PIL-Box advanced notes

1. PIL-Box jumper configuration vs version:

- **JP2** is used to select the speed of the serial link.
  PIL-Box version 1.x: JP2 open 9600 bps JP2 closed 115 kbps
  PIL-Box version 2.1: JP2 open 230 kbps JP2 closed 115 kbps

- **JP3** is used to enable a fix of a problem with some HP-71B HP-IL module version 1A.
  The fix is available since version 1.4. To enable the fix, close JP3.
  See below more information on the fix limitations.

2. Limitations

- **Problems with some HP-71B HP-IL module version 1A.**
  Some rare HP-IL modules version 1A don't work correctly with the PIL-Box.
  Effects are: duplicated characters when using LIST or PLIST to the ILPer printer window, HP-IL errors such as 'Message Error' or 'Frames Altered'.
  The problem can be fixed by closing the JP3 jumper to enable a special correction of the altered frames in the PIL-Box.
  The fix is to be used with these rare HP-71B HP-IL modules version 1A that have problems with the PIL-Box, it has no interest with other controllers (HP41/75/110).
  Note however that the fix is optional because it can safely fix the problem when only one HP-71B is connected to the PIL-Box but may incorrectly modify HP-IL frames if there are more HP-IL devices in the loop.
  So this fix must be considered only as a workaround if it is really needed to use one of these problematic modules 1A, and only for a simple PIL-Box + HP-71B configuration.

- **Use of several PIL-Box/PIL-IO in the same loop**
  It is generally not possible to use several PIL-Boxes or several PIL-IOs, or a mix of the two devices in the same loop.
  This is a limitation of the electrical design of the PIL-Box: the input circuitry of a PIL-Box/PIL-IO cannot manage the signal from the output circuitry if the PIL-Box/PIL-IO share a common reference voltage.
  A multiple PIL-Box/PIL-IO configuration is thus possible in these cases:
  use one (or more) genuine HP-IL device between each PIL-Box/PIL-IO to electrically isolate the HP-IL signals,
  or use an independent (floating) power supply for each PIL-Box/PIL-IO - generally not possible with the USB-powered PIL-Box but easy with the PIL-IO that can be powered from independent batteries.

- **Length of HP-IL cables**
  The length of the HP-IL cables must be limited for a correct operation of the PIL-Box.
  It is recommended to use a 0.5 m cable for wiring to the PIL-Box, cut into two halves to get about 0.25 m cables.
  If a longer cable is used to build the PIL-Box, it is recommended to short the two half cables to about 0.3-0.4 m.
  If a longer cable has to be used for a test or a demo, the two IN and OUT cables must be well separated to limit the electrical interaction (cross-talk) between the cables.
  A cross-talk issue may produce HP-IL errors such as 'Frame Altered'

- **Service request in PIL-Box controller mode**
  When the PIL-Box is used in controller mode (driven by a software on computer side acting as a controller - such as Emu71), the PIL-Box doesn't correctly retransmit the Service Request information in the Identify (and possibly in Data) frames.
  There is no problem when the PIL-Box is in device mode (driven by ILPer for instance).

3. PIL-Box design advanced information:

- **Special HP-IL frames**

  Special frames (not used by the regular HP-IL protocol) are issued by the applications on computer side to set the PIL-Box operating mode. They are not retransmitted on the HP-IL.
  TDIS (0x494) translator disabled, the PIL-Box just re-transmits the HP-IL frames
  CON (0x496) controller on, the PIL-Box is acting as a controller on the HP-IL
  COFF (0x497) controller off, the PIL-Box is acting as a device on the HP-IL
  COFI (0x495) controller off with IDY - since firmware 1.6
  SSRQ (0x49c) set the SRQ bit in IDY frames - obsolete, no more used
  CSRQ (0x49d) don't set the SRQ bit in IDY frames - obsolete, no more used

  At powerup, the PIL-Box is in translator disabled mode (TDIS), ensuring the continuity of the loop until an application on computer side is active. When the application terminates, it should put back the PIL-Box in TDIS mode.

  The SSRQ/CSRQ commands were used to control the SRQ bit in the IDY frames in COFF mode. This didn't work well and was replaced by the COFI mode (since firmware 1.6) in case the IDY frames need to be managed on the computer side.

  In device mode (COFF), the PIL-Box translates all HP-IL frames except RFC and IDY. IDY frames are retransmitted on HP-IL with no translation to the serial link, to free the application on computer side from managing them.
  In device mode with IDY (COFI) and controller mode (CON), the PIL-Box translates all HP-IL frames except RFC.

  CMD/RFC handshake:
  The CMD/RFC handshake is managed by the PIL-Box, the applications on the computer side don't need to manage it.
  In PIL-Box device mode (COFF, COFI), the handshake is done as follow: when the PIL-Box receives a CMD frame from the HP-IL, it keeps a copy of it and transmits the CMD on HP-IL. When a RFC is then received from HP-IL, the PIL-Box sends the previous CMD frame to the serial link. When the CMD frame comes back from the serial link, the PIL-Box retransmits a RFC to the HP-IL.
  In controller mode (CON), the handshake is done as follow: when the PIL-Box receives a CMD frame from the HP-IL, it keeps a copy of it and transmits a RFC on HP-IL. When the RFC comes back from HP-IL, the PIL-Box sends the previous CMD frame to the serial link.

- **Non-concurrent send and receive operations**

  The PIL-Box is based on a software emulation of the HP-IL interface. When a start of HP-IL frame is detected, the microcontroller samples the HP-IL frame at full-speed (one sample every 375-400ns depending on firmware version). During this operation, interrupts are disabled.
  For HP-IL output frame driving, the firmware uses a bit-banging technic using full microcontroller power and disabled interrupts too.
  This means that it is not possible to send and receive a frame at the same time, contrary to the hardware HP-IL chip (1LB3).

  There are situations in the HP-IL protocol where a frame is received during sending, the most trivial case is a controller sending frames in an empty (but closed) loop.
  In these cases, the PIL-Box is able to detect that a frame has been received during transmission (but can't know what kind of frame) and so *assumes* that the received frame is the same that the frame just sent.

  This is generally true, but not in a few special situations.
  First known situation is the case of these rare HP-71B HP-IL modules 1A: in this case, the HP-71B, when in a talker state, is starting to send the next frame a few microseconds before the previous frame is completely received and the PIL-Box is sometimes missing the first bit of the next frame. In that case, the optional fix *assumes* that the frame is a data frame and corrects it.
  Second known situation is when the PIL-Box is controller and sends an IDY frame. IDY frames are automatically re-transmitted by regular (1LB3-based) devices just after the frame type has been detected by decoding the first three bits and so are usually returning to the controller (here the PIL-Box) before the end of the IDY frame generation. The PIL-Box thus assumes that the detected returned frame is the same than the previous generated one. However, if a device flags a Service Request in the IDY frame by changing the SRQ bit 'on the fly', then this SRQ indication is lost. There is no workaround.