



## Functional Specification

# SHORT STRAIGHT SECTION (SSS) TYPES IN THE ARCS FROM Q12 TO Q12

### *Abstract*

This Functional Specification defines the equipment codes of all cold mass (CM) assemblies, SSS cryostats and Short Straight Section (SSS) types in the LHC standard arc from Q12 to Q12. A total of 40 different types of CM assemblies, 10 types of SSS cryostats and 61 different SSS types are identified.

*Prepared by:*

**Martin Schmidlkofer**  
AT-CRI

[martin.schmidlkofer@cern.ch](mailto:martin.schmidlkofer@cern.ch)

*updated by:*

**Makcim Gandel** AT-MCS

[Makcim.Gandel@cern.ch](mailto:Makcim.Gandel@cern.ch)

*Checked by:*

**Samy Chemli** TS-IC  
**Vittorio Parma** AT-MCS  
**Herve Prin** AT-MEL  
**Gerhard Schneider** AT-VAC

*Approved by:*

**Michele Modena** AT-MCS

### *LHC Standard Arc Short Straight Sections List:*

A. Ballarino, Ch. Boccard, N. Bourcey, D. Bozzini, P. dos Santos de Campos, J. Casas-Cubillos, P. Cruikshank, L. Evans, N. Favre, D. Hagedorn, A. Ijspeert, K. Kershaw, Ph. Lebrun, F. Lutton, M. Mayoud, M. Modena, R. Ostojic, V. Parma, J-L. Périnet-Marquet, A. Poncet, H. Prin, P. Proudlock, J-P. Quesnel, Th. Renaglia, G. Riddone, P. Rohmig, L. Rossi, I. Ruehl, R. Saban, K. Schirm, H. Schmickler, M. Schmidlkofer, R. Schmidt, G. Schneider, P. Strubin, L. Tavian, J-Ph. Tock, Th. Tortschnanoff, G. Trinquart, R. van Weelderen, M. Vitasse, L.R. Williams

## History of Changes

Rev. No.	Date	Pages	Description of Changes
0.1 - draft	27-Jul-1999		1 <sup>st</sup> draft prepared by Lars Nielsen.
0.2 - draft	05-Aug-1999		Checked by Peter Rohmig and Claude Hauviller and sent for approval. Corrections introduced following the comments of the Members of the LHC Approval SSS Standard Arc (LQA) Sector.
1.0	27-Sep-99	7 10	Read <b>LQASA</b> , ..., <b>LQASD</b> instead of LQATA, ..., LQATD and <b>LQATA</b> , ..., <b>LQATT</b> instead of LQASA, ..., LQAST. Reference [2] updated. Document released with the approbation of the LHC Approval Standard Arc (LQA) Sector.
2.0 - draft	02-Oct-00	1, 4 1, 4 1, 6, 7, 8, 9 4 5 6 6 7	Modification of the document done by Lars Nielsen and checked by Claude Hauviller: the first <del>five</del> → <b>six</b> letters in the identification code define the cold mass <del>....</del> , the MQ diode type <b>and the welding interface for vacuum barrier</b> . the last <del>three</del> → <b>two</b> letters define the cryostat with respect to <del>vacuum barrier</del> , phase ... A total of <del>36</del> → <b>40</b> different type of cold masses (CM) ... and a total of <del>62</del> → <b>58</b> different types SSS are identified. LHC optics version <del>6.1</del> → <b>6.2</b> . <del>2.6 STANDARD SECTION CRYOSTAT</del> → <b>VACUUM BARRIER</b> <del>2.8 TECHNICAL SERVICE MODULE (QQS)</del> <del>Q: QQS service module with jumper type C</del> (suppressed). <del>20</del> → <b>24</b> arc CM assemblies with octupoles. <del>62</del> → <b>58</b> different arc SSS types ( <del>38</del> → <b>32</b> arc SSS type with octupoles, <del>4</del> → <b>6</b> arc SSS types with skew quadrupoles). Tables 1, 2 and 3 + Figure 1 updated. Sent for approval to LHC Standard Arc Short Straight Section List. Version 2.1 - draft prepared by L. Nielsen, formatted by C. Laverrière, checked by C. Hauviller and H. Prin and sent for approval by P. Rohmig. New Annex 2: SSS Cryostat Types introduced, old Annex 2: SSS Types changed to Annex 3.
2.1 - draft	2001-03-28	16	
3.0	2001-04-20	4, 5, 7, 8, 13 4	Equipment codes for cryostat assembly types modified from LQA to QQA (section 2.2, Tables 2 & 3, Annex 2). Numbers of cryostats corrected in section 2.2. Document released.
3.1 - draft	2002-02-01	All	New SSS and cryostat types with a high version of jumper type A ( $\Delta z=190$ mm), Sector1-2 Q13L; Sector8-1 Q13R Change of cryogenic highest point in the tunnel from Sector3-4 Q21R to Sector3-4 Q25R Change of cryogenic lowest point in the tunnel from Sector7-8 Q21R to Sector7-8 Q25R. Insertion of Tables 1 and 2 + updated versions of Tables 4 and 5 and Annexes 2 and 3. Sent for approval by P. Rohmig.
4.0	2002-05-06	All	Modification <del>Q25R</del> → <b>Q25L (4 and 8)</b> . Document released.
4.1	2003-04-17	1, 2, 6, 8, 9, 13	Minor modification: Cryostat Equipment code QQAIS replaced by <b>QQAIS</b> . Version 4.1 released.
4.2	2005-02-07	5, 9	Introduction of beam screen types; correction of CM type in table 5.
4.2	2005-03-15		Sent for approval using "LHC Short Straight Sections Arc, DS, MS distribution list".

### *History of Changes*

<i>Rev. No.</i>	<i>Date</i>	<i>Pages</i>	<i>Description of Changes</i>
4.3	2005-04-08	All	No modifications. Version 4.3 released.
4.4	2007-04-24	9 10	SSS cryostat reference drawings added (new tab. 5) SSS reference drawings added in tab 6.
	2007-06-11	All	Submission for approval
5.0	2007-07-04	All	Released version

***Table of Contents***

- 1. INTRODUCTION.....5**
- 2. EQUIPMENT CODE NAMES .....5**
  - 2.1 EQUIPMENT CODES FOR CM ASSEMBLIES.....5
  - 2.2 EQUIPMENT CODES FOR SSS CRYOSTATS .....7
  - 2.3 EQUIPMENT CODES FOR SHORT STRAIGHT SECTIONS (SSS) .....7
- 3. COLD MASS (CM) ASSEMBLY TYPES.....8**
- 4. SSS CRYOSTAT ASSEMBLY TYPES .....9**
- 5. SSS TYPES .....9**
- 6. POSITION OF THE TYPES IN THE ARCS .....11**
- 7. REFERENCES.....11**
- ANNEXES .....11**

## 1. INTRODUCTION

This engineering specification defines the equipment codes of all cold mass (CM) assemblies, SSS cryostats and Short Straight Section (SSS) types in the LHC standard arc from Q12 to Q12.

The magnet configuration in the present engineering specification is based on LHC optics version 6.4. The cryogenic parameters are based on the engineering specification LHC-Q-ES-0001, which specifies all cryogenic parameters including phase separators and QQS types.

The electric power scheme is defined by the engineering specification LHC-DCC-ES-0003, which, together with the diode layout and naming given by CEA, defines the scheme for the bus-bar plugs.

An overview of all arcs is presented below in paragraphs 3 (CM assembly types), 4 (SSS cryostat types) and 5 (SSS types). Detailed lists showing the exact position in the arcs of each cold mass, cryostat and SSS type are presented in Annexes 1, 2 and 3.

## 2. EQUIPMENT CODE NAMES

### 2.1 EQUIPMENT CODES FOR CM ASSEMBLIES

The general equipment codes for the Cold Mass (CM) assemblies are:

- LQMO\_ Arc SSS CM with octupole MO.
- LQMS\_ Arc SSS CM with skew quadrupole MQS.
- LQMT\_ Arc SSS CM with tuning quadrupole MQT.

40 different SSS CM assemblies are identified see drawing LHCLQM\_S0001. Their equipment codes are defined in Table 1:

Table 1 - Equipment codes for cold mass assemblies

Equipment code	MQ ext./int.	Sextupole-dipole corrector	Corrector magnet	Cold mass <sup>1</sup> type	Diode type
LQMOA	D/F	MSCBB	MO	D	A
LQMOB	D/F	MSCBB	MO	D	B
LQMOC	D/F	MSCBB	MO	A	A
LQMOD	D/F	MSCBB	MO	A	B
LQMOE	D/F	MSCBB	MO	B	A
LQMOF	D/F	MSCBB	MO	B	B
LQMOG	D/F	MSCBD	MO	D	A
LQMOH	D/F	MSCBD	MO	C	A
LQMOI	D/F	MSCBD	MO	D	B
LQMOJ	D/F	MSCBD	MO	C	B
LQMOK	D/F	MSCBD	MO	B	A
LQMOL	D/F	MSCBD	MO	B	B
LQMOM	F/D	MSCBA	MO	D	A
LQMON	F/D	MSCBA	MO	D	B
LQMOO	F/D	MSCBA	MO	A	A
LQMOP	F/D	MSCBA	MO	A	B
LQMOQ	F/D	MSCBA	MO	B	A
LQMOR	F/D	MSCBA	MO	B	B
LQMOS	F/D	MSCBC	MO	D	A
LQMOT	F/D	MSCBC	MO	C	A
LQMOU	F/D	MSCBC	MO	D	B
LQMOV	F/D	MSCBC	MO	C	B
LQMOW	F/D	MSCBC	MO	B	A
LQMOX	F/D	MSCBC	MO	B	B
LQMSA	D/F	MSCBB	MQS	A	A
LQMSB	D/F	MSCBB	MQS	A	B
LQMSC	F/D	MSCBA	MQS	A	A
LQMSD	F/D	MSCBA	MQS	A	B
LQMTA	D/F	MSCBB	MQT	D	A
LQMTB	D/F	MSCBB	MQT	D	B
LQMTC	D/F	MSCBB	MQT	A	A
LQMTD	D/F	MSCBB	MQT	A	B
LQMTE	D/F	MSCBB	MQT	B	A
LQMTF	D/F	MSCBB	MQT	B	B
LQMTG	F/D	MSCBA	MQT	D	A
LQMTH	F/D	MSCBA	MQT	D	B
LQMTI	F/D	MSCBA	MQT	A	A
LQMTJ	F/D	MSCBA	MQT	A	B
LQMTK	F/D	MSCBA	MQT	B	A
LQMTL	F/D	MSCBA	MQT	B	B

<sup>1</sup> Naming corresponding to drawing LHCLQM\_S0001

## 2.2 EQUIPMENT CODES FOR SSS CRYOSTATS

The general equipment code for the SSS cryostat assemblies is: QQA\_S.

10 different types of SSS cryostat types are identified; their equipment codes are defined in Table 2.

The standard section cryostat types and naming corresponds to the drawings LHCLQA\_S0003 and LHCLQA\_S0004.

The QQS types and naming corresponds to the drawings LHCLQA\_S0012, LHCLQA\_S0014, LHCLQA\_S0016 and LHCLQA\_S0019. The QQS type A\* is a special version of QQS type A with a high jumper version ( $\Delta z=190$  mm).

The phase separator types and naming corresponds to the drawing LHCQQS\_S0003.

Table 2 - Equipment codes for SSS cryostats

Equipment code	Standard cryostat section type	QQS type	Phase separator type	Vacuum barrier
QQAAS	V	B	N	Yes
QQABS	V	D	N	Yes
QQACS	V	B	P	Yes
QQADS	V	D	P	Yes
QQAES	S	A	N	No
QQAFS	S	A	P	No
QQAGS	S	Z	None	No
QQAHS	S	E	None	No
QQAKS	S	F	F	No
QQAJS	S	A*	P	No

## 2.3 EQUIPMENT CODES FOR SHORT STRAIGHT SECTIONS (SSS)

The general equipment codes for the SSS types are:

LQO\_\_ Arc SSS with octupole MO.

LQAS\_ Arc SSS with skew quadrupole MQS.

LQAT\_ Arc SSS with tuning quadrupole MQT.

61 different arc SSS types are identified, their equipment codes are:

LQOAA, ..., LQOAD, LQOAG, ..., LQOAV, 34 arc SSS types with octupoles.

LQOBA, ..., LQOBN

LQASA, ..., LQASG 7 arc SSS types with skew quadrupoles.

LQATA, ..., LQATF, LQATH, ..., LQATQ, 20 arc SSS types with tuning quadrupoles.

LQATS, ..., LQATV

The definition of the SSS equipment codes, giving the corresponding cold mass and cryostat types, is given in Table 6.





#### 4. SSS CRYOSTAT ASSEMBLY TYPES

A total of 10 different SSS cryostat types are defined, see Table 4.

Detailed lists, defining the exact positions in each arc are shown in Annex 2.

The cryostat reference drawing for the different cryostat equipment code is given in Table 5.

Table 4 - SSS cryostat types

Cryostat	Total	Total	Total	Total	Total	Total	Total	Total	Total
Equipment	in	in arc of	in arc of	in arc of	in arc of	in arc of	in arc of	in arc of	in arc of
Code	All Sectors	Sector 1-2	Sector 2-3	Sector 3-4	Sector 4-5	Sector 5-6	Sector 6-7	Sector 7-8	Sector 8-1
QQAAS	40	0	0	2	10	10	10	8	0
QQABS	4	0	0	0	1	1	1	1	0
QQACS	40	10	10	8	0	0	0	2	10
QQADS	4	1	1	1	0	0	0	0	1
QQAES	43	0	0	2	11	11	11	8	0
QQAFS	41	10	11	8	0	0	0	2	10
QQAGS	184	23	23	23	23	23	23	23	23
QQAHS	1	0	0	1	0	0	0	0	0
QQAJS	1	0	0	0	0	0	0	1	0
QQAJS	2	1	0	0	0	0	0	0	1
<b>Total</b>	<b>360</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>

#### 5. SSS TYPES

The complete list of arc Short Straight Sections shows a total of 61 different types.

There are 34 arc SSS types with octupoles MO, 7 arc SSS types with skew quadrupoles MQS and 20 arc SSS types with tuning quadrupoles MQT.

Depending on beam direction there are two types of beam screen pairs and hence two types of BPM beam screen assemblies:

- Beam screen pair type L corresponds to drawings LHCVCMQ\_0044 and LHCVCMQ\_0045.
- Beam screen pair type R corresponds to drawings LHCVCMQ\_0043 and LHCVCMQ\_0046.

Detailed lists of SSS types, defining the exact positions of each type in the arcs are shown in Annex 3.

Table 5 - Cryostat reference drawings

Equipment code	Cryostat reference drawing
QQAAS	<a href="#">LHCLQA_S0065</a>
QQABS	<a href="#">LHCLQA_S0074</a>
QQACS	<a href="#">LHCLQA_S0065</a>
QQADS	<a href="#">LHCLQA_S0074</a>
QQAES	<a href="#">LHCLQA_S0071</a>
QQAFS	<a href="#">LHCLQA_S0071</a>
QQAGS	<a href="#">LHCLQA_S0050</a>
QQAHS	<a href="#">LHCLQA_S0094</a>
QQAJS	<a href="#">LHCLQA_S0086</a>
QQAJS	<a href="#">LHCLQA_S0096</a>



## 6. POSITION OF THE TYPES IN THE ARCS

Annexes 1, 2 and 3 show the position of each type of CM, SSS cryostat and SSS assembly in the arcs of sectors 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8 and 8-1.

The equipment code of each type is given, together with an indication of the half-cells from Q12 to Q12. Existence of a certain type in a given half-cell is indicated by a "1".

## 7. REFERENCES

- [1] "Dimensions, pressures, temperatures and sizing of valves and piping in the LHC machine cryostat and cryogenic distribution line", LHC-Q-ES-0001, G. Riddone, EDMS No. 90032.
- [2] "Powering layout of the SSS correction scheme", LHC-DCC-ES-0003, P. Burla, EDMS No. 104157.
- [3] Drawings LHCLQMAP0002, LHCLQA\_S0003, LHCLQA\_S0004, LHCLQA\_S0012, LHCLQA\_S0014, LHCLQA\_S0016, LHCLQA\_S0019, LHCLQM\_S0001, LHCQQS\_S0003, LHCVCMQ\_0043, LHCVCMQ\_0044, LHCVCMQ\_0045, LHCVCMQ\_0046.
- [4] QRL service module types in the ARL and OS, LHC-QRL-NOT-1134, G. Riddone, EDMS No. 331764.

## ANNEXES

- Annex 1: CM Assembly Types
- Annex 2: SSS Cryostat Types
- Annex 3: SSS Types









