Introduction

The "ST7538/40 FSK Power Line Modem Demo Kit" is a software tool that allows interfacing one or more ST Power Line Modem (PLM) Demo Boards with a Personal Computer. Only PLM Demo Boards equipped with ST7538 and ST7540 devices are supported.

The typical Application Environment consists of a PC that communicates, through a ST7 microcontroller placed on a general purpose board called "EVALCOMMBOARD" (see Section 1.5), with a Power Line Modem Board equipped with ST7538 or ST7540 products as shown in Figure. The interface used to communicate between the PC and the EVALCOMMBOARD is the RS-232 (USB interface will be supported in future). At start-up, the Software recognizes automatically which type of device is connected to PC and modifies its appearance differently for the ST7538 or the ST7540.

This document describes the ST7538 operating mode (see Section 1.5).

A schematic of the application environment

With the "ST7538/40 FSK Power Line Modem Demo Kit" it is possible to:

- Write/read ST7538 (or ST7540) Control Register
- Open a Tx session
- Open a Rx session
- Open a Ping session (minimum two devices required)
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</tr>
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1 Installation information

1.1 Software license agreement

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8. Export regulations
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1.2 System requirements
A Personal Computer (PC) including:
- one or more RS-232 serial ports
- a CD-ROM reader
- a Hard Disk with at least 20 MBytes of free space
- Screen resolution 800x600 or higher
- Operating System Windows NT/2000/XP
- Adobe Acrobat Reader release 4.0 or more recent

1.3 Installing the software
To install the software:
1. Insert the ST7538/40 Demo Board CD-ROM in your PC and execute the setup.exe file.
2. Follow the instructions displayed by the application wizard.

To run the software:
1. Execute the ST7538/40 PLM Demo Kit program (Start → Programs → ST7538_40 FSK PowerLine Modem Demo Kit → ST7538_40 FSK PowerLine Modem Demo Kit).
1.4 Release information and boards supported

This document refers to Release 3.19 of the "ST7538/40 FSK PowerLine Modem Demo Kit".

The following Evaluation Boards are supported by the "ST7538/40 FSK PowerLine Modem Demo Kit":

- ST7538 Evaluation Board rev. 2.1 & rev. 2.2
- EVALCOMMBOARD rev. 1.1 + EVALST7538DUAL rev. 3.1 Dual Channel
- EVALCOMMBOARD rev. 1.1 + EVALST7540-1 rev. 2.1

1.5 Reference documents

For more information about the EVALCOMMBOARD please refer to "UM0240 User Manual Industrial Communication Board - EVALCOMMBOARD"

For ST7540 working mode, please refer to "UM0239 User Manual ST7540 Power Line Modem Demokit GUI".
2 Commonly used terms

Table 1 describes some of the commonly used terms regarding Power Line Communication and other terms used in this document:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCS</td>
<td>Frame Check Sequence. An error detection scheme that uses parity bits generated by polynomial encoding of digital signals.</td>
</tr>
<tr>
<td>FEC</td>
<td>Forward Error Correction. A system of error control for data transmission wherein the receiving device has the capability to detect and correct any character or code block that contains less than a predetermined number of symbols in error. FEC is accomplished by adding bits to each transmitted character or code block, using a predetermined algorithm.</td>
</tr>
<tr>
<td>MAC</td>
<td>Medium Access Control. A service feature or technique used to permit or deny use of a communication medium.</td>
</tr>
<tr>
<td>Mains</td>
<td>The electrical network that supplies homes and businesses with power.</td>
</tr>
<tr>
<td>Ping</td>
<td>Program that measures the time elapsed between the transmission of multiple packets to a remote device and the return to origin (real meaning). In this document, the term ping is used to describe a packet exchange process between a Master device and one or more Slave devices, collecting statistical data about the integrity of packets.</td>
</tr>
<tr>
<td>PLC</td>
<td>Power Line Communication. Communication performed between two or more nodes of the electrical network.</td>
</tr>
<tr>
<td>PLM</td>
<td>Power Line Modem. A device able to transmit and receive information across the electrical network. To ensure reliability of communication, digital data are transformed modulating a carrier signal in transmission and demodulating such a carrier in reception.</td>
</tr>
</tbody>
</table>
3 User interface

Figure 1 shows the main window of the "ST7538/40 FSK PowerLine Modem Demo Kit" program.

Figure 1. Main window

The Main Window consists of:
1. A menu bar
2. A toolbar
3. A status bar

The following sections provide a complete description for each component.

3.1 Menu bar

The Menu Bar enables the user to:
- Select the COM port for communication with the Demo Board
- Modify the size of the Toolbar
- Save the last configuration used when exiting the program (GUI)
- View help and information about this Software and ST7538 and ST7540 devices
- Exit the program
Table 2 summarizes the list of commands available in the menu bar and their functions:

### Table 2. Menu bar commands

<table>
<thead>
<tr>
<th>Menu voice</th>
<th>Submenu voice</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>File</td>
<td>Exit</td>
<td>Exits from the Program</td>
</tr>
<tr>
<td>Commands</td>
<td>COM settings</td>
<td>Opens COM port selected and begins the communication with the Demo Board (ports available from COM1 to COM4)</td>
</tr>
<tr>
<td>Toolbar size</td>
<td></td>
<td>Selects the size of the toolbar (small, medium or large)</td>
</tr>
<tr>
<td>ST7540 Demo kit GUI User Manual</td>
<td>Opens this document</td>
<td></td>
</tr>
<tr>
<td>ST7538 Datasheet</td>
<td>Opens ST7538 specification document</td>
<td></td>
</tr>
<tr>
<td>ST7540 Datasheet</td>
<td>Opens ST7540 specification document</td>
<td></td>
</tr>
<tr>
<td>About</td>
<td></td>
<td>Shows information about Software Release</td>
</tr>
</tbody>
</table>

1. Settings saved refer to all controls present in the “ST7538/40 FSK PowerLine Modem Demo Kit” tool.

### 3.2 Toolbar

The Toolbar is used to access all sections of the program. The sections available are:
- Receiving session
- Transmission session
- Control Register access
- Ping session

![Toolbar controls](image)

Toolbar sections are not available until the correct COM port is selected as described in Section 4.1: Selecting the COM port on page 13.
3.3 Status bar

The Status Bar shows information about software, firmware and about the link between PC and the Evaluation Board.

Figure 3. ST7538 status bar

The left side of the Status Bar indicates the selected COM port by means of Command→COM Settings menu voice. The SW version field indicates the software release. To the right, a text string shows the device used (ST7538 in this case) and the Firmware release of ST7 microcontroller equipped on IBU Communication Board. The LED to the right of the Status Bar (Demo Link) indicates the status of communication between PC and Evaluation board. If a communication error occurs (bad or no response from the MCU to PC), this LED turns from green to red.
4 Getting started

4.1 Selecting the COM port

The first step required for using the PLM Demo Kit program is to select the correct COM port for communication between the PC and the ST7538/40 PLM Demo Board and the ST7 MCU EVALCOMMBOARD.

Warning: When running the program for the first time, the user must perform a Control Register Writing operation before being able to access the other GUI sections.

This action is mandatory because the only communication interface available from the MCU on EVALCOMMBOARD to ST7538 is synchronous, while the default Mains interface of ST7538 is asynchronous. The only action that can be performed before a Control Register Writing is a Control Register Reading, because Control Register Access is always synchronous.

Figure 4. COM selection

Once the correct COM port is selected, the program starts communication with the EVALCOMMBOARD and automatically recognizes the type of device (ST7538 or ST7540) on the PLM Board and the firmware revision of the ST7 microcontroller (on EVALCOMMBOARD). The status bar also displays this data as shown in Figure 3.

If a communication problem occurs during COM selection, e.g. if the Demo Board has not been properly connected to PC, a message box appears and the user must select the device to manage (see Figure 5). The user must select the ST7538 device to ensure correct program behavior (see Note 1).

It is possible to control a maximum of four devices (from COM1 to COM4) using a single Personal Computer by launching four instances of the program. In order to identify the instances, a different window background color is used for every COM port. After the COM selection, the user can access all GUI sections.
Communication errors can occur at any time. The Device Selection message box appears if an error occurs only during the first COM selection. To ensure reliable communications, a link status LED is present on the Status Bar as shown in Figure 3.

Note: 1 If an incorrect device is selected, the user must close and restart the Program in order to avoid undesired behavior.

4.2 Setting the Control Register parameters

To access to the ST7538 Control Register, click the REG button on the Toolbar. The main window then displays the Control Register dialog box as shown in Figure 6.

This dialog box enables the user to modify the Control Register parameters.
This section describes each of the Control Register parameters. Table 3 provides a summary of each parameter, bit-by-bit, as appears in the Control Register string in binary format from MSB to LSB.

### Table 3. Summary of Control Register parameters

<table>
<thead>
<tr>
<th>Bits</th>
<th>Parameter</th>
<th>Bits</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:0</td>
<td>Carrier Frequency</td>
<td>14</td>
<td>Mains Interfacing Mode</td>
</tr>
<tr>
<td>4:3</td>
<td>Baudrate</td>
<td>16:15</td>
<td>Output Clock</td>
</tr>
<tr>
<td>5</td>
<td>Deviation</td>
<td>18:17</td>
<td>Packet Mode Baud Rate</td>
</tr>
<tr>
<td>6</td>
<td>Watchdog</td>
<td>20:19</td>
<td>Packet Length</td>
</tr>
<tr>
<td>8:7</td>
<td>Transmission Timeout</td>
<td>21</td>
<td>Packet Mode enable</td>
</tr>
<tr>
<td>10:9</td>
<td>Frequency Detection Time</td>
<td>22</td>
<td>Sensitivity Mode</td>
</tr>
<tr>
<td>11</td>
<td>Zero Crossing Synchronization</td>
<td>23</td>
<td>Pre-filter</td>
</tr>
<tr>
<td>13:12</td>
<td>Detection Method</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Default values listed in this section refer to the ST7538 Power Line Transceiver.

#### 4.2.1 Carrier Frequency

The Carrier Frequency parameter (Bits [2:0]) defines at which center frequency the signal is transmitted or received across the mains.

If Dual Channel feature is disabled, the Carrier Frequency parameter must be set through the "ST7538 Control Register Parameter Panel". Otherwise, the "Dual Channel Selection" panel must be used. For more information, see Section 4.3: Selecting the Dual Channel option on page 19.
4.2.2 Baud rate

The baud rate parameter (Bits [4:3]) defines the speed of communication.

**Table 5. Baud rate**

<table>
<thead>
<tr>
<th>Bits 4 to 3 (MSB to LSB)</th>
<th>Value (bps)</th>
<th>Bits 4 to 3 (MSB to LSB)</th>
<th>Value (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2400 (default)</td>
<td>10</td>
<td>2400 (default)</td>
</tr>
<tr>
<td>0</td>
<td>4800</td>
<td>11</td>
<td>4800</td>
</tr>
</tbody>
</table>

4.2.3 Deviation

The Deviation parameter (Bit 5) defines the frequency difference between the mark and the space frequency. When set to “0.5”, the difference is one-half the Baud Rate value. Otherwise, the difference is the Baud Rate value itself.

**Table 6. Deviation**

<table>
<thead>
<tr>
<th>Bit 5</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&quot;0.5&quot; (default)</td>
</tr>
<tr>
<td>1</td>
<td>&quot;1&quot;</td>
</tr>
</tbody>
</table>

4.2.4 Interfacing mode

The (Mains) Interfacing mode (Bit 14) defines, when transmitting or receiving data across the Mains, if the timings are managed by ST7538 by means of CLR/T line (Synchronous mode) or by the host (Asynchronous mode).

In Asynchronous mode, data enter directly in the FSK modulator in Transmission mode and are sent directly from the demodulator to the RxD line in Reception mode.

In the current software/firmware release, only Synchronous interfacing mode is available. Due to the fact that Asynchronous Mains interfacing mode is the ST7538 default value, the user must write at least once to the CR (in Synchronous interface mode) before the GUI will perform any other action (except CR reading).

**Table 7. Mains interfacing mode**

<table>
<thead>
<tr>
<th>Bit 14</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Synchronous</td>
</tr>
<tr>
<td>1</td>
<td>Asynchronous (default)</td>
</tr>
</tbody>
</table>
4.2.5 **Watchdog**

The Watchdog parameter (Bit 6) enables the Watchdog function that generates an internal and external reset when the internal Watchdog timer expires. The Watchdog timer is reset by applying a negative pulse on pin WD.

*Note:* The ST7 MCU Firmware (on EVALCOMMBOARD) automatically provides the Watchdog Timer Reset.

<table>
<thead>
<tr>
<th>Bit 6</th>
<th>Value (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disabled</td>
</tr>
<tr>
<td>1</td>
<td>1.5 (default)</td>
</tr>
</tbody>
</table>

**Table 8. Watchdog**

4.2.6 **Transmission timeout**

The Transmission Timeout parameter (Bits [8:7]) defines the maximum time of continuous transmission before a Timeout event occurs. In this case, the transmission is interrupted and the device is set in RX mode.

<table>
<thead>
<tr>
<th>Bits [8:7]</th>
<th>Value (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Disabled</td>
</tr>
<tr>
<td>01</td>
<td>1 (default)</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Not used</td>
</tr>
</tbody>
</table>

**Table 9. Transmission timeout**

4.2.7 **Detection method**

The Detection method (Bits [13:12]) defines the way the modem notifies the presence of a carrier (CD) or preamble (PD) through the ST7538 CD/PD pin. If the Carrier detection method is selected, the CD/PD line becomes active when a signal with a harmonic component close to the programmed Carrier Frequency is detected on the RAI pin. If the Preamble detection method is selected, the CD/PD line becomes active when a signal with a carrier modulated at the programmed Baud Rate for at least 4 consecutive symbols ('1010' or '0101') is detected on the RAI pin. If the Detection method is conditioned CLR/T and RxD signals are enable only when CD/PD line is enable, otherwise CLR/T and RxD are always enabled.

<table>
<thead>
<tr>
<th>Bits [13:12]</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Carrier detection without conditioning</td>
</tr>
<tr>
<td>01</td>
<td>Carrier detection with conditioning</td>
</tr>
<tr>
<td>10</td>
<td>Preamble detection without conditioning (default)</td>
</tr>
<tr>
<td>11</td>
<td>Preamble detection with conditioning</td>
</tr>
</tbody>
</table>

**Table 10. Detection method**
4.2.8 Frequency detection time

This parameter (Bits [10:9]) defines the time within which a carrier must be detected across the Mains before signalling it on ST7538 CD/PD pin. If the Preamble Detection method is selected, the CD/PD becomes active only if also a preamble is detected.

For more information, see Section 4.2.7: Detection method.

Table 11. Frequency detection time

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>0.5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>01</td>
<td>1 (default)</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>

4.2.9 Zero crossing synchronization

This parameter (Bit 11) synchronizes transmissions with the Mains positive zero-crossing transition.

Note: The Zero Crossing Synchronization function requires external circuitry that is not present in all Demo Boards. On PLM Demo Boards that do not support Zero Crossing Synchronization, this setting must be disabled.

Table 12. Zero crossing synchronization

<table>
<thead>
<tr>
<th>Bit 11</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disabled (default)</td>
</tr>
<tr>
<td>1</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

4.2.10 Output clock

The Output Clock parameter (Bits [16:15]) sets the ST7538 MCLK line frequency as a sub-multiple of the 16-MHz oscillator frequency or disables the output clock.

Table 13. Output clock

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>16</td>
<td>10</td>
<td>4 (default)</td>
</tr>
<tr>
<td>01</td>
<td>8</td>
<td>11</td>
<td>Not used</td>
</tr>
</tbody>
</table>

4.2.11 Packet mode baud rate

This feature is not currently available. See Section 4.2.13: Packet mode enable.

4.2.12 Packet length

This feature is not currently available. See Section 4.2.13: Packet mode enable.

4.2.13 Packet mode enable

This feature is not currently available. This bit must always be set to ‘0’ or Disabled.
4.2.14 Sensitivity mode

The Sensitivity Mode parameter (Bit 22) defines the low threshold for the FSK demodulator block.

<table>
<thead>
<tr>
<th>Bit 22</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal Sensitivity (500 µVrms) (default)</td>
</tr>
<tr>
<td>1</td>
<td>High Sensitivity (250 µVrms)</td>
</tr>
</tbody>
</table>

4.2.15 Pre-filter

The Pre-filter parameter (Bit 23) enables a pre-filter on the Reception path.

<table>
<thead>
<tr>
<th>Bit 23</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disabled (default)</td>
</tr>
<tr>
<td>1</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

4.2.16 Limitations on Control Register parameters

Certain parameters are limited during programming because either their functions are not supported by the tool. Table 16 lists these limitations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains Interface mode</td>
<td>Only Synchronous Mains interface mode is supported</td>
</tr>
<tr>
<td>Packet Baud Rate, Packet Length and Packet Mode Enable</td>
<td>Packet mode is not supported</td>
</tr>
</tbody>
</table>

4.3 Selecting the Dual Channel option

Certain ST7538 PLM Demo Boards\(^{(a)}\) have the ability to select the central frequency of external coupling filter between two operating frequencies.

In order to activate this function, the user must select the DUAL CH. check box in the Dual Channel selection pane, set the correct frequencies for each of the two channels. When Dual Channel function is enabled, a command of channel selection is transmitted each time the user pushes the **Write Control Register** button.

When the Dual Channel feature is enabled, the Control Register is programmed according to the selected Dual Channel frequency.

---

\(^{(a)}\) PLM Eval Boards that support the Dual Channel feature have the suffix "DUAL" (i.e. "EVALST7538DUAL Rev. 3.1 Dual Channel")
4.4 Monitoring events

By means of Events Panel LEDs it is possible to monitor the status of the Demo Board. The LEDs represent events occurred during the working session.

The LEDs are updated every time a communication is performed between the software tool and the Demo Board, except for the Link Monitor LED that it is activated also when the user modifies a Control Register parameter using the Control Register Parameters Panel. In this case, the Write Control Register String on the panel no longer corresponds to the ST7538 Control Register. For this reason, the Link Monitor LED is always enabled (red) at first run of the program.

Table 17 lists possible events.

Table 17. Summary of events

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset Event</td>
<td>Event occurs when MCU of EVALCOMMBOARD is reset</td>
</tr>
<tr>
<td>Reg OK Event</td>
<td>Event occurs when ST7538 Control Register content is corrupted</td>
</tr>
<tr>
<td>Timeout Event</td>
<td>Event occurs when a transmission session is longer than the Timeout value (CR Bits [8:7]) or a Thermal Shutdown event is detected</td>
</tr>
<tr>
<td>Link Monitor</td>
<td>Event occurs when:</td>
</tr>
<tr>
<td></td>
<td>– Write Control Register String does not correspond to ST7538 Control Register</td>
</tr>
<tr>
<td></td>
<td>– A reset or a communication problem event occurs</td>
</tr>
</tbody>
</table>
If a communication problem occurs, a message box describing the issue appears. In this case, the user must try again to perform the same operation that caused the problem until no more message boxes appear and the Link Monitor LED becomes green.

**Note:** If communication problems persist, the user can reset the microcontroller on EVALCOMMBORAD by pushing the RES button. After this operation, a Control Register Writing or a Control Register Reading must be performed in order to avoid undesired behavior.

### 4.5 Using the Control Register String

The selected parameter values of the virtual ST7538 Control Register appear in the textbox at the bottom of the Control Register dialog box (Figure 10) in binary format from MSB to LSB. When the user modifies or clicks one of the Control Register parameters, the corresponding bits of the Control Register string become red.

**Figure 10. Write control register string and parameters position**

<table>
<thead>
<tr>
<th>MSB</th>
<th>CONTROL REGISTER</th>
<th>LSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>000011001100010010100111</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reg</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Carrier Frequency (0-2)</td>
</tr>
<tr>
<td>b</td>
<td>Baud Rate (3-4)</td>
</tr>
<tr>
<td>c</td>
<td>Deviation (5)</td>
</tr>
<tr>
<td>d</td>
<td>Watchdog (6)</td>
</tr>
<tr>
<td>e</td>
<td>Tx Time Out (0-2)</td>
</tr>
<tr>
<td>f</td>
<td>Det. Time (9-10)</td>
</tr>
<tr>
<td>g</td>
<td>Zero Cross (11)</td>
</tr>
<tr>
<td>h</td>
<td>Det. Method (12-13)</td>
</tr>
<tr>
<td>i</td>
<td>Output clock (15-16)</td>
</tr>
<tr>
<td>j</td>
<td>TX Time (9-2)</td>
</tr>
<tr>
<td>k</td>
<td>Packet en. Baud rate (17-18)</td>
</tr>
<tr>
<td>l</td>
<td>Packet mode (14)</td>
</tr>
<tr>
<td>m</td>
<td>Pre filter (23)</td>
</tr>
<tr>
<td>n</td>
<td>Sensitivity (22)</td>
</tr>
<tr>
<td>o</td>
<td>Packet length (19-20)</td>
</tr>
<tr>
<td>p</td>
<td>Control Register String</td>
</tr>
</tbody>
</table>
4.6 Reading/Writing Control Register parameters

Figure 11 summarizes the Control Register reading/writing procedures with the PLM Demo Board.

Figure 11. Control register writing/reading procedures

ST7538 CONTROL REGISTER WINDOW

On the Control Register window, click Write CTRL Register to transmit the 24-bit Control Register string to the ST7538 PLM Demo Board.

Click Read CTRL Register to read the contents of the Control Register string. This displays the Read Control Register dialog box shown in Figure 12.

Figure 12. Read CTRL Register dialog box

ST7538 READ CR WINDOW

If no communication issues occur, the Read Control Register string (which is similar to the Write Control Register string) displays the content of the ST7538 Control Register.

Click the Read button in the Read Control Register dialog box to perform a new reading of Control Register string values. Click the Update Ctrl Panel button to update the Control Register parameter values with the 24 bits that are read. Click Close to close the Read Control Register dialog box.
5 Transmission sessions

Click **TX** on the toolbar to open a transmission session and to display the Transmission Monitor dialog box shown in *Figure 13*.

**Figure 13.** Transmission Monitor dialog box

![ST7538 TRANSMISSION WINDOW](image)

The textboxes display the content to be sent across the Mains in hexadecimal and ASCII format, respectively.

**Transmission methods**

Two methods of transmission are available: **Sequence** and **Continuous**.

The Sequence method sends the content of textboxes across the Mains for selected number of times (**Nr.** parameter) with a delay of 200 ms between transmissions. It is important to note that each sequence transmitted is a single transmission session to ensure that no Timeout issues occur if the message to transmit is not too long.

The Continuous method sends the content of the textboxes repeatedly across the Mains in a single transmission until the transmission is interrupted by the user or by a Timeout event.

*Note:* A maximum of 127 bytes can be transmitted to the MCU.

**Transmitting data**

On EVALCOMMBOARD, the orange DL4 LED is turned on when a transmission begins. When a Timeout Event occurs, the red DL2 LED is turned on.

On ST7538 EVAL 2.1 and 2.2, the red D9 LED is turned on when a transmission begins. When a Timeout Event occurs, the red D11 LED is turned on.

Click **ON** to transmit the content of textboxes (that represents the data to be sent in both hexadecimal and ASCII format) across the Mains.

Click **Load File** to load an ASCII or HEX text file in the textbox.

Click **Close** to close the Transmission Monitor dialog box.
6 Receive sessions

Click RX on the toolbar to open a receiving session and to display the Receive Monitor dialog box shown in Figure 14.

**Figure 14. Receive Monitor dialog box**

![Receive Monitor dialog box](image)

The textboxes display the content of the incoming data in hexadecimal and ASCII format, respectively. To clear the Hexadecimal and ASCII textboxes, click Reset Scope.

**Frame synchronization and Header data**

As it is not possible to know when the ST7538 starts to demodulate data incoming from the mains, a Frame Synchronization feature can be enabled in order to know when the data flow begins.

If the Frame Synchronization feature is enabled (Frame Sync toggle switch), the data flow from the ST7538 is filtered from the MCU and the data is sent to the PC only when a header (defined by the Header parameter) is recognized. This ensures that all following bytes are correctly sent to PC if the transmitted message is preceded by a preamble (i.e. 0xAAAA or 0x5555) and by a header (i.e. 0x9B58).

To mask the Header, enter the corresponding hexadecimal value in the Mask textbox. This feature enables the use of less than 16 bits or more than one header. The Masked Header textbox displays the masked header.

The Data Bytes parameter selects how many bytes the MCU must transmit to the PC after a header recognition when in Frame Sync mode.

If frame synchronization is not required, the user can switch OFF the Frame Sync feature and data are sent directly from the ST7538 to the PC. Note that since the first data demodulation time is unpredictable, byte synchronization is not ensured.

**Receiving data**

On EVALCOMMBOARD, the green DL3 LED is turned on in Receive mode. When a Carrier/Preamble is detected across the Mains, the yellow DL1 LED is turned on.
On ST7538 EVAL 2.1 and 2.2, the green D12 LED is turned on in Receive mode. When a Carrier/Preamble is detected across the Mains, the yellow D10 LED is turned on.

Two reception methods are available: Reception with synchronization or Reception without synchronization depending on the Frame Sync parameter setting.

Click **ON** to start receiving data. Click **Close** to stop data reception.

**Saving data**

In order to save data received from the Mains in a text file (in either hexadecimal or ASCII format), click **Save to File** before clicking **ON** to start receiving incoming data. The maximum file size allowed is 64 KBytes. To stop saving data, click **Stop Saving**.

Click **Close** to close the Receive Monitor dialog box.
In order to evaluate the reliability of a communication between two or more devices, a Ping session can be performed. A ping session consists of a Master that sends a sequence of messages to one or more Slaves. If the messages are correctly received by Slaves, they are re-sent to the Master enabling the application to collect a wide variety of statistical data. An error correction algorithm is also included.

Click PING on the toolbar to open a Ping session. First select Master or Slave to set the device in the desired mode and to display the corresponding dialog box shown in Figure 15.

Figure 15. Ping windows
7.1 Opening a Ping Master session

7.1.1 Ping Master parameters

As shown in Figure 16, Table 18 following parameters can be selected for the Master device and the ping session.

Figure 16. Ping Master dialog box

Table 18. Ping master parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Message settings</strong></td>
<td></td>
</tr>
<tr>
<td>Master address</td>
<td>Defines the Address (from 1 to 255) of the Master device.</td>
</tr>
<tr>
<td>Nr. of slave addresses</td>
<td>Defines the Number (from 1 to 255) of Slave devices. Slave Addresses start</td>
</tr>
<tr>
<td></td>
<td>from 1 to Nr. of Slave Addresses.</td>
</tr>
<tr>
<td>Nr. of messages</td>
<td>Defines the total number of messages to send to Slave devices. The messages</td>
</tr>
<tr>
<td></td>
<td>are numbered from 0 to Nr. of Messages. (Message “0” is used only to reset</td>
</tr>
<tr>
<td></td>
<td>Slave statistical data).</td>
</tr>
<tr>
<td>Repetition control</td>
<td>Repetition can be used to improve reliability of communication. When enable,</td>
</tr>
<tr>
<td></td>
<td>if a message is not Acknowledged it is sent until three times before to con</td>
</tr>
<tr>
<td></td>
<td>sider it not Acknowledged.</td>
</tr>
<tr>
<td><strong>Ping Wait Time and Message Number settings</strong></td>
<td></td>
</tr>
<tr>
<td>Wait time</td>
<td>Defines the maximum wait time to obtain a valid response (with a valid</td>
</tr>
<tr>
<td></td>
<td>address) from Slave device before considering not Acknowledged the message.</td>
</tr>
<tr>
<td></td>
<td>The minimum value that can be selected depends on baud rate selected ac</td>
</tr>
<tr>
<td></td>
<td>cording the round trip time of message transmitted. (1)</td>
</tr>
<tr>
<td>Messages sent</td>
<td>Defines the number of last message sent. It goes from 0 to Nr. of Messages</td>
</tr>
<tr>
<td></td>
<td>and it is updated at every new message sent.</td>
</tr>
</tbody>
</table>
7.1.2 Starting a Master Ping session

Click Ping Start to start the ping session. The MCU on EVALCOMMBOARD continuously transmits the current status of every message transmitted to the PC.

Click Ping Stop to end the ping session.

Click Close to close the Ping Master dialog box.
7.2 Opening a Ping Slave session

7.2.1 Ping Slave parameters

As shown in Figure 17, Table 19 following parameters can be selected for the Slave device and the ping session.

Figure 17. Ping slave window

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave address settings</td>
<td></td>
</tr>
<tr>
<td>Slave address</td>
<td>Defines the Address (from 1 to 255) of Slave device.</td>
</tr>
<tr>
<td>Medium access control settings</td>
<td></td>
</tr>
<tr>
<td>Medium Access Control</td>
<td>Defines which type of medium access is used. Choices are “none”, “BU” or</td>
</tr>
<tr>
<td></td>
<td>“PD”. In the two last settings packets are sent only if respectively BU or CD/PD</td>
</tr>
<tr>
<td></td>
<td>lines are not active. If “PD” is selected while “Carrier Detection” CR control is</td>
</tr>
<tr>
<td></td>
<td>used, content of Control Register is changed in order to select the detection</td>
</tr>
<tr>
<td></td>
<td>method to “Preamble detection”.</td>
</tr>
<tr>
<td>Max Wait Slot Nr.</td>
<td>If BU or CD/PD lines are actives (depending on Medium Access Control</td>
</tr>
<tr>
<td></td>
<td>selected), the Slave waits for a time selected randomly between 4ms and</td>
</tr>
<tr>
<td></td>
<td>4 * Max Wait Slot Nr. ms before to analyze if it is possible to transmit a packet.</td>
</tr>
<tr>
<td>Max Wait Time</td>
<td>Defines the maximum time to wait when “BU” or “PD” Medium Access control</td>
</tr>
<tr>
<td></td>
<td>are selected before to transmit the packet. When the Max Wait Time is</td>
</tr>
<tr>
<td></td>
<td>elapsed, the packet is transmitted even if BU or CD/PD lines are actives.</td>
</tr>
<tr>
<td>Last received message information</td>
<td></td>
</tr>
<tr>
<td>Last Received Message</td>
<td>Shows the number of last message received. This field is updated only when</td>
</tr>
<tr>
<td></td>
<td>Get statistical Data button is pressed.</td>
</tr>
</tbody>
</table>
7.2.2 Starting a Slave Ping session

Click **Ping Start** to start the ping session and enable the reception of data.

Click **Ping Stop** to end the ping session.

Click **Close** to close the Ping Slave dialog box.

7.3 Ping protocol

The Ping session consists of an exchange of packets between one Master device and one or more Slave devices. **Figure 18** shows the ping message exchange format.

**Figure 18. Ping message format**

<table>
<thead>
<tr>
<th>ST7538 PING MESSAGE FORMAT</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Field</th>
<th>Byte nr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIGINAL MESSAGE</td>
<td>1</td>
</tr>
<tr>
<td>(NOT CODED)</td>
<td>1</td>
</tr>
<tr>
<td>receiver Address</td>
<td>1</td>
</tr>
<tr>
<td>transmitter Address</td>
<td>1</td>
</tr>
<tr>
<td>Message number</td>
<td>3</td>
</tr>
<tr>
<td>repetition</td>
<td>1</td>
</tr>
<tr>
<td>FCS field</td>
<td>2</td>
</tr>
</tbody>
</table>

| TRANSMITTED MESSAGE    | 22 bytes (CODED) |
|                       | 6             |
| preamble+header        | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |
| FEC                    | 1             |

The following statistical data are collected:

- **OK messages**: the total number of messages properly received plus those corrected through FEC
- **Corrected messages**: the number of messages corrected through FEC
- **RX more than once**: the number of messages received more than once
- **KO messages**: the number of message not received
- **Wrong FCS messages**: the number of messages with incorrect FCS even after correction
- **Not RX messages**: the number of message not received, calculated by subtracting the number of total message received (both the correct and the incorrect ones) from the number of last message received (Last Received Message field)

Click **Get Statistical Data** to update statistical data. Click **Save Statistics** to store collected data in a text file.
When the user clicks **PING START**, the session begins and the Master sends a series of packets to one or more Slave devices. All the packets contain the following information:

- **Preamble** (0xAAAAAAAA): 4 bytes
- **Header** (0x9B58 for Master packets and 0xE958 for Slave packets): 2 bytes

To improve reliability of communications, a FEC algorithm and one redundant byte is used for each of the following bytes of information:

- **Receiver Address**: 1 byte (+ 1 byte for FEC)
- **Transmitter Address**: 1 byte (+ 1 byte for FEC)
- **Current Message number**: 3 bytes (+ 3 bytes for FEC)
- **Repetition** (0x00, 0x01, 0x02 if the same message has been transmitted once, two or three times): 1 byte (+ 1 byte for FEC)
- **FCS field**, obtained through a calculation of 12 previous bytes: 2 bytes (+ 2 byte for FEC)

The Slave detects, through the Receiver Address field, if the packet is headed for it or not. If the message is directed to it, a FCS operation is performed on 12 bytes following the preamble and the header. The result of calculation is compared with FCS field transmitted from Master. If the two values differ, an attempt of correction is executed (through FEC correction code) and a new comparison is performed. If the two FCS fields match, the message is considered OK from Slave and it is resent to the Master (inverting Master Address with Slave Address and recalculating FEC and FCS bytes). Otherwise, the message is considered KO and no response is performed.

An exception occurs when Master transmits the message zero (with Message Number field 0x000000). This message is used to reset the Slave, statistical data collected and no response to Master is needed.

After a packet transmission, the Master waits (for a time defined in Wait Time in Master Window) the response from Slave, and if a message headed for it is detected it performs the same "correctness detection" operation above described in order to consider the message OK or KO.

**Repetition function**

To improve the reliability of communications, it is possible to use the repetition function. In this case, if a response is not detected by Master the packet is sent again for a maximum of three times before it is definitively considered Not Acknowledged.

**Medium access control**

A Medium Access Control is also implemented (for both Master and Slave) in order to prevent two or more devices from transmitting at the same time as described in **Table 18** for the Ping Master parameters and **Table 19** for Ping Slave parameters.

*Note:* For a low-level description of Ping protocol, please refer to “Power Line Modem Evaluation FW”.
7.4 Ping session flowcharts

*Figure 19 and Figure 20* describe the Master and the Slave loops, respectively, while a ping session is in progress.

**Figure 19. Ping master loop**

- **Ping Start**
  - Slave Add. < Slave No.?
  - Yes: Slave Add. = 1
  - No: Slave Add. = Slave No.
  - Create MSG (0)
  - MAC enable?
  - Yes: MAC equal to PD and Control Register set to CD?
  - Yes: Line busy and Max Wait Time not elapsed?
    - Yes: Wait RAND time (from 1 to Max Wait Slot No. * 4 ms)
    - No: Message acknowledged and Wait Time not elapsed?
      - Yes: Master Address correct?
      - Yes: Repetition enabled and < 3 messages transmitted?
        - Yes: Line busy and Max Wait Time not elapsed?
        - No: FCS calculated equal to FCS received?
          - Yes: New FCS equal to FCS of corrected message?
          - No: MSG NOT ACK
        - No: MSG NOT ACK
      - No: MSG NOT ACK
    - No: MSG NOT ACK
  - No: MSG NOT ACK
- **Slave Add. = Slave No.**
  - Create MSG (MSG_NUM)
  - MAC enable?
  - Yes: MAC equal to PD and Control Register set to CD?
  - Yes: Line busy and Max Wait Time not elapsed?
    - Yes: Wait RAND time (from 1 to Max Wait Slot No. * 4 ms)
    - No: Message acknowledged and Wait Time not elapsed?
      - Yes: Master Address correct?
      - Yes: Repetition enabled and < 3 messages transmitted?
        - Yes: Line busy and Max Wait Time not elapsed?
        - No: FCS calculated equal to FCS received?
          - Yes: New FCS equal to FCS of corrected message?
          - No: MSG NOT ACK
        - No: MSG NOT ACK
      - No: MSG NOT ACK
    - No: MSG NOT ACK
  - No: MSG NOT ACK
- **MSG_NUM < TOT MESSAGE NUM?**
  - Yes: MSG_NUM = TOT MESSAGE NUM
  - No: MSG_NUM = MSG_NUM
- **Ping Stop**

**Ping Master settings:**
- MASTER ADDRESS
- SLAVE NUM
- TOT MESSAGE NUM
- WAIT TIME
- MAC (MEDIUM ACCESS CONTROL)
- MAX WAIT SLOT NO.
- MAX WAIT TIME
- REPETITION

**Ping Master current message output data:**
- OK MESS.
- CORR. MESS.
- WRONG FCS MESS
- NOT ACK MESS

**Slave Add. = Slave No.**
- Yes: Create MSG (MSG_NUM)
- No: MSG NOT ACK
Figure 20. Ping slave loop

Ping Slave settings:
- SLAVE ADDRESS
- MAC (MEDIUM ACCESS CONTROL)
  - MAX WAIT SDLT NR.
  - MAX WAIT TIME

Ping Slave Total Message Data:
- LAST MSG REC
- TOT OK MSG
- TOT CORR MSG
- TOT RX MORE MSG
- TOT WR FCS MSG

Ping Slave Loop:
1. Ping start
2. TOT RX MSG ≠ 0
3. TOT CORR MSG ≠ 0
4. TOT RX MORE MSG ≠ 0
5. TOT WR FCS MSG ≠ 0
6. Message detected?
   - NO
   - YES
7. SLAVE ADDRESS correct?
   - NO
   - YES
8. MSG number ≠ 0?
   - NO
   - YES
9. Calculate FCS
10. TOT OK MSG ≠ 0
   - YES
   - NO
11. MAC enable?
    - NO
    - YES
12. Transmit message
13. Line busy and Max Wait Time not elapsed?
    - NO
    - YES
14. Wait RAND time
   - From 1 to Max Wait Slot No. * 4 ms
15. Set Control register to PD
16. New FCS equal to FCS of corrected message?
   - NO
   - YES
17. New FCS calculated and calculated a new FCS
18. MAC equal to PD and Control register set to CD?
   - NO
   - YES
19. Get LAST MSG REC and create reply message
20. TOT RX MSG ≠ 0
   - YES
   - NO
21. MAC enable?
   - NO
   - YES
22. Transmit message
23. Line busy and Max Wait Time not elapsed?
   - NO
   - YES
24. FCS calculated equal to FCS received?
   - NO
   - YES
25. Calculate FCS and calculate a new FCS
26. Message already received?
   - NO
   - YES
27. MSG number = 0?
   - NO
   - YES
28. Message already received?
   - NO
   - YES
29. TOT RX MORE MSG ≠ 0
   - YES
   - NO
30. TOT CORR MSG ≠ 0
   - YES
   - NO
31. TOT WR FCS MSG ≠ 0
   - YES
   - NO
8 Communication session examples

This section provides examples of some of the most common operations that can be performed with two or more Demo Boards. The operations performed are:

- Communication session without Frame Synchronization
- Communication session with Software Frame Synchronization
- Ping session

8.1 Setup procedure

8.1.1 Required hardware

The following hardware is required for these example sessions:

- Two EVALCOMMBOARD rev. 1.1 + EVALST7538DUAL rev. 3.1 (72/86 kHz)
- One PC with two RS-232 ports

8.1.2 Hardware setup

The setup of the communication sessions is common for all tests.

1. Connect the PLM Demo Boards to the EVALCOMMBOARDS.
2. Connect the boards to the two RS-232 PC ports through the serial cables to the PC.
3. Link the PLM Boards to an isolated 110/220V~ Mains voltage.
4. Finally, reset the two EVALCOMMBOARDs by pressing the Reset button.

8.1.3 Software setup

To control two devices at the same time, the user must run two sessions of the program:

1. Open Start, Programs, ST7538_40 FSK Power Line Modem Demo Kit and click ST7538_40 FSK Power Line Modem Demo Kit.
2. Then, select the correspondent COM available for every session (in this example COM1 for the first board and COM3 for the second board); enabling the GUI to communicate with each EVAL Board.

Figure 21. Communication setup: COM selection
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**Note:** After selecting COM port, the Status Bar is updated showing information about the selected COM port, SW/FW revisions and the Link status.

Before starting a Communication session, the user must perform a Write Control Register for the two windows.

3. Click **REG** on the toolbar to open the Control Register dialog box.
4. Ensure that the **Dual Channel** feature is enabled and select 72 kHz for the first channel (CH1) and 86 kHz for the second channel (CH2).

**Note:** In these Dual Channel sessions, the first channel is used so the CH1 is selected (through the binary control below the checkbox).

5. Because only few bits change for the sessions in respect to the default Control Register parameters, click **Read CTRL Register** and then **Update CTRL Panel**.
6. Set the **Carrier Frequency** to 72 kHz and the **Detection Method** to Preamble to ensure that the incoming data are received only when a preamble is detected across the Mains.

Now, the two Control Register dialog boxes should appear as shown in **Figure 22**.

**Figure 22.** Control Register dialog boxes after setup

Once the Control Registers are correctly configured, communication can begin between the boards.

### 8.2 Communication session without Frame Synchronization

In this example, the board connected to COM1 is used as the Transmitter while the board connected to COM3 is used as the Receiver. Five messages are transmitted across the Mains and the receiving method is not synchronized, so incoming data from ST7538 are sent directly to the PC.

Actions to perform on GUI connected with COM3:

1. Click **Rx** on toolbar to open the Rx Monitor dialog box.
2. Set **FRAME SYNC** to OFF.
3. Click ON.

Now the receiving board is waiting incoming data. (It activates itself only when a preamble is detected across the Mains).
Actions to perform on GUI connected with COM1:
1. Click **Tx** on toolbar to open the Tx Monitor dialog box.
2. Write the preamble "AAAAAAAA" in the hexadecimal textbox.
3. Add the text string "transmission without synchronization" in the ASCII textbox.
4. Select **Sequence Mode** and set **Nr.** to “5”.
5. Click **ON**.

Five messages are sent with a temporal distance of 200 milliseconds.

**Figure 23. Communication without Frame Synchronization example**

In **Figure 23** (COM3 section), the five transmitted sequences do not appear to be received correctly. This behavior is due to fact that the ST7538 starts writing data on the RX line at different time for every message, because in Synchronous Mode the PLL that provides the CLR/T signal must reach the lock-in condition.

Lock-in condition can only be reached after an undetermined number of demodulated data transitions (maximum 5) and during this time one or more bits can be lost. For this reason, if a sequence of bits that starts like: "1010-1010-1010-1010-..." (0xAAAA... in hexadecimal) is transmitted, the receiver can only demodulate with correct timings a part of this sequence.

For example, if the first "10101" is lost, the PC will receive the sequence "0101-0101-010..." (or 0x55 in hexadecimal). So, even if all bits are correct, byte synchronization is lost.

**Figure 24** shows an example of timing diagram for a baud rate of 2400.
8.3 Communication session with Frame Synchronization

In this example, the board connected to COM1 is the Transmitter while the board connected to COM3 is the Receiver.

Five messages are transmitted across the Mains and the receiving method includes Frame Synchronization, so incoming data from ST7538 are supervised by the microcontroller on EVALCOMMBOARD and only the bits that follow the sequence "0x9B58" ("1001-1011-0101-1000") are sent to the PC.

Actions to perform on GUI connected with COM3:
1. Click Rx on toolbar to open the Rx Monitor dialog box.
2. Set FRAME SYNC to ON.
3. Write "9B58" in Header textbox and "FFFF" in Mask textbox.
4. Set Data Bytes to "36"
5. Click ON.

Actions to perform on GUI connected with COM1:
1. Click Tx on toolbar to open the Tx Monitor dialog box.
2. Write the preamble "AAAAAAAA" in the hexadecimal textbox.
3. Add the header "9B58" in the hexadecimal textbox.
4. Add the text string "transmission with SW synchronization" (length = 36 bytes) in the ASCII textbox.
5. Select Sequence Mode and set Nr. to "5".
6. Click ON.

Five messages are transmitted.

Using the Frame Synchronization feature, the user ensures that the transmitted bytes always arrive synchronized to the PC as shown in Figure 25.
8.4 Ping session

In this example, the board connected to COM1 is the Master while the board connected to COM3 is the Slave. 100 messages are exchanged from Master to Slave and statistical data (as for Master as for Slave) are saved in two text files.

Actions to perform on GUI connected with COM3:
1. Click PING on toolbar to open the Ping dialog box.
2. Select Slave and click OK.
3. Set Slave Address to "1".
4. Write "Ping session nr. 1" in Slave Description field.
5. Set Medium Access Control to "PD", Max Wait Slot Nr. to "10" and Max Wait Time [ms] to "1000".
6. Click Ping Start.

Actions to perform on GUI connected with COM1:
1. Click PING on toolbar to open the Ping dialog box.
2. Select Master and click OK.
3. Set Master Address and Nr. of Slave Addresses to "1".
4. Set Nr. of Messages to "100" and Repetition Control to "3".
5. Set Wait Time [ms] to "255".
6. Set Medium Access Control to "PD", Max Wait Slot Nr. to "10" and Max Wait Time [ms] to "1000"
7. Click Ping Start to start the ping session.

Saving statistics

When all messages are transmitted, on the Ping Master dialog box click Save Statistics and selecting the path and the name of the text file (in this case "Ping session nr. 1 (Master).txt").
To save Slave statistics, click **Get Statistical Data** (to update the statistics), click **Save Statistics** and selecting the path and the name of the text file (in this case "Ping session nr. 1 (Slave).txt").

**Figure 26.** Ping master session and save statistics

**Figure 27.** Ping slave session and save statistics
## 9 Revision history

<table>
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<tr>
<th>Date</th>
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<th>Changes</th>
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<td>Initial release</td>
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