MetOp Second Generation Front-End Receivers

Requirement Specification for Flight Waveguides

Issue 2.0

	Name	Signature / Date
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Approved by	**F Aparicio (PA Manager)**	Digitally signed by Fabian Aparicio Date: 2018.11.07 10:43:43 Z

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CHANGE LOG

Date	Issue	Revision	Pages	Reason for change
10 Oct 2018	1	0	All	First Issue
01 Nov 2018	2	0	All	Second issue for ITT

CONTENTS

TABLES

FIGURES

Applicable Documents

AD #	APPLICABLE DOCUMENT TITLE	DOCUMENT ID	ISSUE
14b	MetOp SG PA requirements for suppliers	MOS.SP.ASF.SYS.00401	3.0

Reference Documents

RD #	REFERENCE DOCUMENT TITLE	DOCUMENT ID	ISSUE
1	Statement of Work for Flight Waveguides	MOS-SOW-RAL-MWS-FERX0005	2.0
2			

Abbreviations and Definitions

FERX	Front End Receiver
FMn	Flight Model n (n=2, 3)
FS	Flight Spare
MRR	Manufacturing Readiness Review
MWI	Microwave Imager
MWS	Microwave Sounder
PA	Product Assurance
PFM	Protoflight Model

1. INTRODUCTION

1.1 Purpose

The STFC RAL Space Department Millimetre-wave Technology Group (MMTG) is presently embarked on a major equipment supply programme for the MetOp Second Generation (MetOp-SG) series of Earth observation satellites. MetOp-SG will deliver complex multi-wavelength instrument payloads into low Earth orbit via a series of repeat satellite deployments to be initiated in 2021. MMTG are leading a consortium to deliver Front End Receivers (FERX) at frequencies from 166GHz to 325GHz for three different instruments – Microwave Sounder (MWS), Microwave Imager (MWI) and Ice Cloud Imager (ICI). STFC's customers are Airbus UK, Airbus France and Radiometer Physics GmbH (Germany) respectively. The receivers will be integrated into instruments which will ultimately be delivered to the European Space Agency for launch. The FERX for MWS and MWI incorporate high-frequency waveguides with complex geometries which must be manufactured to tight tolerances.

1.2 Scope

This document describes the activities and deliverables required to fulfil the requirement for flight waveguide assemblies for the FERX units to be provided for the MWS and MWI instruments.

2. REQUIREMENTS

The publications listed in the Applicable Document table form part of this document to the extent specified herein. Unless an issue is quoted for a document the current issue is deemed to apply. When an issue is quoted that issue and no other shall be used.

2.1 Waveguide Variants

The required waveguide assembly types are listed in Table 2-1.

Table 2-1 List of Required Waveguide Assembly Types

Drawing number	Description	Used on
KE-0282-015-A	166 GHz LO chain waveguide	MWS-FERX166
KE-0282-018-A	183 GHz LO chain waveguide	MWS-FERX183
KE-0282-026-C	229 GHz LO chain waveguide	MWS-FERX229
KE-0282-038-C	229 GHz LO test port waveguide	MWS-FERX229
KE-0282-132-C	166 GHz LO test port waveguide	MWS-FERX166
KE-0282-220-D	183 GHz LO test port waveguide	MWS-FERX183
KE-0282-433-D	166 GHz LO test port waveguide	MWI-FERX166
KE-0282-533-D	183 GHz LO test port waveguide	MWI-FERX183

Drawings of all required waveguide assemblies are included as Appendix 1.

2.2 Construction

2.2.1 Materials

RAL's preferred construction is for the supplier to provide nickel-plated items (fabricated in e.g. thin-walled copper) for subsequent gold-plating at RAL. This also places the bulk of the qualification activities for the assemblies under RAL control; RAL have excellent facilities for this work and can realise a rapid qualification programme which is essential for this procurement.

2.2.2 Plated Finish

High conductivity surface coating of the inside of the waveguide is required to meet the MetOP SG performance requirements. RAL's requirement is to take delivery of nickel-plated assemblies and to perform the final gold-plating at RAL; in this instance a minimum plated nickel thickness of 2µm is required on the internal waveguide surfaces.

This approach acknowledges that gold-plating of the waveguide internal surfaces is particularly challenging; RAL have a proprietary in-house process for plating the inside of hollow nickel or nickel-plated waveguides which has been demonstrated to have excellent RF performance.

Materials and processes used must be compatible with the MetOP SG Product Assurance Requirements for Suppliers [AD14b], and the performance requirements of section 2.3.

2.3 Performance

The RF performance requirements for nickel-plated waveguide assemblies are presented in Table 2-2.

Table 2-2 Performance Requirements for nickel/nickel-plated waveguide

Part Number	FERX	WG Band	Frequency, f0 (GHz)	Insertion Loss @ F0 (dB)	Return Loss @ F0 (dB)
KE-0282-015-A	MWS165 Chain	WR-10	82.75	<1.2	<-25
KE-0282-018-A	MWS183 Chain	WR-10	91.65	<1.2	<-25
KE-0282-026-C	MWS229 Chain	WR-15	57.25	<0.6	<-25
KE-0282-038-C	MWS229 Test	WR-15	57.25	<1.2	<-25
KE-0282-132-C	MWS165 Test	WR-10	82.75	<2.2	<-20
KE-0282-220-D	MWS183 Test	WR-10	91.65	<2.0	<-20
KE-0282-433-D	MWI165 Test	WR-10	82.75	<1.5	<-20
KE-0282-533-D	MWI183 Test	WR-10	91.65	<2.2	<-20

2.4 Mass

The maximum mass limits for the waveguide assemblies are presented in Table 2-3.

Table 2-3 Mass limits for waveguide assemblies

Part Number	FERX	WG Band	Mass maximum (g)
KE-0282-015-A	MWS165 Chain	WR-10	17
KE-0282-018-A	MWS183 Chain	WR-10	18
KE-0282-026-C	MWS229 Chain	WR-15	17
KE-0282-038-C	MWS229 Test	WR-15	21
KE-0282-132-C	MWS165 Test	WR-10	20
KE-0282-220-D	MWS183 Test	WR-10	20
KE-0282-433-D	MWI165 Test	WR-10	20
KE-0282-533-D	MWI183 Test	WR-10	20

3. QUALITY ASSURANCE PROVISIONS

3.1 Inspection and Acceptance (plating)

3.1.1 Visual Inspection of Plating

Visual inspection and acceptance criteria which will be applied at RAL are described in the following section:

After plating, all waveguide assemblies will be visually inspected. While the ideal is a completely blemish-free assembly, some cosmetic defects due to e.g. surface bubbles during plating may be acceptable. The location (whether it is in a critical or not critical area) and size of such defects will determine the acceptability or otherwise of the assembly.

Critical and non-critical areas (plating).
The critical areas are the internal features of waveguide assemblies and all mating faces; i.e. all areas that may affect the module performance.

Similarly, non-critical areas are any areas that do not affect the module performance and where the impact of any blemish is largely cosmetic.

Figure 1 shows an example of a waveguide assembly highlighting the critical areas.

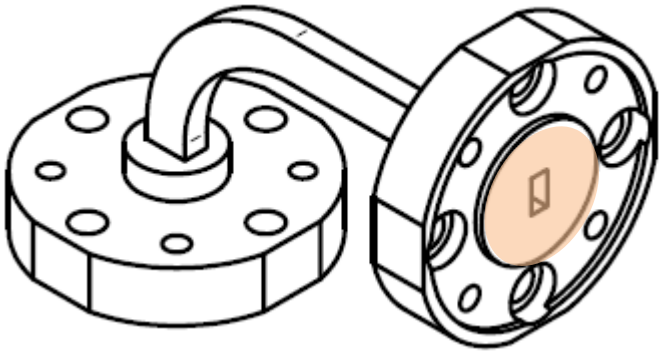


Figure 1 Example of critical areas in a common waveguide assembly

Size definition of cosmetic defects.
Any cosmetic defect larger than 2 mm in diameter and/or length is considered a *large* defect. Any cosmetic defect between 1-2 mm in diameter and/or length is considered a *mid-size* defect and any cosmetic defect of less than 1 mm in diameter and/or length is considered a *small* defect.

Figure 2 shows an example of a plated waveguide assembly with a small surface blemish (circled) close to the front edge. This is a small defect, in a non-critical area of the assembly; provided there are no further blemishes, this assembly would be passed as acceptable.

NB the finish in this instance is gold however the same criteria apply to the required nickel-plated finish.

Figure 2. Example of small blemish in waveguide assembly gold plating in a non-critical area (Accept)

N.B. A similar size blemish occurring in a critical area of the assembly would mean that the assembly was rejected.

Figure 3 and Figure 4 show examples of assemblies, which will be rejected as having unacceptable plating defects, generally indicative of inadequate or incomplete pre-plate cleaning.

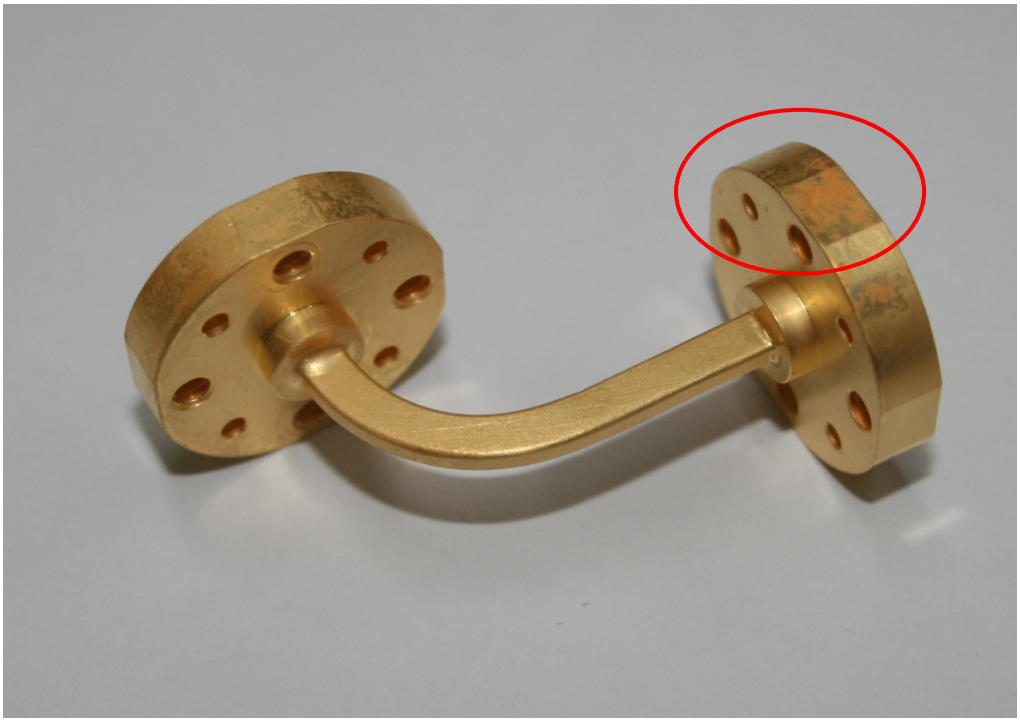


Figure 3. Example of mid-size blemish in gold plating (Reject)

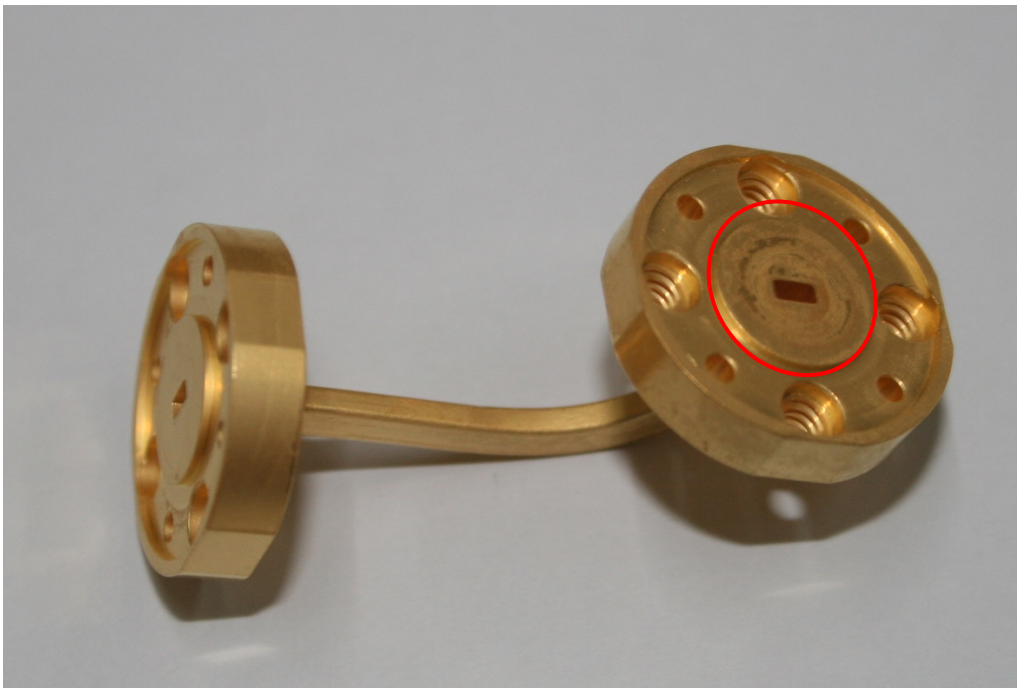


Figure 4. Example of large blemish in gold plating in a critical area (Reject)

3.1.2 Control of Plating Thickness

Plating thickness on all delivered assemblies shall be verified by the supplier using an appropriate method. 100% inspection using X-ray fluorescence is preferred, however micro-section on batch samples is acceptable.

3.2 Inspection of Joints

All joints shall be inspected in accordance with EN ISO 4063-912 and EN ISO 4063-942.

3.2.1 *Visual inspection of joints*

Any joints formed using soldering, brazing or welding shall meet the requirements of [AD14b].

3.2.2 X-ray inspection of joints

The supplier shall inspect all joints formed using soldering, brazing, welding or other additive techniques by means of 100% X-ray imaging prior to delivery to RAL; the imaging reports shall be delivered to RAL with the waveguide assembly. All joints shall meet the requirements of [AD14b].

3.3 Documentation

The supplier shall provide a Certificate of Conformance and accompanying inspection reports certifying that the item(s) conform to the requirements of this requirement specification. The certificates of conformance shall identify the item by, as a minimum, its description and the batch number for the purpose of maintaining traceability.

3.4 Batch Splitting

When a delivery contains more than one batch of an item then each batch and the containers shall be clearly labelled with the different batch numbers and date of manufacture. Separate certificates of conformance shall be supplied. When a batch is split for separate deliveries each delivery shall meet this requirement.

3.5 Packaging, Storage and Transportation

The item shall have been packaged, stored at or by the manufacturer/supplier, and shall be transported in conditions that prevent damage, deterioration and contamination.

3.6 Identification

As a minimum the primary package marking shall identify the material/item by:

- The part/drawing number
- The quantity
- The manufacturer's/supplier's batch number

In addition, the certificates of conformance and/or the accompanying goods despatch/advice note shall provide the following information:

- Procurement Requirement Specification number and issue
- Identification name
- PO number

- Batch identification number
- Date of manufacture and date/time of mix where appropriate
- Supplier's name and address
- Part number
- Drawing number

3.7 Process Qualification

Any processes used by the supplier in the manufacture of the waveguide assemblies, e.g. soldering, brazing, welding, plating etc., shall either be qualified to the requirements of [AD14b] or be capable of qualification to meet said requirements.

Where process qualification is required, the supplier shall provide a quotation for the required qualification activities. Note that RAL may be able to provide support for such a qualification activity in the form of environmental testing and/or destructive physical analysis.

An example of a process qualification workflow meeting the requirements of [AD14b] is presented in Appendix 2.

3.8 Retention of Records

All records pertaining to the delivered product shall be retained for a minimum of five years from shipment or as defined on the PO, whichever is greater.

Where the supplier cannot guarantee record retention for the designated time period for those records then these shall be provided at no extra cost to RAL at time of product delivery.

3.9 Receipt Inspection

The supplier shall provide an inspection report of acceptable dimensional tolerances (as per drawing) and functional features including but not limited to:

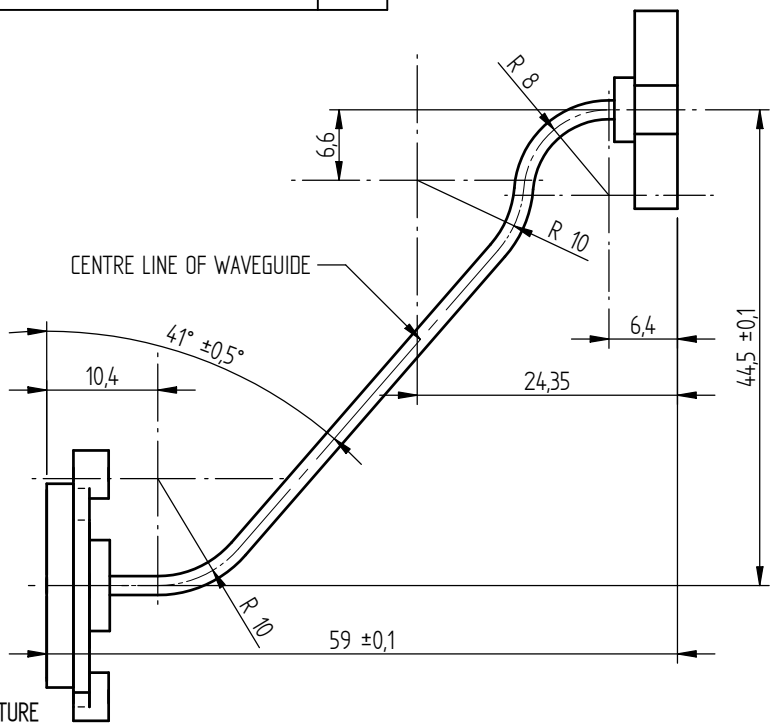
- Solder inspection
- Plating thickness
- RF performance measurements

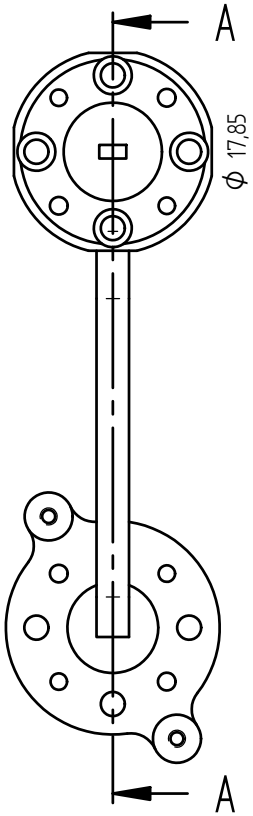
RAL PA will establish to its satisfaction that the item conforms to the requirements of Section 3. This may take the form of either or both source inspection by RAL or its representative and receipt inspection performed using form [RD2] as needed.

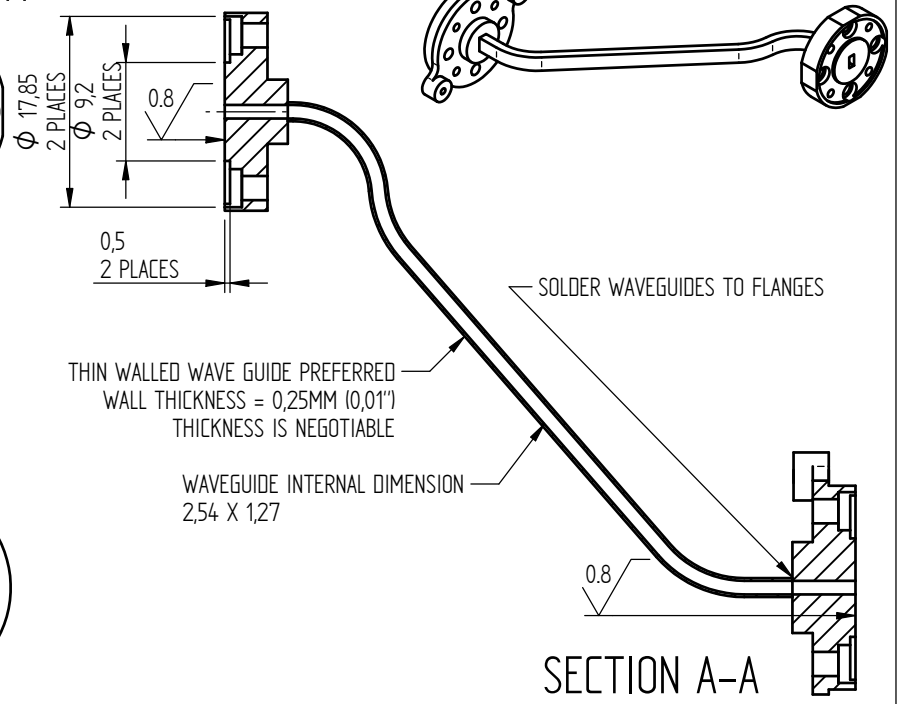
Appendix 1

WAVEGUIDE ASSEMBLY DRAWINGS

A3	KE-0282-220	D







2:1

MANUFACTURE

1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION, SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS

1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH

1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE

1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS – REFER TO ISO-SPAP-MECH-007.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPTICAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

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RAL SPACE — USED ON KE-0282-210

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.019 kg**

SEE NOTES

FINISH **GOLD PLATE**

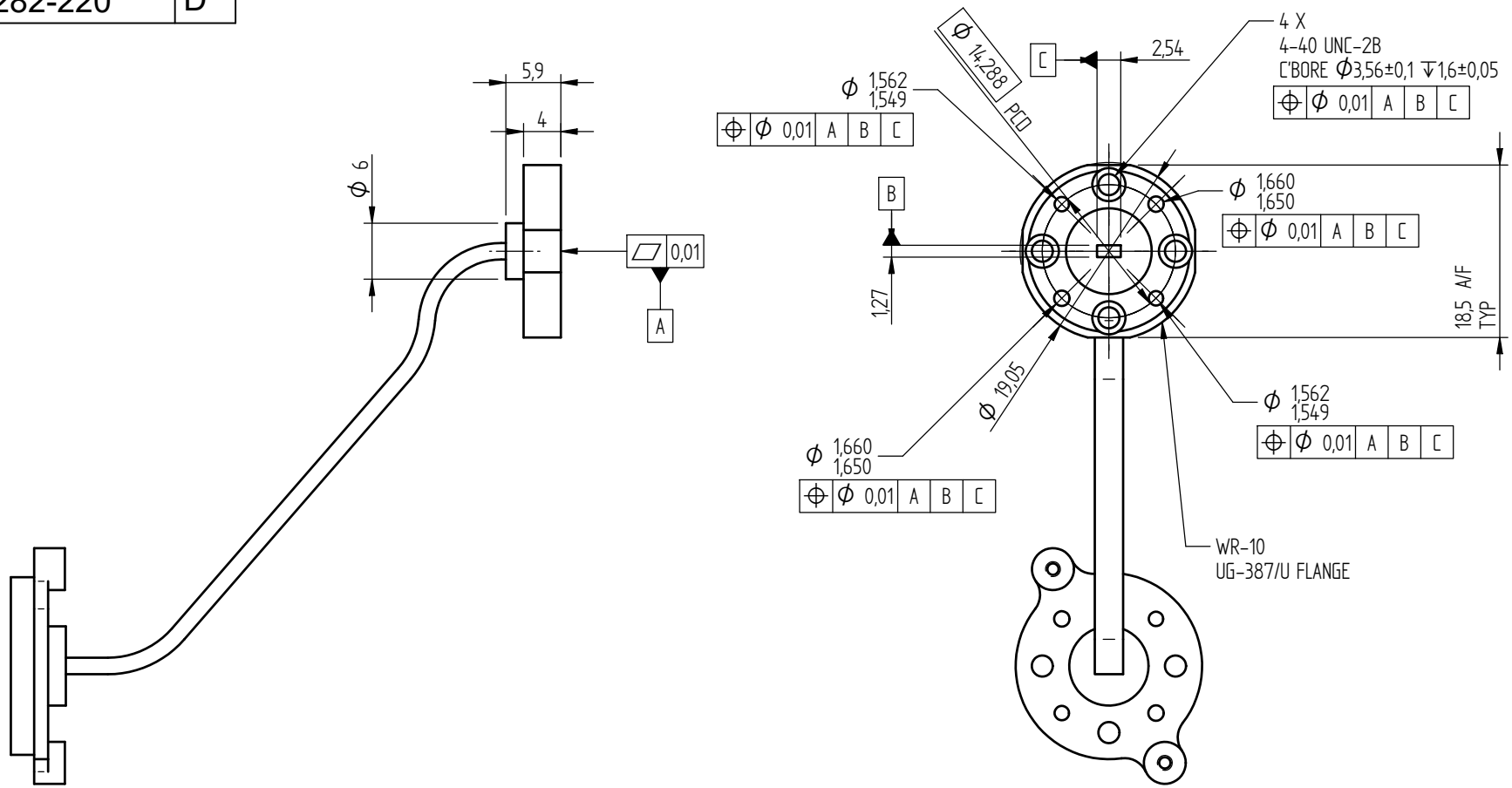
REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 183.3GHz FERx

MetOp-SG — MWS

A3	KE-0282-220	SHEET 1 of 4	D



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RAL SPACE | USED ON KE-0282-210

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.019 kg**

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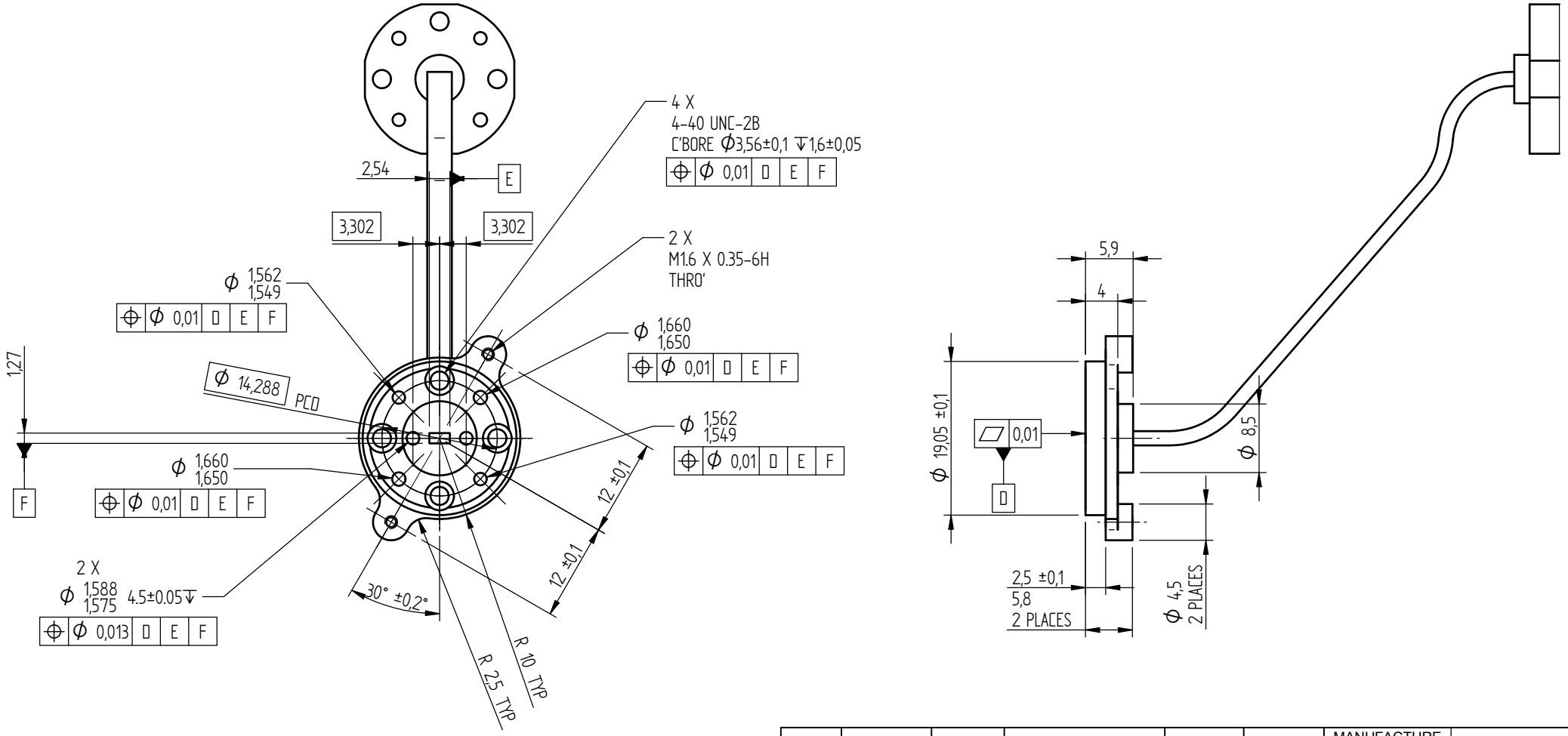
REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

SEE NOTES

WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 183.3GHz FERx

MetOp-SG MWS



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WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 183.3GHz FERx

MetOp-SG MWS

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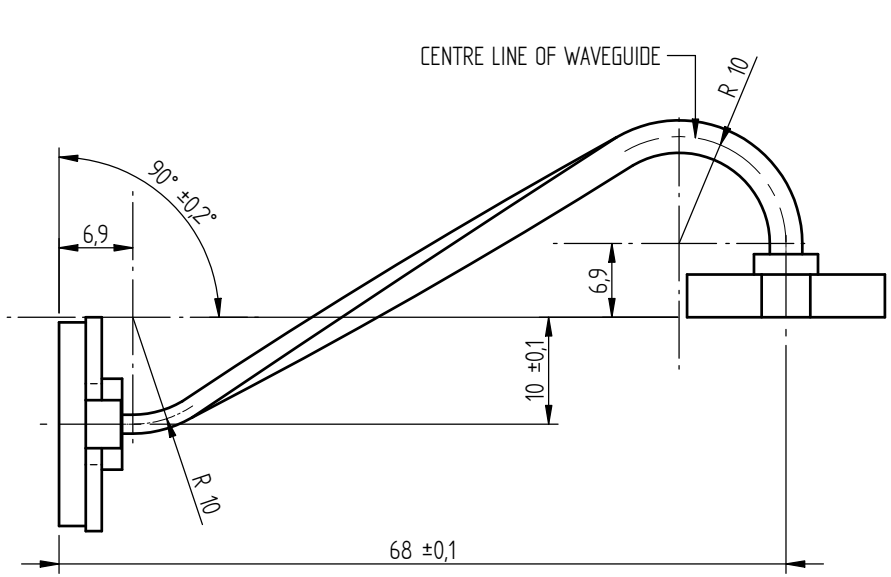

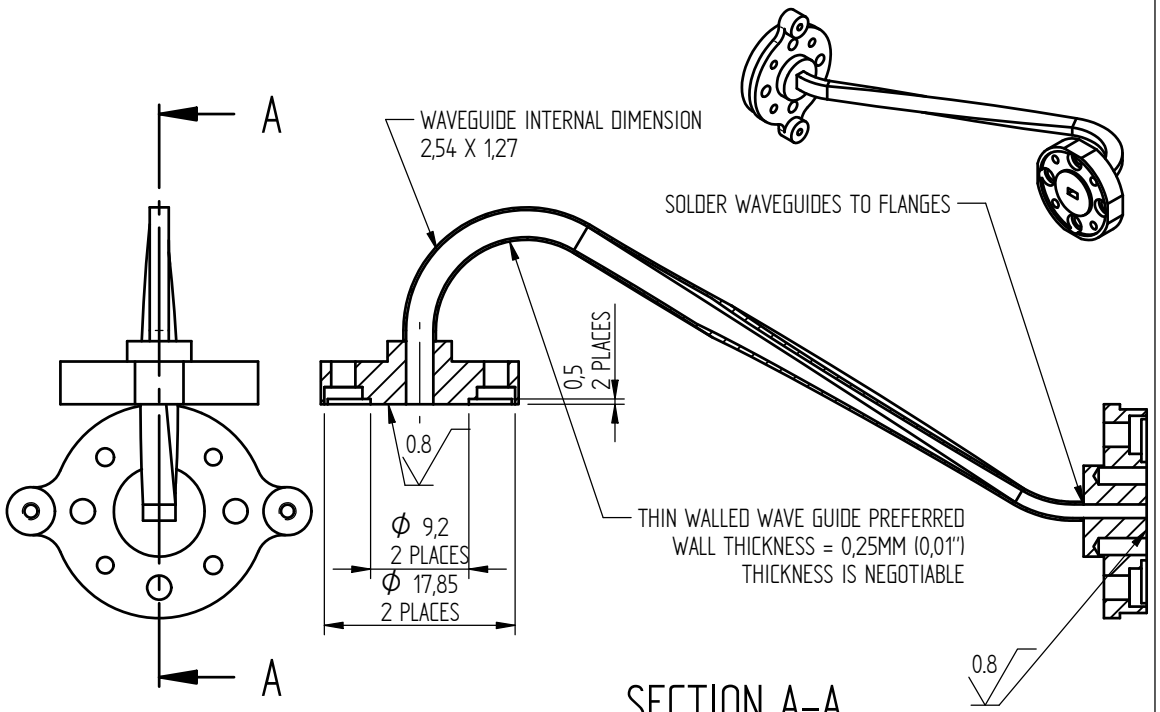

SECTION A–A

2:1

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PROJECT MANAGER	
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ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPITCAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

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HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.019 kg**

SEE NOTES

FINISH **GOLD PLATE**

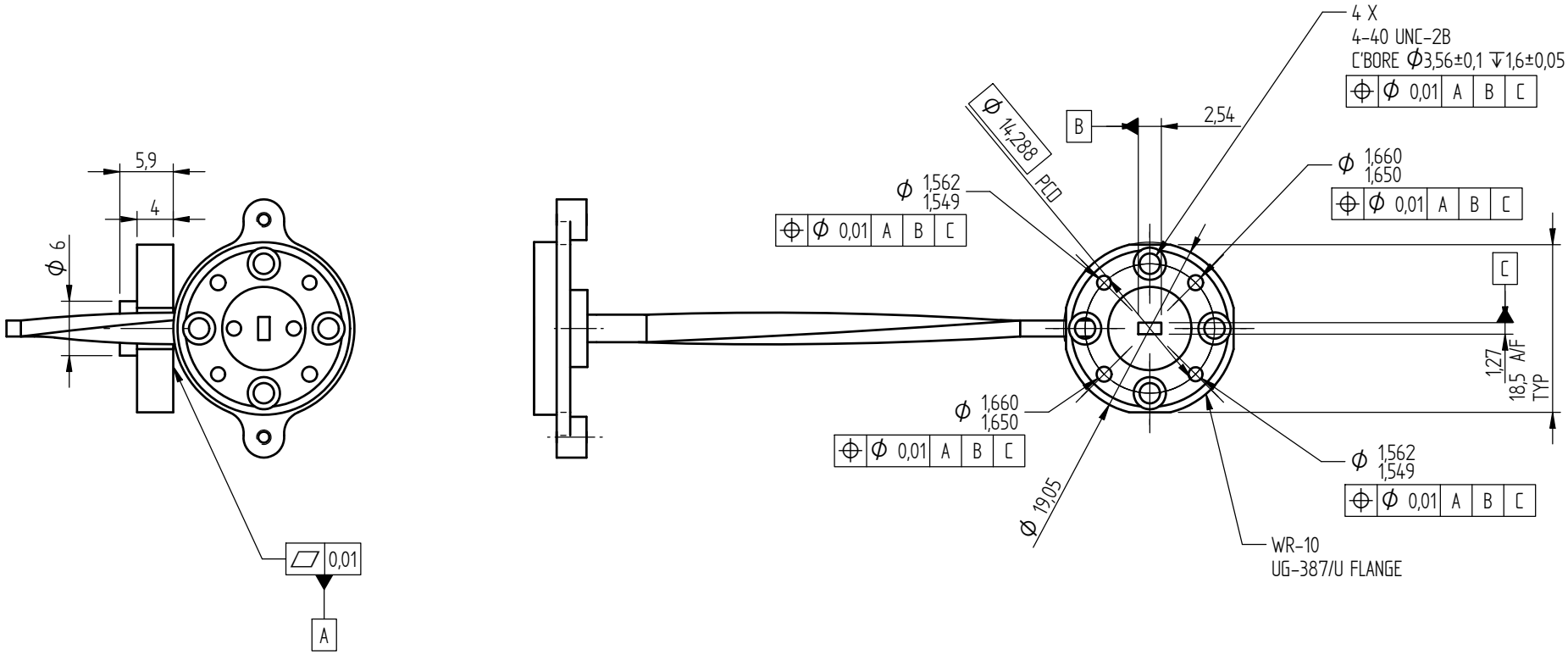
REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 165.5GHz FERx

MetOp-SG MWS

A3	KE-0282-132	SHEET 1 of 4	C



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PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

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FINISH **GOLD PLATE**

REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

SEE NOTES

WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 165.5GHz FERx

MetOp-SG MWS

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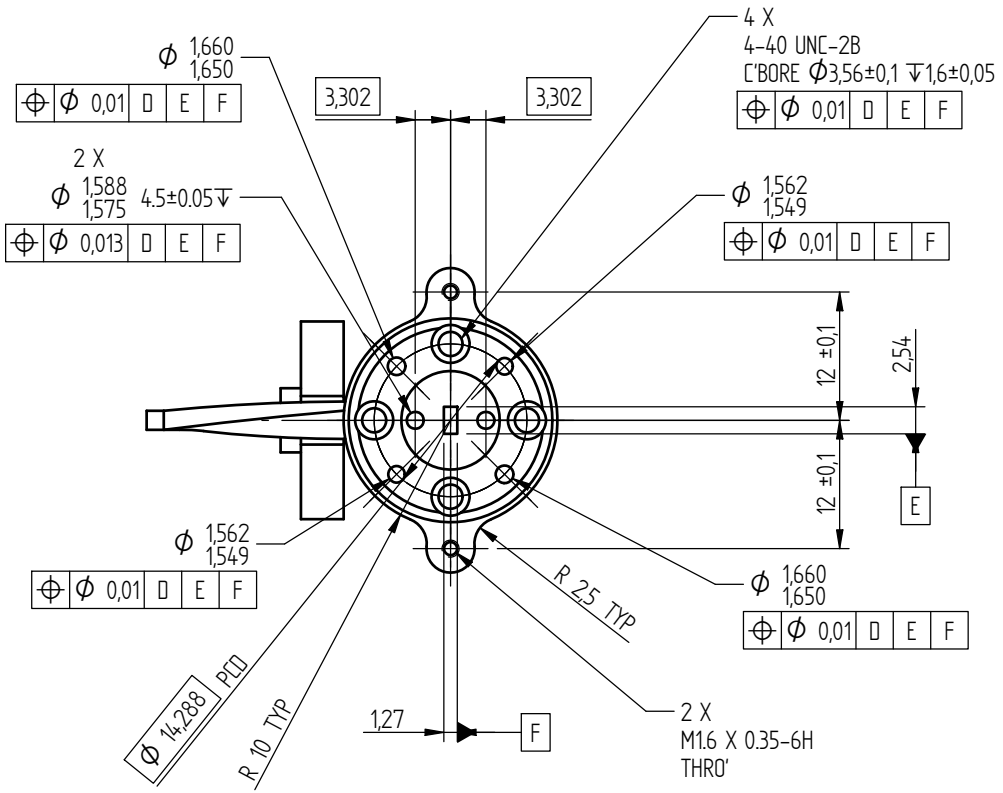

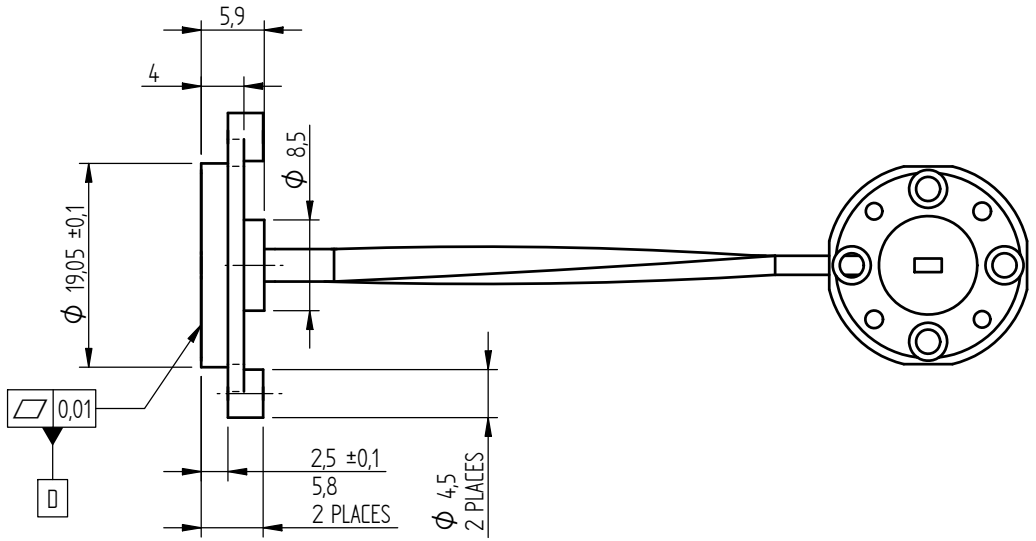

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LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
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REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

SEE NOTES

WR-10 TEST WAVE GUIDE ASSEMBLY - MWS 165.5GHz FERx

MetOp-SG MWS

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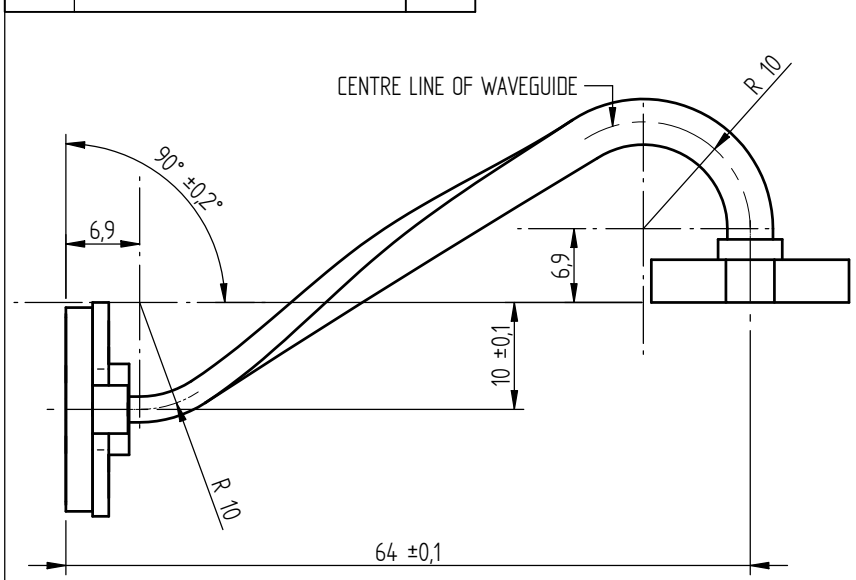
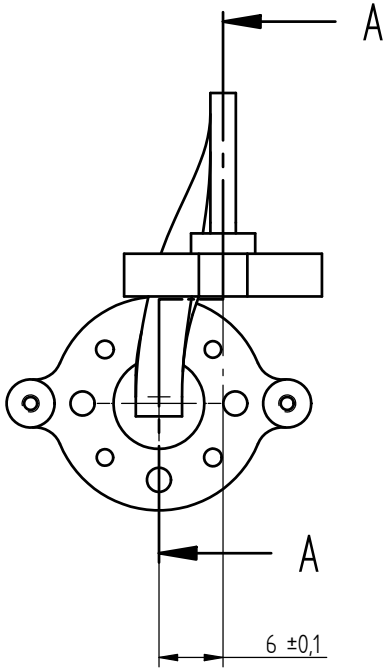
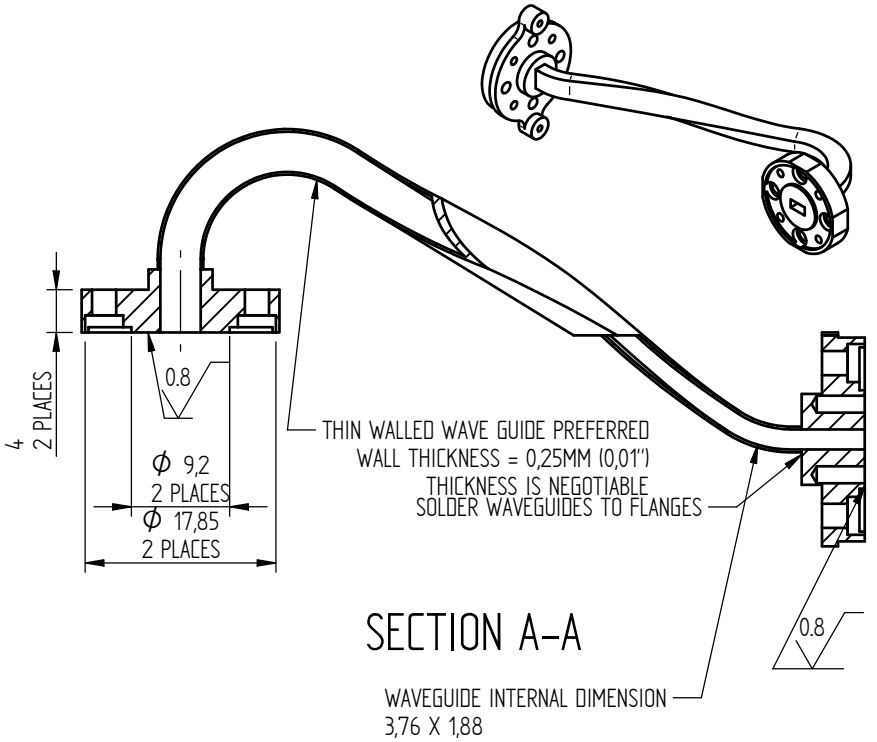






SECTION A–A

2:1

MANUFACTURE

1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION, SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS

1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH

1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE

1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS – REFER TO ISO-SPAP-MECH-007.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPTICAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

ISSUE	DATE	MOD. No.	DRAWN BY	CHKD BY	APPD BY	MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	STATUS
C	18/07/2017	---	J HAMPTON				RELEASED

RAL SPACE — USED ON KE-0282-310

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.020 kg**

SEE NOTES

FINISH **GOLD PLATE**

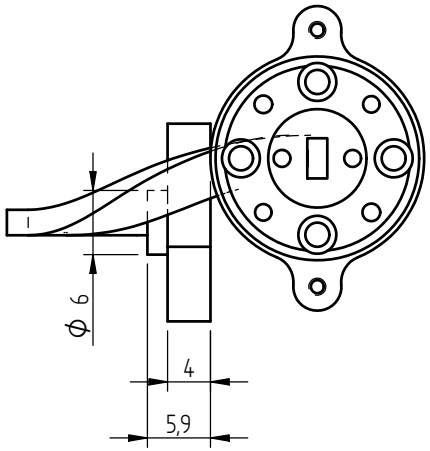
REMOVE ALL BURRS

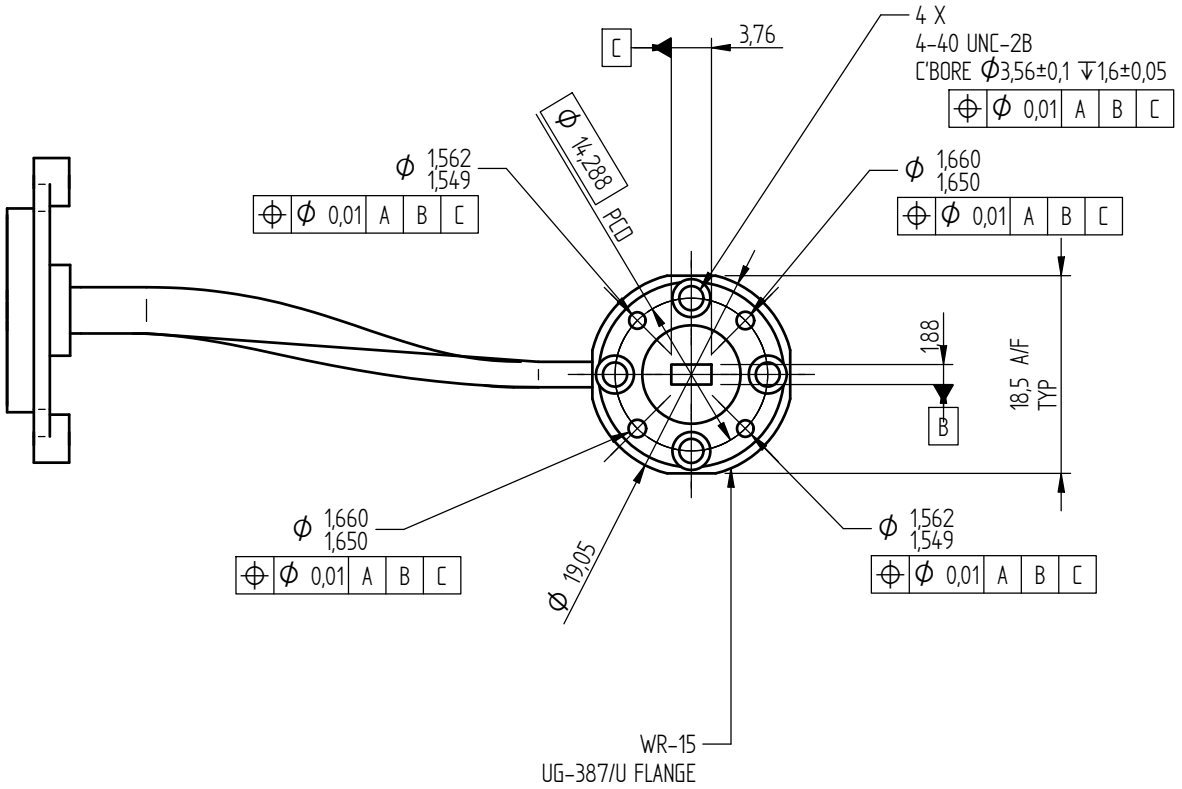
DIMENSIONS IN mm UNLESS STATED

WR-15 TEST WAVE GUIDE ASSEMBLY - MWS 229GHz FERx

Met-Op SG — MWS

A3	KE-0282-038	SHEET 1 of 4	C





C	18/07/2017	---	J HAMPTON			MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	**RELEASED**
ISSUE	DATE	MOD. No.	DRAWN BY	CHKD BY	APPD BY		STATUS

RAL SPACE | USED ON KE-0282-310

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.020 kg**

FINISH **GOLD PLATE**

REMOVE ALL BURRS

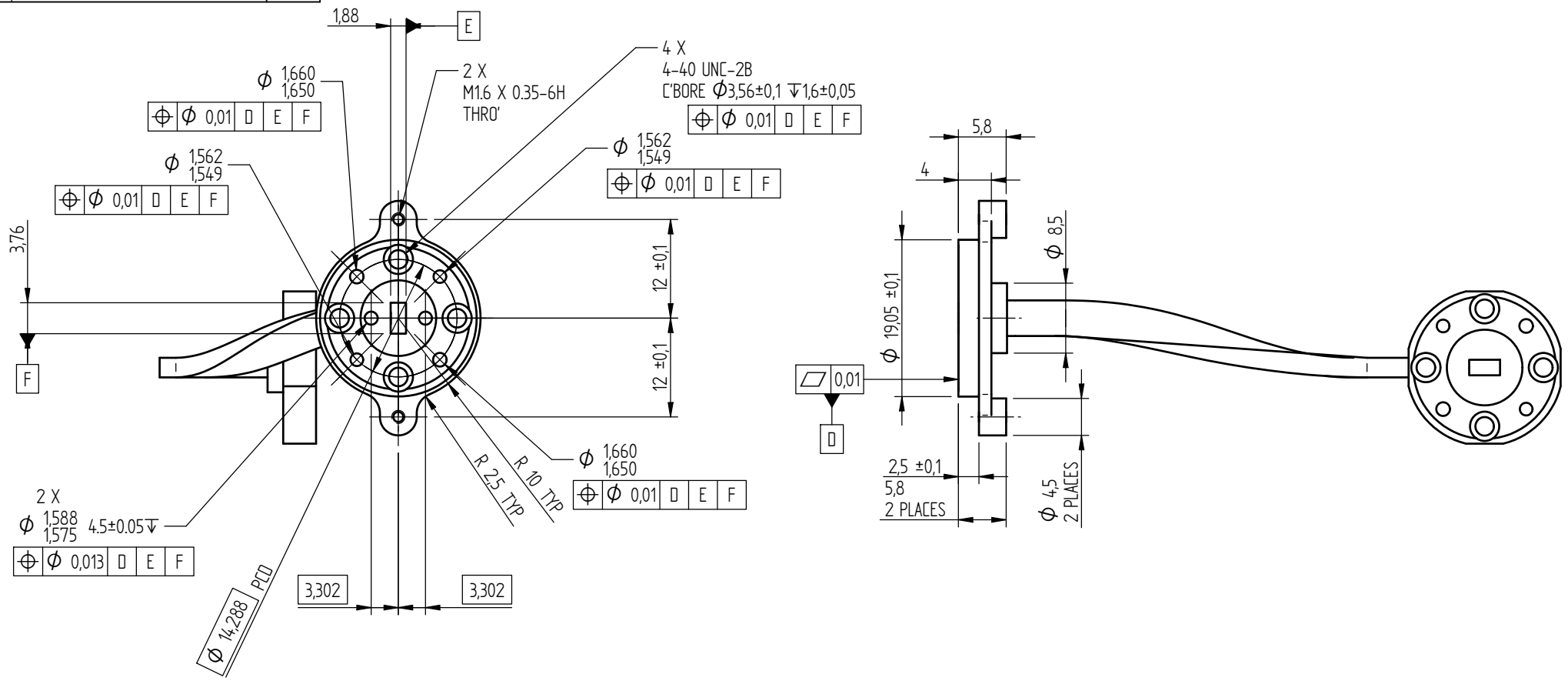
DIMENSIONS IN mm UNLESS STATED

SEE NOTES

WR-15 TEST WAVE GUIDE ASSEMBLY - MWS 229GHz FERx

Met-Op SG MWS

A3 | KE-0282-038 | SHEET 2 of 4 | C



C	18/07/2017	---	J HAMPTON			MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	**RELEASED**
ISSUE	DATE	MOD. No.	DRAWN BY	CHKD BY	APPD BY		STATUS

RAL SPACE | USED ON KE-0282-310

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.020 kg**

SEE NOTES

FINISH
GOLD PLATE
REMOVE ALL BURRS

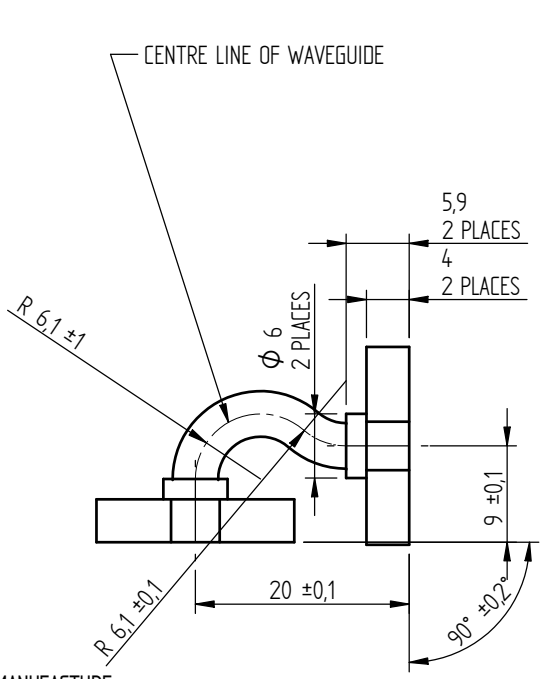
DIMENSIONS IN mm UNLESS STATED

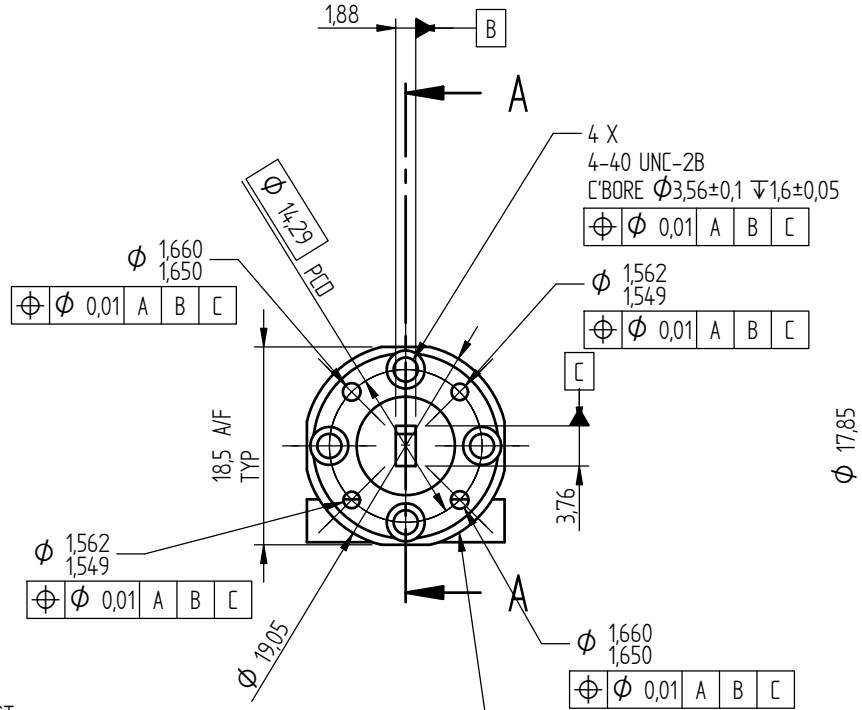
WR-15 TEST WAVE GUIDE ASSEMBLY - MWS 229GHz FERx

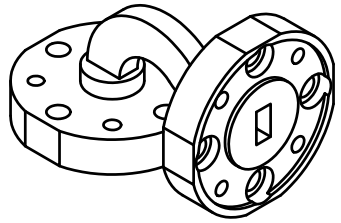
Met-Op SG | MWS

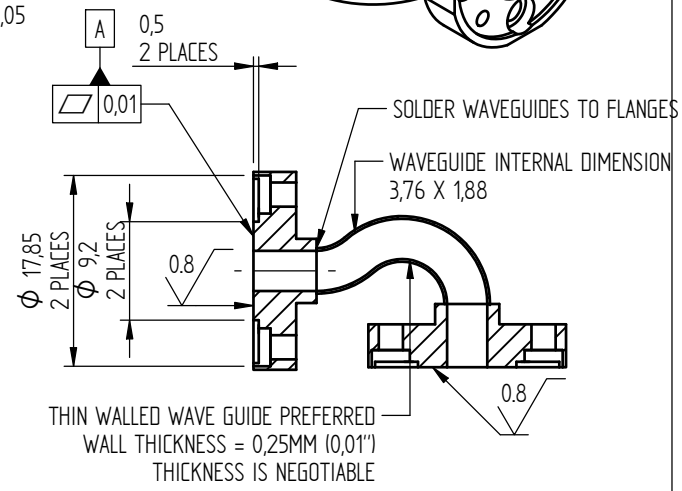
A3 | KE-0282-038 | SHEET 3 of 4 | C

A3	KE-0282-026	C









SECTION A-A

2:1

MANUFACTURE
1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION, SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS
1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH
1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE
1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS – REFER TO ISO-SPAP-MECH-007.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPTICAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

ISSUE	DATE	MOD. No.	DRAWN BY	CHKD BY	APPD BY	MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	STATUS
C	18/07/2017	---	J HAMPTON				RELEASED

RAL SPACE — USED ON KE-0282-302

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.016 kg**

SEE NOTES

FINISH **GOLD PLATE**

REMOVE ALL BURRS

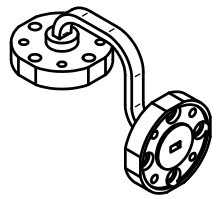
DIMENSIONS IN mm UNLESS STATED

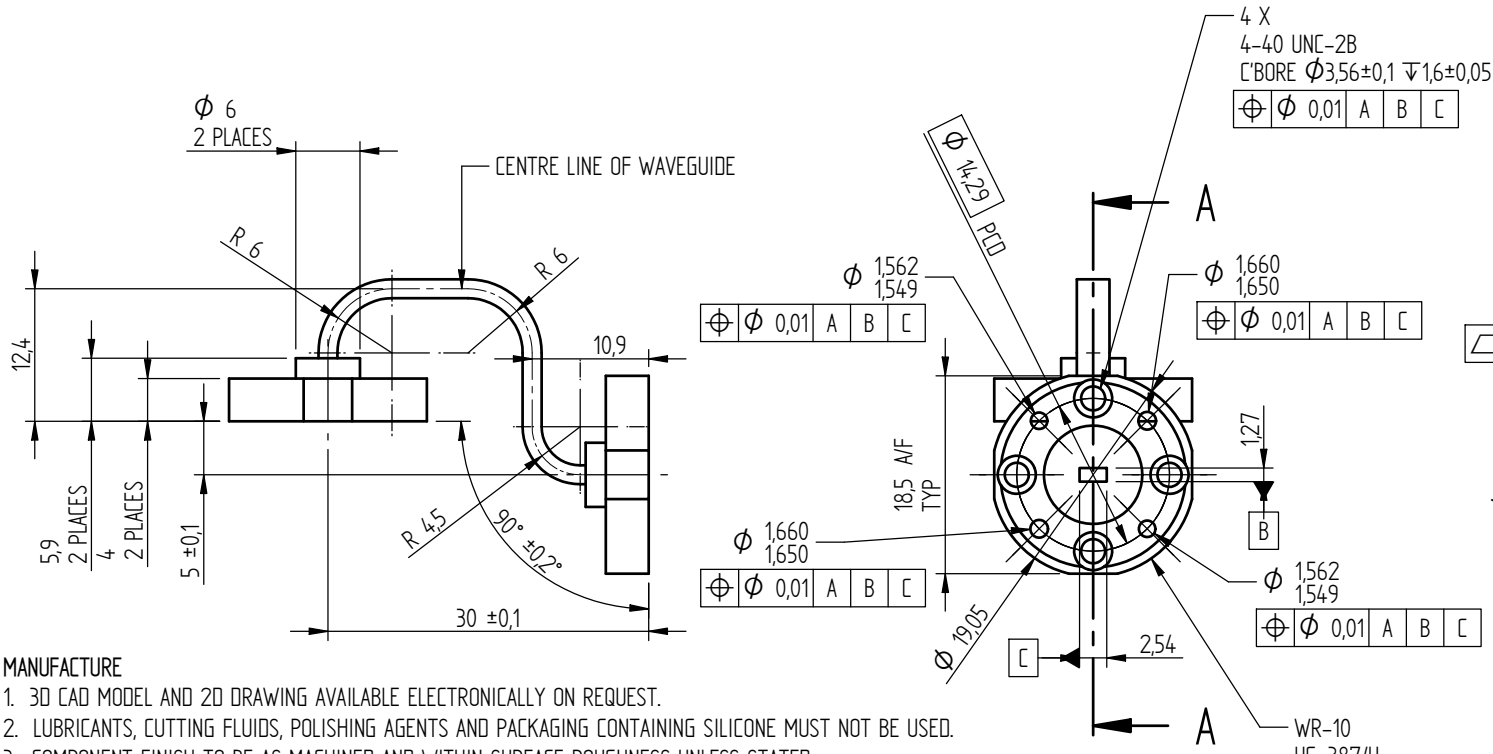
WR-15 BLOCK CHAIN WAVE GUIDE ASSEMBLY - MWS 229GHz FERx

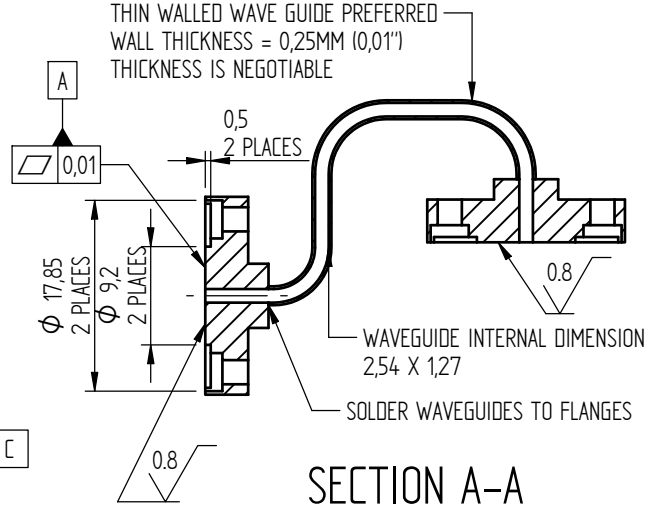
Met-Op SG — MWS

A3	KE-0282-026	SHEET 1 of 2	C

A3	KE-0282-018	A







SECTION A-A

2:1

MANUFACTURE

1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
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   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

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1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
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3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH

1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE

1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS – REFER TO ISO-SPAP-MECH-007.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPTICAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

ISSUE	DATE	MOD. No	DRAWN BY	CHKD BY	APPD BY	MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	STATUS
A	31/10/2016	---	J HAMPTON				RELEASED

RAL SPACE — USED ON KE-0282-202

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.017 kg**

SEE NOTES

FINISH **GOLD PLATE**

REMOVE ALL BURRS

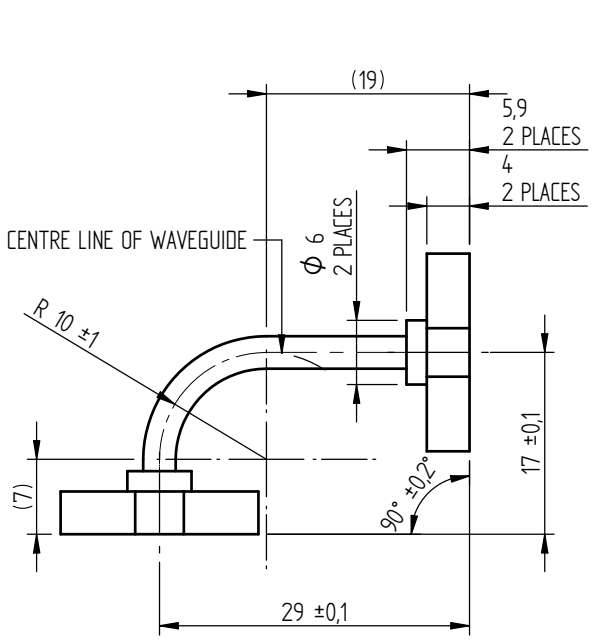
DIMENSIONS IN mm UNLESS STATED

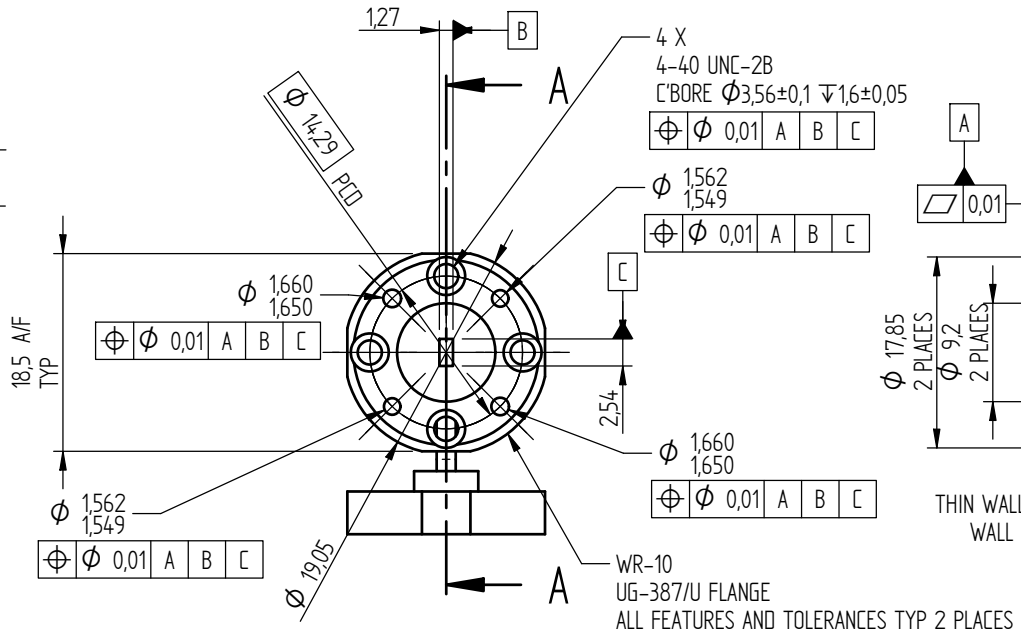
WR-10 BLOCK CHAIN WAVE GUIDE ASSEMBLY - MWS 183.3GHz FERx

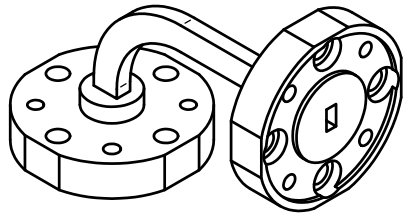
Met-Op SG — MWS

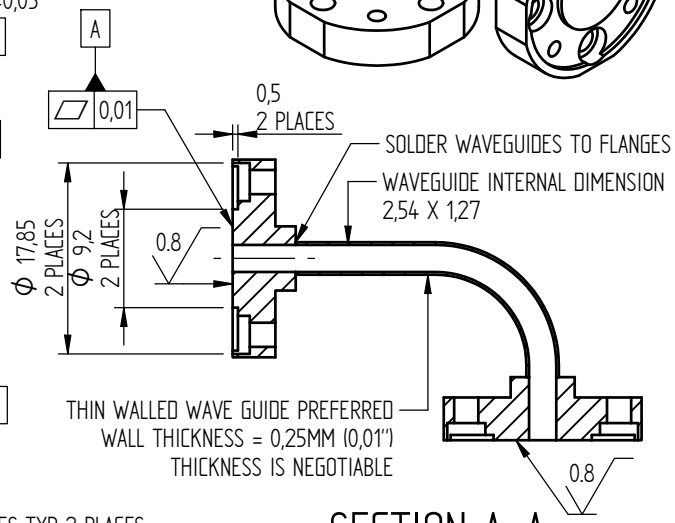
A3	KE-0282-018	SHEET 1 of 1	A

A3	KE-0282-015	A









SECTION A-A

2:1

MANUFACTURE
1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION, SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS
1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH
1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE
1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS - REFER TO ISO-SPAP-MECH-007.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
PA GROUP	
STRESS ENGINEER	
OPTICAL ENGINEER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
AIV GROUP	

ISSUE	DATE	MOD. No	DRAWN BY	CHKD BY	APPD BY	MANUFACTURE ONLY WHEN STATUS IS **RELEASED**	STATUS
A	31/10/2016	---	J HAMPTON				RELEASED

RAL SPACE | USED ON KE-0282-102

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.016 kg**

SEE NOTES

FINISH **GOLD PLATE**

REMOVE ALL BURRS

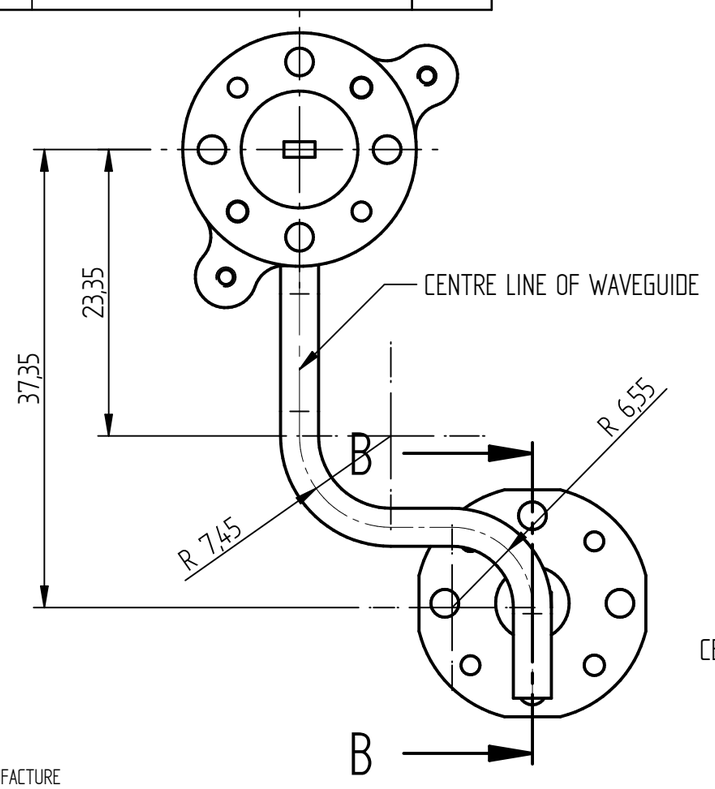
DIMENSIONS IN mm UNLESS STATED

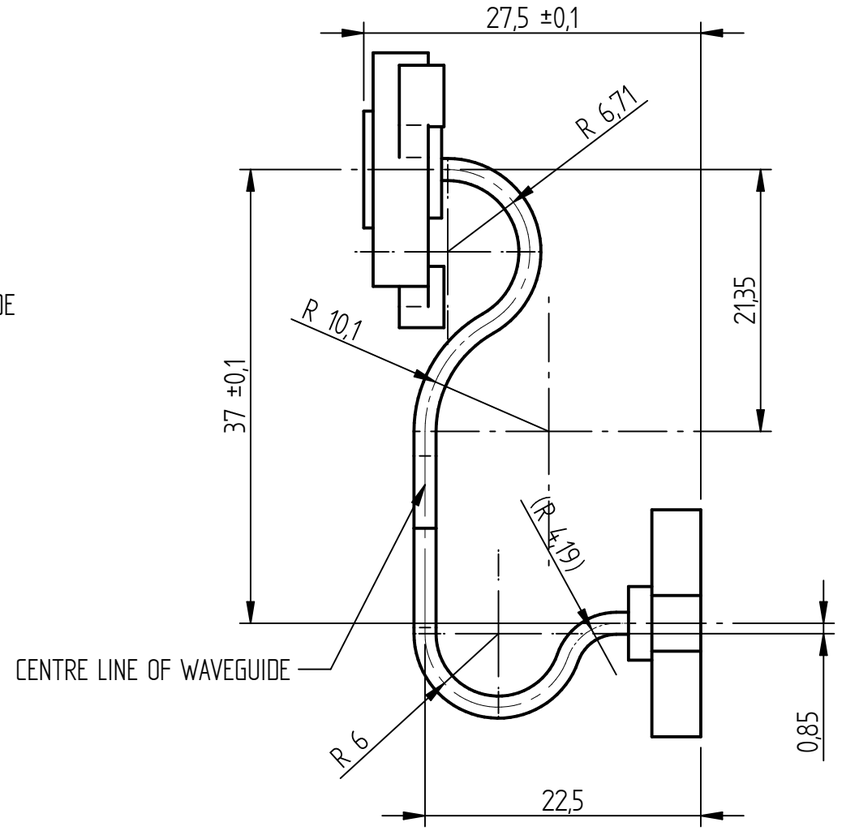
WR-10 BLOCK CHAIN WAVE GUIDE ASSEMBLY - MWS 165.5GHz FERx

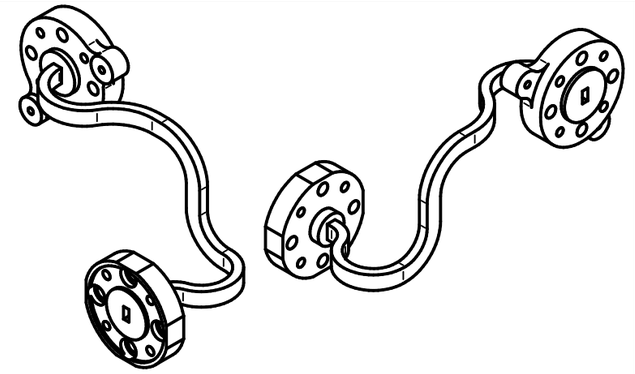
MetOp-SG MWS

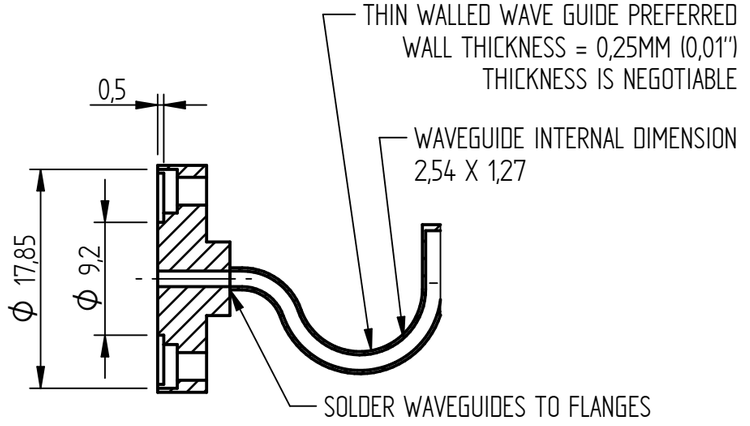
A3	KE-0282-015	SHEET 1 of 1	A

A3	KE-0282-533	D









SECTION B-B

2:1

MANUFACTURE
1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. ALL HOLES INDICATED FOR UNC WIRE INSERTS SHALL BE TAPPED ACCORDING TO BS 3409-2:1966
   WIRE THREAD INSERTS, IN ACCORDANCE WITH DIN 8140 A BRONZE, NON LOCKING, NON SR, NO VARNISH.
   MANUFACTURER: *AMECA*. PROCUREMENT SPECIFICATION: *MPS.0002331.DM.T.ASTR*
   ALL WIRE INSERTS TO BE INSTALLED WITHOUT THE USE OF ANY LUBRICANT OTHER THAN ISOPROPYL ALCOHOL.
   ALL WIRE INSERTS TO BE SUPPLIED BY THE MANUFACTURER.
   ALL WIRE INSERTS TO BE SUPPLIED WITH CERTIFICATE OF CONFORMANCE FOR PART AND MATERIAL.
   ALL WIRE INSERTS TO BE FITTED AFTER SURFACE FINISH PROCESS.
   SEE PROCEDURE FOR FITTING THREAD INSERTS
5. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION,
   SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS
1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH
1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE
1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS – REFER TO ISO-SPAP-MECH-007.

PROCEDURE FOR FITTING THREAD INSERTS
1. AFTER SURFACE TREATMENT CLEAN PART AND HANDLE WITH GLOVES ONLY.
2. RE-TAP THE HOLES.
3. VACUUM OUT THE HOLES TO REMOVE DEBRIS.
4. RINSE PART WITH IPA.
5. DIP THE THREAD INSERT IN IPA AND FLUSH THE HOLE WITH IPA (PROVIDES LUBRICATION).
6. FIT THE THREAD INSERT ENSURING TOP COIL TO BE 0.75 TO 1.5 PITCH BELOW SURFACE.
7. REMOVE THE TANG AND ENSURE IT HAS BEEN REMOVED.
8. CHECK THE THREAD WITH A GAUGE.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
RF ENGINEER	
STRESS ENGINEER	
CONFIGURATION MANAGER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
MANUFACTURING	

D	**04/06/2018**	**---**	**J HAMPTON**			MANUFACTURE ONLY WHEN SIGNED BY CHKD & APPD	**RELEASED**
ISSUE	DATE	MOD. No.	DRAWN BY	CHKD	APPD (PA)		STATUS

RAL SPACE USED ON KE-0282-510

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.022 kg**
SEE NOTES

FINISH **GOLD PLATE**
REMOVE ALL BURRS

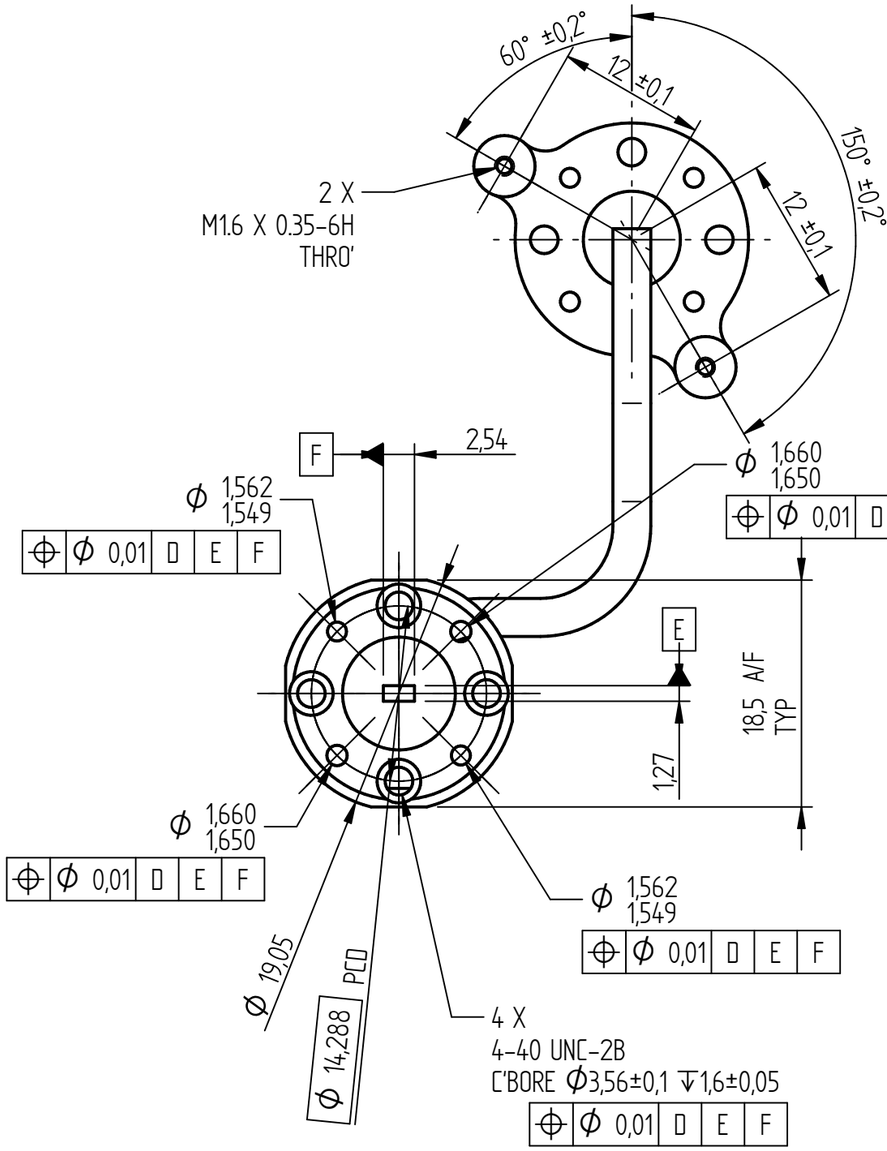
DIMENSIONS IN mm UNLESS STATED

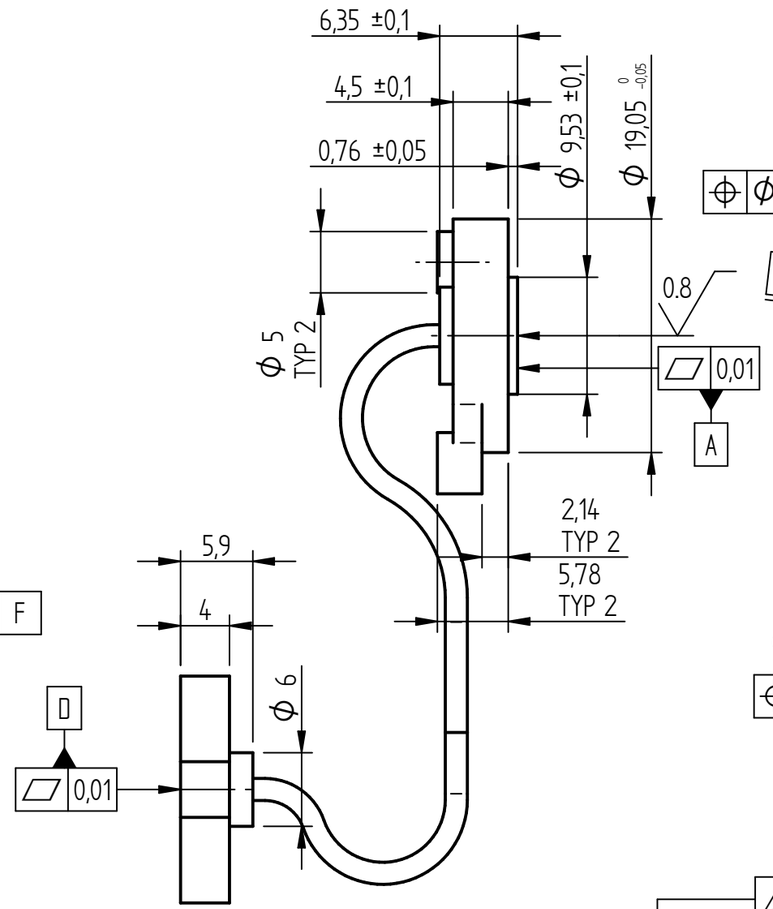
WR-10 TEST WAVE GUIDE ASSEMBLY - MWI 183.3GHz FERx

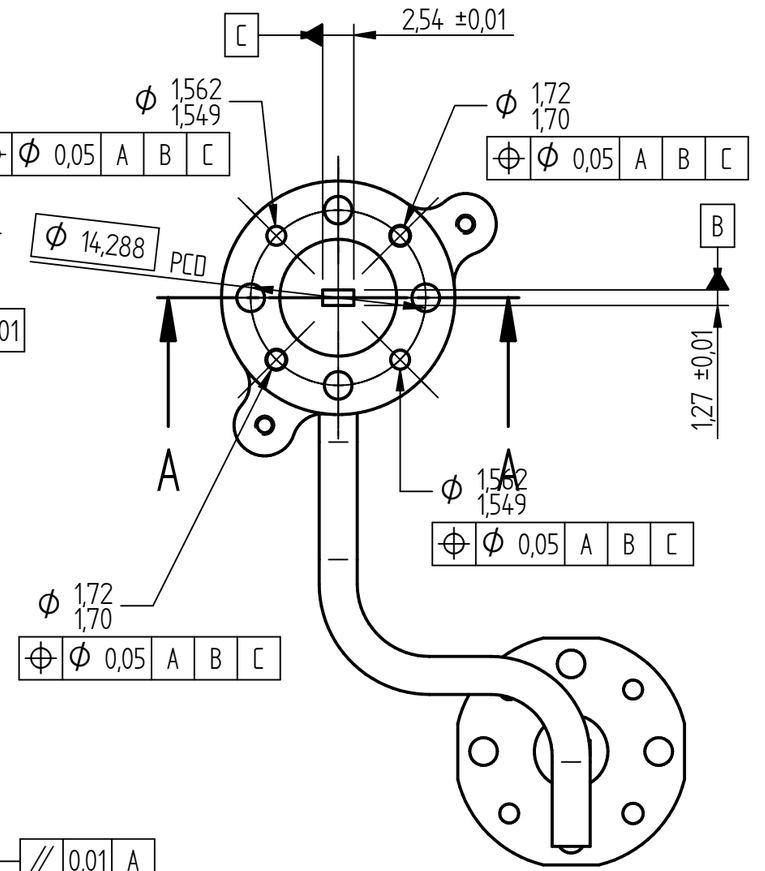
Met-Op SG — MWI

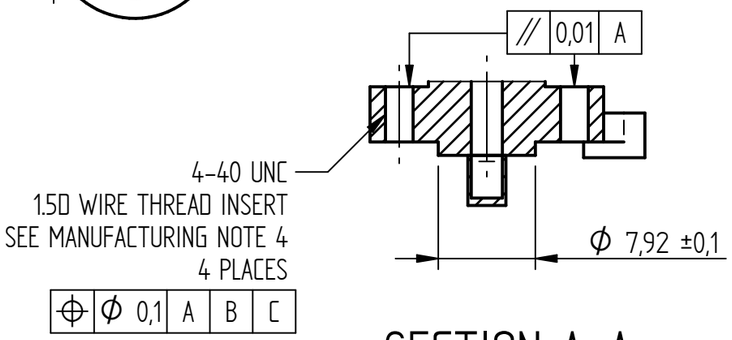
A3	KE-0282-533	SHEET 1 of 3	D

A3	KE-0282-533	D









2:1

SECTION A-A

D	04/06/2018	---	J HAMPTON	SEE SHEET 1	SEE SHEET 1	MANUFACTURE ONLY WHEN SIGNED BY CHKD & APPD	RELEASED
ISSUE	DATE	MOD. No.	DRAWN BY	CHKD	APPD (PA)		STATUS

RAL SPACE — USED ON KE-0282-510

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.022 kg**

SEE NOTES

FINISH
GOLD PLATE

REMOVE ALL BURRS

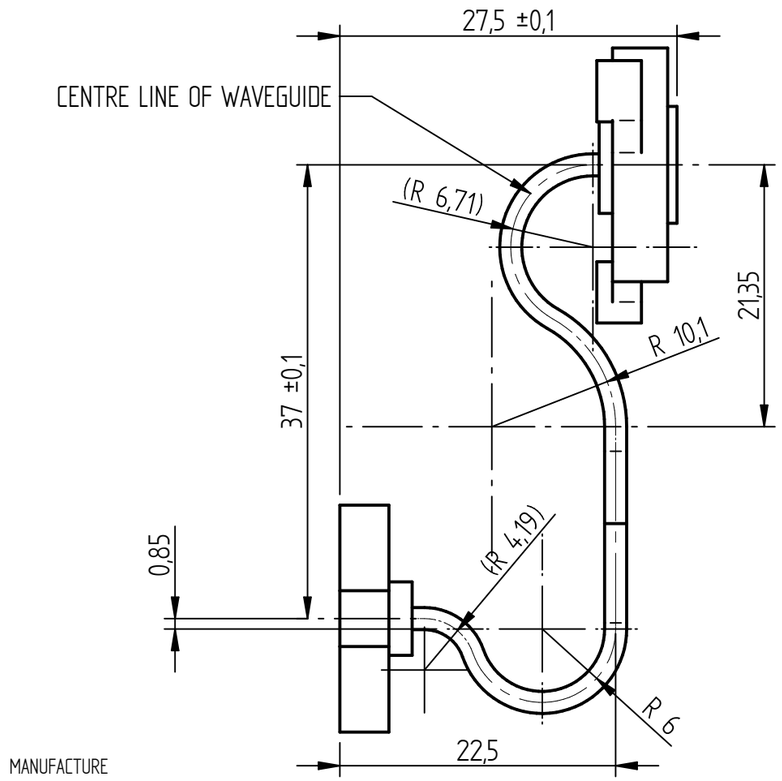
DIMENSIONS IN mm UNLESS STATED

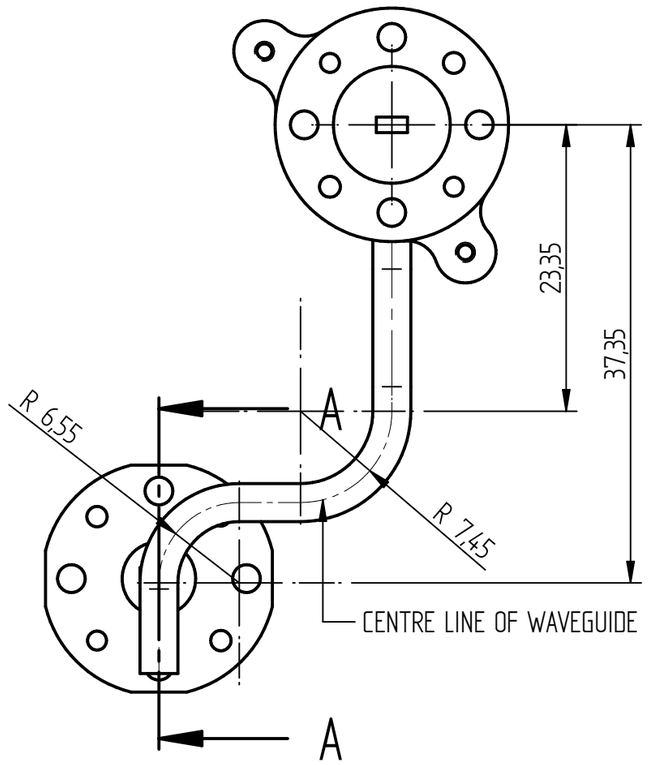
WR-10 TEST WAVE GUIDE ASSEMBLY - MWI 183.3GHz FERx

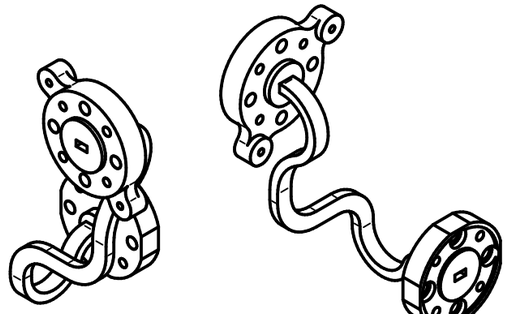
Met-Op SG — MWI

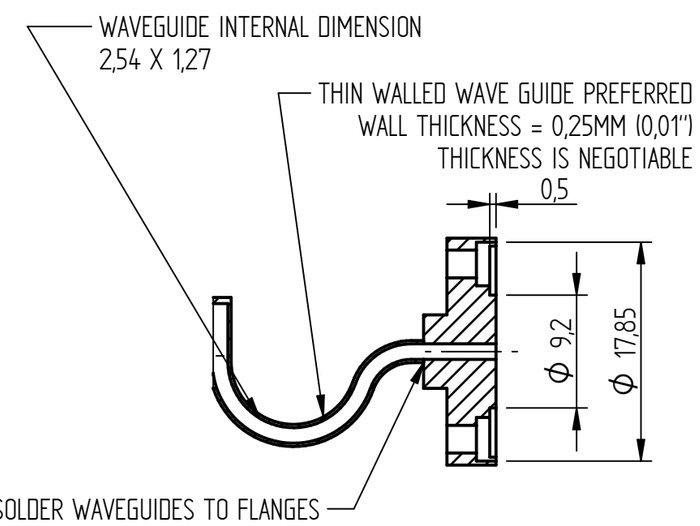
A3	KE-0282-533	SHEET 2 of 3	D

A3	ke-0282-433	D









SECTION A-A

2:1

MANUFACTURE
1. 3D CAD MODEL AND 2D DRAWING AVAILABLE ELECTRONICALLY ON REQUEST.
2. LUBRICANTS, CUTTING FLUIDS, POLISHING AGENTS AND PACKAGING CONTAINING SILICONE MUST NOT BE USED.
3. COMPONENT FINISH TO BE AS MACHINED AND WITHIN SURFACE ROUGHNESS UNLESS STATED.
   DO NOT APPLY ABRASIVES UNLESS SPECIFIED.
4. ALL HOLES INDICATED FOR UNC WIRE INSERTS SHALL BE TAPPED ACCORDING TO BS 3409-2:1966
   WIRE THREAD INSERTS, IN ACCORDANCE WITH DIN 8140 A BRONZE, NON LOCKING, NON SR, NO VARNISH.
   MANUFACTURER: *AMECA*. PROCUREMENT SPECIFICATION: *MPS.0002331.DM.T.ASTR*
   ALL WIRE INSERTS TO BE INSTALLED WITHOUT THE USE OF ANY LUBRICANT OTHER THAN ISOPROPYL ALCOHOL.
   ALL WIRE INSERTS TO BE SUPPLIED BY THE MANUFACTURER.
   ALL WIRE INSERTS TO BE SUPPLIED WITH CERTIFICATE OF CONFORMANCE FOR PART AND MATERIAL.
   ALL WIRE INSERTS TO BE FITTED AFTER SURFACE FINISH PROCESS.
   SEE PROCEDURE FOR FITTING THREAD INSERTS
5. COMPONENT TO BE SUPPLIED IN PROTECTIVE PACKAGING, LABELLED WITH PART NUMBER, REVISION,
   SERIAL NUMBER (IF APPLICABLE), CONTRACT NUMBER, MANUFACTURER'S NAME AND DATE.
   COMPONENT TO BE SUPPLIED WITH MANUFACTURE AND MATERIAL CERTIFICATE OF CONFORMANCE.

MATERIALS
1. ALL MATERIALS MUST BE AGREED UPON TO ENSURE COMPLIANCE WITH ECSS GUIDELINES.
2. FLANGE MATERIAL TO BE EITHER BRASS OR BRONZE. SUPPLIER TO MAKE A PROPOSAL.
3. WAVEGUIDE MATERIAL TO BE PROPOSED BY SUPPLIER.
4. SOLDER TYPE TO BE AGREED WITH SUPPLIER.

SURFACE FINISH
1. COMPONENT SURFACE FINISH: GOLD PLATE. PROCEDURE TBD.

PRODUCT ASSURANCE
1. COMPONENT TO BE CLEANED AT RAL ACCORDING TO RAL SPECIFICATION ISO SPAN AIV 102.
2. INSPECTION REQUIREMENTS - REFER TO ISO-SPAP-MECH-007.

PROCEDURE FOR FITTING THREAD INSERTS
1. AFTER SURFACE TREATMENT CLEAN PART AND HANDLE WITH GLOVES ONLY.
2. RE-TAP THE HOLES.
3. VACUUM OUT THE HOLES TO REMOVE DEBRIS.
4. RINSE PART WITH IPA.
5. DIP THE THREAD INSERT IN IPA AND FLUSH THE HOLE WITH IPA (PROVIDES LUBRICATION).
6. FIT THE THREAD INSERT ENSURING TOP COIL TO BE 0.75 TO 1.5 PITCH BELOW SURFACE.
7. REMOVE THE TANG AND ENSURE IT HAS BEEN REMOVED.
8. CHECK THE THREAD WITH A GAUGE.

PROJECT MANAGER	
SYSTEM ENGINEER	
ELECTRONICS ENGINEER	
RF ENGINEER	
STRESS ENGINEER	
CONFIGURATION MANAGER	
THERMAL ENGINEER	
MECHANICAL ENGINEER	
MANUFACTURING	

ISSUE	DATE	MOD. No.	DRAWN BY	CHKD	APPD (PA)	MANUFACTURE ONLY WHEN SIGNED BY CHKD & APPD	STATUS
D	04/06/2018	---	J HAMPTON				RELEASED

RAL SPACE — USED ON KE-0282-410

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE 0.8 µm

DRAWING CONFORMS TO BS 8888
TOLERANCING ISO 8015

MATERIAL & SPEC. **SEE NOTES**

MASS 0.022 kg

FINISH **GOLD PLATE**

REMOVE ALL BURRS

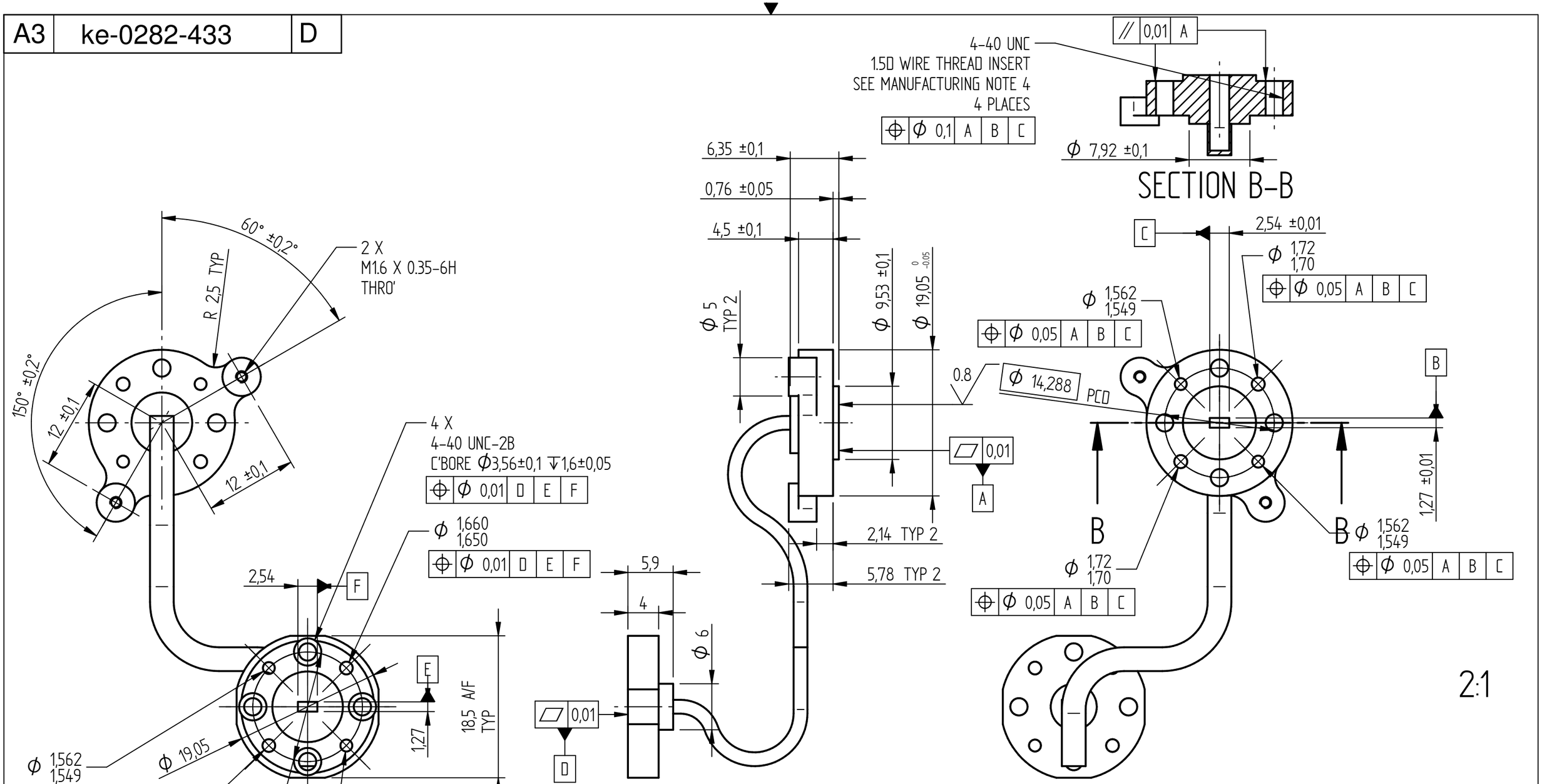
DIMENSIONS IN mm UNLESS STATED

WR-10 TEST WAVE GUIDE ASSEMBLY - MWI 165.5GHz FERx

Met-Op SG — MWI

A3	ke-0282-433	SHEET 1 of 3	D

A3	ke-0282-433	D



D	04/06/2018	---	J HAMPTON	SEE SHEET 1	SEE SHEET 1	MANUFACTURE ONLY WHEN SIGNED BY CHKD & APPD	RELEASED
ISSUE	DATE	MOD. No.	DRAWN BY	CHKD	APPD (PA)		STATUS

RAL SPACE — USED ON KE-0282-410

HARWELL SCIENCE & INNOVATION CAMPUS, RUTHERFORD APPLETON LABORATORY, CHILTON, OXON, OX11 0QX

PROJECTION

TOLERANCES UNLESS STATED
LINEAR ± 0.1
ANGULAR ± 0.2

SURFACE TEXTURE
0.8 µm

DRAWING CONFORMS TO BS 8888 TOLERANCING ISO 8015

MATERIAL & SPEC. **MASS 0.022 kg**

FINISH **GOLD PLATE**

REMOVE ALL BURRS

DIMENSIONS IN mm UNLESS STATED

SEE NOTES

WR-10 TEST WAVE GUIDE ASSEMBLY - MWI 165.5GHz FERx

Met-Op SG — MWI

A3	ke-0282-433	SHEET 2 of 3	D

Appendix 2

PROCESS QUALIFICATION WORKFLOW (INFORMATIVE)

The following example qualification flow illustrates the qualification steps for waveguide assemblies which are manufactured in copper, with soldered flanges, and nickel-plated by the supplier before supply to RAL. Other construction techniques would have a comparable qualification path in order to meet the requirements of [AD14b].

The envisaged process requires 2 categories of test using different test pieces:

1. Bend Test: Test of 6 x sample nickel- and gold-plated test pieces (comprising longitudinally-sectioned straight waveguide pieces as defined in Appendix 3) to verify the integrity and adhesion of the supplier nickel-plating and RAL gold-plating processes (Figure A2-1)
2. Complex Test Piece: Test of 8 complete waveguide assembly samples (defined in Appendix 4), including soldered flanges, nickel- and gold-plating, of which 2 will be retained by the supplier and 6 supplied to RAL for gold-plating and subsequent environmental testing (Figure A2-2)

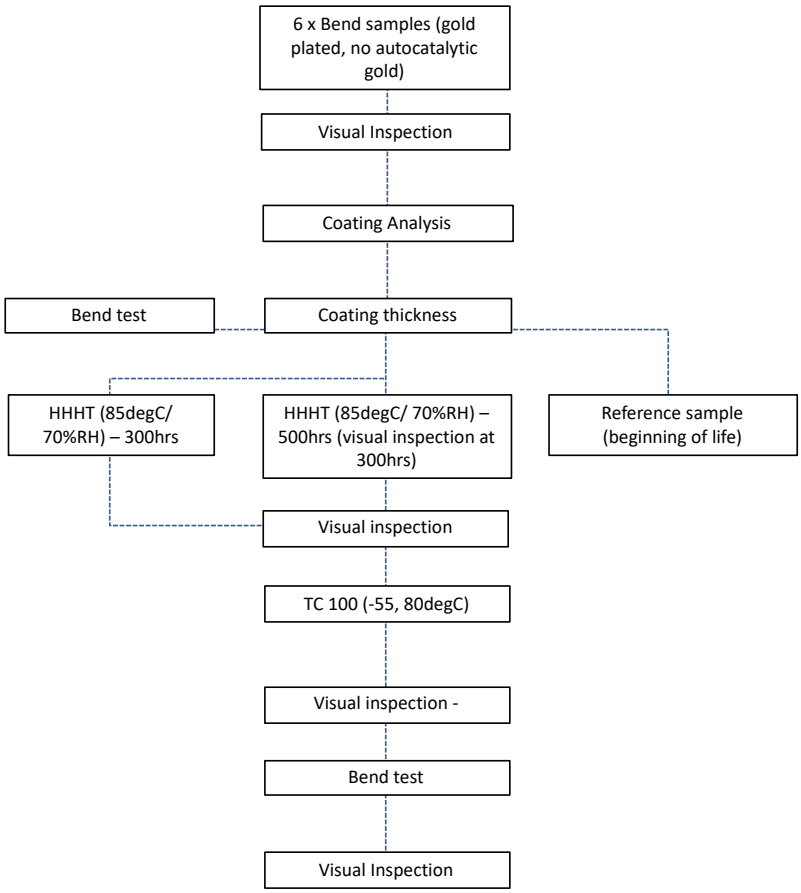


Figure A2-1 Bend Test Workflow for nickel- and gold-plated straight waveguide test pieces

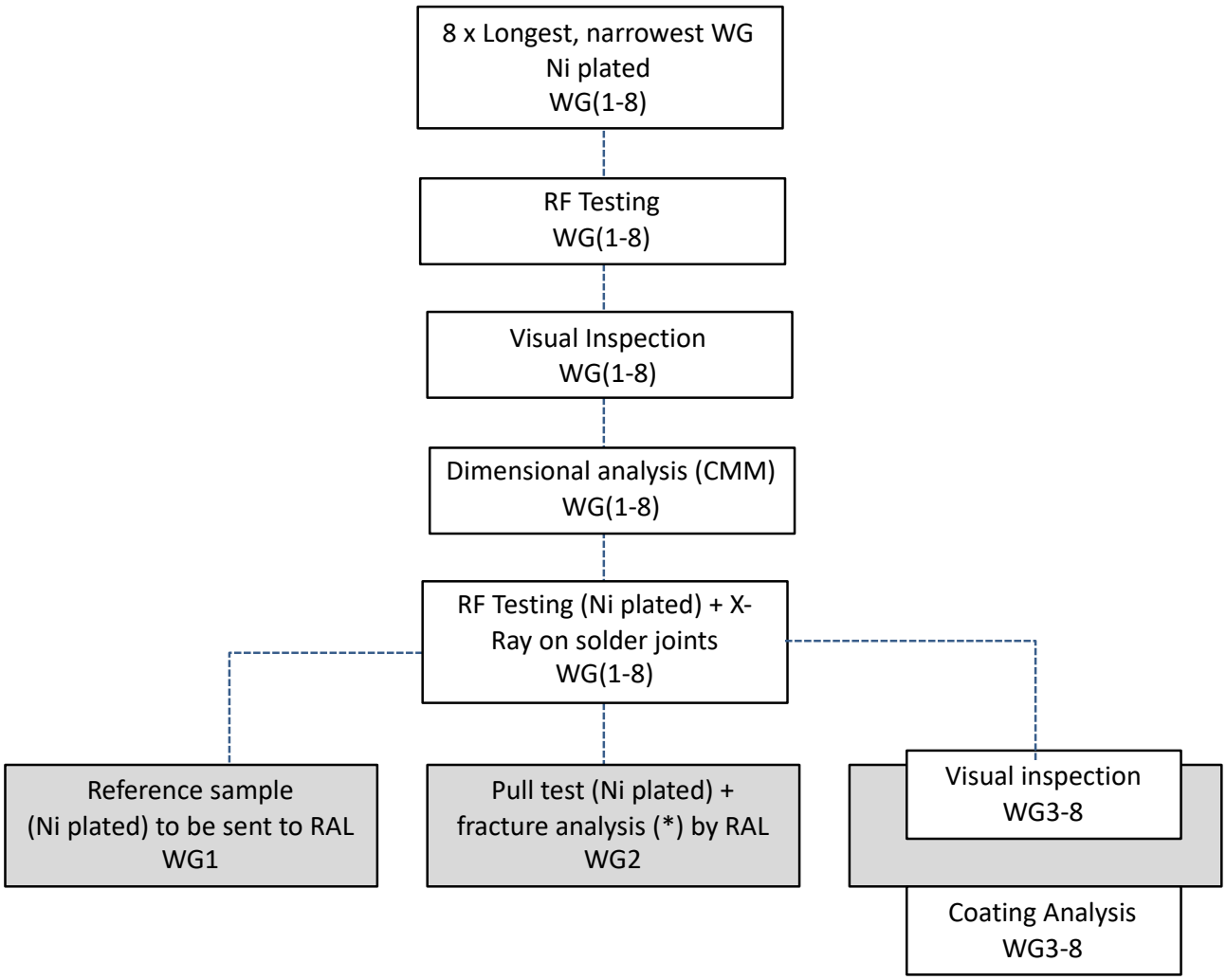


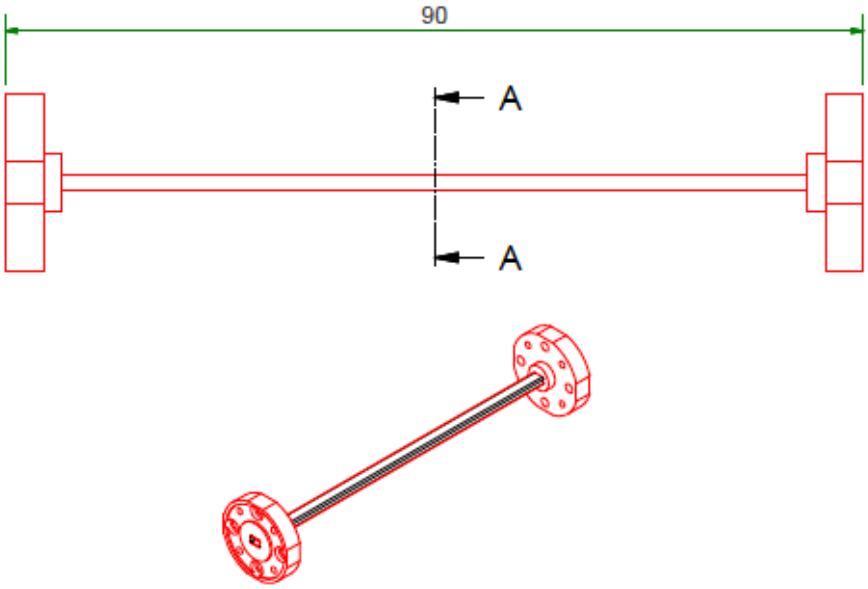
Figure A2-2 Test Workflow for complete Waveguide Assemblies (complex test pieces)

Appendix 3

BEND TEST PIECE

Bend tests will be carried out on “Bend test pieces” fabricated and plated using the same materials and processes as the complex waveguide test pieces and Flight waveguides. Precise definition of the test piece can be agreed between RAL and supplier however a possible configuration is shown below:

The test piece(s) would initially be fabricated and plated as complete straight waveguide assemblies, with flanges.



This would then be gold-plated at RAL, the flanges removed, and the waveguide sectioned along its length to produce the final bend test piece as illustrated below:

Appendix 4

COMPLEX TEST PIECE

The complex test piece will be a complete waveguide assembly, supplied nickel-plated. This will typically be the longest of the required types.