NGPON2 C&S System

Customer User Guide

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Revision History

Rev.	Date	Description	Author	Approved by
1	15/09/2022	Initial Draft	Ricardo Ferreira	José Lima
2	21/09/2022	Add Installation, Diagnostic and Calibration sections	Ricardo Ferreira	José Lima
3	25/10/2022	Improved tester errors and states section; Added TCP commands ID 17 and 18; Added "Update Software / Firmware" section; General review	Ricardo Ferreira	José Lima
4	07/12/2022	Added TCP commands ID 19	Ricardo Ferreira	José Lima

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Purpose

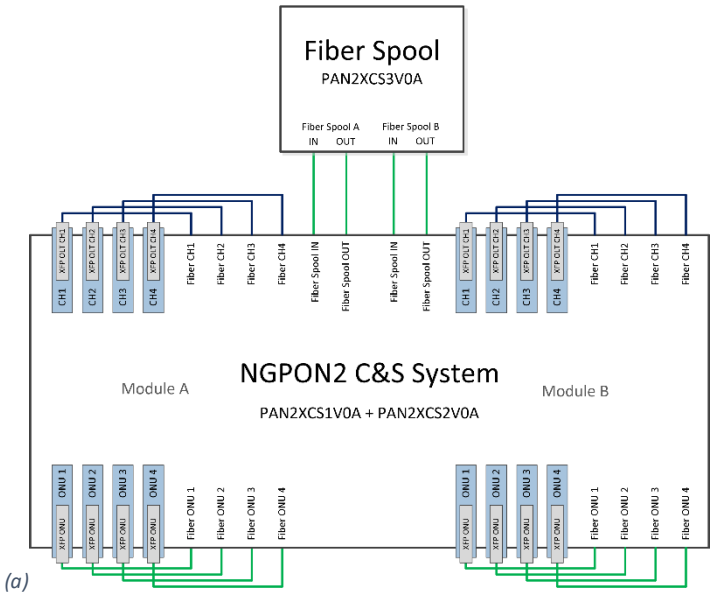
This document is intended to describe the technical details of the NGPON2 C&S System (part numbers PAN2XCS1V0A, PAN2XCS2V0A, PAN2XCS3V0A, PAN2XCSS1V0A, PAN2XCSS2V0A and PAN2XCSS3V0A), containing instructions for use and description of verification and maintenance procedures.

1. Installation

The NGPON2 C&S System requires the following list of material:

- A **main system controller** unit (PAN2XCS1V0A for the two-module version, or PAN2XCS**S**1V0A for the single-module version)
- A **passive optics system** unit (PAN2XCS2V0A for the two-module version, or PAN2XCS**S**2V0A for the single-module version)
- A **10 km fiber spool** unit (PAN2XCS3V0A for the two-module version, or PAN2XCS**S**3V0A for the single-module version)
- 4 channels XFP OLT transceivers (8 for the two-module version)
- 4 SC-UPC to SC-UPC optical fibers (8 for the two-module version)
- 6 SC-APC to SC-APC optical fibers (12 for the two-module version)

Figure 1 depicts the system diagram with all XFP ONU/OLT transceivers and fibers properly connected, with the two-module (a) and single-module (b) version. The top side of the diagram represents the back side connections of the panels, with the 4 channels XFP OLT transceivers properly connected with its fibers, and the **main system controller** and **passive optics system** units connected with the **10 km fiber spool** unit. The bottom side of the diagram corresponds to the front side of the panel, with an example of 4 XFP ONU transceivers to be tested and connected with its associated fiber.



(a)

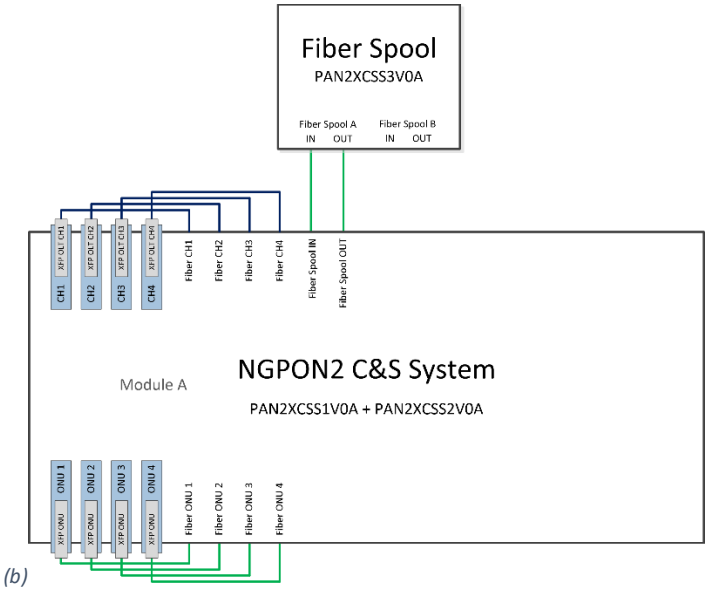


Figure 1 – NGPON2 C&S System diagram with all XFP transceivers and fibers properly connected. (a) version with two modules and (b) version with a single module

For the two-module version, i.e. Figure 1 (a), although both modules are integrated into the same system, they work independently and can be considered as separate modules. And as an example, Module A may be being used for testing purposes, while Module B being calibrated in the same software. **To simplify, the remaining diagrams in this document will be represented with a single module.**

2. Instructions

The NGPON2 C&S System can be controlled using a GUI application or externally using a TCP communication. This section only focuses on the external control of the system and the following table summarizes all TCP socket commands available.

	TCP Sockets Operations					TCP command string	
	ID	Description	Action	Return string	Notes	Mod A	Mod B
Testing	1	Connect system	Yes	Return success or fail	-	1 A	1 B
	2	Read modules	Yes	Return success or fail, with the SNs detected	-	2 A	2 B
	3	Start test	Yes	Return success or fail	(1)	3 A	3 B
	4	Tracking results	-	Return background results (test)	-	4 A	4 B
Diagnostic	5	System diagnostic	Yes	Return success or fail	(2)	5 A	5 B
	6	DS calibration check	Yes	Return success or fail	(2)	6 A	6 B
	7	US calibration check	Yes	Return success or fail	(2)	7 A	7 B
Calibration	8	Calibrate DS	Yes	Return success or fail	(2)	8 A	8 B
	9	Calibrate US	Yes	Return success or fail	(2)	9 A	9 B
Update Board	10	Update firmware	Yes	Return success or fail	(2)	10 A	10 B
	11	Update software	Yes	Return success or fail	(5)	11 A	11 B
Board History	12	Get board history	-	Return test counters per slot	-	12 A	12 B
	13	Reset board history	Yes	Return success	(3)	13 A	13 B
Utilities	14	Continue	Yes	Return success	(4)	14 A	14 B
	15	Cancel	Yes	Return success	(4)	15 A	15 B
	16	Tracking operation	-	Return background results (operation)	-	16 A	16 B
	17	Enable GUI control	Yes	Return success	(5)	17 A	17 B
	18	Disable GUI control	Yes	Return success	(5)	18 A	18 B
	19	Export Tester Data	Yes	Return success or fail	(5)	19 A	19 B

(1) Test runs in background (use operation ID 4 to tracking results);
(2) Test runs in background (use operation ID 16 to tracking operation, and 14/15 to continue/cancel);
(3) Reset counters per slot (when XFP board swaps);
(4) Tool for user interaction, forcing a process to continue;
(5) This command is common to both modules. Therefore, executing a TCP command string "x A" or "x B" forces the same operation (so it is only necessary to run one).

Table 1 – List of TCP socket commands

The commands are divided in the following main categories:

- **Testing (ID 1-4)**: Refers to the commands for the daily use of the tester, including commands to connect to the system, read the XFP detected in the slots for testing, starting the test and finally tracking the results of each test.
- **Diagnostic (ID 5-7):** Includes commands to perform system verification and diagnostic, evaluating the tester performance and the calibration of the DS/US powers. The periodicity of each diagnostic must be properly defined, and the result is a PASS/FAIL criterion.
- **Calibration (ID 8-9):** Commands for system calibration, which needs to be performed only when the setup is mounted and if a diagnostic (operation ID 6-7) fails.
- **Update Board (ID 10-11)**: Commands to trigger the tester's firmware and software update.
- **Board History (ID 12-13)**: Commands to reset/get the test counter per slot.
- **Utilities (ID 14-19)**: Commands for user interaction of any of the operations ID 5-10, to enable/disable the control by the software GUI, and to export the data of the tester.

The last two columns of the table show how to use each command with the associated TCP command string. After the operation ID must follow the module string (i.e. “A” or “B”).

2.1. TCP commands

To establish the TCP communication, by default the system is configured as follow:

- IP address: 127.0.0.1
- Port number: 13000
- Transfer data buffer (size): 8192 bytes

The port number and the IP address can be edited in the "Configuration" tab of the GUI. To force the changes, please restart the application. The next subsections describe all TCP operations available.

2.1.1. Operation ID 1 - Connect system

This command opens a connection with the tester and must be executed whenever a system power reset is performed, after any firmware update or when the software is restarted. To use any of the other commands shown in Table 1 this command must be previously executed. It returns a success or failure message, with the associated error code. Below are some examples:

Example 1 (Fail) - TCP command string: **1 A**
Module A: OLT CH1 not!
Error code: 3

Example 2 (Fail) - TCP command string: **1 A**
Module A: Board was not found!
Error code: 11

Example 3 (Successful connection) - TCP command string: **1 A**
Successfully finished!
Module A is ready to be used!

2.1.2. Operation ID 2 – Read modules

This command read all XFP presented in the tester's slots, returning the Serial Numbers in case of success. This operation must be executed before starting any test. Below are some examples:

Example 1 (Fail) - TCP command string: **2 A**
Error: Module A is not connected!

Example 2 (no XFPs inserted) - TCP command string: **2 A**
Error: No valid XFPs found!

Example 3 (3 XFPs inserted) - TCP command string: **2 A**
Slot 1, Module A, Serial Number: 1014009530
Slot 2, Module A, Serial Number: Not found
Slot 3, Module A, Serial Number: 1015001319
Slot 4, Module A, Serial Number: 1015001342

Example 4 (4 XFPs inserted) - TCP command string: **2 A**
Slot 1, Module A, Serial Number: 1015001350
Slot 2, Module A, Serial Number: 1015001356
Slot 3, Module A, Serial Number: 1015001129
Slot 4, Module A, Serial Number: 1015001319

2.1.3. Operation ID 3 – Start test

This command starts the test of the XFPs detected in the last operation (ID 2). In case of success, the test runs in background and to track its state the operation ID 4 must be used. Below are some usage examples:

Example 1 (Fail) - TCP command string: **3 A**
Error: Module A is not connected!

Example 2 (Fail) - TCP command string: **3 A**
Error: The XFPs were not read, or no valid XFPs detected!

Example 3 (Success) - TCP command string: **3 A**
Successfully started!
Testing is running in background…

2.1.4. Operation ID 4 – Tracking results

This command returns the state and results of all slots under test. For the slots unused it returns empty data. Below are some usage examples (please refer to Section 2.2 to check the list of results obtained from the tester):

Example 1 (PASS unit)

Time Window →		
TCP command string: **4 A**	TCP command string: **4 A**	TCP command string: **4 A**
Serial Number: 1015001350 *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 12/09/2022* *Start time: 10:06:57* *End date:* *End time:* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 35* *XFP firmware version: v10.87* *XFP power consumption: 0* *DDMI Tx Power:* *DDMI Rx Power:* *DDMI Tx Bias Current:* *DDMI Temperature:* *DDMI Vcc:* *Tx Power CH1: -53* *Tx Power CH2: -53* *Tx Power CH3: -53* *Tx Power CH4: -53* *Step 1 PASS/FAIL: PASS* *Step 2 PASS/FAIL: TESTING* *Step 3 PASS/FAIL: -* *Step 4 PASS/FAIL: -* *Step 5 PASS/FAIL: -* *Step 6 PASS/FAIL: -* *Error Code: -* *Final Result: -*	*Serial Number: 1015001350* *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 12/09/2022* *Start time: 10:06:57* *End date:* *End time:* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 35* *XFP firmware version: v10.87* *XFP power consumption: 2.47* *DDMI Tx Power: 7.8* *DDMI Rx Power: -16.5* *DDMI Tx Bias Current: 37.75* *DDMI Temperature: 37* *DDMI Vcc: 3.25* *Tx Power CH1: -53* *Tx Power CH2: -53* *Tx Power CH3: -53* *Tx Power CH4: -53* *Step 1 PASS/FAIL: PASS* *Step 2 PASS/FAIL: PASS* *Step 3 PASS/FAIL: PASS* *Step 4 PASS/FAIL: TESTING* *Step 5 PASS/FAIL: -* *Step 6 PASS/FAIL: -* *Error Code: -* *Final Result: -*	*Serial Number: 1015001350* *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 12/09/2022* *Start time: 10:06:57* *End date: 12/09/2022* *End time: 10:13:27* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 35* *XFP firmware version: v10.87* *XFP power consumption: 2.47* *DDMI Tx Power: 7.8* *DDMI Rx Power: -16.5* *DDMI Tx Bias Current: 37.75* *DDMI Temperature: 37* *DDMI Vcc: 3.25* *Tx Power CH1: 8.78* *Tx Power CH2: 8.82* *Tx Power CH3: 8.42* *Tx Power CH4: 7.02* *Step 1 PASS/FAIL: PASS* *Step 2 PASS/FAIL: PASS* *Step 3 PASS/FAIL: PASS* *Step 4 PASS/FAIL: PASS* *Step 5 PASS/FAIL: PASS* *Step 6 PASS/FAIL: PASS* *Error Code: -* *Final Result: PASS*

Example 2 (FAIL unit)

Time Window →		
TCP command string: **4 A**	TCP command string: **4 A**	TCP command string: **4 A**
Serial Number: 1014009530 *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 13/09/2022*	*Serial Number: 1014009530* *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 13/09/2022*	*Serial Number: 1014009530* *Part Number: PAN2XUXSSA3I* *Slot: 1* *Module: A* *Start date: 13/09/2022*

Start time: 10:58:44 *End date:* *End time:* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 38.25* *XFP firmware version: v10.86* *XFP power consumption: 0* *DDMI Tx Power:* *DDMI Rx Power:* *DDMI Tx Bias Current:* *DDMI Temperature:* *DDMI Vcc:* *Tx Power CH1: -53* *Tx Power CH2: -53* *Tx Power CH3: -53* *Tx Power CH4: -53* *Step 1 PASS/FAIL: TESTING* *Step 2 PASS/FAIL: -* *Step 3 PASS/FAIL: -* *Step 4 PASS/FAIL: -* *Step 5 PASS/FAIL: -* *Step 6 PASS/FAIL: -* *Error Code:* *Final Result: -*	*Start time: 10:58:44* *End date:* *End time:* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 38.25* *XFP firmware version: v10.86* *XFP power consumption: 0* *DDMI Tx Power: 7.48* *DDMI Rx Power: -17.9* *DDMI Tx Bias Current: 38.85* *DDMI Temperature: 40* *DDMI Vcc: 3.26* *Tx Power CH1: -53* *Tx Power CH2: -53* *Tx Power CH3: -53* *Tx Power CH4: -53* *Step 1 PASS/FAIL: PASS* *Step 2 PASS/FAIL: PASS* *Step 3 PASS/FAIL: TESTING* *Step 4 PASS/FAIL: -* *Step 5 PASS/FAIL: -* *Step 6 PASS/FAIL: -* *Error Code:* *Final Result: -*	*Start time: 10:58:44* *End date: 13/09/2022* *End time: 11:04:20* *Software version (tester): v1.12* *Firmware version (tester): v1.45* *Temperature (tester): 38.25* *XFP firmware version: v10.86* *XFP power consumption: 2.62* *DDMI Tx Power: 7.48* *DDMI Rx Power: -17.9* *DDMI Tx Bias Current: 38.85* *DDMI Temperature: 40* *DDMI Vcc: 3.26* *Tx Power CH1: -53* *Tx Power CH2: -53* *Tx Power CH3: -53* *Tx Power CH4: -53* *Step 1 PASS/FAIL: PASS* *Step 2 PASS/FAIL: PASS* *Step 3 PASS/FAIL: PASS* *Step 4 PASS/FAIL: FAIL* *Step 5 PASS/FAIL: -* *Step 6 PASS/FAIL: -* *Error Code: 44* *Final Result: FAIL*

Example 3 (Slot not used)

TCP command string: **4 A**
Serial Number: *Part Number:* *Slot: 2* *Module: A* *Start date:* *Start time:* *End date:* *End time:* *Software version (tester):* *Firmware version (tester):* *Temperature (tester):* *XFP firmware version:* *XFP power consumption:* *DDMI Tx Power:* *DDMI Rx Power:* *DDMI Tx Bias Current:* *DDMI Temperature:* *DDMI Vcc:* *Tx Power CH1:* *Tx Power CH2:* *Tx Power CH3:* *Tx Power CH4:* *Step 1 PASS/FAIL:* *Step 2 PASS/FAIL:* *Step 3 PASS/FAIL:* *Step 4 PASS/FAIL:* *Step 5 PASS/FAIL:* *Step 6 PASS/FAIL:* *Error Code:* *Final Result:*

2.1.5. Operation ID 5 – System diagnostic

This command performs an electro-optic diagnostic to the tester, taking approximately 10 minutes. Once executed, the diagnostic runs in background and operation ID 16 must be used to track its status. The diagnostic is fully automated and requires 4 reference XFP ONUs properly connected with each slot fiber. This diagnostic requires user interaction

and for that operations ID 14 and 15 must be used to respectively continue and cancel the diagnostic. Please refer to Section 3.1 for details of the setup during the different steps. Below are two examples:

Example 1 (Fail) - TCP command string: **5 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **5 A**
Successfully started!
Diagnostic is running in background…

Time Window →			
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
-	-	PASS example	FAIL example
Started... *Step 1 of 13...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!*	*Started...* *Step 1 of 13...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 13...* *Step 3 of 13...* *Step 4 of 13...* *Step 5 of 13...* *Step 6 of 13...* *Step 7 of 13...* *Step 8 of 13...*	*Started...* *Step 1 of 13...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 13...* *Step 3 of 13...* *Step 4 of 13...* *Step 5 of 13...* *Step 6 of 13...* *Step 7 of 13...* *Step 8 of 13...* *Step 9 of 13...* *Step 10 of 13...* *Step 11 of 13...* *Step 12 of 13...* *Step 13 of 13...* *Finished!* *Final Result: PASS!*	*Started...* *Step 1 of 13...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 13...* *Step 3 of 13...* *Step 4 of 13...* *Finished!* *Final Result: FAIL!*

2.1.6. Operation ID 6 – DS calibration check

This command performs a verification of the DS calibration powers, taking approximately 4 minutes. Once executed, the verification runs in background and operation ID 16 must be used to track its status. The verification is semi-automated and requires a Thorlabs power meter. It requires user interaction and for that operations ID 14 and 15 must be used to respectively continue and cancel the verification. Please refer to Section 3.2 for details of the setup during the different steps. Below are two examples:

Example 1 (Fail) - TCP command string: **6 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **6 A**
Successfully started!
Verification is running in background…

Time Window →			
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Step 1 of 8...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable*	*Started...* *Step 1 of 8...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable*	*Started...* *Step 1 of 8...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable*	*Started...* *Step 1 of 8...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable*

+ SC adapter *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 8...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!*	*+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 8...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 8...* *Step 4 of 8...* *Step 5 of 8...* *1. Connect the SC adapter to the Fiber ONU 4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 6 of 8...* *1. Connect the SC adapter to the Fiber ONU 3* *2. Then force 'Continue'!*	*+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 8...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 8...* *Step 4 of 8...* *Step 5 of 8...* *1. Connect the SC adapter to the Fiber ONU 4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 6 of 8...* *1. Connect the SC adapter to the Fiber ONU 3* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 7 of 8...* *1. Connect the SC adapter to the Fiber ONU 2* *2. Then force 'Continue'!*	*+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 8...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 8...* *Step 4 of 8...* *Step 5 of 8...* *1. Connect the SC adapter to the Fiber ONU 4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 6 of 8...* *1. Connect the SC adapter to the Fiber ONU 3* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 7 of 8...* *1. Connect the SC adapter to the Fiber ONU 2* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 8 of 8...* *1. Connect the SC adapter to the Fiber ONU 1* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Finished!* *Final Result: PASS!*

2.1.7. Operation ID 7 – US calibration check

This command performs a verification of the US calibration powers, taking approximately 3 minutes. Once executed, the verification runs in background and operation ID 16 must be used to track its status. The verification is semi-automated and requires a Thorlabs power meter and 4 reference XFP ONUs properly connected with each slot fiber. It requires user interaction and for that operations ID 14 and 15 must be used to respectively continue and cancel the verification. Please refer to Section 3.3 for details of the setup during the different steps. Below are two examples:

Example 1 (Fail) - TCP command string: **7 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **7 A**
Successfully started!
Verification is running in background…

Time Window →			
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Step 1 of 9...*	*Started...* *Step 1 of 9...*	*Started...* *Step 1 of 9...*	*Started...* *Step 1 of 9...*

1. Check the equipment required: *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 9...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!*	*1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 9...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 9...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 4 of 9...* *Step 5 of 9...* *Step 6 of 9...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!*	*1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 9...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 9...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 4 of 9...* *Step 5 of 9...* *Step 6 of 9...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 7 of 9...* *1. Connect the SC adapter to the Fiber CH2* *2. Then force 'Continue'!*	*1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 9...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 9...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 4 of 9...* *Step 5 of 9...* *Step 6 of 9...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 7 of 9...* *1. Connect the SC adapter to the Fiber CH2* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 8 of 9...* *1. Connect the SC adapter to the Fiber CH3* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 9 of 9...* *1. Connect the SC adapter to the Fiber CH4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Finished!* *Final Result: PASS!*

2.1.8. Operation ID 8 – Calibrate DS

This command performs a calibration of the DS powers, taking approximately 15 minutes. Once executed, the calibration runs in background and operation ID 16 must be used to track the calibration status. This calibration is semi-automated and requires a Thorlabs power meter. It requires user interaction and for that operations ID 14 and 15 must be used to respectively continue and cancel the verification. Please refer to Section 4.1 for details of the setup during the different steps. Below are two examples:

Example 1 (Fail) - TCP command string: **8 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **8 A**
Successfully started!
Calibration is running in background...

Time Window →			
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Step 1 of 22...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable* *+ SC adapter* *2. Then force 'Continue'!*	*Started...* *Step 1 of 22...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable* *+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 22...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!*	*Started...* *Step 1 of 22...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable* *+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 22...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 22...* *1. Connect the SC adapter to the Fiber ONU 4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 4 of 22...* *Step 5 of 22...*	*Started...* *Step 1 of 22...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-APC fiber cable* *+ SC adapter* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 2 of 22...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-APC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 3 of 22...* *1. Connect the SC adapter to the Fiber ONU 4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 4 of 22...* *Step 5 of 22...* *Step 6 of 22...* *Step 7 of 22...* *Step 8 of 22...* *1. Connect the SC adapter to the Fiber ONU 3* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 9 of 22...* *Step 10 of 22...* *Step 11 of 22...* *Step 12 of 22...* *Step 13 of 22...* *1. Connect the SC adapter to the Fiber ONU 2* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 14 of 22...* *Step 15 of 22...* *Step 16 of 22...* *Step 17 of 22...* *Step 18 of 22...* *1. Connect the SC adapter to the Fiber ONU 1* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 19 of 22...* *Step 20 of 22...* *Step 21 of 22...*

			Step 22 of 22... *Finished!*

2.1.9. Operation ID 9 – Calibrate US

This command performs a calibration of the US powers, taking approximately 15 minutes. Once executed, the calibration runs in background and operation ID 16 must be used to track the calibration status. This calibration is semi-automated and requires a Thorlabs power meter and 4 reference XFP ONUs properly connected with each slot fiber. It requires user interaction and for that operations ID 14 and 15 must be used to respectively continue and cancel the verification. Please refer to Section 4.2 for details of the setup during the different steps. Below are two examples:

Example 1 (Fail) - TCP command string: **9 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **9 A**
Successfully started!
Calibration is running in background...

Time Window →			
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Step 1 of 23...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 2 of 23...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!*	*Started...* *Step 1 of 23...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 2 of 23...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 3 of 23...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 4 of 23...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 5 of 23...* *Step 6 of 23...*	*Started...* *Step 1 of 23...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 2 of 23...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 3 of 23...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 4 of 23...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 5 of 23...* *Step 6 of 23...* *Step 7 of 23...* *Step 8 of 23...* *Step 9 of 23...* *1. Connect the SC adapter to the Fiber CH2*	*Started...* *Step 1 of 23...* *1. Check the equipment required:* *+ ThorLabs* *+ USB-A/Mini-USB cable* *+ FC-UPC/SC-UPC fiber cable* *+ SC adapter* *+ 4 reference XFP ONUs* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 2 of 23...* *1. Connect the USB-A/Mini-USB cable between the Thorlabs and the computer* *2. Connect the FC-UPC/SC-UPC fiber cable between the ThorLabs and the SC adapter* *3. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 3 of 23...* *1. Make sure you have 4 reference XFP ONUs with its associated fiber properly connected* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 4 of 23...* *1. Connect the SC adapter to the Fiber CH1* *2. Then force 'Continue'!* (TCP command string: **14 A**) *Ok... wait* *Step 5 of 23...* *Step 6 of 23...* *Step 7 of 23...* *Step 8 of 23...* *Step 9 of 23...* *1. Connect the SC adapter to the Fiber CH2*

		2. Then force 'Continue'! (TCP command string: **14 A)** *Ok... wait* *Step 10 of 23...* *Step 11 of 23...*	*2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 10 of 23...* *Step 11 of 23...* *Step 12 of 23...* *Step 13 of 23...* *Step 14 of 23...* *1. Connect the SC adapter to the Fiber CH3* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 15 of 23...* *Step 16 of 23...* *Step 17 of 23...* *Step 18 of 23...* *Step 19 of 23...* *1. Connect the SC adapter to the Fiber CH4* *2. Then force 'Continue'!* (TCP command string: **14 A)** *Ok... wait* *Step 20 of 23...* *Step 21 of 23...* *Step 22 of 23...* *Step 23 of 23...* *Finished!*

2.1.10. Operation ID 10 – Update firmware

This command forces a firmware update of the tester, running in background. Internet connection is required for this operation, otherwise the update must be coordinated with the tester's support team. Once the firmware update is started, the operation ID 16 must be used to track the updating status. Below are two examples:

Example 1 (Fail) - TCP command string: **10 A**
Error: Module A is not connected!

Example 2 (Success) - TCP command string: **10 A**
Successfully started!
Upgrading is running in background...

Time Window →		
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Download files...* *Programming main controller...*	*Started...* *Download files...* *Programming main controller...* *Programming slot 4...* *Programming slot 3...*	*Started...* *Download files...* *Programming main controller...* *Programming slot 4...* *Programming slot 3...* *Programming slot 2...* *Programming slot 1...* *Finished!*

2.1.11. Operation ID 11 – Update software

This command forces a software update of the tester. Internet connection is required for this operation, otherwise the update must be coordinated with the tester's support team. This command is common to both modules. Therefore executing "11 A" or "11 B" forces the same operation (so it is only necessary to run one).

Example - TCP command string: **11 A**
Upgrading started... wait until the new GUI opens

2.1.12. Operation ID 12 – Get board history

This command returns the test counters per slot. The NGPON2 C&S System includes two type of counters:

- **Global counter**: Accumulates the total number of tests of the system.
- **Reset counter**: Indicates the number of tests per slot since the last reset. Its purpose is to be reset when the XFP ONU board swaps (please see Section 2.1.13 to reset this counter).

Example - TCP command string: **12 A**
Slot 1 reset counter (Module A): 29
Slot 2 reset counter (Module A): 5
Slot 3 reset counter (Module A): 36
Slot 4 reset counter (Module A): 31

Slot 1 global counter (Module A): 29
Slot 2 global counter (Module A): 5
Slot 3 global counter (Module A): 36
Slot 4 global counter (Module A): 31

Example - TCP command string: **12 B**
Slot 1 reset counter (Module B): 4
Slot 2 reset counter (Module B): 1
Slot 3 reset counter (Module B): 12
Slot 4 reset counter (Module B): 1

Slot 1 global counter (Module B): 11
Slot 2 global counter (Module B): 8
Slot 3 global counter (Module B): 25
Slot 4 global counter (Module B): 8

2.1.13. Operation ID 13 – Reset board history

This command forces a reset to the **reset counter** (please refer to Section 2.1.12 for further details). The next example shows the functionality of this operation in combination with operation ID 12.

Example:

Time Window →		
TCP command string: **12 A**	TCP command string: **13 A**	TCP command string: **12 A**
Before reset	-	After reset
Slot 1 reset counter (Module A): 29 *Slot 2 reset counter (Module A): 5* *Slot 3 reset counter (Module A): 36* *Slot 4 reset counter (Module A): 31* *Slot 1 global counter (Module A): 29* *Slot 2 global counter (Module A): 5* *Slot 3 global counter (Module A): 36* *Slot 4 global counter (Module A): 31*	*Successful operation!*	*Slot 1 reset counter (Module A): 0* *Slot 2 reset counter (Module A): 0* *Slot 3 reset counter (Module A): 0* *Slot 4 reset counter (Module A): 0* *Slot 1 global counter (Module A): 29* *Slot 2 global counter (Module A): 5* *Slot 3 global counter (Module A): 36* *Slot 4 global counter (Module A): 31*

2.1.14. Operation ID 14 / 15 – Continue / Cancel

These commands force a process running in background to continue (14) or cancel (15). This is applied to user interaction of any of the ID 5 to 10 operations.

Example 1 (Continue) - TCP command string: **14 A**
Ok!
Operation running in background…

Example 2 (Cancel) - TCP command string: **15 A**
Operation canceled!

2.1.15. Operation ID 16 – Tracking operation

This operation tracks the status of any operation running in background. This is applied to any of the ID 5 to 10 operations. Next example shows the returned string with this command when operation ID 10 (firmware update) is running in background.

Example:

Time Window →		
TCP command string: **16 A**	TCP command string: **16 A**	TCP command string: **16 A**
Started... *Download files...* *Programming main controller...*	*Started...* *Download files...* *Programming main controller...* *Programming slot 4...* *Programming slot 3...*	*Started...* *Download files...* *Programming main controller...* *Programming slot 4...* *Programming slot 3...* *Programming slot 2...* *Programming slot 1...* *Finished!*

2.1.16. Operation ID 17 – Enable GUI control

This command enables all controls in the software GUI. By default the software starts with all controls disabled in the GUI. This command is common to both modules. Therefore executing "17 A" or "17 B" forces the same operation (so it is only necessary to run one).

Example - TCP command string: **17 A**
Successful operation!

2.1.17. Operation ID 18 – Disable GUI control

This command disables all controls in the software GUI. This command is common to both modules. Therefore executing "18 A" or "18 B" forces the same operation (so it is only necessary to run one).

Example - TCP command string: **18 A**
Successful operation!

2.1.18. Operation ID 19 – Export Tester Data

This command exports the data of the tester. This command is common to both modules. Therefore executing "19 A" or "19 B" forces the same operation (so it is only necessary to run one).

Example - TCP command string: **19 A**
Done!
'ExportedData.zip' file created on 'D:\Software'

2.2. List of results

Table 2 reports the list of results obtained from the tester.

Parameter	Type	Example	Range	Unit
Serial Number	string	1015006512		
Part Number	string	PAN2XUXSSA3I		
Slot	int	0	0 - 3	
Module	string	A	A, B	
Start date	string	14/07/2022		
Start time	string	12:49:44		
End date	string	14/07/2022		
End time	string	12:58:12		
Software version (tester)	string	v1.1		

Firmware version (tester)	string	v1.5		
Temperature (tester)	double	52.65		Degrees
XFP firmware version	string	v10.87		
XFP power consumption	double	2.31		W
DDMI Tx power	double	7.3		dBm
DDMI Rx power	double	-35.5		dBm
DDMI Tx Bias current	double	39.5		mA
DDMI Temperature	double	35.75		Degrees
DDMI Vcc	double	3.125		Voltage
Tx Power CH1	double	7.12		dBm
Tx Power CH2	double	7.25		dBm
Tx Power CH3	double	7.02		dBm
Tx Power CH4	double	6.8		dBm
Step 1 PASS/FAIL	string	PASS		
Step 2 PASS/FAIL	string	PASS		
Step 3 PASS/FAIL	string	PASS		
Step 4 PASS/FAIL	string	PASS		
Step 5 PASS/FAIL	string	FAIL		
Step 6 PASS/FAIL	string	-		
Error Code	int	52		
Final Result	string	FAIL		

Table 2 – List of results returned on the tester

2.3. List of testing states

Table 3 reports the list of states of the tester, including a summary of the tests performed in each state.

Step	List of tests
Step 1: Check Transceiver Integrity	+ Functional test of BOSA/PCB + Check Preliminary diagnostics + Check LOS
Step 2: Check Tx/Rx tuning times	+ Performs all Tx/Rx channel tuning sequences and check if tuning time is always <1 sec
Step 3: Check Tx wavelength	+ Check if all Tx channel wavelength are stable and in the expected wavelength
Step 4: Check DS	+ Check Rx sensitivity in all channels (BER test in B2B)
Step 5: Check US	+ Check Tx sensitivity in all channels (BER test in B2B) + Check Tx optical power in all channels
Step 6: Check US OPP	+ Check Tx OPP in all channels (BER test with 10km fiber)

Table 3 – List of testing states

2.4. List of error codes

Table 4 reports the list of error codes of the tester, including the failure criterion (if applied) and a brief description of each error.

Step	Error Code	Description	Fail Criterion	Description
Common to all step	1	Tester setup fail	N/A	Indicates an error of the tester. Repeat the test, and if the error persists perform the System Diagnostic (Section 2.1.5)
	2	XFP was removed	N/A	The tester lost electrical connection with the XFP. The XFP has been removed by the operator, or the XFP connector is not in good condition
	3	XFP in protection mode	N/A	XFP enter in protection mode during the test. This indicates abnormal behavior of XFP
	4	Wavelength error	N/A	Indicates that the Tx wavelength of the XFP does not meet the NGPON2 standard. This error occurs when Tx power is detected outside the configured channel
	5	Tx Low Power	<3.5 dBm	Indicates that low Tx power was detected in the tester. This may be related to the following issues: • Optical fiber not properly connected (verify fiber connection and repeat the test)

				• Incorrect calibration of the tester. Please perform the System Diagnostic (Section 2.1.5) to evaluate the tester performance • Degradation of XFP optical Tx
Step 1	11	Optical Tx	N/A	Indicates an electrical or optical fault with the Tx part of the XFP
	12	Optical Rx	N/A	Indicates an electrical or optical fault with the Rx part of the XFP
	13	PCB	N/A	Indicates a PCB fault (hardware) of the XFP
	14	Preliminary Tx power	<4 dBm or >11 dBm	Indicates that the DDMI Tx power reported is abnormal Typical power reported is 7 to 8 dBm
	15	Preliminary Rx power	<-24.7 dBm or >-10 dBm	Indicates that the DDMI Rx power reported is abnormal: • Low powers usually indicate that the optical fiber is not properly connected with the XFP. • For powers <-30 dBm ○ The XFP OLTs transceivers may be in fault ○ The XFP is not locking on the Rx (XFP FAIL) Typical power reported is -18 to -14 dBm
	16	Tx Bias	<20 mA or >60 mA	Indicates that the DDMI Tx bias reported is abnormal. Typical bias reported is 30 to 50 mA
	17	Vcc	<2.9 V or >3.6 V	Indicates that the DDMI Vcc reported does not meet the NGPON2 standard
	18	Temperature	<10 ºC or >75 ºC	Indicates that the DDMI temperature reported is abnormal. This indicates a problem with the temperature sensor of the XFP, or overheating of the XFP
	19	Alarmistic	N/A	Alarmistic fault in the XFP. This can be trigger by the Tx fault and the TEC Tx/Rx
Step 2	21	Tuning times Tx	> 1 sec	Indicates a channel Tx tuning time fail. Tuning time does not meet the NGPON2 standard
	22	Tuning times Rx	> 1 sec	Indicates a channel Rx tuning time fail. Tuning time does not meet the NGPON2 standard
	23	LOS pin	N/A	Indicates that the LOS pin is not working properly
Step 3	31	Spectrum stability	N/A	Indicates that the Tx wavelength of the XFP is not stable
Step 4	41	Fail DS CH1	At DS power -28 dBm, BER > 1e-3	BER test of the DS. Indicates that the DS sensitivity does not meet the NGPON2 standard. This can also indicate that the optical fiber is not properly connected with the XFP, or at least a XFP OLT Tx is in fault.
	42	Fail DS CH2	At DS power -28 dBm, BER > 1e-3	
	43	Fail DS CH3	At DS power -28 dBm, BER > 1e-3	
	44	Fail DS CH4	At DS power -28 dBm, BER > 1e-3	
Step 5	51	Fail US CH1	At BER 1e-3, US power > -27 dBm	BER test of the US. Indicates that the US sensitivity does not meet the NGPON2 standard. This can also indicate that the optical fiber is not properly connected with the XFP, or at least a XFP OLT Rx is in fault.
	52	Fail US CH2	At BER 1e-3, US power > -27 dBm	
	53	Fail US CH3	At BER 1e-3, US power > -27 dBm	
	54	Fail US CH4	At BER 1e-3, US power > -27 dBm	
Step 6	61	Fail US OPP CH1	OPP > 2 dB	BER test of the US with 10 km fiber. Indicates that the US OPP does not meet the NGPON2 standard. This can also indicate that the 10 km fiber spool in not in good condition, or at least a XFP OLT Rx is not ok.
	62	Fail US OPP CH2	OPP > 2 dB	
	63	Fail US OPP CH3	OPP > 2 dB	
	64	Fail US OPP CH4	OPP > 2 dB	

Table 4 – List of error codes

3. Diagnostic

The NGPON2 C&S System includes 3 operations to perform system verification and diagnostic, evaluating the tester performance and the calibration of the DS/US powers:

- System diagnostic;
- DS calibration check;
- US calibration check.

The periodicity of each diagnostic must be properly defined, and the result of each test is a PASS/FAIL criterion. This section intends to describe the process and setups used in each diagnostic/verification. The following list of material is required, depending on the diagnostic:

- 1 x Thorlabs PM100D;
- 1 x Fiber FC-UPC to SC-APC;
- 1 x Fiber FC-UPC to SC-UPC;
- 1 x SC fiber adapter;
- 1 x Mini-USB to USB-A cable;
- 4 x Reference XFP ONU transceivers.

3.1. System Diagnostic

This operation is fully automated and performs a diagnostic to the tester, taking 10-15 minutes to be performed. Please refer to **Section 2.1.5** for details on how to start the diagnostic in the software. Figure 2 depicts the required setup for this diagnostic, being the same as the one employed in the "daily" use of the tester. It requires 4 reference XFP ONU transceivers to perform a properly diagnostic/verification.

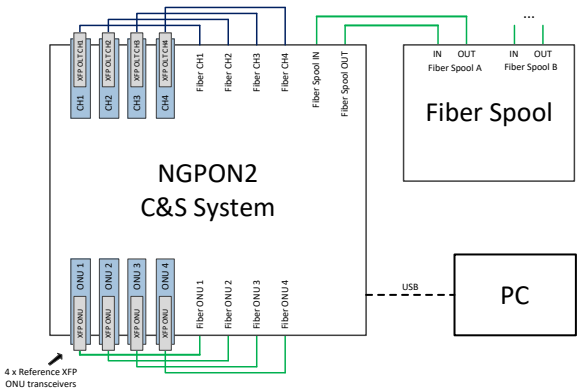


Figure 2 - Setup used for system diagnostic

In case of **diagnostic FAIL**, please check if the diagnostic was carried out with the optical fibers properly connected to the XFP ONU and OLT transceivers and run the diagnostic again. If the FAIL persists, please verify if all optical fibers of the tester are in good conditions. If so, a recalibration of the DS or US may be needed, but before that run first the next two diagnostics. In case of FAIL, force the system calibration (see sections 4.1 and 4.2 for DS and US calibration).

3.2. DS calibration check

This operation performs a verification of the DS calibration powers and it is a semi-automated diagnostic. Figure 3 depicts the setup used for this diagnostic, with a diagram showing the differences between the system used for testing (a) and the system prepared for the verification (b). The XFP ONU transceivers can be removed from the tester, and the Thorlabs power meter properly connected with a FC-UPC to SC-APC fiber.

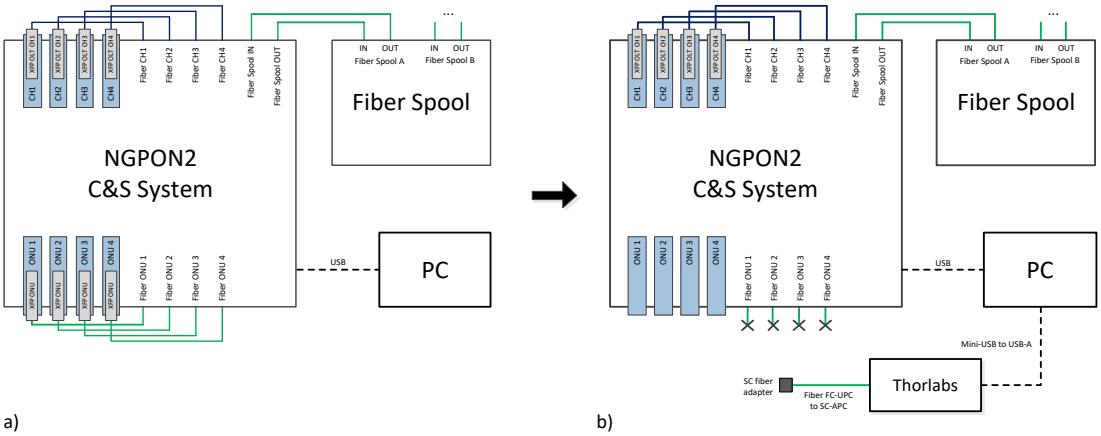


Figure 3 - Setup used for testing (a) and for DS calibration check (b)

Then all 4 optical fibers can be verified. Please refer to Section 2.1.6 for details on how to start the diagnostic in the software. During the diagnostic the software will request to change the slot fiber from the Fiber ONU 4 to ONU 1. Figure 4 shows the setup in each of the 4 stages. In case of **diagnostic FAIL**, please check if the diagnostic was carried out with the optical fibers properly connected to Thorlabs and run the diagnostic again. If the FAIL persists, please verify if the optical fiber of the failed slot is in good condition. If so, a recalibration of the DS should be performed and for that please refer to sections 2.1.8 and 4.1.

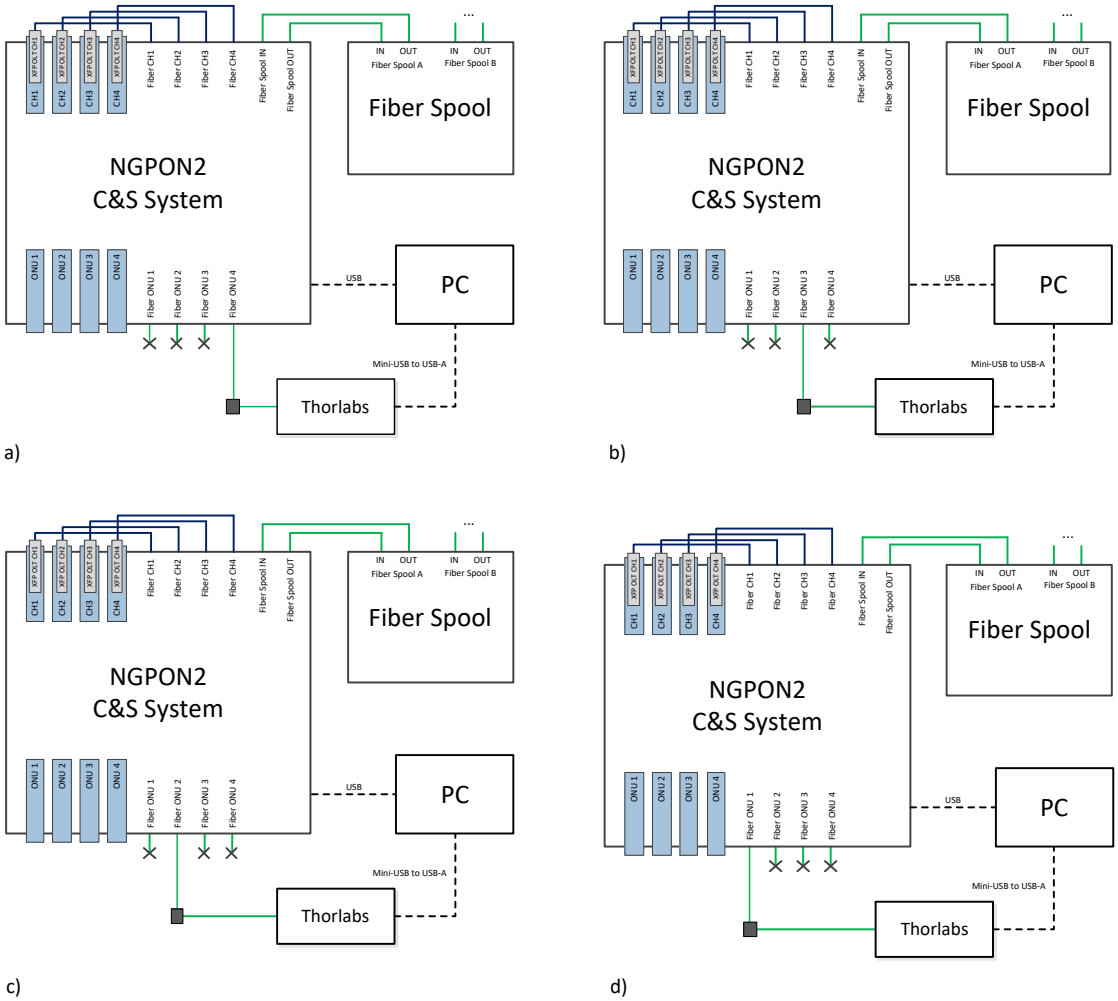


Figure 4 - Setup used for DS calibration check of all optical fibers connected to the XFP ONU transceivers, from slot 4 (a), slot 3 (b), slot 2 (c) to slot 1 (d) (corresponding to the verification sequence)

3.3. US calibration check

This operation performs a verification of the US calibration powers and it is a semi-automated diagnostic. Figure 5 depicts the setup used for this diagnostic, with a diagram showing the differences between the system used for testing (a) and the system prepared for the verification (b). The XFP OLT transceivers can be removed from the tester, and the Thorlabs power meter properly connected with a FC-UPC to SC-UPC fiber. Use 4 reference XFP ONU transceivers to perform a properly verification.

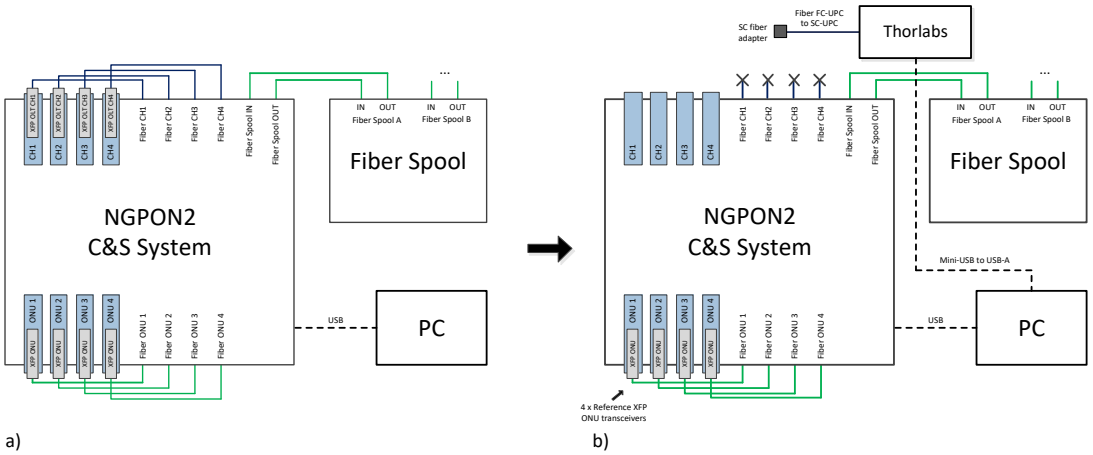


Figure 5 - Setup used for testing (a) and for US calibration check (b)

Then all 4 optical fibers can be verified. Please refer to Section 2.1.7 for details on how to start the diagnostic in the software. During the diagnostic the software will request to change the slot fiber from the Fiber CH1 to CH4. Figure 6 shows the setup in each of the 4 stages. In case of **diagnostic FAIL**, please check if the diagnostic was carried out with the optical fibers properly connected to Thorlabs and run the diagnostic again. If the FAIL persists, please verify if the optical fiber of the failed slot is in good condition. If so, a recalibration of the US should be performed and for that please refer to Sections 2.1.9 and 4.2.

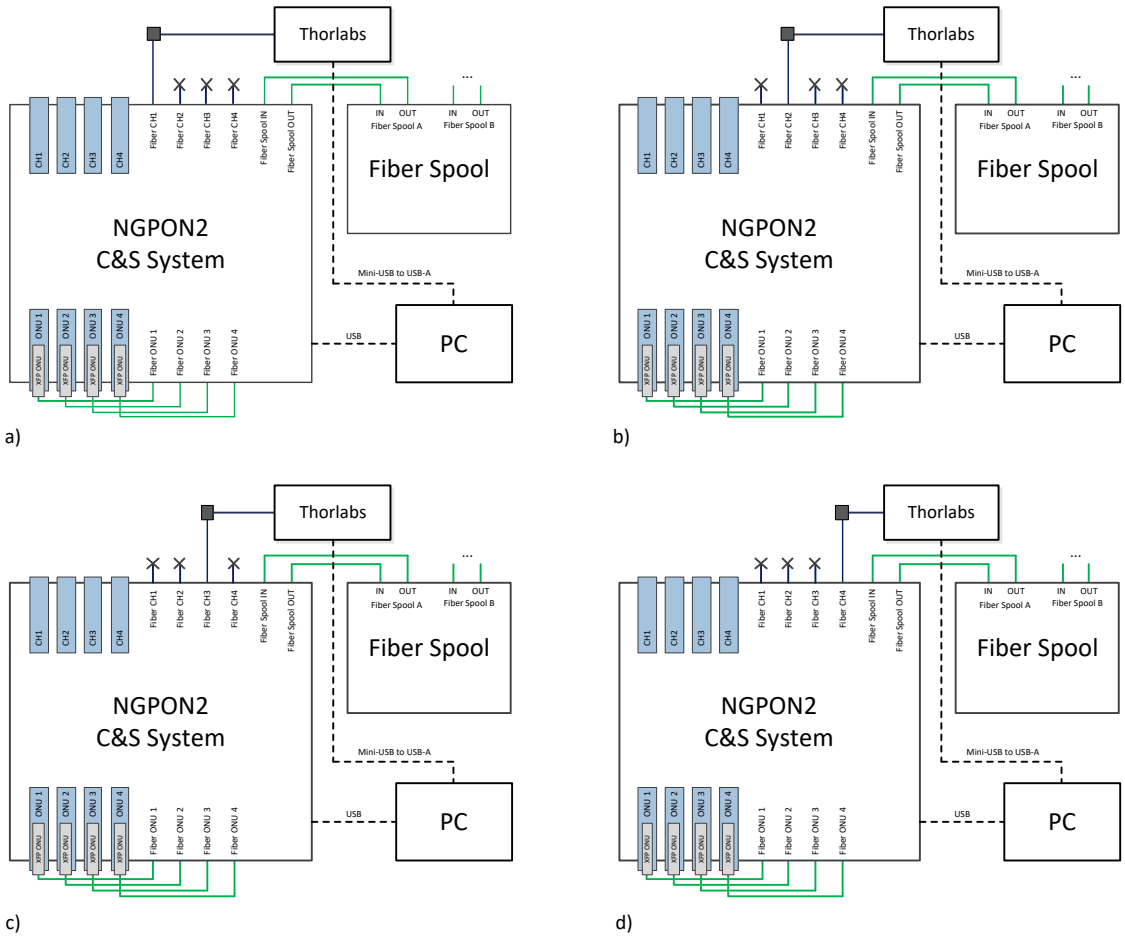


Figure 6 - Setup used for US calibration check of all optical fibers connected to the XFP OLT transceivers, from CH1 (a), CH2 (b), CH3 (c) to CH4 (d) (corresponding to the verification sequence)

4. Calibration

The NGPON2 C&S System includes built-in power meters that need to be calibrated. This operation involves the calibration of all optical fibers connected to the XFP transceivers of the tester and this section intends to describe the setups that should be employed. The calibration is divided into two main different steps, the DS (downstream) and US (upstream) calibration, corresponding respectively to the optical fibers connected to the XFP ONU and XFP OLT transceivers. The calibration requires the following additional material:

- 1 x Thorlabs PM100D
- 1 x Fiber FC-UPC to SC-APC
- 1 x Fiber FC-UPC to SC-UPC
- 1 x SC fiber adapter
- 1 x Mini-USB to USB-A cable
- 4 x Reference XFP ONU transceivers

Each calibration is semi-automated, requiring the user interaction to change the slot fiber (0, 1, 2 and 3). Next, we describe each of the calibrations.

4.1. DS Calibration

Figure 7 depicts the setup used for the DS calibration, with a diagram showing the differences between the system used for testing (a) and the system prepared for calibration (b). The XFP ONU transceivers can be removed from the tester, and the Thorlabs power meter properly connected with a FC-UPC to SC-APC fiber.

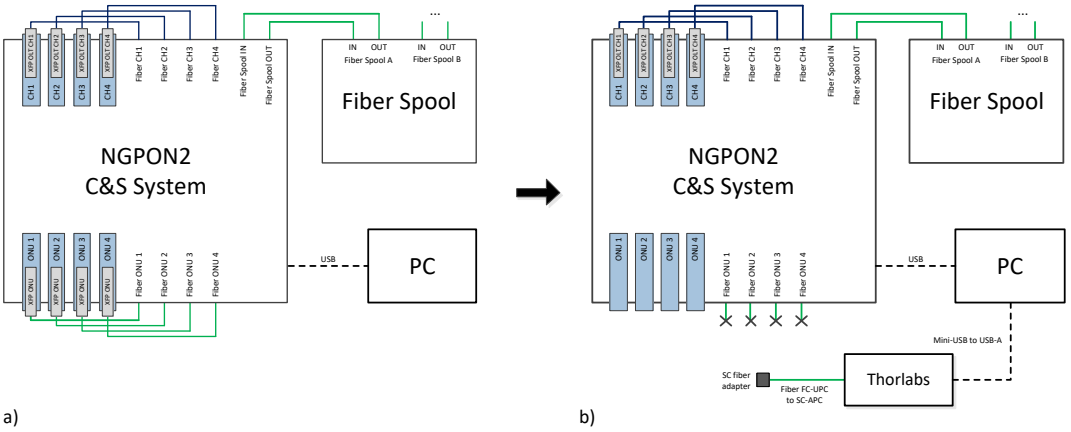


Figure 7 - Setup used for testing (a) and for DS calibration (b)

Then all 4 optical fibers can be calibrated. Please refer to Section 2.1.8 for details on how to start the calibration in the software. During the calibration the software will request to change the slot fiber from the Fiber ONU 4 to ONU 1. Figure 8 shows the setup in each of the 4 stages. **Before forcing proceed to any next step, please always make sure all optical fibers are properly connected to the Thorlabs and to the XFP OLT transceivers, otherwise the setup may be incorrectly calibrated.**

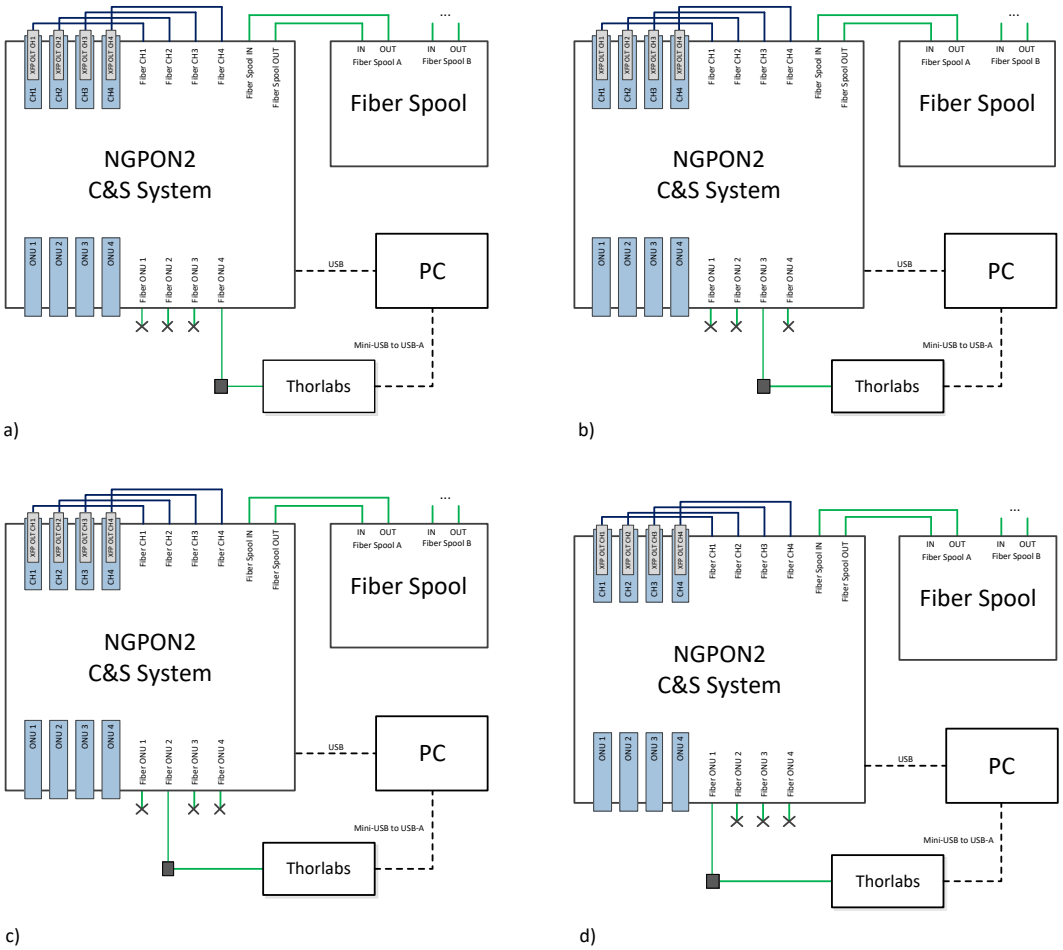


Figure 8 - Setup used for DS calibration of all optical fibers connected to the XFP ONU transceivers, from slot 4 (a), slot 3 (b), slot 2 (c) to slot 1 (d) (corresponding to the calibration sequence)

4.2. US Calibration

Figure 9 depicts the setup used for the US calibration, with a diagram showing the differences between the system used for testing (a) and the system prepared for calibration (b). The XFP OLT transceivers can be removed from the tester, and the Thorlabs power meter properly connected with a FC-UPC to SC-UPC fiber.

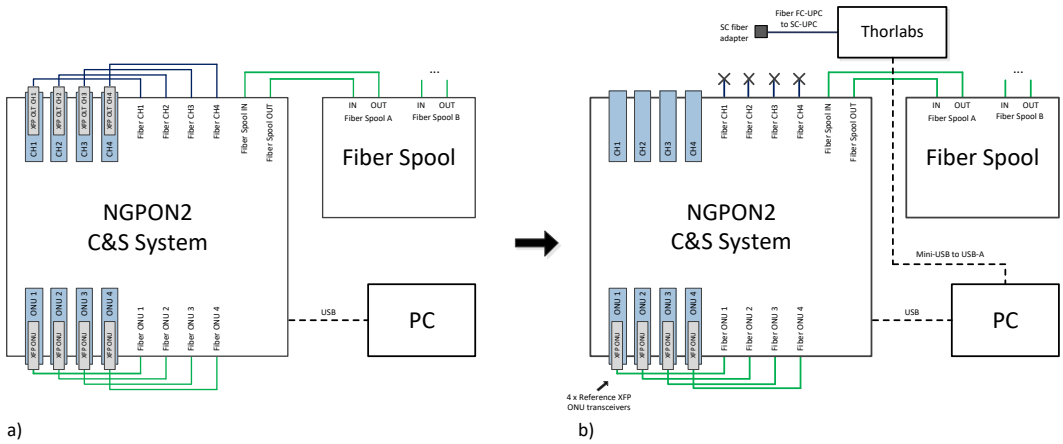


Figure 9 - Setup used for testing (a) and for US calibration (b)

Then all 4 optical fibers can be calibrated. Please refer to Section 2.1.9 for details on how to start the calibration in the software. During the calibration the software will request to change the slot fiber from the Fiber CH1 to CH4. Figure 10 shows the setup in each of the 4 stages. **Before forcing proceed to any next step, please always make sure all optical fibers are properly connected to the Thorlabs and to the reference XFP ONU transceivers, otherwise the setup may be incorrectly calibrated.**

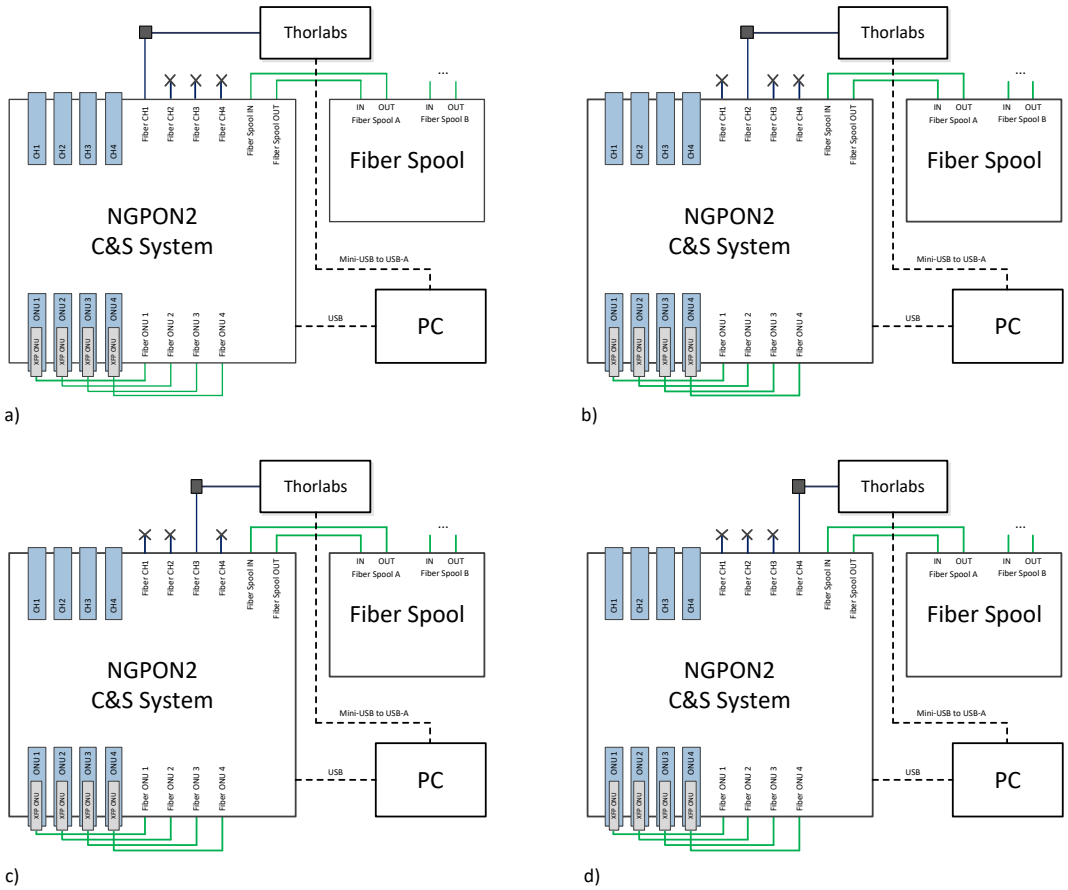


Figure 10 - Setup used for US calibration of all optical fibers connected to the XFP OLT transceivers, from CH1 (a), CH2 (b), CH3 (c) to CH4 (d) (corresponding to the calibration sequence)

5. Update Software / Firmware

This section intends to describe how to proceed for software and firmware update of the tester using external **TCP commands** or the **Software GUI**. The update can be performed with or without internet connection. **For the single-module version, ignore the Module B steps.**

5.1. Update using external TCP commands

5.1.1. With internet connection

With the current software open, execute the following sequence of TCP commands:

- "11 A" – Update Software
  - Wait until the new GUI opens (typically <10 sec)
- "1 A" – Connect Board (Module A)
  - Wait to the connection with the module (typically <5 sec)

- "10 A" – Update Firmware (Module A)
  - The update runs in background (~2min) – Use command "16 A" to track the update – It is concluded with the "Finished!" message
- "1 B" – Connect Board (Module B)
  - Wait to the connection with the module (typically <5 sec)
- "10 B" – Update Firmware (Module B)
  - The update runs in background (~2min) – Use command "16 B" to track the update – It is concluded with the "Finished!" message.

5.1.2. Without internet connection

Download the software folder provided by the manufacturer and run "App.exe" (this is the new executable of the software). Then, execute the following sequence of TCP commands:

- "1 A" – Connect Board (Module A)
  - Wait to the connection with the module (typically <5 sec)
- "10 A" – Update Firmware (Module A)
  - The update runs in background (~2min) – Use command "16 A" to track the update – It is concluded with the "Finished!" message
- "1 B" – Connect Board (Module B)
  - Wait to the connection with the module (typically <5 sec)
- "10 B" – Update Firmware (Module B)
  - The update runs in background (~2min) – Use command "16 B" to track the update – It is concluded with the "Finished!" message

5.2. Updating using the Software GUI

5.2.1. With internet connection

With the current software open, move to the "Calibration" tab and:

- Click on the "Update Software" button
  - Wait until the new GUI opens (typically <10 sec)
- Execute the TCP command "17 A" (externally) to enable the GUI of the new software
  - This command is required for software versions beyond v1.3
- Click on the "Connect Board (Module A)" button
  - Wait to the connection with the module (typically <5 sec)
- In the top left combo-box, select "Module A"
- Click on the "Update Firmware" button
  - The update takes ~2min – It is concluded with the "Finished!" message in the dialog box on the right
- Click on the "Connect Board (Module B)" button
  - Wait to the connection with the module (typically <5 sec)
- In the top left combo-box, select "Module B"
- Click on the "Update Firmware" button
  - The update takes ~2min – It is concluded with the "Finished!" message in the dialog box on the right

5.2.2. Without internet connection

Download the software folder provided by the manufacturer and run "App.exe" (you can then fix this executable to the taskbar). Then, move to the "Calibration" tab and:

- Execute the TCP command "17 A" (externally) to enable the GUI of the new software
  - This command is required for software versions beyond v1.3
- Click on the "Connect Board (Module A)" button

- Wait to the connection with the module (typically <5 sec)

- In the top left combo-box, select “Module A”
- Click on the “Update Firmware” button
  - The update takes ~2min – It is concluded with the “Finished!” message in the dialog box on the right
- Click on the “Connect Board (Module B)” button
  - Wait to the connection with the module (typically <5 sec)
- In the top left combo-box, select “Module B”
- Click on the “Update Firmware” button
  - The update takes ~2min – It is concluded with the “Finished!” message in the dialog box on the right