, the MSB is set at 00h.
2..variable	DATA	Data to be written in the MIB location INDEX.

5.3.6 CMD_WriteDBConfirm (42h)

This command is sent by the ST7570 to acknowledge a CMD_WriteDBRequest() if the request has been accepted and executed without errors. Otherwise a CMD_WriteDBError() is returned.

The field ConfirmData returned by this command has the same format and content of the field RequestData (*Table 27*) of the CMD_WriteDBRequest().

Table 28. CMD_WriteDBConfirm: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_WriteDBConfirm(ConfirmData)	None

5.3.7 CMD_WriteDBError (43h)

This command is sent by the ST7570 to notify that a CMD_WriteDBRequest() performed by the external host has been rejected because of invalid request data.

Table 29. CMD_WriteDBError: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_WriteDBError(ErrorData)	None

Table 30. CMD_WriteDBError: ErrorData

Byte index	Label	Description
0	ERROR	Error code: 11h: ERR_UNAVAILABLE_RESOURCE: the selected MIB object does not exist or it does not exist for the current operating mode (MAC or PHY) 12h: ERR_REQUEST_NOT_ALLOWED: the writing request to a MIB object failed 22h: ERR_ILLEGAL_DATA_COMMAND: the format or value of the request data is not valid for the selected object 23h: ERR_ILLEGAL_LOCAL_MAC_ADR: invalid local MAC address 24h: ERR_ILLEGAL_INITIATOR_MAC_ADR: invalid initiator MAC address

5.3.8 CMD_ReadDBRequest (90h)

This command is used by the external host to read the current value of an MIB object.

The ST7570 checks the parameters for validation:

- if valid, the request is accepted and the ST7570 returns the object value through a CMD_ReadDBConfirm(*Section 5.3.9*)
- if the check is not valid, the request is rejected and the ST7570 replies with a CMD_ReadDBError(*Section 5.3.10*).

Table 31. CMD_ReadDBRequest: Syntax

Source	Command(Args)	Possible response
Ext. host	CMD_ReadDBRequest (RequestData)	Request accepted: CMD_ReadDBConfirrm(RequestData) Error: CMD_ReadDBError(ErrorCode).

Table 32. CMD_ReadDBRequest: RequestData

Byte index	Label	Description
0 - 1	INDEX	Database entry index. Refer to MIB table for available objects. LSByte sent first, the MSByte is always set at 00h.

5.3.9 CMD_ReadDBConfirm (91h)

This command is sent by the ST7570 to acknowledge a CMD_ReadDBRequest() performed by the external host, if the request has been accepted and executed without errors.

The ConfirmData field returned by this command has the same format and content of the field RequestData (*Table 27*)of the CMD_WriteDBRequest().

Table 33. CMD_ReadDBConfirm: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_ReadDBConfirm(ConfirmData)	None

5.3.10 CMD_ReadDBError (92h)

This command is sent by the ST7570 to notify that a CMD_ReadDBRequest() performed by the external host has been rejected because of an invalid request data.

Table 34. CMD_ReadDBError: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_ReadDBError(ErrorData)	None

Table 35. CMD_ReadDBError: ErrorData

Byte index	Label	Description
0	ERROR	Error code: 11h: ERR_UNAVAILABLE_RESOURCE: the selected MIB object does not exist or it does not exist for the current operating mode (MAC or PHY) 12h: ERR_REQUEST_NOT_ALLOWED: the writing request to an MIB object failed 22h: ERR_ILLEGAL_DATA_COMMAND: the format or value of the request data is not valid for the selected object

5.3.11 CMD_DataIndication (50h)

This command exports the following services to the external host:

- PHY mode: P_Data.Indication
- MAC mode: M_Data.Indication.

This command is sent by the ST7570 to indicate the reception of data at PHY or MAC level, according to the operating mode selected.

When operating in MAC mode and a frame with repetitions (i.e. with credits IC and CC > 0) is received, the CMD_DataIndication is always notified upon receipt of the first valid MAC frame within the repetition burst (*Figure 19*).

Figure 19. Receipt of a MAC frame with repetitions (example with IC=3)

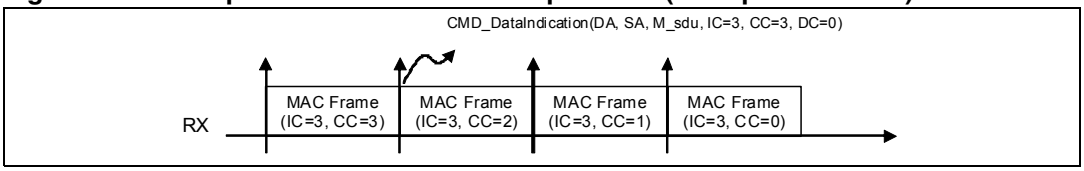


Table 36. CMD_DataIndication: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_DataIndication(IndicationData)	None

Table 37. CMD_DataIndication: IndicationData (PHY mode)

Byte index	Label	Description
0..37	P_SDU	38 bytes containing the received data at the physical layer (PHYsical service data unit)
38..39	ASK0	Number of bits equal to ‘0’ demodulated incrementing the ASK counter (*Section 3.6.2*)
40..41	ASK1	Number of bits equal to ‘1’ demodulated incrementing the ASK counter (*Section 3.6.2*)
42..43	FSK	Number of bits demodulated incrementing the SFSK counter (*Section 3.6.2*)
44..46	SNR0	Estimated signal-to-noise ratio on channel 0 (*Section : Fine estimation*)
47..49	SNR1	Estimated signal-to-noise ratio on channel 1 (*Section : Fine estimation*)

Table 38. CMD_DataIndication: IndicationData (MAC mode)

Byte index	Label	Description
0	CREDIT	Credit information b7 – b5: Initial credit IC b4 – b2: Current credit CC b1 – b0: Delta credit DC UART data transmission: LSBit first (from b0 to b7)
1..3	ADDRESS	b23 – b12: MAC source address b11 – b0: MAC destination address UART data transmission: MSByte first. Therefore, the 3 bytes are transmitted following this order: • From b16 to b23 • From b8 to b15 • From b0 to b7.
4	PAD	1 byte padding
5..246	M_SDU	MAC service data unit. (up to 242 bytes). UART data transmission: MSByte first.

5.3.12 CMD_DataRequest (51h)

This command exports the following services to the external host:

- PHY mode: P_Data.Request
- MAC mode: M_Data.Request.

This command is sent by the external host to request data transmission.

The request can be accepted or refused by the ST7570:

- If accepted, the ST7570 performs a transmission starting on the next time-slot. A positive CMD_DataConfirm (*Section 5.3.13*) is generated at the end of the transmission
- If refused, the modem generates an immediate negative CMD_DataConfirm (*Section 5.3.13*).

Table 39. CMD_DataRequest: Syntax

Source	Command(Args)	Possible response
Ext. Host	CMD_DataRequest(RequestData)	CMD_DataConfirm(ConfirmData)

Table 40. CMD_DataRequest: RequestData (PHY mode)

Byte index	Label	Description
0..37	P_SDU	Physical service data unit.

Table 41. CMD_DataRequest: RequestData (MAC mode)

Byte index	Label	Description
0	CREDIT	Credit information b7 – b5: Initial credit IC b4 - b2: Current credit CC b1 – b0: Delta credit DC UART data transmission: LSBit first (from b0 to b7)
1..3	ADDRESS	b23 – b12: MAC source address b11 – b0: MAC destination address UART data transmission: MSByte first, LSBit first. Therefore, the 3 bytes are transmitted following this order: • From b16 to b23 • From b8 to b15 • From b0 to b7.
4	PAD	1 byte padding (equal to 00h)
5..246	M_SDU	Mac service data unit (up to 242 bytes). UART data transmission: MSByte first.

5.3.13 CMD_DataConfirm (52h)

This command exports the following services to the external host:

- PHY mode: P_Data.Confirm
- MAC mode: M_Data.Confirm.

This command is sent by the ST7570 to provide a positive or negative confirmation to a data request previously requested by the external host.

The data field is a 1-byte field containing the result of the previous request.

When operating in MAC mode and a frame with repetitions (i.e. with credits IC and CC > 0) is transmitted, the CMD_DataConfirm is always notified as soon as the transmission of the first MAC frame within the repetition burst is completed (*Figure 20*).

Figure 20. Transmission of a MAC frame with repetitions (example with IC=3)

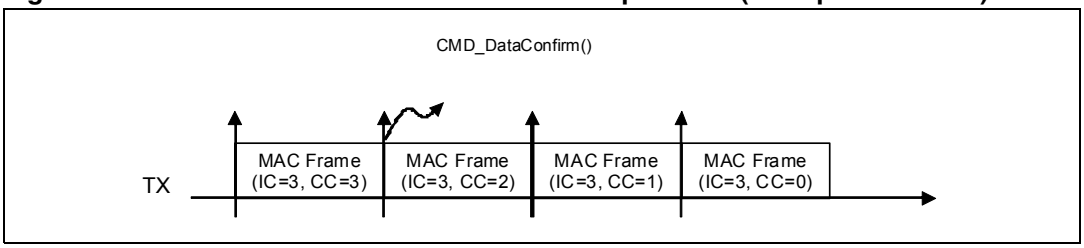


Table 42. CMD_DataConfirm: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_DataConfirm(ConfirmData)	None

Table 43. CMD_DataConfirm: ConfirmData (PHY or MAC mode)

Byte index	Label	Description
0	CONFIRM_CODE	PHY mode: LP_TU (00h): PHY layer is busy (e.g.: another transmission is already pending or in progress, data request outside the acceptance window) LM_SE (03h): Length not correct on DataRequest LP_NS (04h): Modem is not mains-synchronized LP_NOT_VALID (06h): No data request pending or error at physical layer LP_OK (FFh) : No error
		MAC mode: LM_TU (00h): MAC layer is busy LM_NI (01h): Not available type LP_HF (02h): Error at physical level LM_SE (03h): Length not correct on DataRequest LM_NS (04h): Modem is not synchronized LM_IS (05h): Modem is during Intelligent Synchronization Search LM_NOT_VALID (06h): No data request pending LM_OK (FFh): No error

5.3.14 CMD_AlarmIndication (8Ah)

This command exports the following services to the external host:

- PHY mode: P_Alarm.Indication
- MAC mode: M_Alarm.Indication.

This command is sent by the ST7570 to indicate the receipt of an alarm.

The additional data provided depends on the indication format selected through MIB object 0086h (SN indication, *Section 6.5.28*):

- Short alarm indication: the modem sends a 4-byte counter for the number of alarms received
- Long alarm indication: the modem sends a 4-byte alarm counter followed by the signal and noise estimations.

Table 44. CMD_AlarmIndication: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_AlarmIndication(Data)	None

Table 45. CMD_AlarmIndication: Data (PHY or MAC mode)

Byte index	Label	Description
0..3	CNT	Alarms received counter.
If a long alarm indication is selected:		
4..6	S0	Amplitude estimation of channel 0 signal.
7..9	N0	Amplitude estimation of channel 0 noise.
10..12	S1	Amplitude estimation of channel 1 signal.
13..15	N1	Amplitude estimation of channel 1 noise.
16	PAD	Padding byte.

5.3.15 CMD_AlarmRequest (88h)

This command exports the following services to the external host:

- PHY mode: P_Alarm.Request
- MAC mode: M_Alarm.Request.

This command is sent by the external host to request the transmission of an alarm.

A positive or negative confirmation (CMD_AlarmConfirm) follows this request; if accepted, the request is accomplished in the next alarm slot.

Table 46. CMD_AlarmRequest: Syntax

Source	Command(Args)	Possible response
Ext. Host	CMD_AlarmRequest(none)	CMD_AlarmConfirm(Data)

5.3.16 CMD_AlarmConfirm (89h)

This command exports the following services to the external host:

- PHY mode: P_Alarm.Confirm
- MAC mode: M_Alarm.Confirm.

This command is sent by the ST7570 to confirm an alarm request.

The data field is a 1-byte field containing the result of the previous request.

Table 47. CMD_AlarmConfirm: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_AlarmConfirm(Data)	None

Table 48. CMD_AlarmConfirm: Data (PHY or MAC mode)

Byte index	Label	Description
0	CONFIRM_CODE	LP_TU (00h): Modem busy. LP_NS (04h): Physical layer is not synchronized. LP_IS (05h): Modem is during Intelligent Synchronization search. LP_OK (FFh): The request has been successfully accomplished.

5.3.17 SPY_No_SubframeIndication (A0h)

If the ST7570 is configured to operate in PHY mode and as Monitor (refer to *Section 3.4.1*), and it is mains synchronized, this command is sent to indicate that no valid preamble+SSD sequence has been detected during the current time-slot.

Available in PHY mode only.

Table 49. SPY_No_SubframeIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_No_SubframeIndication(SpyData)	None

Table 50. SPY_No_SubframeIndication: SpyData (PHY mode only)

Byte index	Label	Description
0..2	S0	Signal amplitude estimated on channel 0 (*Section : Raw estimation*)
3..5	N0	Noise amplitude estimated on channel 0 (*Section : Raw estimation*)
6..8	S1	Signal amplitude estimated on channel 1 (*Section : Raw estimation*)
9..11	N1	Noise amplitude estimated on channel 1 (*Section : Raw estimation*)
12..69	PAD	Padding Bytes.

5.3.18 SPY_SubframeIndication (B0h)

If the ST7570 is configured to operate in PHY mode and as Monitor (*Section 3.4.1*), and is mains synchronized, this command is sent to indicate the reception of a valid physical subframe.

This command replaces the CMD_DataIndication used for ‘Client’ and ‘Server’ operating modes.

Available in PHY mode only.

Table 51. SPY_SubframeIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_SubframeIndication(SpyData)	None

Table 52. SPY_SubframeIndication: SpyData (PHY mode)

Byte index	Label	Description
0..2	S0	Signal amplitude estimated on channel 0 (*Section : Raw estimation*)
3..5	N0	Noise amplitude estimated on channel 0 (*Section : Raw estimation*)
6..8	S1	Signal amplitude estimated on channel 1 (*Section : Raw estimation*)
9..11	N1	Noise amplitude estimated on channel 1 (*Section : Raw estimation*)
12..13	ASK0	Number of bits demodulated using an ASK method on channel 0 (*Section 3.6.2*)
14..15	ASK1	Number of bits demodulated using an ASK method on channel 1 (*Section 3.6.2*)
16..17	FSK	Number of bits demodulated using an SFSK method (*Section 3.6.2*)
18	PGA	PGA Gain code (*Section 3.6.3*)
19..56	P_SDU	38-byte physical service data unit
57..59	SNR0	Signal to noise ratio on channel 0 (*Section : Fine estimation*)
60..62	SNR1	Signal to noise ratio on channel 1 (*Section : Fine estimation*)

5.3.19 SPY_SearchSynchroIndication (C0h)

If the ST7570 is configured to operate in PHY mode and as Monitor (*Section 3.4.1*), and is not mains synchronized, this command is sent from the ST7570 to the external host on the beginning of each time-slot until a valid synchronization is found.

Available in PHY mode only.

Table 53. SPY_SearchSynchroIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_SearchSynchroIndication(none)	None

5.3.20 SPY_SynchroFoundIndication (D0h)

If the ST7570 is configured to operate in PHY mode and as Monitor (refer to *Section 3.4.1*), it generates the SPY_SynchroFoundIndication as soon as it changes its synchronization status from not synchronized to synchronized.

Available in PHY mode only.

Table 54. SPY_SynchroFoundIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_SynchroFoundIndication(SpyData)	None

Table 55. SPY_SynchroFoundIndication: SpyData (PHY mode)

Byte index	Label	Description
0..2	S0	Signal amplitude estimated on channel 0 (*Section : Raw estimation*)
3..5	N0	Noise amplitude estimated on channel 0 (*Section : Raw estimation*)
6..8	S1	Signal amplitude estimated on channel 1 (*Section : Raw estimation*)
9..11	N1	Noise amplitude estimated on channel 1 (*Section : Raw estimation*)
12..13	ASK0	Number of bits demodulated using an ASK method on channel 0 (*Section 3.6.2*)
14..15	ASK1	Number of bits demodulated using an ASK method on channel 1 (*Section 3.6.2*)
16..17	FSK	Number of bits demodulated using an SFSK method (*Section 3.6.2*)
18	PGA	PGA gain code (*Section 3.6.3*)

5.3.21 SPY_No_AlarmIndication (E0h)

If the ST7570 is configured to operate in PHY mode and as Monitor, and is mains synchronized, this command is sent to indicate that no alarms have been received.

Available in PHY mode only.

Table 56. SPY_No_AlarmIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_No_AlarmIndication(SpyData)	None

Table 57. SPY_No_AlarmIndication: SpyData (PHY mode)

Byte index	Label	Description
0..2	AL_S0	Signal amplitude estimated on channel 0 (*Section : Raw estimation*)
3..5	AL_N0	Noise amplitude estimated on channel 0 (*Section : Raw estimation*)
6..8	AL_S1	Signal amplitude estimated on channel 1 (*Section : Raw estimation*)
9..11	AL_N1	Noise amplitude estimated on channel 1 (*Section : Raw estimation*)
12..18	PAD	Padding bytes
19..21	ALARM	Alarm pattern (569E89h, MSByte first transmission)

5.3.22 SPY_AlarmIndication (F0h)

If the ST7570 is configured to operate in PHY mode and as Monitor, and it is mains synchronized, this command is sent to indicate that an alarm has been received.

Available in PHY mode only.

Table 58. SPY_AlarmIndication: Syntax

Source	Command(Args)	Possible response
ST7570	SPY_AlarmIndication(SpyData)	None

Table 59. SPY_AlarmIndication: SpyData (PHY mode)

Byte index	Label	Description
0..2	AL_S0	Signal amplitude estimated on channel 0 (*Section : Raw estimation*)
3..5	AL_N0	Noise amplitude estimated on channel 0 (*Section : Raw estimation*)
6..8	AL_S1	Signal amplitude estimated on channel 1 (*Section : Raw estimation*)
9..11	AL_N1	Noise amplitude estimated on channel 1 (*Section : Raw estimation*)
12..18	PAD	Padding bytes
19..21	ALARM	Alarm pattern (569E89h, MSByte first transmission)

5.3.23 CMD_RC_Request (61h)

This command is sent by the external host to request a Repeater Call session (*Section 7.3*).

The request can be accepted or refused by the MAC layer only, and it is always followed by a positive or negative confirmation (CMD_RC_Confirm(*Section 5.3.24*)). If the node is set at PHY layer, the command does not take any effect.

Table 60. CMD_RC_Request: Syntax

Source	Command(Args)	Possible Response
Ext. Host	CMD_RC_Request(RequestData)	CMD_RC_Confirm(ConfirmData)

Table 61. CMD_RC_Request: RequestData

Byte index	Label	Description
0..1	TX_POS	Transmitting position
2..3	RC_THRESHOLD	SNR threshold value (to be expressed in 100*dBµV). A node set as Server or Monitor will decide its Repeater Status after comparison with this value.

If the two listed parameters of the command are filled to zero, and the node is set as MAC server:

- TX_POS will be filled by ST7570 equal to node Local MAC Address (if the node is NEW, it won't take part to Repeater Call procedure);
- RC_THRESHOLD value will be read by ST7570 from MIB object 000Ch (RC Threshold, *Section 6.5.13*).

5.3.24 CMD_RC_Confirm (62h)

This command is sent by the ST7570 to confirm a Repeater Call request.

Table 62. CMD_RC_Confirm: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_RC_Confirm(ConfirmData)	None

Table 63. CMD_RC_Confirm: ConfirmData

Byte Index	Label	Description
0	RESULT	LP_TU (00h): Repeater Call has been refused LP_NI (01h): Modem not yet initialized for Repeater Call (local MAC Address = NEW, TxPosition = 0) LP_NS (04h): Modem is not synchronized LP_NOT_VALID (06h): Repeater Call has been refused because the modem is configured as NEVER_REPEATER (MIB object 000Bh, TIC selector and Repeater Setting, *Section 6.5.12*) LP_OK (FFh): Repeater Call was accepted and ended successfully
1	REPEATER STATE	Repeater state set during the Repeater Call session. 0: NEVER_REPEATER 1: ALWAYS_REPEATER 2: NO_REPEATER 3: REPEATER
In the case the node is a SERVER and the RESULT field is LP_OK, additional data are appended about the RC pattern received:		
2..4	S	Estimated signal amplitude (100*dBµV), averaged on both channels
5..7	N	Estimated noise amplitude (100*dBµV), averaged on both channels
8..9	RX_POS	RX Position (sub-timeslot where the RC pattern has been received)

5.3.25 CMD_IS_Indication (15h)

This command is sent by the ST7570 to external host to notify it after the MIB object 0009h (Timeout Intelligent Synchronization, *Section 6.5.10*) value will be elapsed.

Table 64. CMD_IS_Indication: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_IS_Indication(IndicationData)	None

Table 65. CMD_IS_Indication: ConfirmData

Byte Index	Label	Description
0	IS_STATUS	LM_LOCKED (01h): A valid MAC frame has been received within the Intelligent Synchronization Timeout by at least one Initiator with a MAC address within FIMA and LIMA LM_NOT_LOCKED (02h): A valid MAC frame has not been received within the Intelligent Synchronization Timeout by at least one Initiator with a MAC address within FIMA and LIMA LM_NOT_REGISTERED (03h): after receiving a valid MAC frame during Intelligent Synchronization first phase, the node has not been registered (its Local MAC address is still equal to NEW) LM_TO_NOT_ADDRESSED (04h): after receiving a valid MAC frame during Intelligent Synchronization first phase, the Timeout frame not addressed elapsed.
In the case the IS_STATUS is equal to LM_LOCKED, the following additional bytes are appended		
1..2	ADD	Initiator MAC Address of the MAC frame received with the highest signal level during Intelligent Synchronization first phase.
3..4	S	Max Received Signal level (between S0, S1), expressed as 100*dBµV

5.3.26 CMD_SyntaxError (20h)

This command is sent by the ST7570 to the external host after receiving a local frame with syntax errors, meaning that at least one of the following cases has been detected:

- the value declared in the length field has not been respected in the data field transmission
- the value declared in command code does not correspond to any command listed in *Table 15*.

After the reception of a local frame with a wrong checksum field, an NAK acknowledgement is sent.

Table 66. CMD_SyntaxError: Syntax

Source	Command(Args)	Possible response
ST7570	CMD_SyntaxError(ErrorData)	None

Table 67. CMD_SyntaxError: ErrorData

Byte index	Label	Description
0	ERROR	01h: Error

6 Management information base (MIB)

The MIB collects all the parameters that allow the host to set and control the modem operation.

The host can update an MIB object through a CMD_WriteDBRequest specifying the object index and related value(s). The modem returns a confirmation message (CMD_WriteDBConfirm()) if the write request was correct, otherwise it returns an error message (CMD_WriteDBError()) according to the command failure.

Each MIB object can also be read by using the CMD_ReadDBRequest command. If the read request is correct the modem returns a confirmation message (CMD_ReadDBConfirm), otherwise it returns an error message (CMD_ReadDBError) according to the command failure.

Both read and write confirm messages (CMD_WriteDBConfirm() and CMD_ReadDBConfirm) have the same syntax and are specific for each MIB parameter.

6.1 MIB write request

This command is used by the external host to update the value of an object of the ST7570 MIB. A CMD_WriteDBRequest is composed of two fields, as in *Table 68*:

Table 68. MIB write request: Data

Byte index	Label	Description
0..1	INDEX	Object index (2bytes). Refer to the MIB table (*Table 71*) for available objects.
2..variable	DATA	Data to be written into the MIB location INDEX.

Both index and data field must be sent LSByte first.

The ST7570 checks the request for validation. Then, according to the result of the check:

- if valid, the object is updated in the MIB and the ST7570 replies with a CMD_WriteDBConfirm()
- if not valid, the request is rejected and the ST7570 replies with a CMD_WriteDBError().

In the following sections the details of all accepted index and data fields are described, as well as the error messages returned for each parameter.

6.2 MIB read request

This command is used by the external host to read the value of an object of the ST7570 MIB. A CMD_ReadDBRequest contains the MIB parameter to be read:

Table 69. MIB read request: Data

Byte	Label	Description
0 .. 1	INDEX	Database entry index. Refer to the MIB table (*Table 71*) for available objects. LSByte sent first.

The ST7570 checks the request for validation. Then, according to the result of the check:

- if valid, the object is read from the MIB and the ST7570 replies with a CMD_ReadDBConfirm
- if not valid, the request is rejected and the ST7570 replies with a CMD_ReadDBError().

6.3 MIB error message codes

All the error message codes are listed and described in *Table 70*, with identifier values.

Please note that these are only the error codes common to all the MIB parameters: for specific error codes of every MIB object, refer to the single MIB parameters description.

Table 70. MIB error message codes

Error ID	Description	Value
ERR_UNAVAILABLE_RESOURCE	Unavailable resource: no MIB parameter with the specified index	011h
ERR_REQUEST_NOT_ALLOWED	Request not allowed	012h
ERR_ILLEGAL_DATA_COMMAND	Illegal data command	022h
ERR_ILLEGAL_LOCAL_MAC_ADR	Illegal local MAC address	023h
ERR_ILLEGAL_INITIATOR_MAC_ADR	Illegal initiator MAC address	024h
ERR_PARAM_VAL_OUTOFRANGE	Parameter value out of range	026h

6.4 MIB table

Table 71 lists all the available MIB objects, with the related indexes, the default values, and the allowed request type (read and write).

Table 71. Database objects

Index	Name	Factory default	R/W
0000h	FIMA / LIMA	0C00h / 0DFFh	R/W
0001h	LocalMacAdd/InitMacAdd	NEW (0FFEh) / NOBODY(0000h)	R/W
0002h	Timeout synchro confirmation	3 s	R/W
0003h	Timeout frame not ok	40 s	R/W
0004h	Timeout not addressed	360 min	R/W
0005h	MAC group addresses	0000h, 0000h, 0000h, 0000h, 0000h	R/W
0006h	Invalid frame counter	0	R/W
0007h	Minimum delta credit	7	R/W
0008h	Disable frame type check Disable CRC check	Enabled (0) Enabled (0)	R/W
0009h	Timeout intelligent synchronization	0 s	R/W
000Ah	Valid frame counter	0	R/W
000Bh	TIC selector Repeater settings	0, NEVER_REPEATER (0)	R/W
000Ch	RC threshold	28A0h (104 dBµV)	R/W
000Dh	S0, N0, PGA	0,0,0	R
000Eh	S1, N1, phase	0,0,0	R
000Fh	Transmitted frame counter	0	R/W
0010h	Repeated frame counter	0	R/W
0011h	Bad frame indicator counter	0	R/W
0012h	Frame indicator	0000h (long MAC frame)	R/W
0013h	Smart-phase detect	0 (smart-phase detect disabled)	R/W
0014h	Phase	0	R/W
0015h	Auto synchronization reject	0	R/W
0016h	Intelligent synchronization threshold	2968h (106 dBµV)	R/W
0017h ... 0080h	Unused	----	----
0081h	Reserved	---	---
0082h	TX output gain Current limiting	Current control disabled (0), 10h	R/W

Table 71. Database objects (continued)

Index	Name	Factory default	R/W
0083h	Received alarm counter	0	R/W
0084h	Transmitted alarm counter	0	R/W
0085h	Alarm repeater Alarm before indication Alarm reject window	08h 02h 09h	R/W
0086h	Alarm indication Repetition disable SN indication disable	Enabled (0) Enabled (0) Disabled (1)	R/W
0087h ... 009Fh	Unused	---	---
00A0h	New synchronization	0	W
00A1h	PLC configuration	PHY mode, IDLE state, bit rate 1200 bits/s, ZC PLL 50 Hz, f_0=74.0kHz, f_1=63.3 kHz, current control disabled	R/W
00A2h	Reserved	--	--
00A3h	Reserved	--	--
00A4h	Programmable digital I/O pins	PRESLOT (0), OFF (0)	R/W
00ABh	Max PGA Gain	8	R/W
00ACh	Soft start	0000Ah	R/W
00C2h	Time-slot reset bit	1	R/W
00D1h	ZC delay compensation	0	R/W

6.5 MIB parameters

In this section all the MIB object are described in detail.

6.5.1 0000h (first and last initiator address, FIMA/LIMA)

This object stores the values of the FIMA (first initiator MAC address) and LIMA (last initiator MAC address) addresses.

Table 72. MIB object 0000h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	FIMA	First initiator MAC address	0000h .. 0FFFh	0C00h
2..3	LIMA	Last initiator MAC address	0000h .. 0FFFh	0DFFh

Read/write confirm data format:

The same as write request.

Table 73. MIB object 0000h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_ILLEGAL_INITIATOR_MAC_ADR	Parameter value is out of the allowed range

6.5.2 0001h (local MAC address and the initiator MAC address)

This object stores the values of the local MAC address and the Initiator MAC address.

Table 74. MIB object 0001h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	LocalMACAdd	Local MAC address	0000h <= x <= 0FFFh	NEW (0FFEh)
2..3	InitMACAdd	Initiator MAC address	0000h (NO-BODY), or FIMA <= x<=LIMA	NOBODY (0000h)

Read/write confirm data format:

The same as write request.

Table 75. MIB object 0001h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_ILLEGAL_LOCAL_MAC_ADR	Local MAC Address value is out of the allowed range
	ERR_ILLEGAL_INITIATOR_MAC_ADR	Initiator MAC Address value is out of the allowed range

6.5.3 0002h (timeout synchro confirmation)

This object stores the value (in seconds) of the synchronization-confirmation-timeout (*Section 4.6*). This object is applicable in Server mode only.

Table 76. MIB object 0002h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	Timeout synchro confirmation	Timeout value	0..65535 s	3 s

Read/write confirm data format:

The same as write request.

Table 77. MIB object 0002h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The modem is configured as Monitor

6.5.4 0003h (timeout frame not OK)

This object stores the value (in seconds) of the timeout-frame-not-OK (*Section 4.6*). This object is applicable in Server mode only.

Table 78. MIB object 0003h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	Timeout frame not ok	Timeout value	0 .. 65535 s	40 s

Read/write confirm data format:

The same as request.

Table 79. MIB object 0003h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The modem is configured as Monitor

6.5.5 0004h (timeout frame not addressed)

This object stores the value (in minutes) of the timeout-not-addressed (*Section 4.6*).

This object is applicable in Server mode only.

Table 80. MIB object 0004h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	Timeout not addressed	Timeout value	0 .. 65535 min	360 min

Read/write confirm data format:

The same as request.

Table 81. MIB object 0004h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The modem is configured as Monitor

6.5.6 0005h (MAC group addresses)

This object stores the values of the 5 MAC group addresses. (refer to [2]).

Table 82. MIB object 0005h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	MAC group address 0	1st MAC group address	0000h ... 0FFFh	0000h
2..3	MAC group address 1	2nd MAC group address	0000h ... 0FFFh	0000h
4..5	MAC group address 2	3rd MAC group address	0000h ... 0FFFh	0000h
6..7	MAC group address 3	4th MAC group address	0000h ... 0FFFh	0000h
8..9	MAC group address 4	5th MAC group address	0000h ... 0FFFh	0000h

Read/write confirm data format:

The same as request.

Table 83. MIB object 0005h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes or at least one address value out of range

6.5.7 0006h (invalid frame counter)

This object stores the number of the invalid received MAC frames.

After checking FI and Ns parameters in the received MAC frame, the counter is increased if at least one of the two following events occurred:

- The frame indicator parameter (FI) is not equal to LONG_MAC_FRAME (0000h) even if the frame type check is disabled (in Monitor modes only)
- The number of subframes (Ns field) in a received MAC frame is not correct
- The CRC field is wrong (even if CRC check is disabled, *Section 6.5.9*).

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 84. MIB object 0006h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	PAD	Padding bytes	0 .. FFFFFFFFh	0

Table 85. MIB object 0006h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Invalid frame counter	Invalid frame counter value	0 .. FFFFFFFFh	0

Table 86. MIB object 0006h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.8 0007h (minimum delta credit)

This object stores the minimum value of the delta credit DC parameter among all MAC frames received.

The confirm message of a CMD_ReadDBRequest returns the current value of the min. delta credit and keeps the value itself unchanged, the CMD_WriteDBRequest resets the value of the min. delta credit (7) and the confirm message returns its reset value (7).

Table 87. MIB object 0007h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Minimum delta credit	PAD word (can be any value)	0 .. 7	7

Table 88. MIB object 0007h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0	Minimum delta credit	Minimum delta credit value	0 .. 7	7

Table 89. MIB object 0007h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.9 0008h (disable frame type check and disable CRC check)

The frame type check (i.e. the check of the FI field of the MAC subframes) can be disabled only if the ST7570 operating mode is Monitor. If the frame type check is disabled, a received MAC frame provides a CMD_DataIndication to the host, even if the value of field FI is not 0000h; however, the bad frame init counter (MIB object 0011h) and the invalid frame counter (MIB object 0006h) are increased.

The CRC check can be disabled only if the ST7570 operating mode is a Monitor. If the CRC check is disabled, a received MAC frame provides a CMD_DataIndication to the host even if the FCS check fails; however, the invalid frame counter is increased (MIB object 0006h).

Table 90. MIB object 0008h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Disable frame type check	b0: • 0: Enable frame type check • 1: Disable frame type check	00h .. 0Fh	0
	Disable CRC check	b1: • 0: Enable frame CRC check • 1: Disable frame CRC check		0

Read/write confirm data format:

The same as request.

Table 91. MIB object 0008h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_PARAM_VAL_OUTOFRANGE	Data byte value out of available range

6.5.10 0009h (Timeout Intelligent Synchronization)

This object stores the value (in minutes) of the Timeout Intelligent Synchronization procedure.

This object is applicable to the SERVER mode only.

Table 92. MIB object 0009h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	Timeout intelligent synchronization	Intelligent synchronization timeout value (minutes)	0 .. 65535 min	0 min

Read/write confirm data format:

The same as request

Table 93. MIB object 0009h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The modem is configured as MONITOR

6.5.11 000Ah (valid frame counter)

This object stores the number of the valid received MAC frames. The counter is increased if all the FI fields, number of NS subframes, and the CRC are correct.

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 94. MIB object 000Ah: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	PAD	PAD word (any value)	0 .. FFFFFFFFh	0

Table 95. MIB object 000Ah: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Valid frame counter	Valid frame counter value	0 .. FFFFFFFFh	0

Table 96. MIB object 000Ah: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.12 000Bh (TIC selector and repeater setting)

This object stores the ST7570 repeater settings and the inter-character timeout (TIC) value. Both parameters are available in MAC mode, whereas in PHY mode only the inter-character timeout selector bit (b7) is active and all the other bits must be set at 0, otherwise an ERR_ILLEGAL_DATA_COMMAND error message is returned.

Table 97. MIB object 000Bh: Write request data format

Byte	Label	Description	Available range	Factory default
0	TIC selector / repeater setting	b0..b1: repeater settings (MAC mode only) 00b NEVER_REPEATER (node is not a REPEATER) 01b ALWAYS_REPEATER (node is a REPEATER) 10b NO_REPEATER node is not a Repeater for Repeater Call session (*Section 7.3*) 11b REPEATER node is a Repeater for Repeater Call session (*Section 7.3*)	00h .. FFh (MAC) 00h or 80h (PHY)	0
		b2..b6: unused		
		b7: inter-character timeout (T_{ic}) 0: the T_{ic} value represents 5 characters depending on the UART communication speed (defined by two local input ports BR0 and BR1) 1: the T_{ic} value is equal to 10 ms		0

Read/write confirm data format:

The same as request.

Table 98. MIB object 000Bh: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes or value out of the available range (PHY only)

6.5.13 000Ch (RC Threshold)

This object stores the RC detection threshold value, expressed in 100*dBµV.

The RC message is considered valid only if the SRC > NRC and SRC is greater than the RC detection threshold parameter. (Refer to 2. chapter Repeater Call, Heading 1).

The confirm message of a CMD_ReadDBRequest will return the current value without changing it. The CMD_WriteDBRequest will set the threshold value and the confirm message will return the value.

Table 99. MIB object 000Ch: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	RC threshold	Minimum signal amplitude value to be measured during a Repeater Call detection.	0000h .. FFFFh	28A0h (104 dBµV)
2..3	PAD	Padding Bytes	0000h	0000h

Read/write confirm data format:

The same as request.

Table 100. MIB object 0005h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.14 000Dh (S0, N0, PGA)

This object stores the Signal and Noise amplitude values measured for frequency f_0 and the PGA gain set during the last CMD_DataIndication.

Refer to *Section : Raw estimation* to convert the returned codes for N0 and S0 to electrical values measured in dBµV.

Write request data format:

As this parameter is read-only, the CMD_ReadDBRequest can be used, the CMD_WriteDBRequest cannot.

Table 101. MIB object 000Dh: Read confirm data format

Byte	Label	Description	Available range	Factory default
0..3	S0	Measured signal level at frequency f_0 during the last MAC frame (preamble, SSD sequence)	000000h .. 0FFFFFh	000000h
4..7	N0	Measured noise level at frequency f_0 during the last MAC frame (preamble, SSD sequence)	000000h .. 0FFFFFh	000000h
8..9	PGA	RX programmable gain amplifier (0.. 8) level set during the last MAC frame received	0 .. 8 (MSByte always equal to 0)	00h

6.5.15 000Eh (S1, N1, phase)

This parameter keeps the signal and noise amplitude values measured for frequency f_1 and the electrical delta-phase measured during the last MAC frame reception.

Refer to *Section : Raw estimation* to convert the returned codes for N1 and S1 to electrical values measured in dBµV.

Write request data format:

As this parameter is read only, the CMD_ReadDBRequest can be used, the CMD_WriteDBRequest cannot.

Table 102. MIB object 000Eh: Read confirm data format

Byte	Label	Description	Available range	Factory default
0..3	S1	Measured signal level at frequency f_1 during the last MAC frame (preamble, SSD sequence)	000000h .. 0FFFFFh	000000h
4..7	N1	Measured noise level at frequency f_1 during the last MAC frame (preamble, SSD sequence)	000000h .. 0FFFFFh	000000h
8..9	Phase	Phase	0000h.. 00FFh (MSByte always equal to 0)	0000h

6.5.16 000Fh (transmitted frame counter)

This object stores the number of the transmitted MAC frames.

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 103. MIB object 000Fh: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	PAD	PAD word (any value)	0 .. FFFFFFFFh	0

Table 104. MIB object 000Fh: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Transmitted frame counter	Transmitted frame counter value	0 .. FFFFFFFFh	0

Table 105. MIB object 000Fh: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.17 0010h (repeated frame counter)

This object stores the number of MAC frame repetitions.

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 106. MIB object 0010h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	PAD	PAD word (any value)	0 .. FFFFFFFFh	0

Table 107. MIB object 0010h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Repeated frame counter	Repeated frame counter value	0 .. FFFFFFFFh	0

Table 108. MIB object 0010h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.18 0011h (bad frame indicator counter)

This object stores the number of the received MAC frames with the invalid long frame indicator field (FI). The counter is increased each time the FI is not equal to LONG_MAC_FRAME (0000h) even if the frame type check is disabled (Monitor modes only).

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 109. MIB object 0011h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	PAD	PAD word (any value)	0 .. FFFFFFFFh	0

Table 110. MIB object 0011h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Bad frame indicator counter	Bad frame indicator counter value	0 .. FFFFFFFFh	0

Table 111. MIB object 0011h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.19 0012h (frame indicator)

The frame indicator value is used to build the frame indicator parameter (FI) in a MAC frame to be transmitted. During a MAC frame reception the frame indicator is always checked on the default value (long MAC frame, 0000h).

Table 112. MIB object 0012h: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	Frame indicator	User defined TX frame indicator	0000h .. FFFFh	0000h

Read/write confirm data format:

The same as request.

Table 113. MIB object 0012h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.20 0013h (smart-phase detection)

This MIB parameter takes effect at 2400 bps operating baud rate only and can be used in order to avoid ambiguity about positive or negative zero-crossing on the time-slot starting instant (see *Section 4.9.1* for parameter description).

The confirm message of a CMD_ReadDBRequest returns the current value without changing it. The CMD_WriteDBRequest sets the suitable parameter and the confirm message returns its value.

Table 114. MIB object 0013h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Smart-phase detect	0: SMART_DISABLED 1: SMART_TX 2: SMART_RX 3: SMART_TXRX	0 .. 3	0

Read/write confirm data format:

The same as request.

Table 115. MIB object 0013h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.21 0014h (phase)

This object stores the delta-phase extracted on the last received MAC frame and adjusted, after taking all MAC frame fields (Ns, CC, IC) into account, to remove ambiguity regarding zero-crossing positive or negative on the time-slot starting instant. The parameter value is refreshed only in the case of smart-phase detection active on reception (i.e.: Smart-phase detection parameter equal to Smart_RX or Smart_TXRX) and a message originated by an initiator.

The confirm message of a CMD_ReadDBRequest returns the current value without changing it. The CMD_WriteDBRequest cannot be applied on this read only parameter.

Table 116. MIB object 0014h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Phase	Phase	00h .. 0Fh	00h

Read/write confirm data format:

The same as request.

Table 117. MIB object 0014h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.22 0015h (auto synchro reject)

This MIB object is related only to Monitor MAC mode (*Section 4.2.1*).

The auto synchro reject is used to reject the synchronization at the end of each received frame; when activated, this setting allows a modem in Monitor MAC mode to receive any MAC frame without constraints on time-slot synchronization.

Table 118. MIB object 0015h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Auto synchro reject	0: disabled 1: enabled	0 .. 1	0

Read/write confirm data format:

The same as request.

Table 119. MIB object 0015h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The modem is not configured as Monitor
	ERR_PARAM_VAL_OUTOFRANGE	The value is out of the available range

6.5.23 0016h (Intelligent synchronization threshold)

During the Intelligent Synchronization procedure, this parameter defines the minimum received signal level which triggers the Fast Intelligent Synchronization procedure.

The value is expressed in 100*dBµV.

Table 120. MIB object 0016h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	IS threshold	Intelligent synchronization threshold	0 .. FFFFFFh	FFFFFFh

Read/write confirm data format:

The same as Request.

Table 121. MIB object 0016h: Write error data format

Byte	Returned value	Error description
0	ERR_UNAVAILABLE_RESOURCE	The modem is not configured as MAC
	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.24 0082h (TX output gain and current limiting)

This object controls the TX output gain and the current limiting feature. This object has the same function of parameters “TX output gain” and “TX current limiting” of MIB object 00A1h (PLC configuration).

Table 122. MIB object 0082h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Current limiting	0: disabled 1: enabled	0 .. 1	0
1	Target output gain	Selects the desired TX output gain as attenuation ranging from -31 dB to 0 dB with respect to the maximum output voltage. Note that if the current limiting is enabled, the desired value may not be reached in the case of overcurrent.	0 .. 31	16 (10h)

Table 123. MIB object 0082h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0	Current limiting	0: disabled 1: enabled	0 .. 1	0
1	Target output gain	Desired output gain set by means of the write request.	0 .. 31	16
2	Actual output gain	Actual output gain. Depending on the current limiting: • disabled: this value is equal to the “target output gain” • enabled: this value represents the actual output gain chosen by the current limiting algorithm in order to avoid overcurrent	0 .. 31	16

Table 124. MIB object 0082h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.25 0083h (received alarm counter)

This object counts the number of received alarms.

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter to 0 and the confirm message returns the reset value (0).

Table 125. MIB object 0083h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	Received alarm counter	PAD word (any value)	0 .. FFFFFFFFh	0

Table 126. MIB object 0083h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Received alarm counter	Received alarm counter value	0 .. FFFFFFFFh	0

Table 127. MIB object 0083h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.26 0084h (transmitted alarm counter)

This object counts the number of the transmitted alarms, even if repeated.

The confirm message of a CMD_ReadDBRequest returns the current value of the counter without changing it. The CMD_WriteDBRequest resets the value of the counter (0) and the confirm message returns the reset value (0).

Table 128. MIB object 0084h: Write request data format

Byte	Label	Description	Available range	Factory default
0..3	Transmitted alarm counter	PAD word (any value)	0 .. FFFFFFFFh	0

Table 129. MIB object 0084h: Read/write confirm data format

Byte	Label	Description	Available range	Factory default
0..3	Transmitted alarm counter	Transmitted alarm counter value	0 .. FFFFFFFFh	0

Table 130. MIB object 0084h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.27 0085h (alarm repetition, alarm before indication, alarm reject window)

This object controls the alarm management (*Section 7.2*):

- Alarm repetition: it sets the number of alarms that are sent when an alarm transmission is requested. If the “alarm repetition” feature is enabled (*Section 6.5.28*), the same number of alarms is sent also as soon as an alarm coming from another node is received
- Alarm before indication: number of alarms to be received before sending an CMD_AlarmIndication to the host
- Alarm reject window: number of alarm events to be rejected after an indication, repetition or transmission.

The confirm message of a CMD_ReadDBRequest returns the current value without changing it. The CMD_WriteDBRequest sets the threshold value and the confirm message returns the value.

Table 131. MIB object 0085h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Alarm repetition (N_{TX})	Number of repeated alarm transmissions	0 .. FFh	8
1	Alarm before indication (N_{RX})	Number of alarm events to be received before sending an alarm indication to the host	0 .. FFh	2
2	Alarm reject window (N_{REJ})	Number of alarm events to be rejected after a transmission, reception or repetition of an alarm.	0 .. FFh	9

Read/write confirm data format:

The same as request.

Table 132. MIB object 0085h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.28 0086h (alarm indication, repetition, SN indication disable)

This MIB parameter keeps three types of settings related to alarm management:

- Alarm indication: bit to enable/disable the transmission of CMD_AlarmIndication to the host
- Alarm repetition: bit to enable/disable the alarm message repetition
- Alarm S/N indication: bit to append, or not, the signal and noise levels to the CMD_AlarmIndication sent to the host.

The ST7570 configured as Monitor in PHY mode always sends an alarm indication even if the alarm indication bit is disabled;

The confirm message of a CMD_ReadDBRequest returns the current value without changing it. The CMD_WriteDBRequest sets the coded values and the confirm message returns them.

Table 133. MIB object 0086h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Alarm indication	b0: • 0: enabled • 1: disabled	0.. 1	0
	Alarm repetition	b1: • 0: enabled • 1: disabled	0 .. 1	0
	Alarm S N indication	b2: • 0: enabled • 1: disabled	0 .. 1	1

Read/write confirm data format:

The same as request.

Table 134. MIB object 0086h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.29 00A0h (New synchronization)

This MIB parameter is used to force the ST7570 in MAC mode to discard the current synchronization and look for a new one.

The CMD_WriteDBRequest sets the coded values and the confirm message returns them.

Table 135. MIB object 00A0h: Write request data format

Byte	Label	Description	Available range	Factory default
0	New synchronization	New synchronization request 0: no effect 1: discard current sync and look for a new sync	0 .. 1	0

As this MIB parameter is used for immediate effect, by setting it to the “discard current sync” coded value, it can’t be read by the external host command.

Write confirm data format:

The same as request.

Table 136. MIB object 00A0h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes or value out of the available range

6.5.30 00A1h (PLC configuration)

This object stores the settings used to configure the modem. *Table 137* below lists these features:

Table 137. MIB object 00A1h: Write request data format

Byte	Label	Description	Available range	Factory default
0	Operating mode, bit rate	b0..b2: operating mode • 0: IDLE (Not Set or Not Configured) • 1: Client (Master) • 2: Server (Slave) • 3: Monitor (Spy or Sniffer) • 4: Test on Ch.0 (Single tone continuous transmission on ch. 0) • 5: Test on Ch.1 (Single tone continuous transmission on ch. 1) • 6: Test on Ch.0 and Ch.1 (Alternate tones continuous transmission)	0 ... 6	IDLE (0)
		b3..b4: bit rate • 0: 1200 bit/s • 1: 2400 bit/s	0 .. 1	0
		b5..7: unused		
1	PLL freq	b0..b2: reserved	0	0
		b3: zero-crossing Synchronization (PLL) • 0: Mains frequency is 50 Hz • 1: Mains frequency is 60 Hz	0 .. 1	50 Hz (0)
		b4: reserved	0	0
		b5..7: unused		
2	Target output gain	The gain used during transmission, as attenuation from -31 to 0 dB (3.6.5)	00h..1Fh	10h
3..5	f_0	Data 0 frequency (Hz)	Any value in CENELEC band A, B, C	74000 Hz (012100h)
6..8	f_1	Data 1 frequency (Hz)	Any value in CENELEC band A, B, C	63300 Hz (00F744h)
9..11	PAD	Padding bytes	0	-
12	Access layer mode	1: Physical layer mode (PHY) 2: MAC layer mode (MAC)	1 .. 2	1 (PHY)
13	TX current limiting	TX current limiting enable flag: 0: disabled 1: enabled	0 .. 1	0 (Disabled)

Read/write confirm data format:

The same as request.

Table 138. MIB object 00A1h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes or value out of available range
	ERR_PARAM_VAL_OUTOFRANGE	At least one configuration value is out of the related available range

6.5.31 00A4h (PRESLOT/ZC/TS/BIT and ZC_IN_D configuration)

This parameter configures the operating functions of PRESLOT/ZC/TS/BIT output and ZC_IN_D pins.

The confirm message of a CMD_ReadDBRequest returns the current values without changing them. The CMD_WriteDBRequest sets the corresponding operating functions and the confirm message returns the corresponding value.

Table 139. MIB object 00A4h: Write request data format

Byte	Label	Description	Available range	Factory default
0	PRESLOT/ZC/TS/BIT and ZC_IN_D	b0..b2: PRESLOT/ZC/TS/BIT • 0: PRESLOT • 1: ZC • 2: TS • 3: BIT • 4: TXP • 5: RXP • 6: TXRXP	0 .. 6	PRESLOT
		b3: ZC_IN_D • 0: ZC_IN_D_OFF • 1: ZC_IN_D_ON	0 .. 1	ZC_IN_D_OFF
		b4..b7: reserved	0	0

Read/write confirm data format:

The same as request.

Table 140. MIB object 00A4h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.32 00ABh (Max PGA Gain)

This object stores the Maximum Value Gain to limit the PGA control block amplification.

The confirm message of a CMD_ReadDBRequest will return the current value without changing it. The CMD_WriteDBRequest will set the value and the confirm message will return it.

Table 141. MIB object 000Ch: Write request data format

Byte	Label	Description	Available range	Factory default
0..1	GAIN	Maximum PGA gain	0000h .. 0008h	0008h
2..3	PAD	Padding bytes	0000h	0000h

Read/write confirm data format:

The same as request.

Table 142. MIB object 0005h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes

6.5.33 00ACh (soft start)

This object stores the time value to reach the fixed output gain during a frame.

The value stored in the MIB object has to be multiplied by a constant interval equal to 13 µs to calculate the “soft start” duration.

The confirm message of a CMD_ReadDBRequest returns the current value without changing it. The CMD_WriteDBRequest sets the corresponding time value and the confirm message returns it.

Table 143. MIB object 00ACh: Write request data format

Byte	Label	Description	Available range	Factory default
0..2	Soft Start	b0..19: 13 µs delay steps	000000h .. 0FFFFFh	000000h
		b20..23: unused		---

Read/write confirm data format:

The same as request.

Table 144. MIB object 00ACh: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The writing request failed

6.5.34 00C2h (time-slot delay bit)

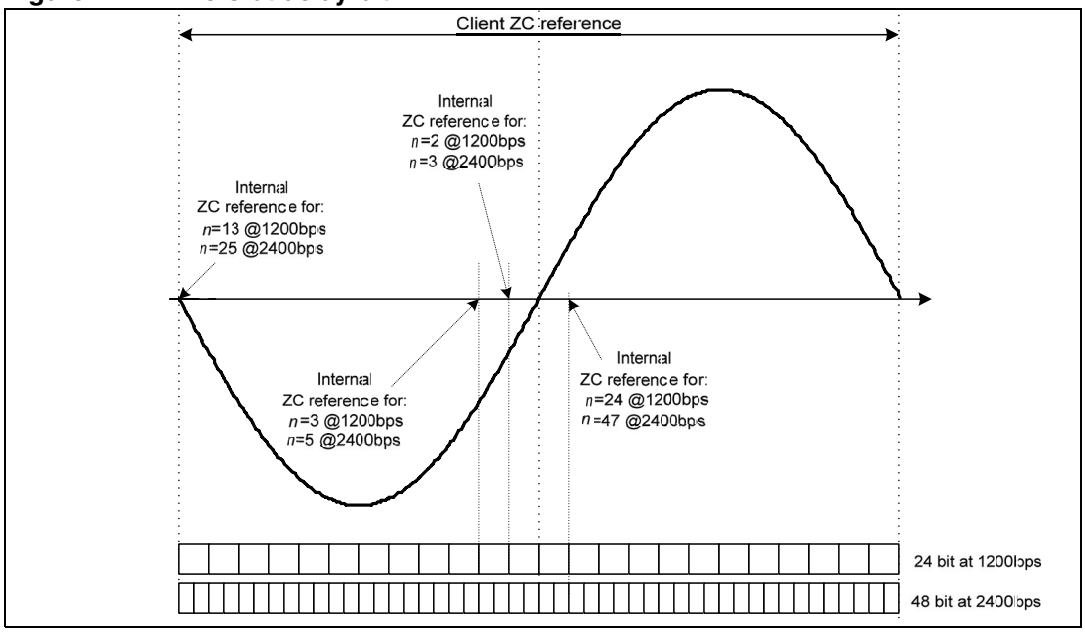
This object stores the delay between the external mains zero-crossing signal and the internal reference, used to set the starting position of the time-slot. The time unit is the bit. This object is useful for the Client operating mode only, as the Server fixes the internal time-slot reference after receiving a frame transmission by the Client.

The value *n* stored is equal to *n-1* delay bit number: an *n* value equal to 1 means that the Client aligns its time-slot with the external zero-crossing event. A value equal to 2 means that the Client forces its time-slot to start 1 bit before the external zero-crossing event.

Any change to this value takes effect only after a de-synchronization of the Client.

Figure 21 shows some examples of the relation between the external zero-crossing signal and internal reference for some values of *n*:

Figure 21. Time-slot delay bit



The confirm message of a CMD_ReadDBRequest returns the current constant without changing it. The CMD_WriteDBRequest sets the corresponding time value and the confirm message returns it.

Table 145. MIB object 00C2h: Write request data format

Byte	Label	Description	Available range	Factory default
0..2	Time-slot delay bit	b0..19: bit-time delay	000000h .. 0FFFFFh	1
		b20..23: unused		---

Read/write confirm data format:

The same as request.

Table 146. MIB object 00C2h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The writing request failed

6.5.35 00D1h (ZC delay compensation)

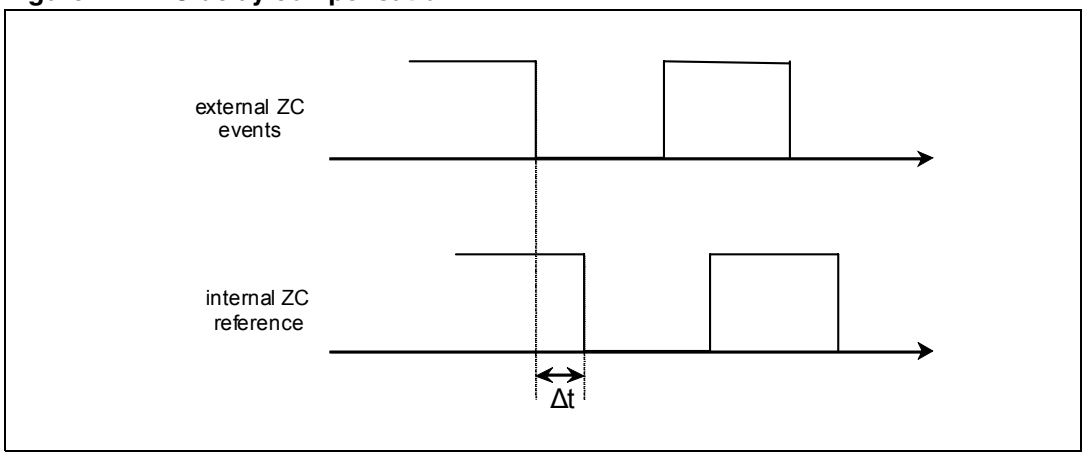
This object stores the delay (Δt) between the power line zero-crossing and the ST7570 zero-crossing internal reference. The step is 13 µs.

The ST7570 changes its internal ZC reference as soon as the value is written on the MIB object.

Equation 3

$$\Delta t = \text{compensation} \cdot 13\mu s$$

Figure 22. ZC delay compensation



The confirm message of a CMD_ReadDBRequest returns the current constant without changing it. The CMD_WriteDBRequest sets the corresponding time value and the confirm message returns it.

Table 147. MIB object 00D1h: Write request data format

Byte	Label	Description	Available range	Factory default
0..2	ZC delay compensation	b0..19: 13µs delay steps	000000h .. 0FFFFFh	000000h
		b20..23: unused		---

Read/write confirm data format:

The same as request.

Table 148. MIB object 00D1h: Write error data format

Byte	Returned value	Error description
0	ERR_ILLEGAL_DATA_COMMAND	Wrong number of data bytes
	ERR_REQUEST_NOT_ALLOWED	The writing request failed

7 Extended functions

The ST7570 embeds the following extended functions:

- Automatic reconfiguration
- Support for alarm management.
- Repeater Call service

7.1 Automatic reconfiguration

This feature allows automatic reconfiguration of the PHY and MAC layer settings after an unexpected modem reset.

If a reset occurs, the modem checks the integrity of the internal settings and the reconfiguration takes place if no corruption is detected. Otherwise, the settings are reset to their factory default values.

The settings of PHY and MAC are managed independently.

7.1.1 PHY reconfiguration

Table 149 lists all the PHY layer settings managed by the auto reconfiguration feature.

Table 149. MIB objects checked after reset event in PHY mode

PHY settings	MIB object
Access layer mode	00A1h (PLC configuration) and 00A2h (PHY or MAC Mode selector)
Operating mode	00A1h (PLC configuration)
Bit rate	00A1h (PLC configuration)
Digital gain	00A1h (PLC configuration) and 0082h (TX output gain and current limiting)
Current control enabled	00A1h (PLC configuration) and 0082h (TX output gain and current limiting)
High frequency	00A1h (PLC configuration)
Low frequency	00A1h (PLC configuration)
Alarm disabled	00A1h (PLC configuration)
PLL frequency	00A1h (PLC configuration)
Automatic gain control	00A1h (PLC configuration)
TIC selector	000Bh (TIC selector and repeater State)
Alarm repetitions	0085h (alarm repeater, alarm before indication, alarm reject window)
Alarm before indication	0085h (alarm repeater, alarm before indication, alarm reject window)
Alarm reject window	0085h (alarm repeater, alarm before indication, alarm reject window)
Alarm indication disabled	0086h (alarm indication, repetition, SN indication disable)
Alarm SN indication disabled	0086h (alarm indication, repetition, SN indication disable)
Alarm repetition disabled	0086h (alarm indication, repetition, SN indication disable)
Programmable digital output status	00A4h (PRESLOT/ZC/TS/BIT and ZC_IN_D configuration)
Time-slot delay bit	00C2h (time-slot delay bit)
ZC delay compensation	00D1h (ZC delay compensation)

7.1.2 MAC reconfiguration

Table 150 lists all the MAC settings managed by the auto reconfiguration feature.

Table 150. MIB objects checked after reset event in MAC mode

MAC settings	MIB object
MAC address	0001h (local MAC address and the Initiator MAC address)
Initiator MAC address	0001h (local MAC address and the Initiator MAC address)
MAC group address	0005h (MAC group addresses)
Repeater state	000Bh (TIC selector and repeater state)
FIMA	0000h (first and last initiator address, FIMA/LIMA)
LIMA	0000h (first and last initiator address, FIMA/LIMA)
Synchronization confirm timeout	0002h (timeout synchro confirmation)
Not ok timeout	0003h (timeout frame not OK)
Not addressed timeout	0004h (timeout frame not addressed)
Intelligent synchronization timeout	0009h (timeout intelligent synchronization)
Disable frame type check	0008h (disable frame type check and disable CRC check)
Disable CRC check	0008h (disable frame type check and disable CRC check)
Auto synchronization reject	0015h (auto synchro reject)
Repeater call threshold	000Ch (RC threshold)
Intelligent synchronization threshold	0016h (intelligent synchronization threshold)
Frame indicator	0012h (frame indicator)
Smart-phase detection	0013h (smart-phase detection)

7.2 Alarm management

The ST7570 features advanced alarm messages management, aimed at:

- Avoiding false alarm detections, through the programmable alarm filtering used in reception
- Avoiding echo effects, by ignoring all the alarms that can occur immediately after alarm transmission, reception (or repetition in MAC mode).

Alarms can be used in both PHY and MAC modes.

7.2.1 Alarm transmission

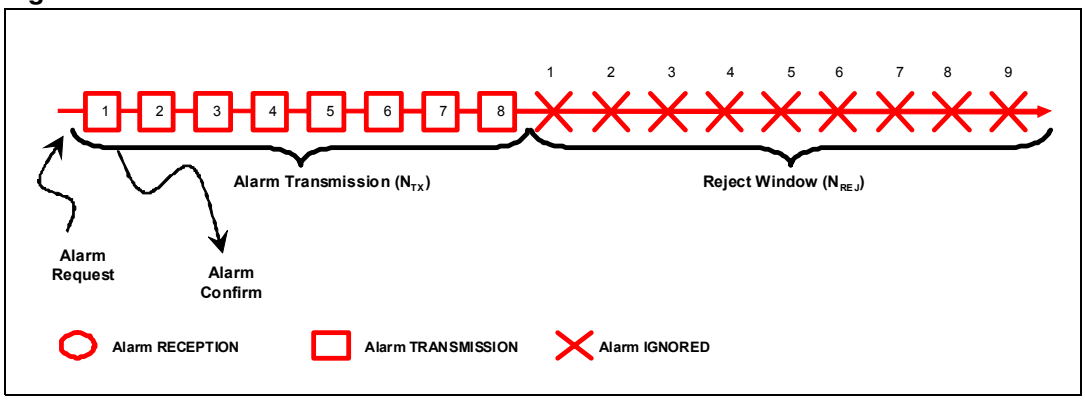
The host can request the ST7570 transmitting burst of N_{TX} alarms by using the command CMD_AlarmRequest. As soon as the transmission is completed, the ST7570 ignores all the alarms that may occur in the next N_{REJ} time-slots.

The confirmation to the alarm request (CMD_AlarmConfirm) is generated immediately after the first alarm burst. If other CMD_AlarmRequests are sent during the alarm transmission or the reject window, the ST7570 provides an immediate positive confirmation but it does not send any additional alarms.

Both N_{TX} and N_{REJ} values are programmable by accessing the MIB object 0085h (*Section 6.5.27*). Default values are N_{TX} = 8 and N_{REJ} = 9.

Figure 23 shows the transmission of an alarm with default values.

Figure 23. Alarm transmission



7.2.2 Alarm reception

As soon as a burst of alarms is received, the ST7570 generates a CMD_AlarmIndication message to the host.

In order to avoid the detection of fake or corrupted alarm messages, the system generates an indication only if N_{RX} consecutive alarms are received. Parameter N_{RX} is programmable through the MIB object 0085h (*Section 6.5.27*).

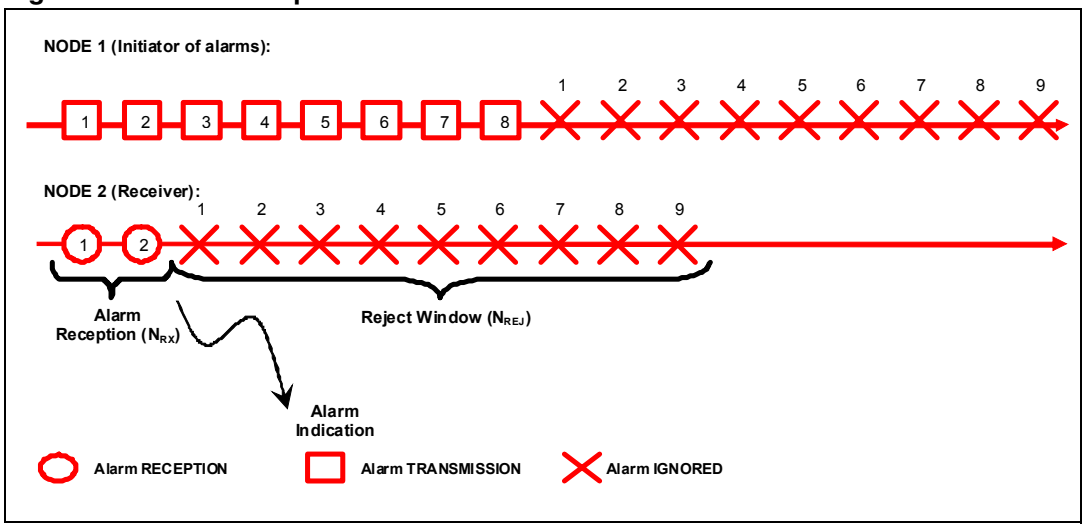
After the CMD_AlarmIndication message, the ST7570 ignores all the alarms that may occur in the next N_{REJ} time-slots.

If a CMD_AlarmRequest message is sent during the alarm reception or the reject window, the ST7570 provides an immediate positive confirmation but it does not transmit any additional alarms.

Default values are N_{RX} = 2 and N_{REJ} = 9.

Figure 24 shows the behavior of a node (node 2) with N_{RX} = 2, assuming that node 1 is transmitting an alarm burst (with N_{TX} = 8 and N_{REJ} = 9).

Figure 24. Alarm reception



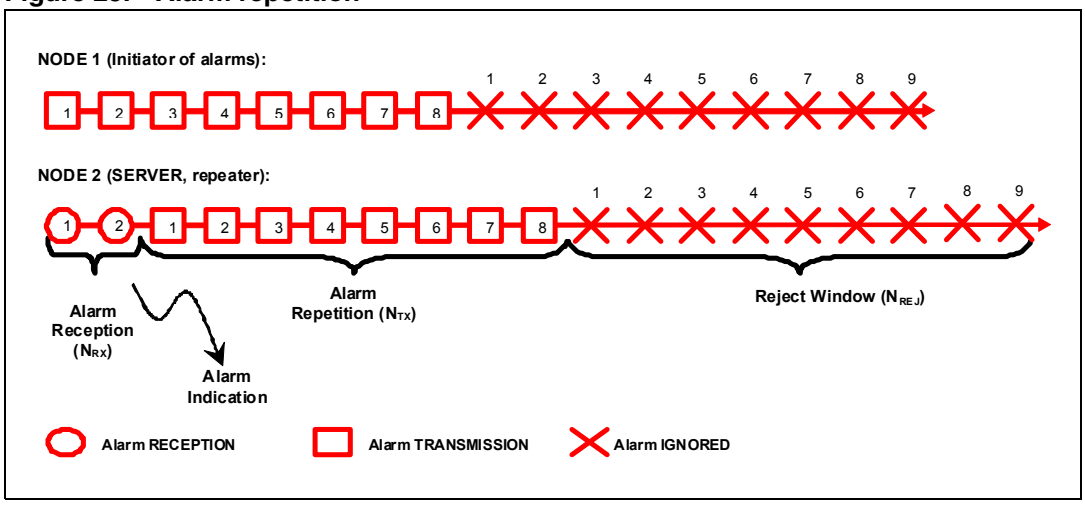
7.2.3 Alarm repetition

If the node is a Server and is configured as REPEATER or ALWAYS_REPEATER (through the MIB object 000Bh, *Section 6.5.12*) it repeats the alarms by sending N_{TX} alarms. After the transmission is complete, it ignores all alarms that it eventually receives in the next N_{REJ} time-slots.

If a CMD_AlarmRequest is sent during the alarm reception, repetition, or the reject window, the ST7570 provides a positive confirm message without sending any additional alarms.

Figure 25 shows the behavior of a server, configured as REPEATER, (node 2) with $N_{RX} = 2$, assuming that node 1 is transmitting an alarm burst with $N_{TX} = 8$ and $N_{REJ} = 9$.

Figure 25. Alarm repetition



7.3 Repeater call

The Repeater Call (RC) is a special service supported by the ST7570 at MAC layer, with specific short messages (RC messages).

During the Repeater Call mode, the physical layer does not send or receive the frames over powerline in the usual form. In fact, the physical time-slot (*Section 3.3*) is split down into 21 sub-timeslots (SubTslot) with a duration equivalent to 2 bytes. Since the Pause/Alarm time is not used by the RepeaterCall function, the alarms remain active during this period.

During each sub-timeslot of the RepeaterCall mode, a node can either receive or send a 2-byte fixed pattern (2EC5h), with a behavior in accordance with its configuration (Client or Server).

7.3.1 Client

The ST7570 will accept a CMD_RC_Request if this command is received while a transmission or reception on powerline is in progress only, and refused otherwise. If accepted, the node will start the Repeater Call mode at the beginning of the first timeslot after the current transmission or reception completion.

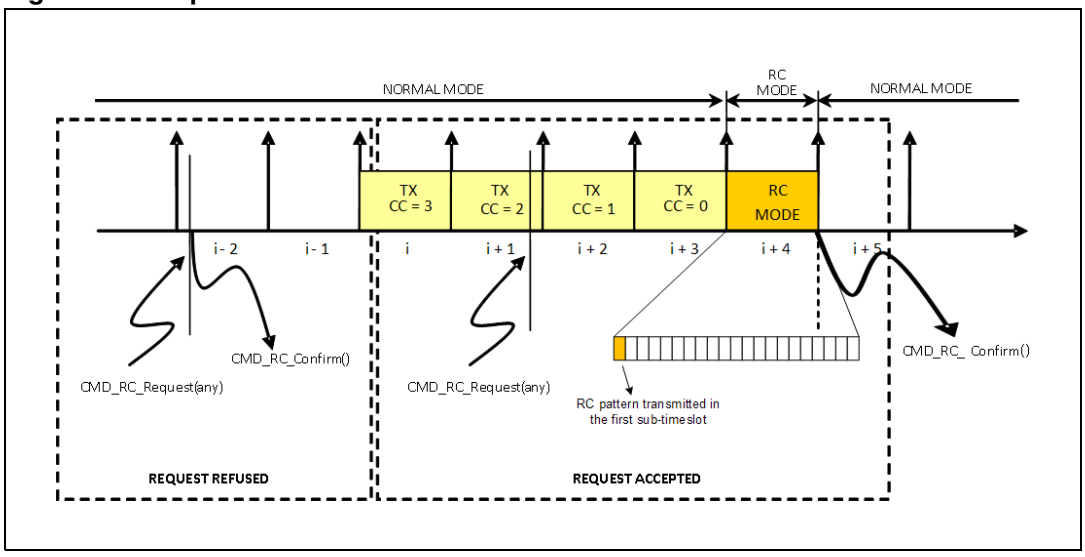
The Client leaves the Repeater Call mode and goes back to the normal mode after one timeslot.

A confirmation and an exit code (CMD_RC_Confirm(RC_Result)) are always generated to the host.

The ST7570 configures as a Client will transmit the RC message at position 0 (first sub-timeslot), whatever is the value of parameter “TxPosition” in the CMD_RC_Request.

The *Figure 26* shows an example with a Client sending a MAC frame with IC=CC=3 and a M_sdu of 26 bytes.

Figure 26. Repeater call for client



7.3.2 Server

The ST7570 set as Server also accepts a CMD_RC_Request if the command is received from the external host while a transmission, reception or repetition is in progress over the powerline only; otherwise it refuses it. A positive or negative confirmation (CMD_RC_Confirm(RC_Result)) is always generated.

If accepted, the node will start the Repeater Call mode at the beginning of the first timeslot after the completion of the current transmission, reception or repetition.

During the Repeater Call mode, the Server listens for RC messages and may also transmit a RC pattern.

The transmitting subtimeslot position is different according the local MAC address:

- if the node is registered (address not equal to NEW), the transmitting position of the RC message transmitted matches the local MAC address. The parameter “TxPosition” in the CMD_RC_Request (*Section 5.3.23*) has to be equal to 0000h;
- if the node is not registered (address NEW) or its local MAC address is higher, the transmitting position of the RC message transmitted matches the parameter “TxPosition” declared in the CMD_RC_Request (*Section 5.3.23*) message received.

During RC messages reception, the Server performs an estimation of signal (S_{RC}) and noise (N_{RC}) by averaging the amplitude of signal and amplitude of noise on both channels (f_0 and f_1):

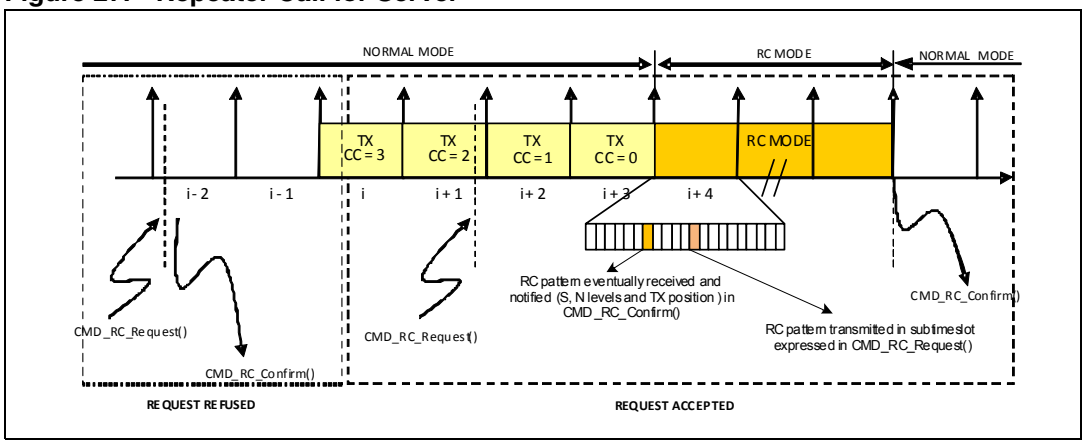
Equation 4

$$\begin{cases} S_{RC} = \dfrac{S_0 + S_1}{2} \\ N_{RC} = \dfrac{N_0 + N_1}{2} \end{cases}$$

The RC message is considered valid only if the $S_{RC} > N_{RC}$ and S_{RC} is greater than the RC detection threshold passed in CMD_RC_Request(*Section 5.3.23*) or (if RC_THRESHOLD = 0) written into MIB object 000Ch (RC Threshold, *Section 6.5.13*).

Figure 27 shows and example of Repeater Call procedure for Server, with both received and transmitted patterns.

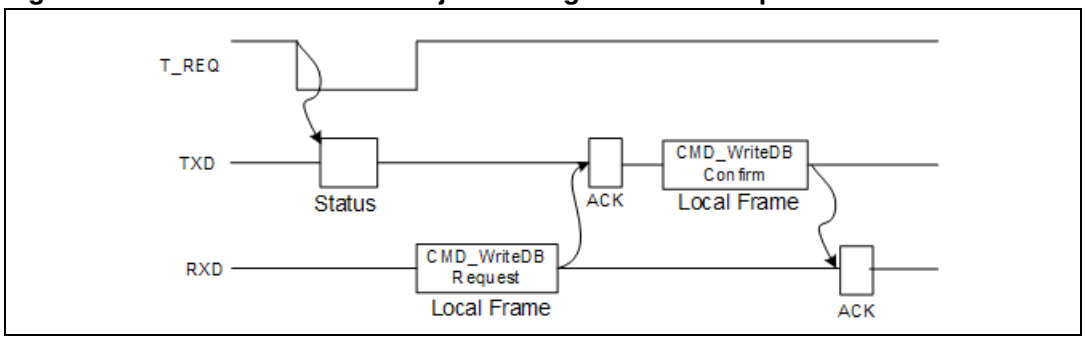
Figure 27. Repeater Call for Server



8 Modem configuration

The first step to configure the ST7570 modem in accordance with the required operating conditions is the writing operation of MIB object 00A1h (PLC configuration) (*Section 6.5.30*). This step is aimed at allowing the ST7570 device to communicate through a power line network and the time diagram of the commands exchanged between the ST7570 and its external host is represented in *Figure 28*.

Figure 28. Host interface: MIB object writing command sequence



For example, in order to set the operating parameters as listed below, leaving the other parameters involved in MIB object 00A1h at their default values:

- Access layer mode = MAC mode
- Operating mode = Client
- Mains frequency = 50 Hz
- Bit rate = 2400 bps
- Target output gain = -15 dB
- Current Limiting = enabled.

The exchanged local frames are as follows:

CMD_WriteDBRequest()

The local frame is built and sent by the external host through the host interface with the dedicated command CMDWriteDBRequest, after receiving a Status Message (NOT_SET bit = 1) from the ST7570:

STX	Length	Command Code	DATA									CHK
			MIB Index	Mode	ZC	Gain	f0	f1	PAD	Layer	Current Ctrl	
02h	13h	41h	A1.00h	09h	00h	10h	10.21.01h	44.F7.00h	00.00.00h	02h	01h	7E.02h

The byte graphical ordering (from left to right) reflects the byte time ordering (every sub-field is sent LSByte first). In particular, the labels in the data fields assume the values:

- Mode: b0..b2=100b (Client mode), b3-b4=10b (2400 bps baud rate), b5..b7=000b (padding)
- ZC: b0..b2=000b (padding), b3=0b (50 Hz mains frequency), b4..b7=000b (padding)
- Gain: b0..b7=10h (TxGain parameter: 31-15=16d=10h)
- F_0=74000Hz $\Rightarrow$ 12110h, transmitted LSByte first
- F_1=63300Hz $\Rightarrow$ F744h, transmitted LSByte first
- Layer: 02h (MAC mode)
- Tx Current Control: 01h (enabled).

CMD_WriteDBConfirm()

The confirmation message from the ST7570 consists of a local frame with a command CMD_WriteDBConfirm message, different from previous local frames on command code, checksum codes only:

STX	Length	Command Code	DATA									CHK
			MIB Index	Mode	ZC	Gain	f0	f1	PAD	Layer	Current Ctrl	
02h	13h	42h	A1.00h	09h	00h	10h	10.21.01h	44.F7.00h	00.00.00h	02h	01h	7F.02h

9 PHY mode communication example

This example shows how to use the PHY data services (*Section 3.5.1*) in order to perform the transmission of a PHY frame from station1 to station2 (*Figure 29*), with a detailed time diagram of data exchanged on the UART interfaces of both stations (*Figure 30*).

It is assumed that both station1 and station2 have been initialized, in accordance with the initialization procedure as in *Section 8.1*, and they have been further set with the same value for MIB object 00A1h (with access layer mode equal to PHY), except for operating mode, that is Client for station1 and Server for station2.

Figure 29. Data communication

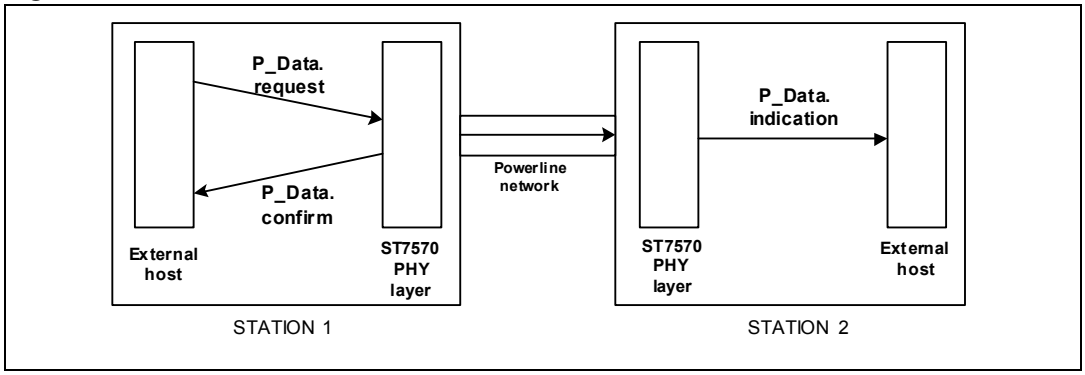
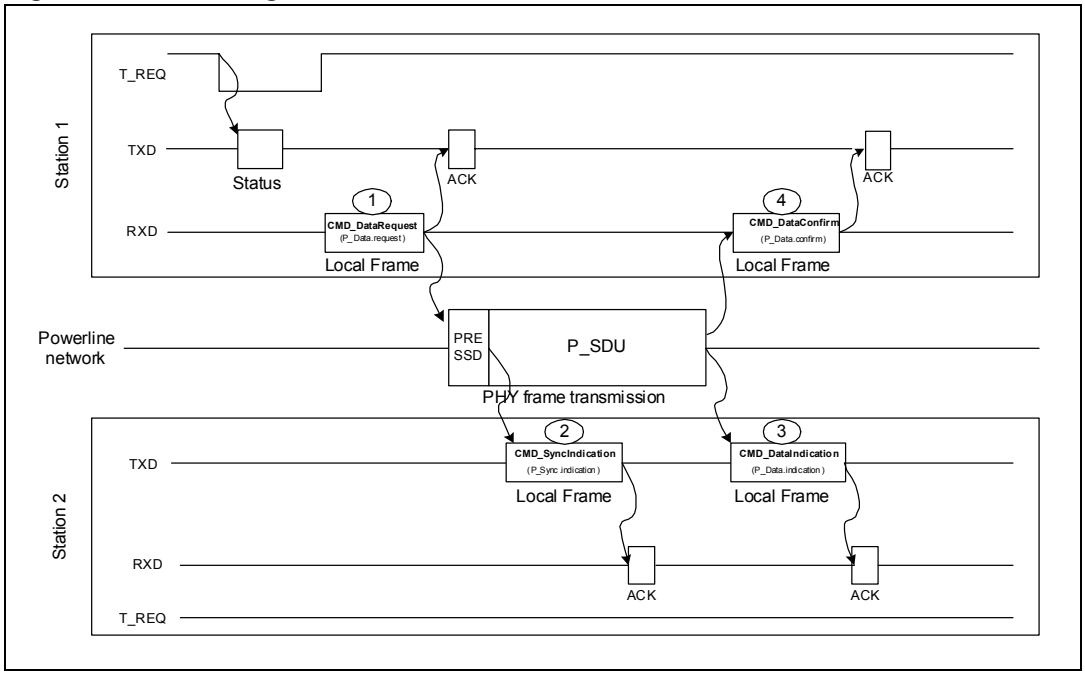
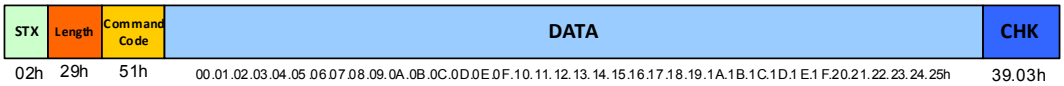


Figure 30. Time diagram: host interface communication

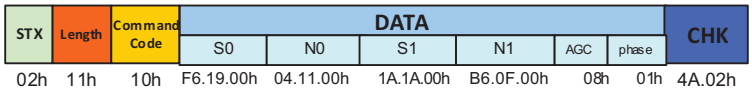


The exchanged local frames, as in *Figure 30*, have the following syntaxes:

1. Station1: CMD_DataRequest() from external host to ST7570, assuming a P_sdu = 00h 01h 02h … 25h:



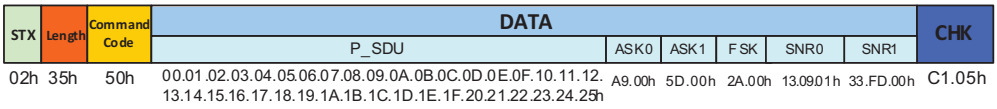
2. Station2: CMD_SynchroIndication() sent from ST7570 to the external host. The ST7570 modem received a PRE+SSD sequence correctly and it notified the change in its synchronization status.



The S0, N0, S1, N1 fields can be decoded to obtain the RMS values (in dBµV units):

- S0: 19F6h = 6646d ⇒ 66.46 $dB\mu V_{RMS}$
- N0: 1104h = 4356d ⇒ 43.56 $dB\mu V_{RMS}$
- S1: 1A1Ah = 6682d ⇒ 71.848 $dB\mu V_{RMS}$
- N1: FB6h = 4022d ⇒ 40.22 $dB\mu V_{RMS}$

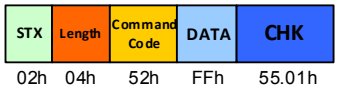
3. Station2: CMD_DataIndication() sent from ST7570 to the external host to notify the receipt of P_sdu.



The ASK0, ASK1, FSK, SNR0, and SNR1 fields can be decoded to obtain the estimated values of the demodulated signals:

- ASK0 = 00A9h: 169 bits equal to “0” decoded independently
- ASK1 = 005Dh: 93 bits equal to “1” decoded independently
- FSK = 002Ah: 42 bits decoded through measurements on both tones
- SNR0 = 10913h = 67859d ⇒ 24.936 $dB\mu V_{RMS}$
- SNR0 = FD33h = 64819d ⇒ 23.819 $dB\mu V_{RMS}$

4. Station1: CMD_DataConfirm() sent from ST7570 to the external host, meaning that the transmission of the PHY frame over the power line has finished.



The only label in the data field is the Confirm_Code (*Section 5.3.13*) equal to the FFh value, meaning that the P_SDU transmission was performed with no errors. The checksum is equal to 155h value.

10 MAC mode communication example

This section provides an example which describes how to properly configure two ST7570 modems in MAC mode as Client and Server, respectively, and perform a communication with a suitable address and credits through the following steps, to be followed after the initialization and basic configuration steps described in *Section 8*:

1. Address configuration (optional)
2. Server time-outs configuration (optional)
3. Transmitting a MAC frame from Client to Server
4. Transmitting a MAC frame from Server to Client.

It is assumed that both station1 and station2 have identical MIB object 00A1h (PLC configuration) with the exception of operating mode parameter:

- Access layer mode: MAC mode
- Operating mode: Client for station1, Server for station2
- Baud rate: 2400 bps
- Mains frequency: 50 Hz
- f_0=74 kHz, f_1=63.3 kHz
- Target output gain = -15 dB
- Tx current control: enabled.

10.1 Step 1: address configuration

Addresses can be configured by accessing MIB object 0001h (local MAC address and the initiator MAC address) through command CMD_WriteDBRequest().

The time diagram of the commands exchanged between the ST7570 and its external host is the same as *Figure 28*, as a CMD_WriteDBRequest() is still involved.

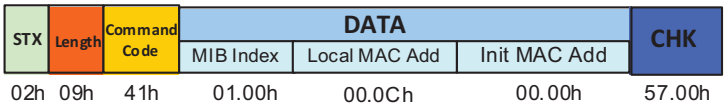
10.1.1 Station1 (Client)

For a Client station (also called initiator), the local MAC address is usually within the FIMA range (C00h as default value) and LIMA (DFFh as default value), while the initiator MAC address has no meaning.

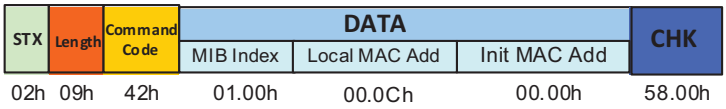
In this example:

- local MAC address = C00h
- initiator MAC address = 000h (NO-BODY).

For station1 the CMD_WriteDBRequest is composed as:



The expected CMD_WriteDBConfirm local frame on the ST7570 TXD pin has the fields represented as:



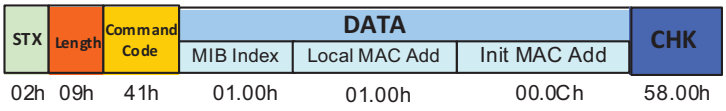
10.1.2 Station2 (Server)

For a Server station, the local MAC address is usually NEW or within the range 001h and (FIMA-1) (C00h as default value), while the initiator MAC address should be set equal to the initiator (i.e. Client) local MAC address.

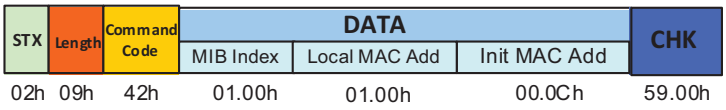
In this example:

- local MAC address = 001h
- initiator MAC address = C00h.

For station2 the CMD_WriteDBRequest is composed as:



And the expected CMD_ReadDBRequest from the ST7570 device:



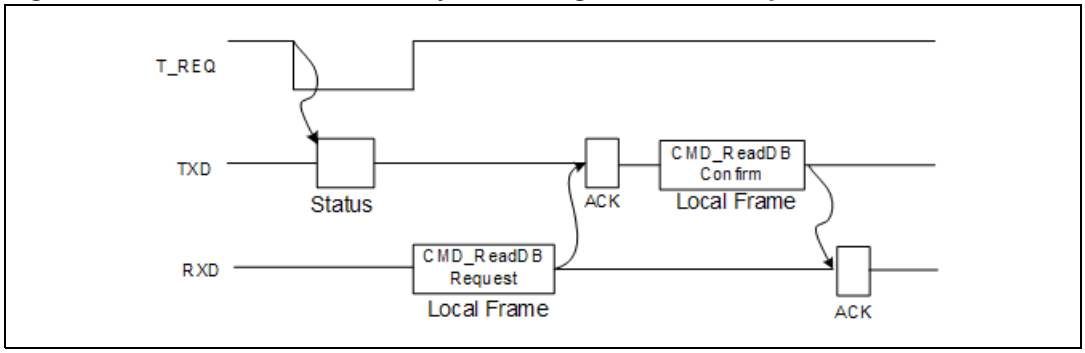
10.2 Step 2: Server time-outs configuration

The MAC time-outs (*Section 4.6*) must be programmed to suitable values according to the application requirements.

The factory default values are used in this example.

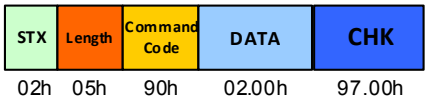
The factory default values are read through CMD_ReadDBRequest() (*Figure 31*) only to show the of use of the command.

Figure 31. Host interface: MIB object reading command sequence

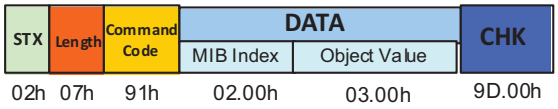


10.2.1 Synchronization-confirmation-timeout reading

The local frame encapsulating the CMD_ReadDBRequest() to read the MIB object 0002h:



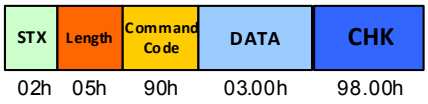
and the expected CMD_ReadDBConfirm() returned by the ST7570:



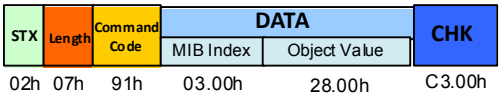
Therefore, the synchronization-confirmation-timeout is set at 3s.

10.2.2 Timeout-frame-not-ok reading

The local frame encapsulating the CMD_ReadDBRequest() to read the MIB object 0003h:



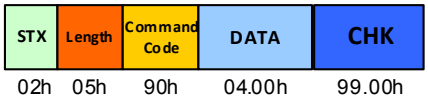
and the expected CMD_ReadDBConfirm() returned by the ST7570:



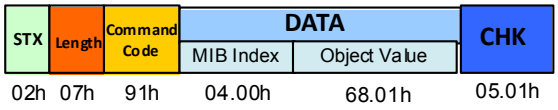
Therefore, the timeout-frame-not-ok default value is set at 40s.

10.2.3 Timeout-frame-not-addressed reading

The local frame encapsulating the CMD_ReadDBRequest() to read the MIB object 0004h:



and the expected CMD_ReadDBConfirm() returned by the ST7570:



Therefore, the timeout-frame-not-addressed default value is set at 40 s.

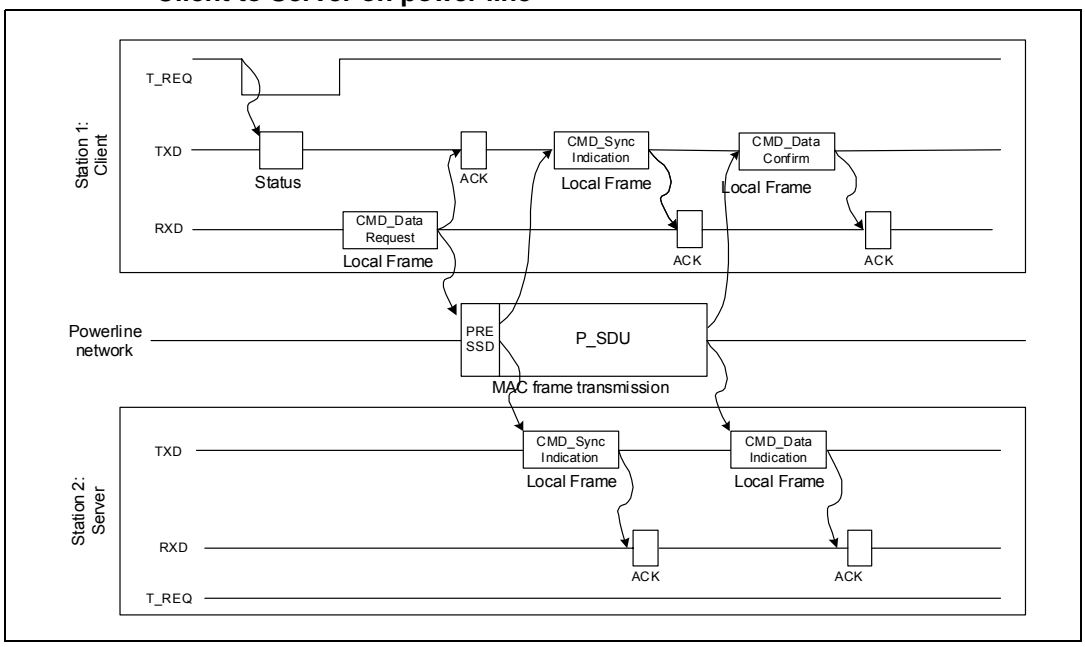
10.3 Step 3: Transmitting a MAC frame from Client to Server

After having configured both station1 and station2, it is now possible to send a MAC frame from station1 (Client) to station2 (Server). The external host of station1 can initiate the transmission by sending a CMD_DataRequest to the ST7570 with the following sample parameters:

- M_sdu = 00h 01h 02h ... 18h 19h
- IC=0, CC=0, DC=0
- DA=001h.

Figure 32 shows the exchanged local frames during a transmission from Client to Server:

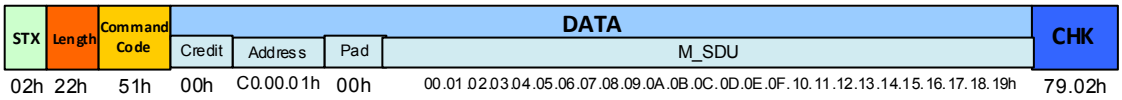
Figure 32. Host interface communication during a MAC frame transmission from Client to Server on power line



10.3.1 Station1 (Client)

CMD_Data Request

The local frame encapsulating the CMD_DataRequest():



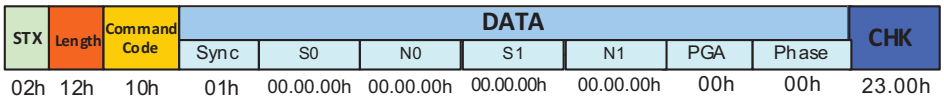
The credit and address fields are filled as follows:

- IC=000b, CC=000b, DC=00b ⇒ 00h
- SA: C00h, DA: 001h ⇒ C0.00.01h.

This request causes the modem to start the transmission of the MAC frame over the power line.

CMD_SynchroIndication

As this is the first transmission performed after the modem configuration (step 1), station1 generates locally a CMD_SyncIndication() to notify that a time-slot synchronization has been successfully found:

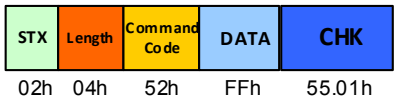


As the node was not synchronized, no estimation is performed. Therefore, values of fields S0, N0, S1, N1, PGA, phase are equal to zero while field Sync is as follows::

- Sync=01h means that the time-slot synchronization has been achieved (but still to be confirmed)

CMD_DataConfirm

As soon as the transmission over the power line is complete, station1 generates locally a CMD_DataConfirm() as follows:

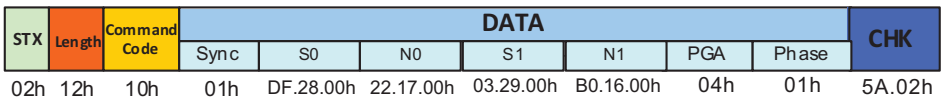


The data value equal to FFh (LP_OK, *Section 5.3.13*) notifies that the transmission completed successfully.

10.3.2 Station2 (Server)

CMD_SynchroIndication

The reception of the PRE+SSD sequence causes station2 to generate locally a CMD_SynchroIndication():

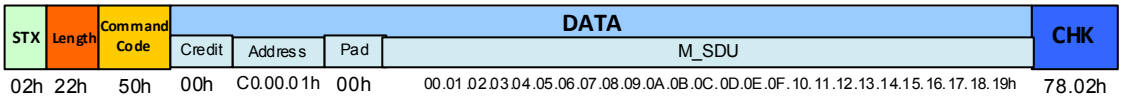


The Label values can be decoded in the same way as in *Section 10.3.1*:

- Sinc=01h means that the modem synchronization has been achieved
- S0: 0028DFh = 10463d $\Rightarrow$ 104.63 dBµV_{RMS}
- N0: 001722h = 5922d $\Rightarrow$ 59.22 dBµV_{RMS}
- S1: 002903h = 10499d $\Rightarrow$ 104.99 dBµV_{RMS}
- N1: 0016B0h = 5808d $\Rightarrow$ 58.08 dBµV_{RMS}
- PGA=04h
- Phase=01h.

CMD_DataIndication

As soon as the whole MAC frame is received (assuming that no corruption occurred), station2 notifies the reception of the M_sdu through a CMD_DataIndication() as follows:



Below is the meaning of the sub-fields encapsulated in the data field:

- Credit = 00h ⇒ IC=000b, CC=000b, DC=00b
- Address = C0.00.01h ⇒ SA: C00h, DA: 001h
- M_sdu = 00h 01h ... 18h 19h.

10.4 Step 4: Transmitting a MAC frame from Server to Client

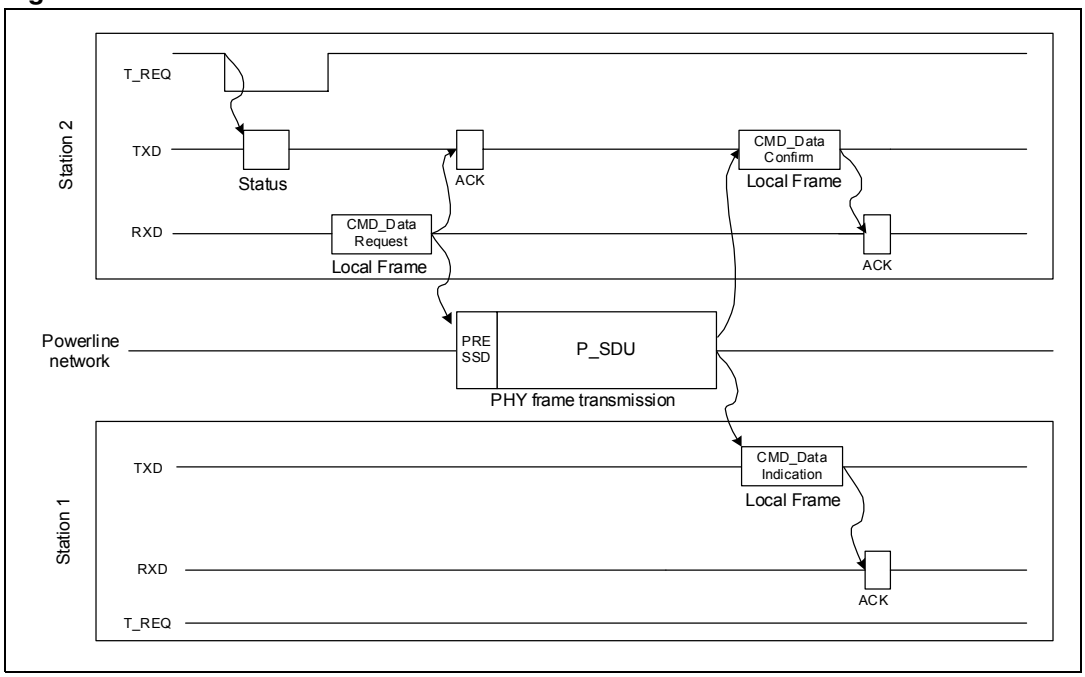
Thanks to the valid MAC frame received from station1, station2 is now synchronized and able to send frames.

The external host of station2 can initiate the transmission by sending a CMD_DataRequest to the ST7570 with the following sample parameters:

- M_sdu = 00h 01h 02h ... 18h 19h
- IC=0, CC=0, DC=0
- DA=C00h.

Figure 33 shows the exchanged local frames during a transmission from Server to Client:

Figure 33. MAC frame transmission from Server to Client



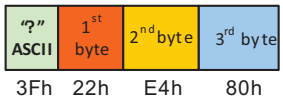
As station1 has already achieved the time-slot synchronization, it does not generate any CMD_SynchroIndication() notification.

10.4.1 Station2 (Server)

Status message

Before sending the data request, the external host must set the T_REQ signal at low level and wait for the status message from the ST7570 modem.

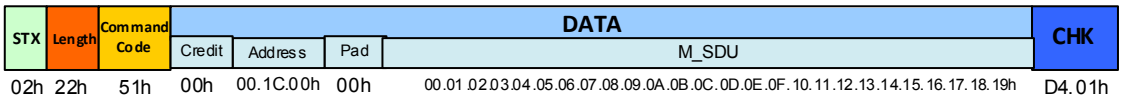
The status message can be used by the external host to quickly retrieve useful information about the status of the modem. A typical status message is as follows:



- Byte 0: 3Fh ("?" ASCII code)
- Byte 1: 22h ⇒ MAC server mode, not NEW, synchronized, not busy
- Byte 2: E4h ⇒ TS_COUNTER=7, alarm not received in the previous time-slot, PLL not ZC_FAIL, device out of hardware reset/boot, FW release = 1
- Byte 3: 80h ⇒ Phase = 4 (180°), Delta Credit = 0, No repeater

CMD_DataRequest

The local frame encapsulating the CMD_DataRequest():

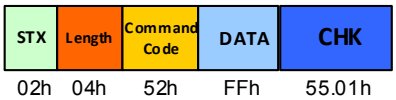


The fields are filled in the same way as the data request from Client to Server (*Section 10.3.1*), with the only exception on the address sub-field:

- SA: 001h, DA: C00h ⇒ Address = C0.00.01h

CMD_DataConfirm

As soon as the transmission over the power line is complete, station2 generates locally a CMD_DataConfirm() as follows

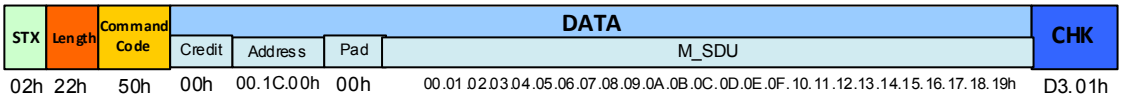


The data value equal to FFh (LP_OK, *Section 5.3.13*) notifies that the transmission completed successfully.

10.4.2 Station1 (Client)

CMD_DataIndication

As soon as the whole MAC frame is received (assuming that no corruption occurred), station1 notifies the reception of the M_sdu through a CMD_DataIndication() as follows:



Below is the meaning of the sub-fields encapsulated in the data field:

- Credit = 00h ⇒ IC=000b, CC=000b, DC=00b
- Address = 00.1C.00h ⇒ SA: 001h, DA: C00h
- M_sdu = 00h 01h ... 18h 19h.

11 References

1. STMicroelectronics, ST7570; *S-FSK power line networking system-on-chip,* datasheet.
2. International Electrotechnical Commission (IEC), IEC 61334-5-1 ed2.0.

12 Revision history

Table 151. Document revision history

Date	Revision	Changes
08-Nov-2010	1	Initial release
20-Sep-2011	2	Commands and MIB objects added for Repeater Call and Intelligent Synchronization features in *Section 5 on page 36*. New Status Message format, MIB object: Max PGA Gain (*Section 6.5.32 on page 88*), selections for PRESLOT/ZC/TS/BIT pin (*Section 6.5.31 on page 87*) and conversion formula for S, N raw estimators

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