



# IFS Box Interfaces and Documentation

G. D'Angelo



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# Outline

- Overview of IFSs for HL-LHC
  - Recall types, variants
- Documentation status
  - Under approval, Released, To be updated
- Singularities for the IT string
  - Description of known singularities for IT string
- Conclusions

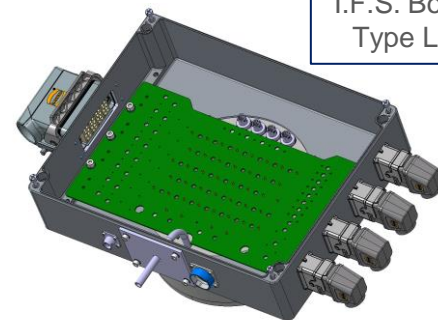
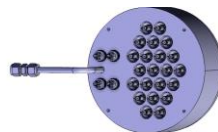
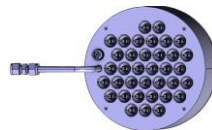
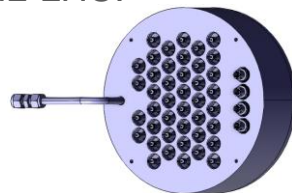
# Introduction

- Dedicated HL-LHC Instrumentation Feedthrough System (I.F.S.) boxes have been designed to route HL-LHC instrumentation from the cold part to the warm part of cold mass assemblies.
- Following the HL-LHC instrumentation review (sep.2020), and after final optimization, 3 types of cover flanges were retained to cover the needs of HL-LHC components: cover flange type L, M and S.
- After integration studies, the DFX and DFM components also use HL-LHC IFS boxes and flanges to route part of its instrumentation needed for monitoring and protection.
- The integration of the flanges and the I.F.S. boxes was performed carefully with integration team.
- Design is completed and series production started with delivery of some HL-LHC I.F.S. boxes.

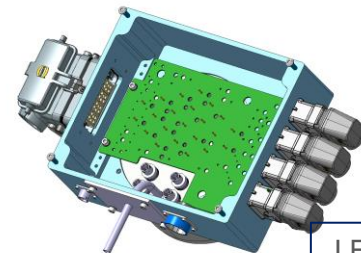
# HL-LHC cover flange types

Final configuration of cover flange type approved for HL-LHC:

- Cover Flange Type L:
  - Diameter: 260 mm
  - **42** HV Feedthroughs
  - 4 x LV Feedthroughs (4 pins)
- Cover Flange Type M (LHC type):
  - Diameter: 208 mm
  - **36** HV Feedthroughs
  - 1 x LV Feedthroughs (4 pins)
- Cover Flange Type S:
  - Diameter: 208 mm, same dimension as LHC type
  - **22** HV Feedthroughs
  - 4 x LV Feedthroughs (4 pins)



I.F.S. Box  
Type L



I.F.S. Box  
Type S

6 prototypes flanges “Type L” of 48 HVs were produced in prototyping phase and are used in the first Q1/Q3 magnets. Two prototype flanges “Type S” of 18 HVs were also produced and will be used on first Q2 magnets. The IFS boxes are adapted accordingly and are identical from outside.

# HL-LHC I.F.S. boxes type

Based on the 3 type of flanges, **14 different type of IFS boxes** are needed in order to cope the diversity of instrumentation present in HL-LHC:

- 3 types of PCBs, multipurpose:
  - **S** - 22 HV Feedthroughs (+ 2 protos of 18HVs)
  - **M** - 36 HV Feedthroughs
  - **L** - 42 HV Feedthroughs (+ 8 protos of 48HVs)

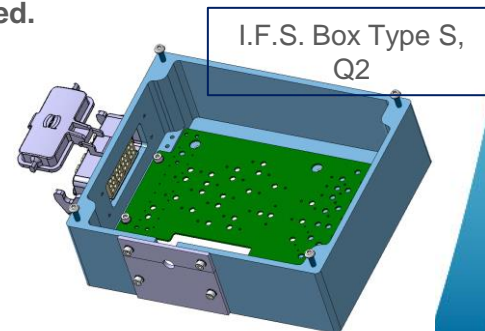
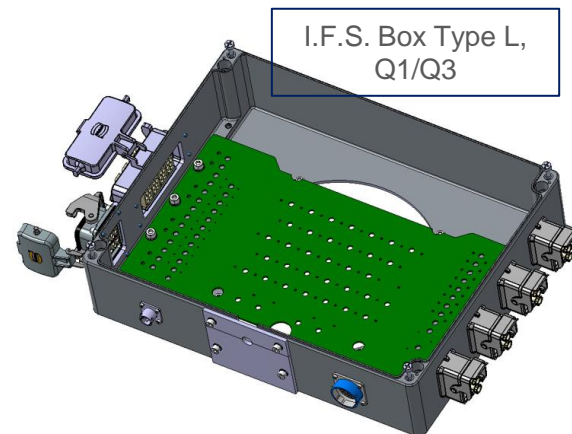
Entire PCB production for HL-LHC received and stored in MPE lab.

- 2 size of enclosures (alu. boxes):
  - **S** and **M** : 300 x 210 x 110 mm
  - **L** : 400 x 310 x 110mm

All aluminum enclosures needed for HL-LHC are stored. Some already machined.

- Variety of industrial connectors:
  - Industrial “Harting” types for magnet protection.
  - Industrial “military” type for cryogenic instrumentation.

Partially received for the entire need of HL-LHC I.F.S boxes.



# HL-LHC I.F.S. boxes type

- Each magnet assembly or cryo-component has its own interface document giving details about signal routing, connector type, etc.
- Signal routing was optimized for protection scheme (WP7).
- Documents are stored and available in EDMS, see next slide



EDMS NO. 2823710	REV. 0.1	VALIDITY DRAFT
REFERENCE : LHC-LMRDE-ES-0002		

## INTERFACE SPECIFICATION

### HL-LHC MAGNET CIRCUIT FORUM

#### INSTRUMENTATION FEEDTHROUGH SYSTEMS FOR THE MBRD AND MCBRD MAGNETS (D2)

##### Abstract

This document presents the interface specifications of the quench detection and other instrumentation of the D2 magnet, and in particular the detailed pin-out and connection scheme of the Instrumentation Feedthrough System (IFS) boxes installed on the cold-mass assemblies. The information provided in this interface document reflects the instrumentation baseline as endorsed by the HL-LHC Instrumentation Review and the subsequent discussions and presentations held at the Magnet Circuit Forum (MCF) and the HL-LHC Technical Committee (TCC) [1][2].

## 2 INSTRUMENTATION AND QUENCH DETECTION SCHEME

The quench detection of the superconductive elements inside the cold-mass (coils, busbars and splices) will be done as shown at the example of the MBRD magnet on Figure 2. For the proper quench detection scheme and magnet protection, a total of 34 High Voltage (HV) feedthroughs are required for the MBRD magnet, and a total of 32 HV feedthroughs for the MCBRD magnets as shown on Figure 3. Additional Low Voltage (LV) feedthroughs (with 4 pins each) are required for the routing of the cryogenic instrumentation. The detailed V-taps scheme of the magnets is shown in [5][8].

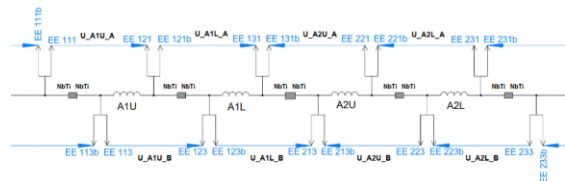
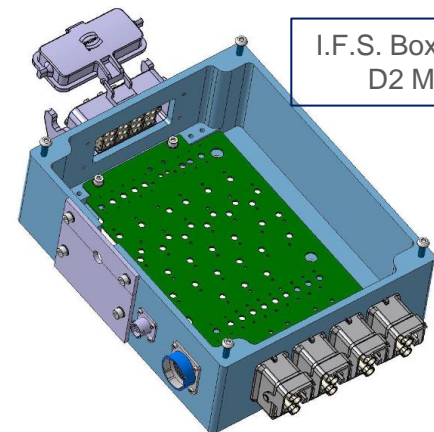
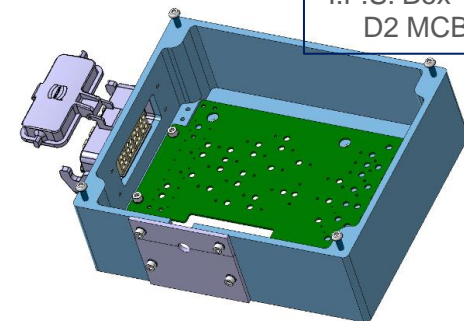


Figure 2. Quench detection scheme for coils, busbars and splices at the example of the MBRD magnet [7]



I.F.S. Box Type M,  
D2 MBRD

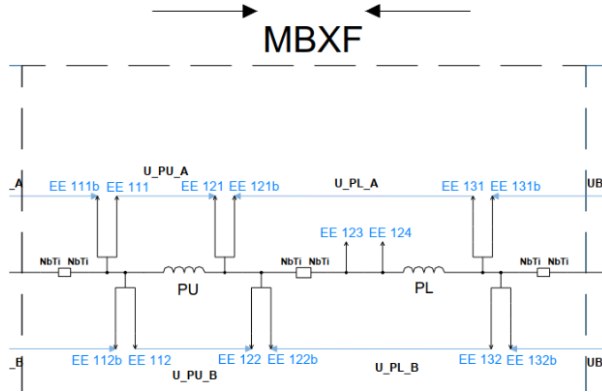


I.F.S. Box Type M,  
D2 MCBRDs

# Overview of IFS interface documents

Diff type of IFS	MAGNETS / ITEM	IFS NAME	HL-LHC I.F.S ASSEMBLY CDD NUMBER	EDMS interface doc number	Version	Status
1	Q1A, Q3A	L TYPE A_Q1/Q3_A 42HV's	<a href="#">LHCDIILQA0002</a>	<a href="#">2470513</a>	2.0	Released
2	Q1B, Q3B	L TYPE A_Q1/Q3_B 42HV's	<a href="#">LHCDIILQB0001</a>			
3	Q2A, Q2B	S TYPE B_Q2 22HV's	<a href="#">LHCDIISQ0002</a>	<a href="#">2749958</a>	1.0	Released
4		L TYPE A_Q2 42HV's	<a href="#">LHCDIILQC0001</a>			
5	CP	L TYPE B_CP 22HV's	<a href="#">LHCDIILC0002</a>	<a href="#">2823709</a>	0.1	HL Eng. Check
6		M TYPE B_CP 36 HV's	<a href="#">LHCDIIMC0002</a>			
7	D1	S TYPE A_D1 22HV's	<a href="#">LHCDIISB0003</a>	<a href="#">2800776</a>	1.0	Released
8	D2	M TYPE A_D2 36HV's	<a href="#">LHCDIIMBA0001</a>	<a href="#">2823710</a>	0.1	HL Eng. Check
9		M TYPE C_D2 36HV's	<a href="#">LHCDIIMBB0002</a>			
10	DFX	L TYPE B_DFX 42HV's	<a href="#">LHCDIILFA0002</a>	<a href="#">2896457</a>	0.1	HL Eng. Check
11		L TYPE C_DFX 42HV's	<a href="#">LHCDIILFB0002</a>			
12	DFM	L TYPE B_DFM 42HV's	<a href="#">LHCDIILFC0001</a>	<a href="#">2896453</a>	0.1	HL Eng. Check
13	DCM	M TYPE B_DCM 36HV's	<a href="#">LHCDIIMF0002</a>	<a href="#">2896449</a>	0.1	HL Eng. Check
14	CD	S TYPE C_CD 22HV's	<a href="#">LHCDIISQD0002</a>	<a href="#">2896437</a>	0.1	HL Eng. Check

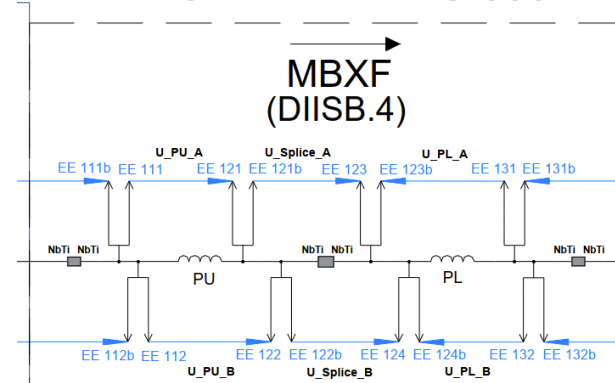
# Updating D1 I.F.S.



Previous protection scheme

D1 - IFS Box Type S, named LHCDIISB0003									
Name	Item Name	Function	Type	Cabling	PCB		Connector		
					#feedthrough (22HV)	Label	Name	Pin	
EE 111		Voltage Tap, Protection	V-tap	Twisted	6	EEEx01			1
EE 121		Voltage Tap, Protection	V-tap	Twisted	7	EEEx02			2
EE 131		Voltage Tap, Protection	V-tap	Twisted	1	EEEx03			3
EE 121b		Voltage Tap, Protection bridge with EE121	V-tap	Twisted	4			A	4
EE 112		Voltage Tap, Protection	V-tap	Twisted	3	EEEx04			5
EE 122		Voltage Tap, Protection	V-tap	Twisted	4	EEEx05			6
EE 132		Voltage Tap, Protection	V-tap	Twisted	2	EEEx06			7
EE 122b		Voltage Tap, Protection bridge with EE122	V-tap	Twisted	2				8
EE 111b		Voltage Tap, Protection bridge with EE 111	V-tap	Twisted	1				1
EE 112b		Voltage Tap, Protection bridge with EE 112	V-tap	Twisted	2				2
EE 131b		Voltage Tap, Protection bridge with EE 131	V-tap	Twisted	3				3
EE 132b		Voltage Tap, Protection bridge with EE 132	V-tap	Twisted	4				4
EE 123		Voltage Tap, Protection bridge with EE123	V-tap	Twisted	5	EEEx07			5
EE 124		Voltage Tap, Protection bridge with EE124	V-tap	Twisted	8	EEEx08			6
				Twisted	7				7
				Twisted	8				8
Spare 1				Twisted	13	EEEx09			1
Spare 2				Twisted	9	EEEx10			2
				Twisted	3				3
				Twisted	4				4
				Twisted	5				5
				Twisted	6				6
				Twisted	7				7
				Twisted	8				8
					1				1
					2				2

## LHC-LMBRDE-ES-0001



Updated protection scheme, cover symmetric quench detection

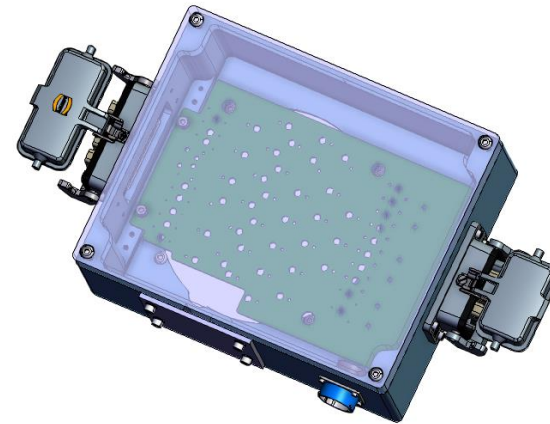
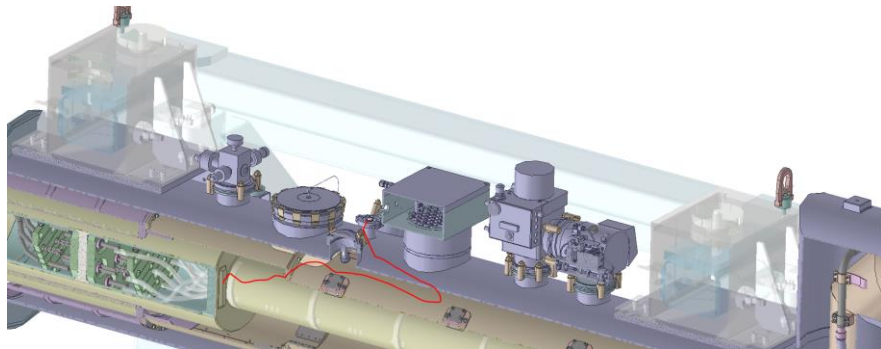
D1 - IFS Box Type S, named LHCDIISB0003									
Name	Item Name	Function	Type	Cabling	PCB		Connector		
					#feedthrough (22HV)	Label	Name	Pin	
EE 111		Voltage Tap, Protection	V-tap	Twisted	6	EEEx01			1
EE 121		Voltage Tap, Protection	V-tap	Twisted	7	EEEx02			2
EE 121b		Voltage Tap, Protection bridge with EE121	V-tap	Twisted	4				3
EE 123		Voltage Tap, Protection	V-tap	Twisted	5	EEEx07			4
EE 131		Voltage Tap, Protection	V-tap	Twisted	1	EEEx03			5
EE 123b		Voltage Tap, Protection bridge with EE123	V-tap	Twisted	2				6
EE 112		Voltage Tap, Protection	V-tap	Twisted	3	EEEx04			7
EE 122		Voltage Tap, Protection	V-tap	Twisted	4	EEEx05			8
EE 122b		Voltage Tap, Protection bridge with EE122	V-tap	Twisted	1				1
EE 124		Voltage Tap, Protection	V-tap	Twisted	8	EEEx08			2
EE 132		Voltage Tap, Protection	V-tap	Twisted	2	EEEx06			3
EE 124b		Voltage Tap, Protection bridge with EE124	V-tap	Twisted	4				4
EE 111b		Voltage Tap, Protection bridge with EE 111	V-tap	Twisted	1				5
EE 112b		Voltage Tap, Protection bridge with EE 112	V-tap	Twisted	2				6
EE 131b		Voltage Tap, Protection bridge with EE 131	V-tap	Twisted	3				7
EE 132b		Voltage Tap, Protection bridge with EE 132	V-tap	Twisted	4				8
Spare 1				Twisted	13	EEEx09			1
Spare 2				Twisted	9	EEEx10			2
				Twisted	3				3
				Twisted	4				4
				Twisted	5				5
				Twisted	6				6
				Twisted	7				7
				Twisted	8				8
					1				1
					2				2



# Singularities for IT String: DCM

As mentioned in the EDMS 2896449, in the IT string version the HL-LHC IFS named LHCDIIMF0002 will route two temperature sensors out of the IFS box, where in case of the LHC machine none (input from WP3).

	STRING	Tunnel
Quantity of CERNOX in helium volume (routed through IFS)	2	0
Quantity of CERNOX in vacuum volume (routed through dedicated ISO-K DN40 feedthrough)	2	2

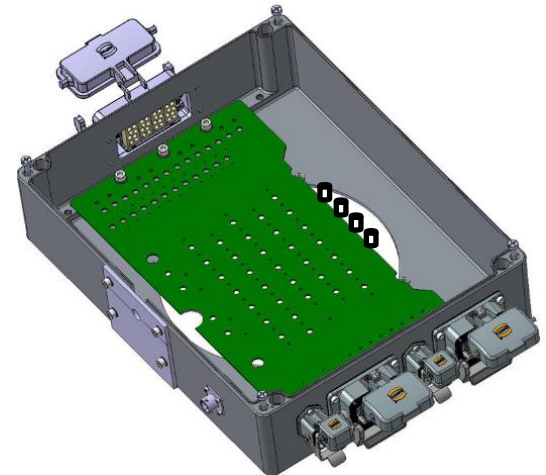
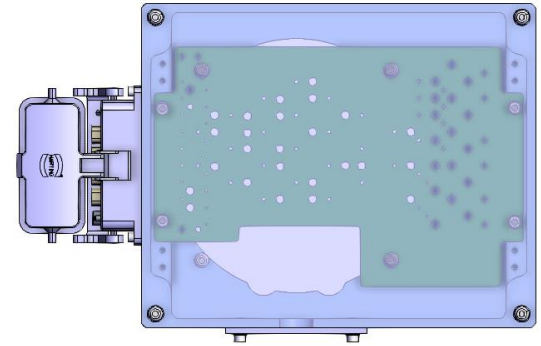


DCM - IFS Box, Type M, called LHCDIIMF0002									
Name	Function	Type	Cabling	Connector		PCB		Cable	
				Name	Pin	#Feedthroug [36HV <sub>s</sub> ]	Label		
TT 829a	TT 829a sensor using LV feedthroughs, U+	CX	Twisted	C10	A	C01_a			
	TT 829a sensor using LV feedthroughs, U-				B	C01_b			
	TT 829a sensor using LV feedthroughs, I+		C		C01_c				
	TT 829a sensor using LV feedthroughs, I-		D		C01-d				
TT 829b	TT 829b sensor using HV feedthroughs, U+	CX	Twisted	C10	E	14	EEExt15	NE4	
	TT 829b sensor using HV feedthroughs, U-				F	26	EHxv1-		
	TT 829b sensor using HV feedthroughs, I+		G		27	EHxv2+			
	TT 829b sensor using HV feedthroughs, I-		H		33	EHxv2-			

Table 3 - Detailed pin-out of Low Voltage Feedthroughs for DCM instrumentation, IFS Type M (36HV<sub>s</sub>), named LHCDIIMF0002, "string version".

# Singularities for IT String: Q2A and CP

- First Q2A will have 2 additional pressure sensors located at the extremities of the cold mass and will be routed via its IFSs (type L and type S) using spares low voltage feedthroughs: local cabling to be adapted in agreement with WP3.
- First C.P. will also have 2 additional pressure sensors located at the extremities of the cold mass and will be routed via its IFS (type L) using spares low voltage feedthroughs: local cabling to be adapted in agreement with WP3.



# Conclusions

- The design of all HL-LHC I.F.S. boxes is completed.
- Interface documents exist for all types and some are “Released” while others are in “Engineering Check” state.
- Series production and delivery of HL-LHC I.F.S. boxes started.
- Some singularities related to the “string” will be present and the cabling adapted accordingly.

**Thank you for your attention !**