



INSTALLATION MANUAL

Fiber Optic Strain Gauge

CS_DUAL_PATCH

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Page numbers reflect this revision's layout.

Abbreviations

COPV	Composite Overwrapped Pressure Vessel
FBG	Fiber Bragg Grating
FO	Fiber Optic

[A HTML / Smartphone friendly version of this manual can be downloaded here](#)

■ 1. Introduction

CS DUAL PATCH

This document describes the tools and procedures used to install the CS_Dual_Patch with two FBG sensors in series configuration, see Figure 1 and Figure 2.

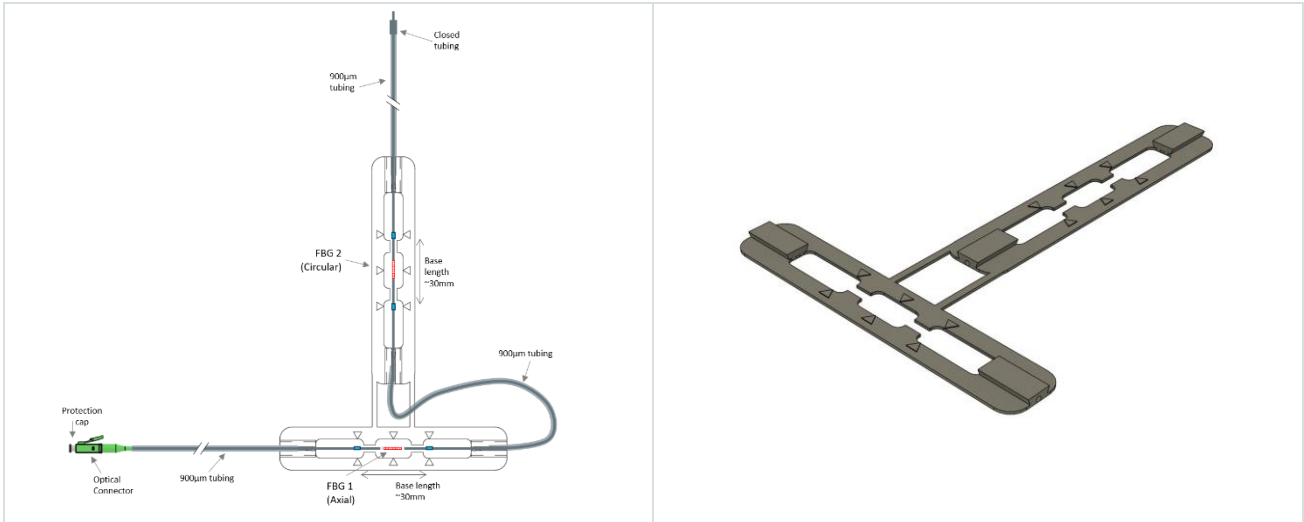


Figure 1. 2D representation of the CS_Dual_Patch template with two FBG sensors in series configuration (left); 3D representation (right).

This sensor patch consists of two prestrained FBG sensors in series configuration, designed to easily bond the FBGs to the material surface using the CS_UV_Bonding Kit (Item 2 in Items & Tools). The CS_DUAL_PATCH is a pre-assembled template that enables strain measurement in two directions perpendicular to each other. It is especially designed to bond FBG sensors onto the surface of composite overwrapped pressure vessels (COPVs), enabling simultaneous strain measurement in the axial (FBG1) and circular (FBG2) directions, see Figure 2.

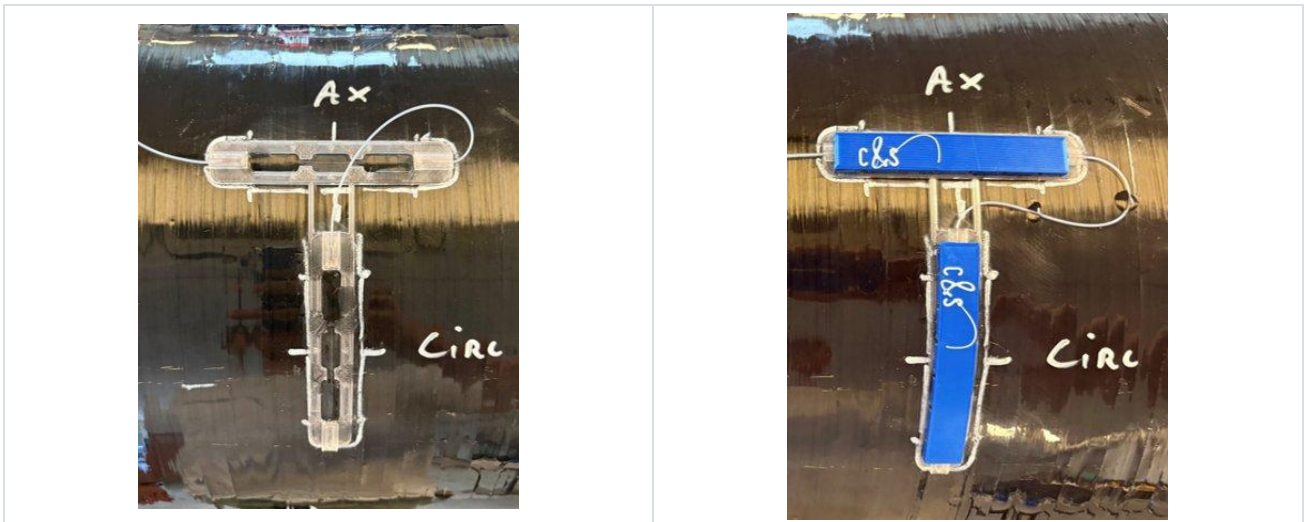


Figure 2. CS_Dual_Patch bonded to a COPV (left) and fitted with protective covers (right).

The template is made from transparent PET material and includes holes and openings for applying glue to bond the optical fiber directly to the material surface. This design uses an 'extensometer principle', where the fiber of the FBG sensor is glued before and after the FBG to measure the average strain over a set base length. This allows measurement of extremely high strain, up to breakage, on composite materials without distortion of the FBG spectrum, and avoids peak-picking problems in the FBG interrogator software.

CS DUAL PATCH can be supplied via our webshop : [Buy Online](#)

CS UVACR

To bond the CS_Dual_Patch and optical fibers, in-house developed CS UVACR adhesives based on **monoacrylates** are used. The CS UVACR is a one-component, water and solvent free UV-curing adhesive.

Three glue systems are available:

CS UVACR01	CS UVACR02	CS UVACR03
		
Buy Online	Buy Online	Buy Online
Technical DataSheet	Technical DataSheet	Technical DataSheet
Safety DataSheet	Safety DataSheet	Safety DataSheet

The bonding methodology is easy, quick (a few minutes), and provides very reproducible bonding quality. The sensors can be used immediately after gluing.

■ 2. Items & Tools

This section lists the items and tools needed to prepare the test specimen and install the patch. An overview of most items is shown in Figure 3.

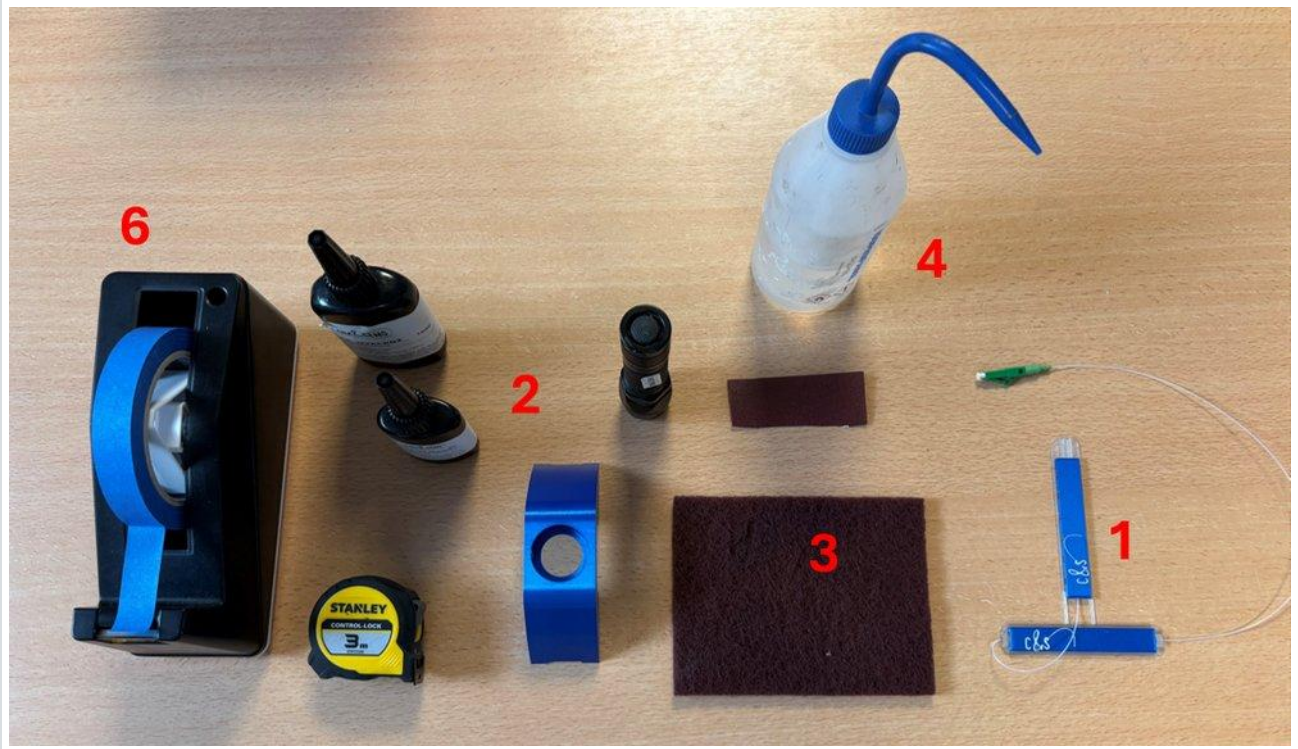
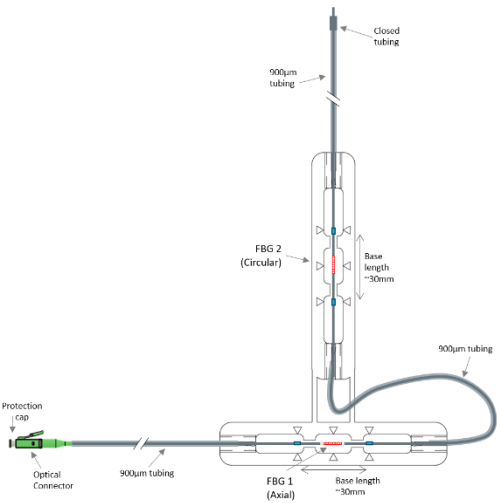


Figure 3. Example items and tools used to install the CS_Dual_Patch (see the numbered list below for the current item reference numbers).

No.	Item	Picture
1	Fiber optic strain sensor with 2 FBG <u>(CS_DUAL_PATCH)</u>	
2	<u>CS UV Bonding Kit</u> CS_UVACRO1 (or O3) and CS_UVACRO2 adhesives, UV lamp, handheld lamp support and protection glasses <i>Optional. Available via the Com&Sens webshop.</i>	
3	Sanding paper or scuff pad <i>Not included.</i>	

4	Isopropanol <i>Not included.</i>	
5	Wiping tissues <i>Not included.</i>	
6	Masking or paper tape <i>Not included.</i>	
7	LC/APC – LC/APC adaptor to extend optical cables <i>Optional. Available via the Com&Sens webshop.</i> Buy Online	
8	FO connector cleaning pen <i>Optional. Available via the Com&Sens webshop.</i>	

■ 3. Installation Procedure

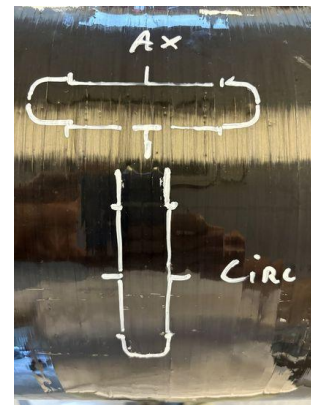
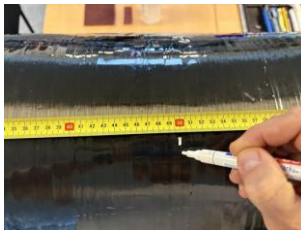
Installation should be carried out in a dry, dust-free environment. The adhesive cures on exposure to UV light, so exposure to direct daylight can cause the glue to cure undesirably. More information on the adhesives (CS_UVACRO1, O2 and O3) and guidelines for storage and curing can be found in the MSDS and TDS sheets, available on the Com&Sens webshop.

To install the CS_DUAL_PATCH, we recommend following the five steps below.

Step 1: Surface Preparation

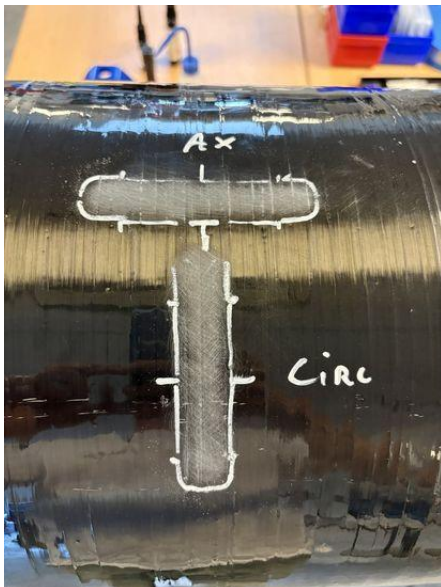
1-1

Measure the position of the sensors on your structure or test specimen and **mark the area**¹.



1-2

Prepare the surface by sanding or scuffing prior to bonding, using 120, 180 or 240 grit sanding paper or a scuff pad, then **clean** the substrate surface using isopropanol and wiping tissues or a clean rag.



¹First slide off the blue covers to expose the open template and sensor zones.

Step 2: Template & Sensor Preparation

2-1

Connect the sensor to the **FBG interrogator** to **validate proper signal**². If the signal is satisfactory, proceed with step 2-2.

2-2

Flip the **CS_DUAL_PATCH** over and **clean** the sensor patch template and optical fiber using **isopropanol** and a wiping tissue, then **apply small drops** of **CS_UVACRO2 glue** on the **back** of the template.



2-3

If preferred, the **signal** of the connected sensors can be **checked** at all times during the next steps, which can, for instance, be used to check the **prestrain during and after bonding**.

²If the signal-to-noise ratio is not satisfactory, or a high backreflection or noise level is present, use an FO cleaner to clean the ferrule and troubleshoot from there. An angled cut at the fiber end can also help clear optical backreflection or high noise.

Step 3: Gluing the CS_DUAL_PATCH Template

3-1

Position the CS_DUAL_PATCH (with the small dots of glue on the back) on the marked area. Fix the template temporarily with tape if needed, to keep it straight and in place.

Cure the CS_UVACRO2 glue with the UV lamp for approximately 30 seconds, starting with the axial sensor template first.

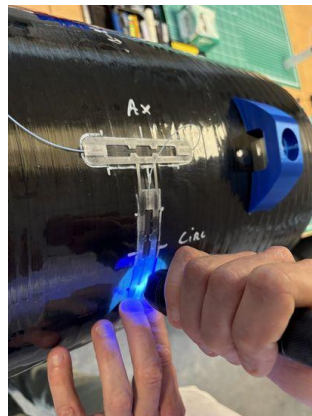
Always cure one side of the template first and work step by step to the other side. Make sure the template is pushed well onto the surface before curing³.

You can use the handheld lamp support to hold the UV lamp in position for longer periods.



3-2

Repeat curing of the dots for the circular sensor template, curing step by step from top to bottom while pressing the template onto the material surface.



³Strain transfer is most consistent when the distance between the material surface and the optical fiber sensor is kept to a minimum.

Step 4: Gluing the CS_DUAL_PATCH Sensors

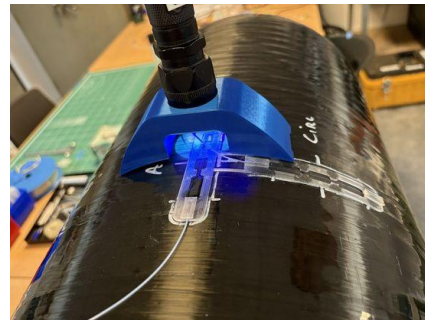
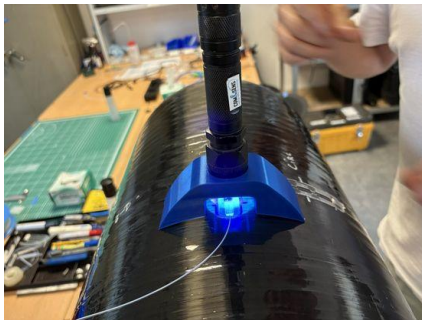
4-1

The template has openings to be filled with CS_UVACRO1 glue.
First fill the left and right openings of the axial sensor (FBG1) with CS_UVACRO1 glue. Do not use excessive glue: apply and dose the glue carefully until each opening is completely filled⁴.



4-2

Cure each filled area for a minimum of 120 seconds.



4-3

Repeat steps 4-1 and 4-2 for the circular sensor (FBG2), for the top and bottom areas. If needed, turn the vessel slightly before applying the glue if the circular sensor template sits too vertically, to prevent the glue from running downward.



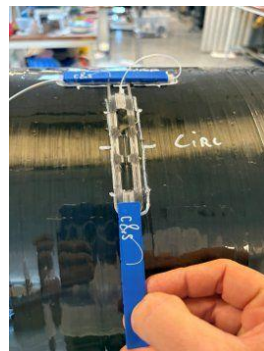
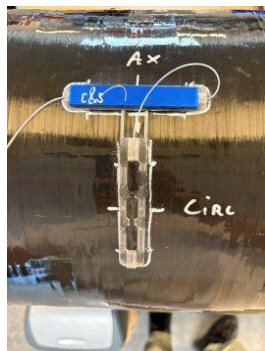
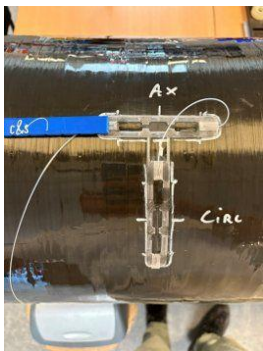
⁴Do not fill the centre opening: this must be kept free of glue so the FBG can measure the average strain over the base length, ensuring an undistorted FBG spectrum at high strains.



Step 5: Finalization of Sensor Covers & Cabling

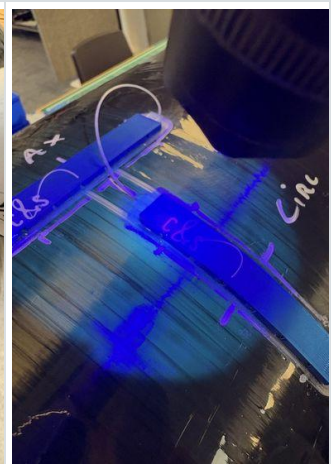
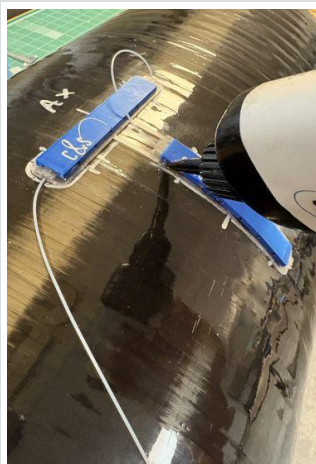
5-1

The FBG sensors are protected by sliding a blue plastic flexible cover over each FBG (axial and circular).



5-2

The covers should be fixed to the template at **one side only**⁵ using a small dot of CS_UVACRO2 glue and curing it for approximately 30 seconds.

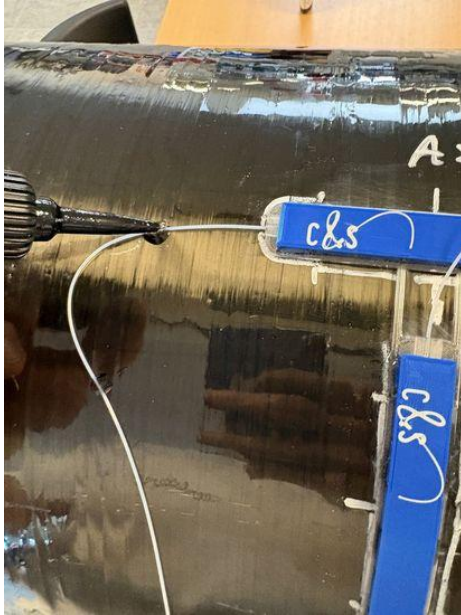


⁵Fixing the flexible cover at only one side allows it to move and expand freely without applying extra load to the sensor template.

5-3

To guide and fix the fiber, tubing and connector, again use small dots of CS_UVACRO2.

The CS_DUAL_PATCH is now ready to use!



■ Quick Reference

Installation sequence at a glance.

01 PREPARE Mark, sand or scuff and clean the substrate.	02 VERIFY Connect to the interrogator and check the FBG signal.	03 POSITION Clean the patch, apply CS_UVACRO2 and position the template.
04 CURE TEMPLATE Approximately 30 s per area: axial first, then circumferential.	05 BOND FBG CS_UVACRO1 in the outer bonding openings only.	06 CURE FBG Minimum 120 s for each filled bonding area.
07 PROTECT Slide covers over both FBGs and fix one side only.	08 ROUTE Secure fiber, tubing and connector with small CS_UVACRO2 dots.	09 CHECK Verify the signal and installation before use.