



This Application Note illustrates Packet Error Rate (PER) testing using boards from an NXP evaluation kit fitted with JN517x wireless microcontrollers. PER testing can be used to evaluate the communication range achievable in different operating environments. Packets are sent from one device to another, and the number of failed packets is assessed and displayed.

## 1 Application Overview

The software supplied with this Application Note allows Packet Error Rate (PER) testing to be conducted using boards from an NXP evaluation kit fitted with JN516x-based modules. Two applications are provided, one for a PER Master and another for a PER Slave. The supplied application binary files must be loaded into two evaluation kit boards – the PER Master application into a board with an LCD expansion board fitted or connected to a PC via serial port. Packets (frames) are sent between the boards and the PER results are displayed on the LCD screen of the Master board, as well as on a serially connected PC (if required). Installation and operating instructions are provided below.

## 2 Compatibility

The software provided with this Application Note is intended to be used with the following kits and SDK versions:

Product Type	Part Number	Version
SDK Libraries	JN-SW-4263	1546
LPCXpresso		7.9.2

## 3 Building and Loading the Application


These applications can be built for the JN517x microcontrollers using LPCXpresso or makefiles.

Build the application as described in the appropriate section below, depending on whether you intend to use LPCXpresso or makefiles.

### 3.1 Using LPCXpresso

To build one of the applications and load it into a JN517x-based module, follow the instructions below (only one application can be present in Flash memory at a time):

1. Start LPCXpresso and import the project as follows:
  - a) In LPCXpresso, select **Import project(s)** from the **Quickstart Panel** to display the Import Project(s) dialogue.
  - b) In the dialogue box, click **Browse...** in the **Project Archive (zip)** pane.
  - c) Browse to and select the downloaded project archive.
  - d) Click **Next**.

- e) In the **Projects** box, select the project to be imported and click **Finish**.
2. Build the application. To do this, ensure that the project is highlighted in the left panel of LPCXpresso and use the drop-down list associated with the hammer icon  in the toolbar to select the relevant build configuration – once selected, the application will automatically build.  
  
The binary file will be created in the **Build** directory, the resulting filename indicating the chip type (e.g. **JN5179**) for which the application was built.
3. Load the resulting binary files into the board. You can do this using the integrated Flash programmer, as described in the *JN517x LPCXpresso Installation and User Guide (JN-UG-3109)*.

## 3.2 Using Makefiles

Each application (PER Master and PER Slave) has its own **Build** directory, which contains the makefiles for the application.

To build each application and load it into a JN517x-based board, follow the instructions below:

1. Extract the project archive.
2. Start a terminal shell.



**Note:** A MSYS shell must be used on Windows. MSYS may either be installed separately or can be launched from:

**<LPCXpresso installation root>\lpcxpresso\msys\msys.bat**

3. Export the SDK folder location. At the command prompt, enter:  

```
export SDK_HOME=<LPCXpresso root>/lpcxpresso/sdk/
```
4. Navigate to the **Build** directory for the application to be built and then enter a make command, as described below.

At the command prompt, enter:

```
make clean all
```

Alternatively, the JN517x chip type can be specified in the make command – for example, in the case of JN5179:

```
make JENNIC_CHIP=JN5179 clean all
```

4. Load one of the resulting binary files into the board. You can do this from the command line using the JN51xx Production Flash Programmer (described in the *JN51xx Production Flash Programmer User Guide (JN-UG-3099)*).

## 4 Installation

The application binaries must be loaded into the JN51xx evaluation kit boards, as described below.

Load the following binaries into the boards:

- **AN1212\_PER\_Master\_JN517x.bin** into a JN517x module on an OM15028 Carrier Board fitted with a DR1215 LCD Expansion Board
- **AN1212\_PER\_Slave\_JN517x.bin** into a JN517x module on an OM15028 Carrier Board

Results are displayed on the LCD screen but are also output on the serial port of the master board to a PC. To display the results on a PC, use the Terminal view in LPCXpresso, TeraTerm or similar with the following settings: 115200 bps, 8 bits, no parity, 1 stop bit, no flow control.



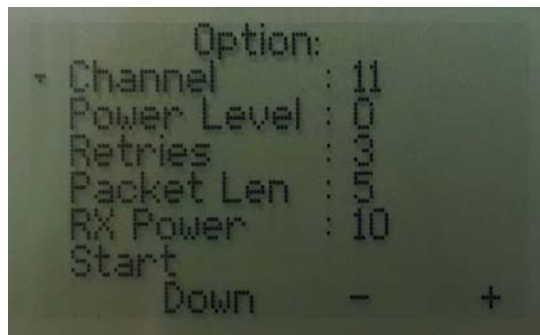
**Note:** If the LCD Expansion Board is not available in your evaluation kit, you should output the results to your PC, as described above.

## 5 Operating Instructions

### 5.1 Options Menu

When the PER Master board is first powered on, a menu is displayed containing entries for 'Channel', 'Power Level', 'Retries', 'Packet Len', 'RX Power' and 'Start'. You can use button SW2 to move down the menu and SW3 and SW4 to change or select the current menu item. When the bottom of the menu is reached pressing SW2 will loop back to the first entry.

On a PC terminal use the cursor keys to move around the menus and select/change the current items.



#### 5.1.1 Channel

The channel number on both boards can be incremented and decremented by pressing button SW3 and SW4 on the PER Master board.

#### 5.1.2 Power Level

The transmit power level for JN5179-based modules can be set from -32 to 0 dBm.

### 5.1.3 Retries

The 'Retries' entry is used to set the number of frame retransmission attempts. The number can be incremented and decremented by pressing button SW3 and SW4.

### 5.1.4 Packet Len

The 'Packet Len' entry is used to set the payload length of the 15.4 packet. The length can be incremented and decremented in steps of 10 bytes.

### 5.1.5 RX Power

The 'RX Power' entry is used to control the maximum input power level of the JN5179. The JN5179 device can receive radio signals with power of up to 10 dBm before the input is saturated. However, it is possible to configure the device to saturate at a reduced incoming signal power of 0 dBm, which has the advantage of drawing less current and prolonging battery life.

### 5.1.6 Start

Select 'Start' to apply the settings and start the PER test. The application will now move on to the 'Ack Mode' menu (see next section).

## 5.2 Ack Mode Menu

The 'Ack Mode' menu allows the mode of operation to be changed between 'no ack' and 'ack' (see sections below). This menu also allows the channel to be changed. The default mode is 'ack' and the default channel is 11.

To move between 'ack' and 'no ack' modes, press button SW4 on the PER Master board or key '3' on a connected terminal. In 'ack' mode, LED D3 will illuminate on the PER Slave board. The mode will be shown as 'ack' on the LCD screen of the PER Master board (and through the serial port, if used).

The Link Quality Indication (LQI) value is displayed on the LCD screen as a bar graph and is output to the serial port as a text value.



### 5.2.1 'Ack' Mode

In 'ack' mode, frames are sent from the PER Master using 802.15.4 clear channel assessment. The PER Slave code acknowledges the frames using 802.15.4 standard acknowledgements.



**Note:** The default retry value is set to 3, as defined by the IEEE 802.15.4 standard.

The PER Master displays the current channel, the number of successfully acknowledged frames, the total number of frames it sent and the percentage of unacknowledged frames (where 0% PER signifies ideal results and 100% PER implies no reception of frames). It also shows the percentage of frames that failed to be transmitted due to the channel being noisy with other traffic (CCA fail) and the setting of the number of retransmission attempts.

The values are accumulated over all of the frames that have been seen. To stop the accumulation of results, press button SW3 or key '2' - the results screen then freezes and LED D6 illuminates on the PER Slave board. Press button SW3 or key '2' again to reset and restart the results display - LED D6 will also be extinguished on the PER Slave board.

### 5.2.2 'No ack' Mode

In 'no ack' mode, frames are sent in one direction only. The PER Slave code sends short frames at the rate of about 1000 frames per second.

The PER Master code displays the current channel, the number of frames seen, the total number of frames that the master believes were sent and the percentage ratio of these two frame counts (where 0% PER signifies ideal results and 100% PER implies no reception of frames).

The values are accumulated over all of the frames that have been seen. To stop the accumulation of results, press button SW3 or key '2' - the results screen then freezes and LED D6 illuminates on the PER Slave board. Press button SW3 or key '2' again to reset and restart the results display - LED D6 will also be extinguished on the PER Slave board.



**Note:** If the device containing the PER Slave code is switched off while using 'no ack' mode, the reported PER value will not rise to 100% but will be frozen at its last measured value.

## Revision History

Version	Notes
1.0	First release
1.1	Updated for JN-SW-4263 SDK r1546 and to support only the OM15028 Carrier Board

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