Docklight Application Note:
Docklight Tap Pro and Docklight Tap 485

Table of Contents

Docklight Application Note: Docklight Tap Pro and Docklight Tap 485 1
1 Docklight Tap Pro and Docklight Tap 485 1
2 Wiring and connections 2
2.1 RS232 monitoring using Docklight Tap Pro 2
2.2 RS232 monitoring using Docklight Tap 485 3
2.3 RS485 2-wire (half duplex) monitoring using Docklight Tap 485 4
2.4 RS485/RS422 4-wire (full duplex) monitoring using Docklight Tap 485 5
3 Software Options 6
4 Docklight Pro Monitor 6
4.1 Quickstart 6
5 Docklight and Docklight Scripting 7
5.1 Quickstart 7
5.2 Time Stamp Resolution and Processing 8
5.2.1 Hardware Timing vs. Windows Time 8
5.2.2 Idle Times Resolution 8
5.3 How to Display and Evaluate Handshake Signals 9
5.3.1 Signal Function Character '!' (F11) in Tap Pro and Tap 485 mode 9
5.3.2 Function Character '^' (F12) for Bitwise Comparisons 9
5.3.3 DL.GetHandshakeSignals() Script Method 10
5.4 Receive Sequence Comment Macros 10
6 Driver Installation 11
7 Copyright 12
8 References 12

1 Docklight Tap Pro and Docklight Tap 485

Docklight Tap Pro and **Docklight Tap 485** are advanced serial data monitoring taps for the following areas of application:

- **RS232** (RS232 and 3.3V/5V TTL voltage levels) – Docklight Tap Pro and Docklight Tap 485
- **RS485 2-wire** and **RS422 4-wire** differential voltage levels – Docklight Tap 485

Both tap devices use their own real-time clock to timestamp all serial data with internal accuracy 1µs.

Latency problems and Windows System Time inaccuracies as described in the Docklight Tap Application Note [3] do not occur, and there is no need for advanced Docklight options like “Expert Options: External / High Priority Process Mode” (see Docklight User Manual [2], “How to Obtain Best Timing Accuracy”) .

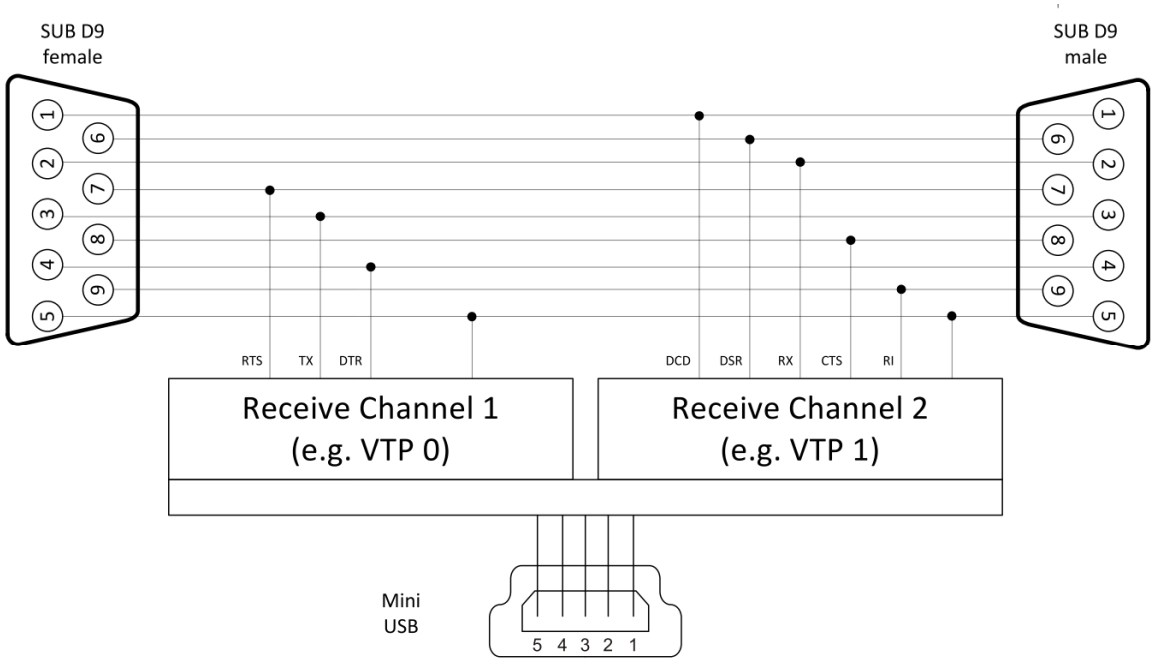
NOTE: Docklight Tap Pro and Docklight Tap 485 are passive monitoring devices only. For sending and receiving data on a RS485 bus, use Docklight and a standard USB-to-RS485 adapter as described in Docklight Application Note: RS422/485 communication [4] :

http://docklight.de/pdf/Docklight_Application_Note_RS422_485.pdf

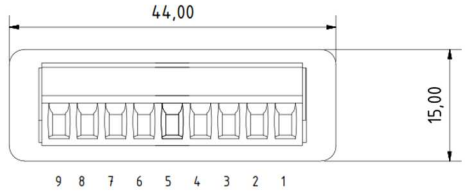
2 Wiring and connections

2.1 RS232 monitoring using Docklight Tap Pro

Docklight Tap Pro works as an insert into standard RS232 SUB D9 communication connections. It can monitor both data transfer directions TX + RX, as well as handshake / flow control signals RTS, DTR, DCD, DSR, CTS and RI.



2.2 RS232 monitoring using Docklight Tap 485

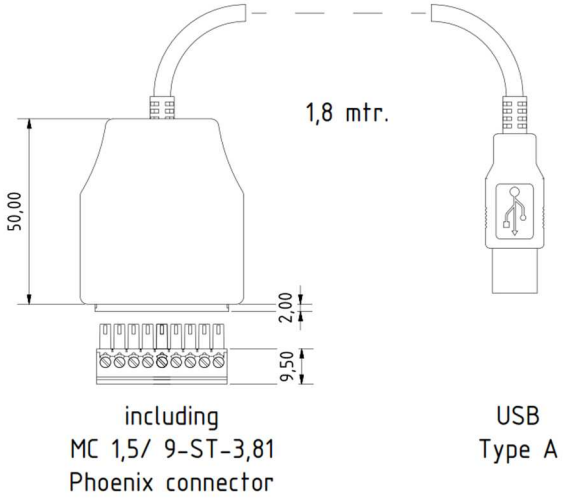


Tap Signal Level
0 - RS232 / TTL
2 - RS232 / TTL inverted

Pin No.	Signal Name	Description
1	DCD	Data Carrier Detect
2	RX	Receive Data
3	TX	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

Tap Signal Level
1 - RS422 / 485

Pin No.	Signal Name	Description
1	TX+	Transmit Data
2	TX-	
3	RTS+	Request To Send
4	RTS-	
5	GND	Signal Ground
6	RX+	Receive Data
7	RX-	
8	CTS+	Clear To Send
9	CTS-	

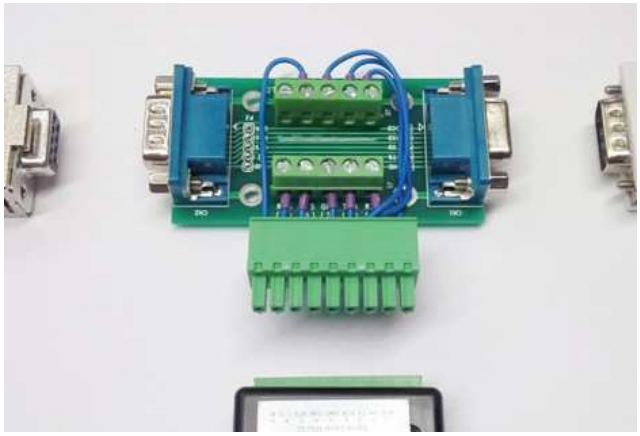


In RS232 mode, the Docklight Tap 485 pin assignment on the Phoenix 9-pole connector corresponds to the RS232 SUB D9 pinout:

RS232 Pin No.	Signal Name	Description	DTE in/out
1	DCD	Data Carrier Detect	Input
2	RX	Receive Data	Input
3	TX	Transmit Data	Output
4	DTR	Data Terminal Ready	Output
5	SGND	Signal Ground	-
6	DSR	Data Set Ready	Input
7	RTS	Request To Send	Output
8	CTS	Clear To Send	Input
9	RI	Ring Indicator	Input

For convenient monitoring of RS232 SUB D9 connections using Docklight Tap 485, we include a free breakout board readily wired for the Docklight Tap 485 9-pole Phoenix connector.

NOTE: Such unshielded breakout/wiring boards may not be suitable for very high speed connections (close to 1 Mbps) or environments with problematic EMI.



2.3 RS485 2-wire (half duplex) monitoring using Docklight Tap 485

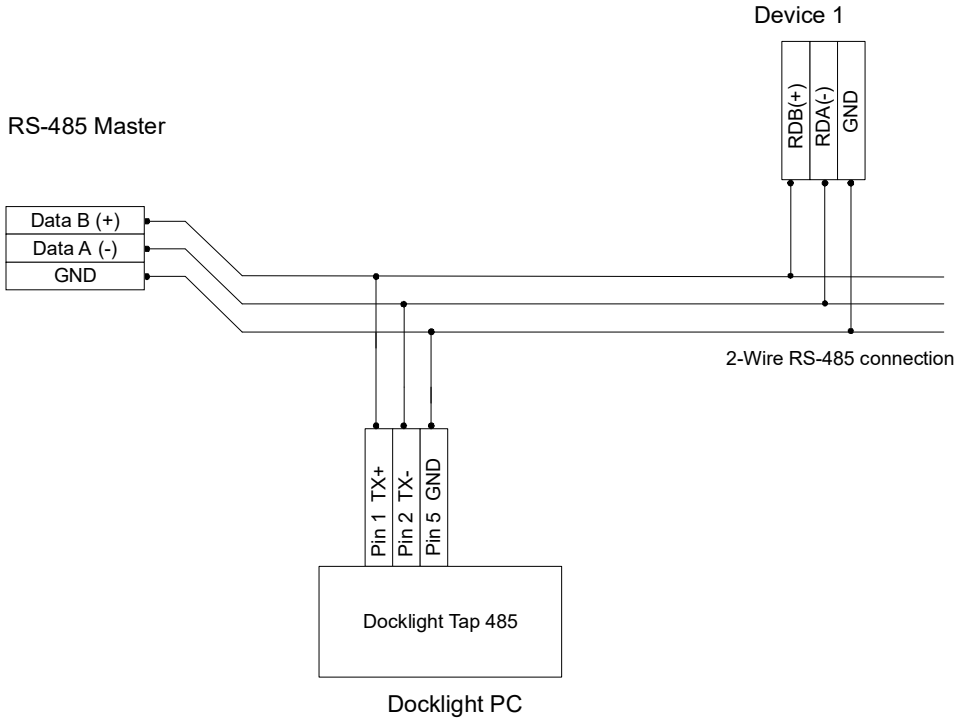
In RS485/RS422 signal mode, Docklight Tap 485 uses the following pin assignment:

Pin No.	Signal Name	Description
1	TX+	Transmit Data
2	TX-	
3	RTS+	Request To Send
4	RTS-	
5	GND	Signal Ground
6	RX+	Receive Data
7	RX-	
8	CTS+	Clear To Send
9	CTS-	

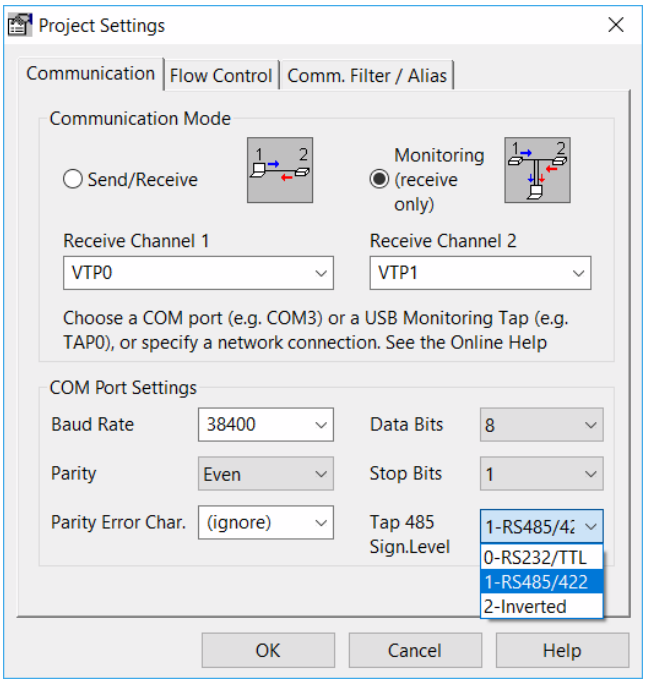
In the majority of RS485 and RS422 applications, the RTS and CTS handshake signals are not used and only the Transmit and Receive data connections need to be wired.

For standard RS485 2-wire applications, connect the RS485 +/- data signal lines and GND signal ground to Docklight Tap 485 TX+ and TX- inputs.

NOTE: Signal ground connections in RS485/422 systems require careful design, because of possible problems with ground loop currents (when signal GND is connected between remote bus nodes) or high ground potential differences GPD (when no common signal GND is used). See also “Grounding and Insulation” in Texas Instruments Application Report: The RS-485 Design Guide SLLA272C [7].

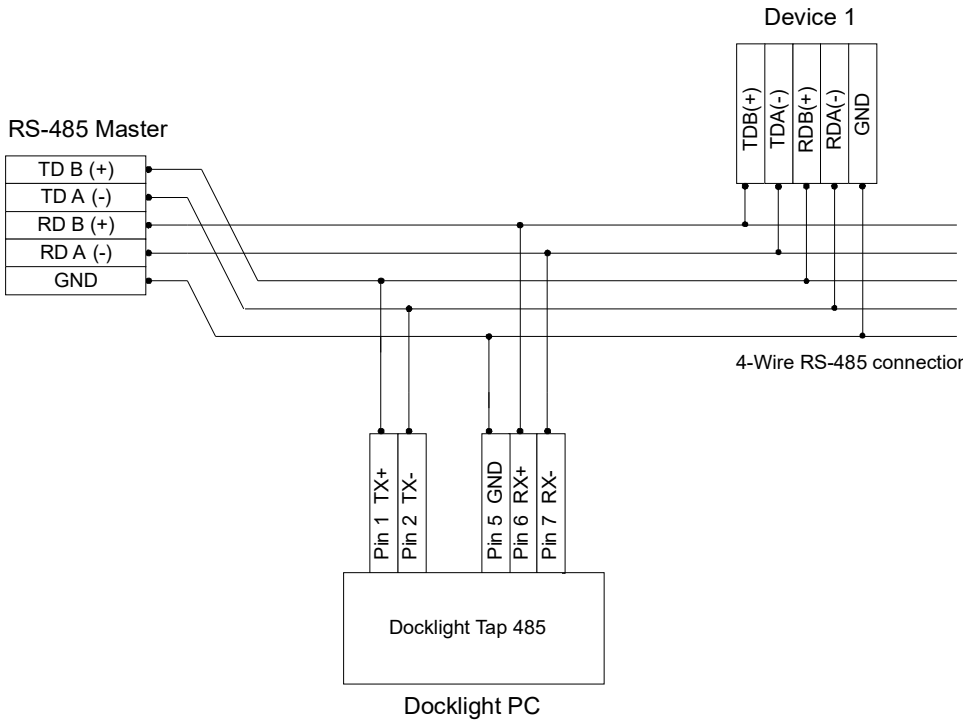


NOTE: In the **Docklight Project Settings** dialog, make sure the **Tap 485 Signal Level** is set correctly: **RS485/RS422**.



2.4 RS485/RS422 4-wire (full duplex) monitoring using Docklight Tap 485

In 4-wire applications, Docklight Tap 485 can distinguish two different data directions: “Transmit/TD/TX” and “Receive/RD/RX”. In addition to the 2.3 wiring, the RD/RX data direction is connected to Docklight Tap 485 at pin no. 6 (RX+) and 7 (RX-).



3 Software Options

For monitoring applications with Docklight Tap Pro and Docklight Tap 485 you can choose between the following Windows software options:

- **Docklight RS232 Terminal / RS232 Monitor** – the solution for advanced data sequence detection and reformatting, but with limitations when it comes to high baud rates (>100 kbps) and high data throughput.
- **Docklight Scripting** – an extended edition of Docklight RS232 Terminal / RS232 Monitor with built-in scripting capabilities for additional post-processing and data evaluation.
- **Docklight Pro Monitor** – a lightweight and lightning-fast monitoring tool for high-speed connections and high data throughput. Docklight Pro Monitor is a free addition to Docklight Scripting.

4 Docklight Pro Monitor

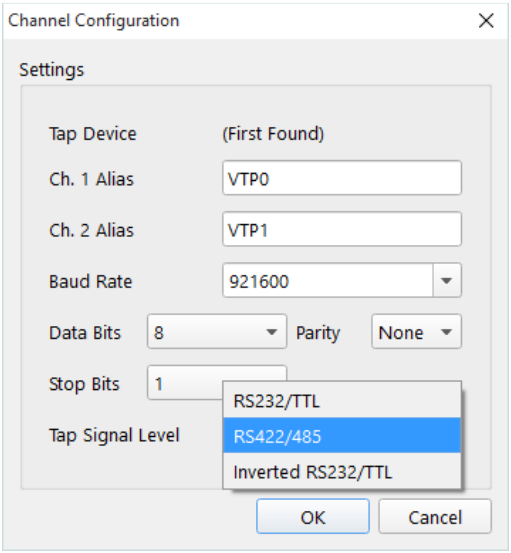
4.1 Quickstart

1. Make sure you have installed the latest Docklight Tap USB drivers (FTDI device drivers).

   On Windows 10, Windows 8 and Windows 7 this is fully automatic – just plug in the Tap USB cable and Windows Update will download and install the correct drivers, if required.

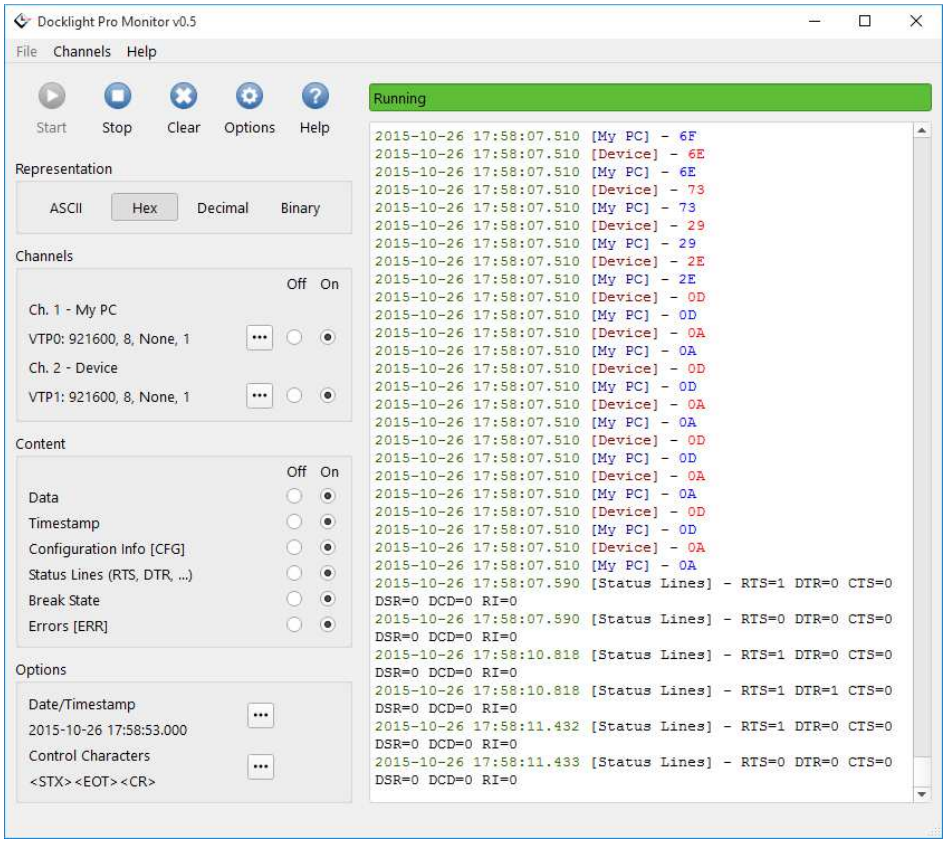
   For details see Section 6: Driver Installation.

2. Download and install **Docklight Pro Monitor** from http://docklight.de/download/DocklightProMonitorSetup.exe
3. Start Docklight Pro Monitor, and choose **Channels -> Configuration**
4. Pick the correct **Serial Communication Parameters** (baud rate, parity, …) and **Signaling Level** (0 – RS232/TTL, 1 – RS422/485, 2 = Inverted RS232/TTL)



5. Confirm and press **Start** (F5).
6. On-the-fly adjustments of the amount of detail displayed can be made using the **Content Off / On** switches.

7. Copy communication data to clipboard (**Ctrl+C**) or switch between ASCII, HEX, Decimal or Binary representation while monitoring.



5 Docklight and Docklight Scripting

5.1 Quickstart

1. Make sure you have installed the latest Docklight Tap USB drivers (FTDI device drivers).

   On Windows 10, Windows 8 and Windows 7 this is fully automatic – just plug in the Tap USB cable and Windows Update will download and install the correct drivers, if required.

   For details see Section 6: Driver Installation.

2. Download and install **Docklight** or **Docklight Scripting** from http://docklight.de/downloads/

3. Start Docklight, choose the menu **Tools > Project Settings...** and select **Communication Mode: Monitoring**. For **Receive Channel 1** and **Receive Channel 2**, select the **VTP** ports available from the dropdown lists, e.g. **VTP0** and **VTP1**.

4. Review and adjust the **COM Port Settings** (baud rate, parity, …). For the **Tap Pro / Tap 485** you can additionally set the **Signaling Level** (0 – RS232/TTL, 1 – RS422/485, 2 = Inverted RS232/TTL). Confirm all settings with **OK**.

5. Press **Start Communication (F5)** in Docklight and start your monitoring application.

Docklight Tap Pro and Docklight Tap RS485 support very high baud rates (up to 921000 baud) with maximum monitoring accuracy. Depending on your average data traffic and your Docklight program

settings, you can easily run into situations where Docklight is simply not fast enough to display and process all the incoming monitoring data, and you will receive a „Input Buffer Overflow“ message by Docklight.

To avoid such overflows, you can either:

- Switch to a simpler display representation. See the Docklight User Manual [2] section „How to Increase the Processing Speed…“ for more information and how to resolve this problem: http://docklight.de/manual/howtoincreasetheprocessing.htm
- Use **Docklight Pro Monitor** instead, as described in section 4.

NOTE: All Docklight Tap devices are „hot-pluggable“ when used with Docklight – if the device becomes unavailable during a Docklight monitoring session, Docklight issues a warning and reconnects to the device when it is plugged back in again.

5.2 Time Stamp Resolution and Processing

Docklight Tap Pro and Docklight Tap RS485 provide exact hardware microseconds timing. Docklight does not expose the full internal resolution of the time tagging, and the visible time stamp resolution is milliseconds, as in other Docklight applications.

5.2.1 Hardware Timing vs. Windows Time

Docklight provides time stamps that are linked to the *Windows* local time on the PC. It reads the **Tap Pro / Tap 485** hardware clock for measuring short time intervals (below 10 seconds) with high accuracy, but refers/synchs to the *Windows* local time on communication start, or after communication idle times larger than 10 seconds.

In addition, Docklight makes sure that the hardware time provided does not slowly drift away from the *Windows* local time during long-term measurements with continuous data.

This effectively gives you the best of both worlds: true milliseconds accuracy and correct order of data when you need it, but also meaningful “drift-free” local time when you are measuring over a long period of time.

5.2.2 Idle Times Resolution

Since the time stamp information is generated by the **Tap Pro / Tap 485** device itself, Docklight needs to manually request new time stamps in periodic intervals during communication idle times. The resulting update interval is then approx. 15 milliseconds. So the following **Docklight Scripting** script

```
DL.StartCommunication()
Do
    DL.AddComment DL.GetDocklightTimeStamp()
Loop
```

will result in output similar to this, if there is no serial communication data currently:

```
27.06.2015 20:07:36.102
27.06.2015 20:07:36.102
27.06.2015 20:07:36.102
27.06.2015 20:07:36.118
27.06.2015 20:07:36.118
27.06.2015 20:07:36.118
27.06.2015 20:07:36.118
27.06.2015 20:07:36.118
27.06.2015 20:07:36.118
27.06.2015 20:07:36.134
```

This behavior is by design and does not influence the time stamp accuracy for received serial communication data in any way.

5.3 How to Display and Evaluate Handshake Signals

The **Tap Pro / Tap 485** devices report handshake signal changes from both communication directions: DTE (Docklight Receive Channel 1) and DCE (Docklight Receive Channel 2).

Signal changes can be evaluated as described in the Docklight User Manual [1] section “Controlling and Monitoring RS232 Handshake Signals”: http://docklight.de/manual/setandreadhandshake.htm

5.3.1 Signal Function Character ‘!’ (F11) in Tap Pro and Tap 485 mode

The **Function Character ‘!’ (F11)** supports the following parameter values when used in Tap Pro and Tap 485 applications:

Bit No.	Character Value (Decimal Mode)	Handshake Signal
0	001	CTS = High (DCE side / Docklight Receive Channel 2)
1	002	DSR = High (DCE side / Channel 2)
2	004	DCD = High (DCE side / Channel 2)
3	008	RI (Ring Indicator) = High (DCE side / Channel 2)
4	016	RTS = High (DTE side / Channel 1)
5	032	DTR = High (DTE side / Channel 1)

For easy evaluation of bit-oriented data like the above handshake signal states, two new features have been added to the Docklight Receive Sequence syntax:

5.3.2 Function Character ‘^’ (F12) for Bitwise Comparisons

The Function Character ‘^’ can be added by pressing **F12** in the **Edit Receive Sequence** dialog. After the ‘^’ Function Character, two additional character values specify which bits to check (<mask>) and which values to expect for these bits (<value>).

Receive Sequence (HEX Mode)	Description
^ | <mask> | <value>	Is a match for the next character received, when the following is true: ((<next Byte received> XOR <value>) AND <mask>) = 0 In other words - the ‘^’ character picks only the bits marked in <mask> and compares them with the corresponding bits in <value>. See below for examples.
^ | 0F | 05	Is a match, when for the next character the following is true: Bit 0 = 1 Bit 1 = 0 Bit 2 = 1 Bit 3 = 0 Bit 4-7 = (don’t care)
! | ^ | 10 | 10	This Receive Sequence triggers when the new handshake signal state says RTS = High All other handshake signals can have any state.

TIP: This extension is also demonstrated in the Docklight Scripting example project **Docklight_TapPro_Demo.ptp** (see the folder **Extras\TapPro** in your Script Samples directory)

5.3.3 DL.GetHandshakeSignals() Script Method

The script method **DL.GetHandshakeSignals()** returns the current handshake signal states as an integer bit field, in the same way the function character '!' works (see table in section 5.3).

Code Example:

```
DL.StartCommunication
Do
     DL.AddComment DL.GetDocklightTimeStamp() & " - GetHandshakeSignals() = " &
DL.GetHandshakeSignals()
     DL.Pause 200
Loop
```

Example Communication Window output:

```
6/23/2015 10:07:44.244  - GetHandshakeSignals() = 0
6/23/2015 10:07:44.469  - GetHandshakeSignals() = 48
6/23/2015 10:07:44.677  - GetHandshakeSignals() = 48
6/23/2015 10:07:44.884  - GetHandshakeSignals() = 48
```

(RTS and DTR are changing to High in this example).

NOTE: It can take 5-10 milliseconds after **DL.StartCommunication()** until **DL.GetHandshakeSignals()** reports the correct signal state.

5.4 Receive Sequence Comment Macros

The following macro keywords can be used to create Docklight comment texts with dynamic data, e.g. the actual data received.

Comment Macro	Description
%_L	Insert a line break
%_T	Insert the time stamp for the data received
%_C	Insert the Docklight channel no. / data direction (1 or 2) for the data received
%_A	Insert the actual data that triggered this Receive Sequence. Use ASCII representation
%_H	Same as %_A, but in HEX representation
%_D	Same as %_A, but in Decimal representation
%_B	Same as %_A, but in Binary representation
%_A(1,4)	Extended syntax: Insert only the first 4 characters of this Receive Sequence (start with Character No. 1, sequence length = 4)
%_H(3,-1)	Extended Syntax: Insert everything from the third character until the end of the sequence (length = -1). Use HEX representation.

Example for detecting and displaying the Tap Pro and Tap 485 handshake signals changes:

1. Open the **Edit Receive Sequence** dialog and create a Receive Sequence with a Function Character '!' (F11), followed by a '?' wildcard (F7) :

! | ?

2. In **3 – Action**, add the following **Comment** text:

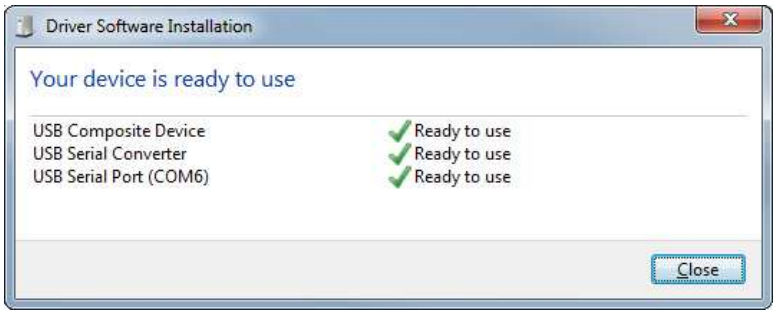
```
%_L%_T Handshake Signals 0|0|DTR|RTS|RING|DCD|DSR|CTS = %_B(2,1)
```

This Receive Sequence will trigger on any handshake signal change reported and add an extra line to the Docklight Communication Window output:

```
6/22/2015 17:01:32.058  Handshake signals 0|0|DTR|RTS|RING|DCD|DSR|CTS =
00100000
```

6 Driver Installation

Driver download on Windows 10, Windows 8, Windows 7 is fully automatic via Windows. After plugging in the Docklight Tap USB cable, the device drivers are installed automatically, if required.



For additional instructions and installation details on Windows XP, or for driver uninstallation or other special cases, please see the installation guides for the FTDI chipset used in Docklight Tap Pro and Docklight Tap 485, as available on the FTDI web site:

http://ftdichip.com/Documents/InstallGuides.htm

7 Copyright

Copyright 2018 Flachmann und Heggelbacher GbR

All rights reserved. No parts of this work may be reproduced in any form or by any means - graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems - without the written permission of the publisher.

Trademarks

Products that are referred to in this document may be either trademarks and/or registered trademarks of the respective owners. The publisher and the author make no claim to these trademarks.

Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

Disclaimer

While every precaution has been taken in the preparation of this document, the publisher and the author assume no responsibility for errors or omissions, or for damages resulting from the use of information contained in this document or from the use of programs and source code that may accompany it. In no event shall the publisher and the author be liable for any loss of profit or any other commercial damage caused or alleged to have been caused directly or indirectly by this document.

Contact

E-Mail Support: docklight@fuh-edv.de
Flachmann & Heggelbacher
Waldkirchbogen 27
D-82061 Neuried (Munich)
Germany
http://www.fuh-edv.de

8 References

[1] Docklight Pro Monitor User Manual
http://docklight.de/pdf/DocklightProMonitor_manual.pdf

[2] Docklight Scripting User Manual
http://docklight.de/pdf/docklight_scripting_manual.pdf

[3] Docklight Tap Application Note
http://docklight.de/pdf/Docklight_Application_Note_DocklightTap.pdf

[4] Docklight Application Note: RS422/485 communication
http://docklight.de/pdf/Docklight_Application_Note_RS422_485.pdf

[5] Docklight Tap Pro Product Sheet
http://www.docklight.de/pdf/Docklight_Tap_Pro.pdf

[6] Docklight Tap 485 Product Sheet
http://www.docklight.de/pdf/Docklight_Tap_485.pdf

[7] Texas Instruments Application Report: The RS-485 Design Guide (SLLA272C)
http://www.ti.com/lit/an/slla272c/slla272c.pdf