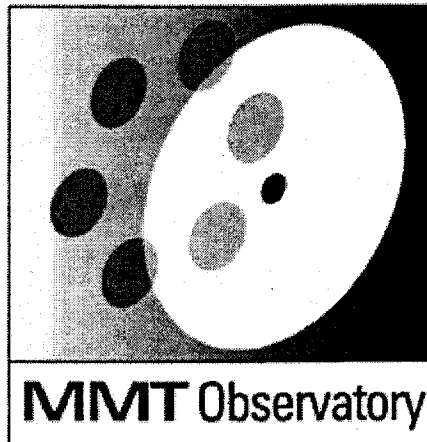


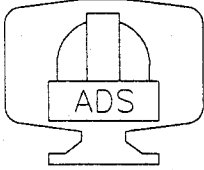
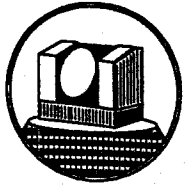
# MMTO Internal Technical Memorandum #01-1



Smithsonian Institution &  
The University of Arizona\*

**Secondary Mirrors Support  
M2/F5 Hexapod Data Package**

April 2001

	<b>MMT CONVERSION</b>	
	<p>Doc.No. : H5 DP AD 01001  Issue : A  Date : 27 April 2001</p>	

**PROGRAMME :**           **MMT CONVERSION**  
**SECONDARY MIRRORS SUPPORT**  
**M2/F5 HEXAPOD**

**CUSTOMER :**           **Steward Observatory**  
The University of Arizona  
Tucson – AZ 85721-0065 USA  
Phone: (520) 626-5231  
Fax: (520) 621-9843

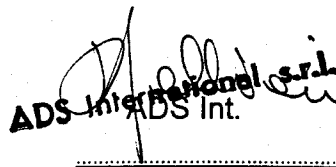
**CONTRACTOR :**       **ADS International S.r.l.**  
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23900 LECCO - ITALY  
Tel.: +39-0341-259231  
Fax: +39-0341-259235  
e-mail: information@ads-int.com

**DOCUMENT TITLE :**   **M2/F5 HEXAPOD DATA PACKAGE**  
**Issue : A**  
**Date : 27/04/2001**

**DOCUMENT ID. :**      **H5-DP-AD-01001**

**DOCUMENT TYPE :**   **DATA PACKAGE**

**ISSUED BY:**

  
**ADS International S.r.l.**  
ADS Int.

27/04/2001

Signature

Date

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## 1. SCOPE OF THE WORK

This document reports the information related to the MMT M2 f/5 Hexapod manufacturing, assembly and integration, together with its transportation, installation and maintenance instructions.

The design of this mechanism is reported in AD1 and AD2, while the ambient test of the individual actuators are documented in AD3.

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## 2. APPLICABLE DOCUMENTS

- AD1 Document H5-RP-AD-99001, "MMT Conversion – Secondary Mirrors Support – M2/F5 Hexapod Design – Technical Report", Issue E dated 17/05/2000;
- AD2 Document H5-TN-AD-001, "Hexapod Kinematics Algorithm", Issue 1 dated 26/08/99;
- AD3 Document H5-TR-AD-01001, "MMT Conversion – Secondary Mirrors Support – M2/F5 Hexapod Test Report", Issue A dated 21/04/2001;

### 3. HEXAPOD DESCRIPTION

The f/5 hexapod is made of the following subsystems:

- seven linear actuators (six integrated into the hexapod mechanism + one spare);
- one fixed and one mobile platforms;
- six interface supports to fix the actuator joints on the platforms.

The actuator is based on a direct drive configuration with a frame-less motor, a brake and a rotary encoder on the same spindle axis.

A LVDT is mounted on board of each actuator to provide an measurement of its length.

The actuator nominal length (zero nominal stroke position) is 460 mm, measured between actuator's joints ledges.

The actuator nominal stroke is  $\pm 23$  mm from the zero position, while the mechanical stops are placed at  $\pm 25$  mm.



The max angular displacements of the universal joints is  $\pm 3,5$  degree.

The satellite roller screw is of the re-circulating rollers type.

The motor gives 6.8 Nm peak torque while the brake has 4 Nm static torque.

The incremental encoder has 3600 divisions per revolution resolution which gives 14400 cts/rev. that is  $0,07 \mu\text{m}$  linear resolution on the 1 mm pitch screw.

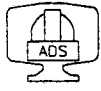
LVDT measured performances are reported in the test report (AD3).

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#### 4. **LINEAR ACTUATORS**

##### 4.1. *Parts and material list*





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## Parts list

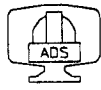
MMT HEXAPOD M2-F5  
 LINEAR ACTUATOR  
 WORKSHOP LIST

**ADS S.R.L.**  
 Caso Promessi Spesi 23/d - 23900 Lecco  
 Phone +39 0341 259231 - Fax +39 0341 259235  
 e-mail: information@ads-int.com - Itp://www.ads.it/ads

Quantity	DESIGNATION	Format	Item	MATERIAL	Single Piece weight (kg)	REMARKS	Mod.
1	Cardan Joint - External Fork	3	01	AISI 303	0.286	Dwg. n° 301006	B
2	ENCODER HOUSING	3	02	Anticorodal 9006/4	0.39	Dwg. n° 300969	B
1	ENCODER-BEARING SUPPORT	3	03	AISI 303	0.55	Dwg. n° 300970	B
1	FRAMELESS MOTOR SUPPORT	3	04	Anticorodal 9006/4	0.5	Dwg. n° 300971	B
1	DISTANCE RING	4	05	AISI 303	0.025	Dwg. n° 400733	A
1	BUSHING	4	06	AISI 303	0.22	Dwg. n° 400734	A
1	BRAKE-BEARINGS SUPPORT	3	07	AISI 303	3.75	Dwg. n° 300972	B
2	Cardan Joint - Cross piece	4	08	AISI 303	0.135	Dwg. n° 400774	A
1	COVER	4	09	AISI 303	0.37	Dwg. n° 400736	B
1	PROXIMITY SUPPORT	3	10	Anticorodal 9006/4	0.113	Dwg. n° 300973	B
1	PROTECTION	4	11	Anticorodal 9006/4	0.08	Dwg. n° 400737	B
1	PROTECTION RING	4	12	Anticorodal 9006/4	0.05	Dwg. n° 400738	A
1	SATELLITE ROLLER SCREW SUPPORT	3	13	Anticorodal 9006/4	0.45	Dwg. n° 300974	B
1	Cardan Joint - Fork	3	14	AISI 303	0.433	Dwg. n° 301008	B
Index		Number of assemblies :		7	ACTUATOR ASSEMBLY DWG N°200528		
Date		Weight for 1 ass. :		8.440 Kg.	HEXAPOD ASSEMBLY DWG N°200529		
Name		Weight for all ass. :		61.2+61.4= 122.6 Kg.	HEXAPOD TOTAL WEIGHTH : ~ 164 Kg.		

1) Quantity for 1 assembly 2) Quantity for execution  
 sheet 01 of 02  
 FILE 400777 B





# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



## Parts list

Quantity		DESIGNATION	Item	MATERIAL	Piece weight (kg)	REMARKS	Mod.
1	2						
1	7	SATELLITE ROLLER SCREW (ROLLVIS RVR 25x1)	100	X46Cr13	~ 1.5	DWG.300966/B	
1	7	ENCODER (HEIDENHAIN ERO 1324)	101		0.145		
1	7	BALL BEARING (FAG 6000 Z15)	102		0.019	To grease with ISOFLEX NBU 15	
2	14	SNAP RING FOR HOLES ø26 UNI 7437	103	50 Cr V 4	0.001		
1	7	SELF LOCKING RING (GUK M15x1)	104	Steel R490N/mm <sup>2</sup> Zinc plated	0.015		
3	21	GRUB SCREW M4x4 UNI 5923	105	INOX UNI 7323/8	0.002		
1	7	FRAMELESS BRUSHED MOTOR-ROTOR (INLAND)	106		1.575	Type QT-2603 "... WINDING	
1	7	FRAMELESS BRUSHED MOTOR-STATOR (INLAND)	107				
1	7	BRAKE (ELECTROID Type EFSB 35) Hub	108		1.215		
1	7	BRAKE (ELECTROID Type EFSB 35) Armature plate	109				
1	7	KEY 5x5x14 UNI 6604--A	110	Steel R590 N/mm <sup>2</sup>	0.002	DWG. 400745 for machining	
1	7	SELF LOCKING RING (GUK M25x1.5)	111	Steel R490N/mm <sup>2</sup> Zinc plated	0.03		
2	14	AXIAL RADIAL BEARINGS (FAG B7205E.T.P4S.DBH)	112		0.16	To grease with ISOFLEX NBU 15	
2	14	BELLEVILLE WASHER 31.5x16.3x0.8 DIN 2093	113	50 Cr V 4	0.002	4.794	
Index		Number of assemblies :		7			
Date		Weight for 1 ass. :		5.25		Kg.	
Name		Weight for all ass. :		36.75x1.004=37.754		Kg.	
1) Quantity for 1 assembly		2) Quantity for execution					

sheet 01 of 03  
 FILE 400778 A



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
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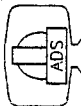
## Parts list

MMT HEXAPOD M2-F5

LINEAR ACTUATOR

COMMERCIAL LIST

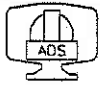

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Quantity	DESIGNATION	Item	MATERIAL	Piece weight (kg)	REMARKS	Mod.
1	LVDT SENSOTEC Model DLA "BY132HQ"	114	Stainless Steel	0.285	Stroke Range ±1.0"	
2	PROXIMITY (BAUMER Type IFR 05.26.45/L)	115	AINI 303 (Housing)	0.025		
16	SOCKET HEAD SCREW M5x15 UNI 5931	116	INOX UNI 7323/8	0.055		
12	SOCKET HEAH SCREW M5x20 UNI 5931	117	INOX UNI 7323/8	0.048		
6	SOCKET HEAD SCREW M5x25 UNI 5931	118	INOX UNI 7323/8	0.028		
4	SOCKET HEAD SCREW M5x35 UNI 5931	119	INOX UNI 7323/8	0.025		
7	SOCKET HEAD SCREW M4x15 UNI 5931	120	INOX UNI 7323/8	0.015		
4	WASHER 4.3x9x0.8 UNI 6592	121	INOX UNI 7323/8	0.005		
8	SCREW M2.5x5 UNI 5933 (or UNI 6109)	122	INOX UNI 7323/8	0.005		
4	SCREW M3x60 UNI 5933 (or UNI 6109)	123	INOX UNI 7323/8	0.03		
2	GRUB SCREW M3x5 UNI 5923	124	INOX UNI 7323/8	0.001		
4	WASHER 5.3x9.5x1 UNI 6592	125	INOX UNI 7323/8	0.005		
3	SCREW M2.5x10 UNI 5933 (or UNI 6109)	126	INOX UNI 7323/8	0.015		
32	SCREW M2x6 UNI 6107	127	INOX UNI 7323/8	0.007		
Index		Number of assemblies :		7		
Date		Weight for 1 ass. :		5.25	Kg.	
Name		Weight for all ass. :		36.75+1.004=37.754	Kg.	

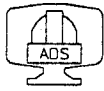
1) Quantity for 1 assembly 2) Quantity for execution  
 sheet 02 of 03  
 FILE 400778 A



	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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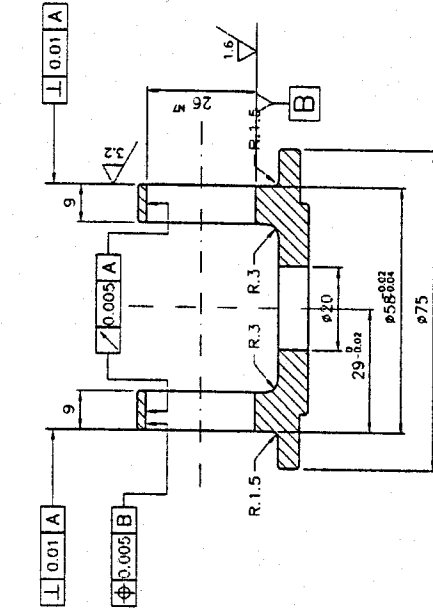
#### **4.2. *Assembly and Workshop Drawings***





# MMT CONVERSION

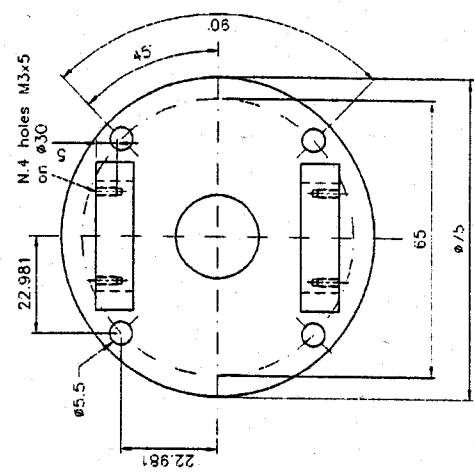
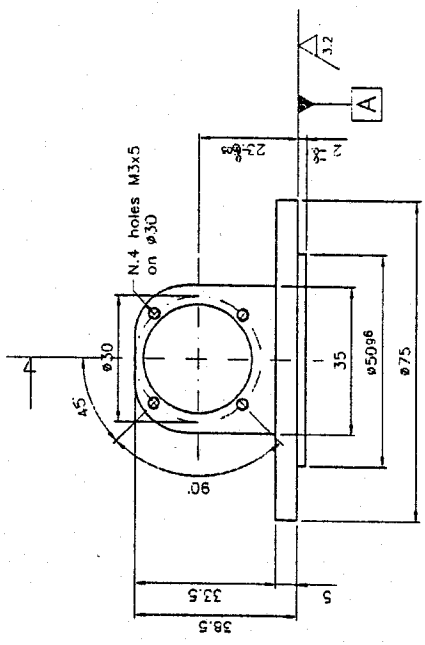
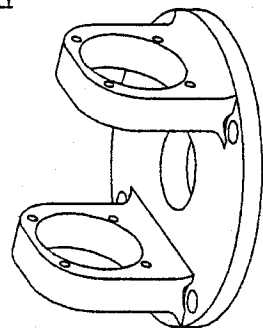
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General tolerance ±0.1

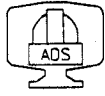


01	14	Fork	ASIS 303	MATERIAL	UNI	0.286	Weight Kg	LIST
PROJECT			6.5 MMT CONVERSION			SCALE		
Hexapod Five Axis Secondary Positioner			MODIFICATION			DATE		
ISSUE	SIGN	DATE	APPROVED			DATE		
D			APPROVED			05		
C			APPROVED			03		
B			APPROVED			2000		
<b>ADS SRL</b> Via S. Felice 23/d - 23900 Lecco - Italy Phone: +39 0341 250331 Fax: +39 0341 250335 e-mail: <a href="mailto:Information@ads-srl.com">Information@ads-srl.com</a> - <a href="http://www.ads-srl.com">http://www.ads-srl.com</a>			<b>Steward Observatory</b> University of Arizona - (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721			SOBST. IL. _____ FIRST. DA. _____ CO. _____ <b>301006 B</b>		
MMT F5 HEXAPOD			Cardan Joint			Item 01		
External Fork								



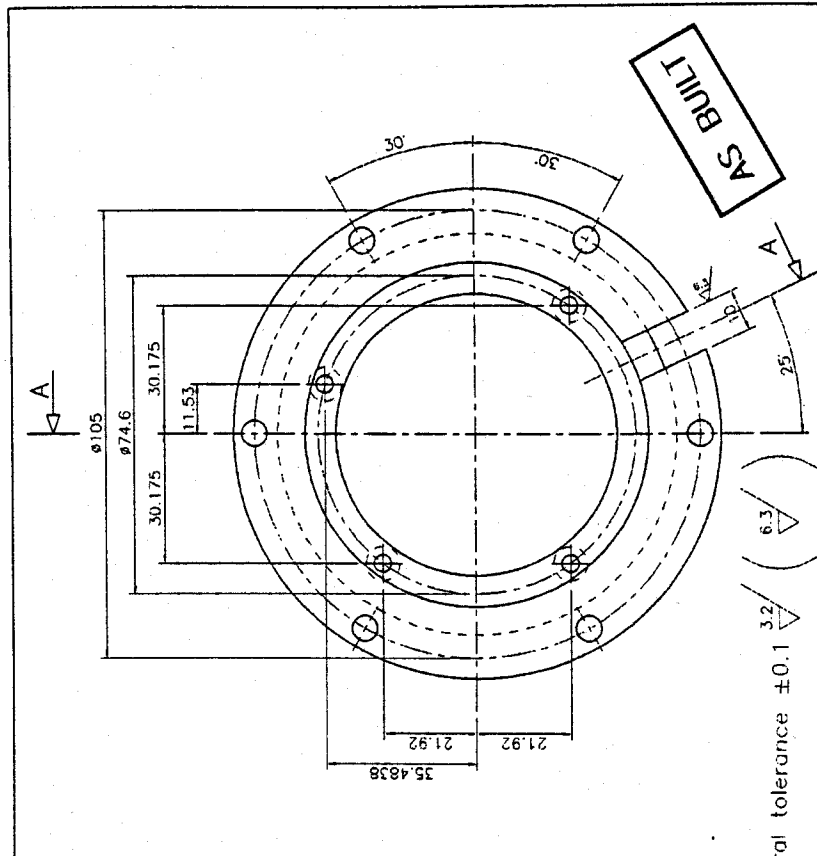






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 Issue : A  
 Date : 27 April - 2001



General tolerance  $\pm 0.1$   $\nabla$  (3.2)  $\nabla$  (6.3)  $\nabla$  (12.5)

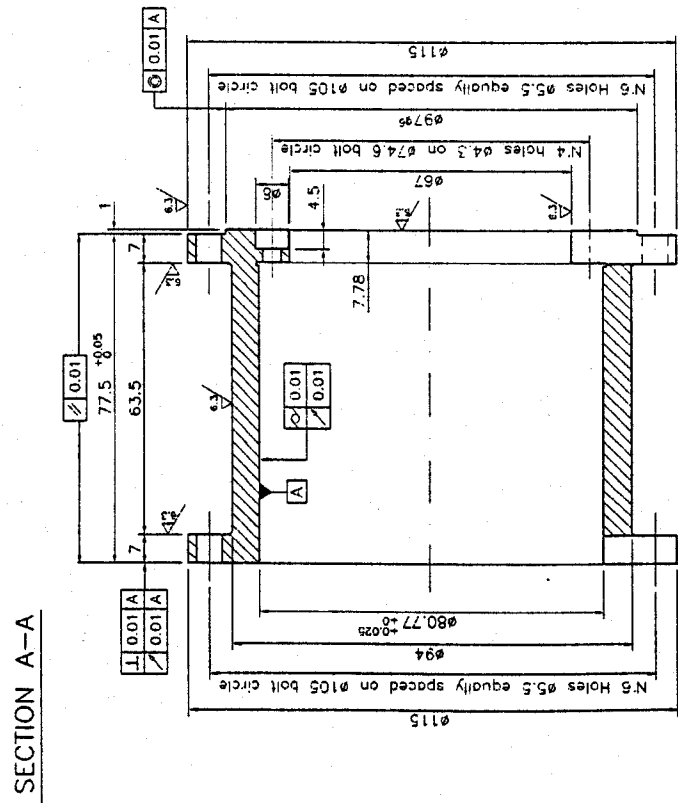
04	7	FRAMELESS MOTOR SUPPORT	ANTICORRODAL	9006/4	0.55
POS.	QTY	DENOMINATION	MATERIAL	UHI	LIST
PROJECT		6.5 MMT CONVERSION			
Hexapod Five Axis Secondary Positioner		MODIFICATION			
ISS.	SIGN.	DATE	CHECKED	APPROVED	DATE
D					03 12 1997
VARIATION					
D					
C					
D					

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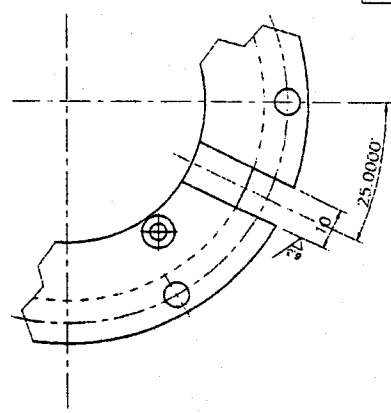
**Steward Observatory**  
 University of Arizona - (520)621-7659  
 933 N Cherry Ave., Tucson, Arizona 85721

MMT F5 HEXAPOD  
 FRAMELESS MOTOR SUPPORT  
 POS. 04

SOFT IL. CO. 300971 B

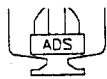


VIEW B



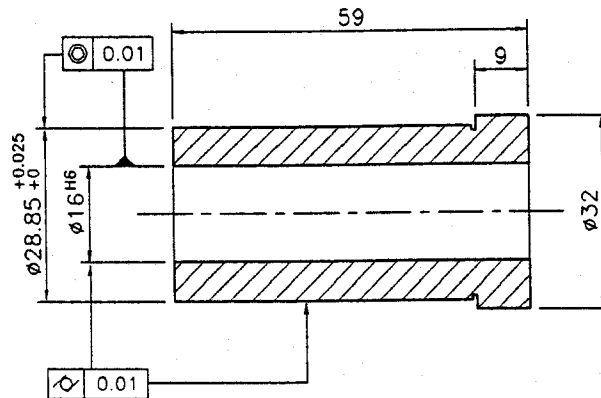
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General tolerance  $\pm 0.1$

3.2

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06	7	BUSHING	AISI 303		0.22	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg.	LIST

PROJECT	6,5 MMT CONVERSION				DRAWN	SCALE
	Hexapod Five Axis Secondary Positioner				ADS-C.Pesca	1:1
VARIATION	ISS.	SIGN.	DATE	MODIFICATION	CHECKED	DATE
	D					
	C					
	B				APPROVED	03 12 1997



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## Steward Observatory

University of Arizona - (520)621-7659  
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MMT F5 HEXAPOD	WORK ORDER	SOST.IL	OBTAINED
BUSHING		SOST.DA	CO.
POS. 06		400734 A	



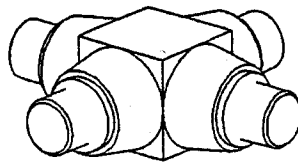
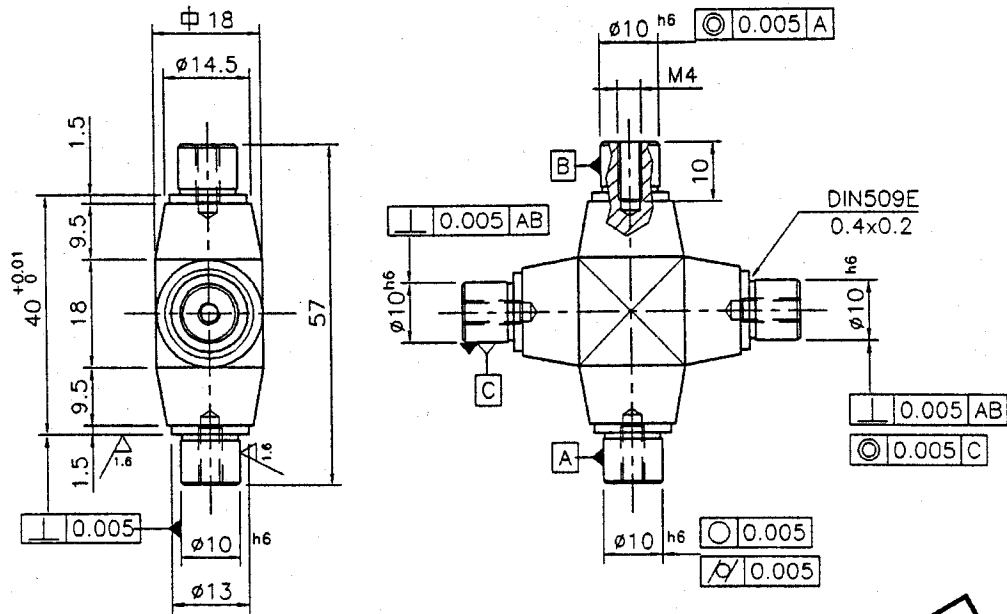


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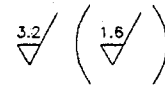
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Issue : A

Date : 27 April - 2001



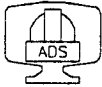
**AS BUILT**



General tolerance  $\pm 0.1$   $\nabla 3.2$

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08	14	Cardan Joint	AISI 303		0.135	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg.	LST
PROJECT		6.5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	1:1
		MODIFICATION			CHECKED	DATE
VARIATION	ISS.	SIGN.	DATE		APPROVED	16
	D					06
	C					
	B					1999
		<b>ADS S.R.L.</b>				
		C.so Promessi Sposi 23/d - 23900 Lecco Phone +39 0341 259231 - Fax +39 0341 259235 e-mail: information@ads-int.com - http://www.enet.it/ads		Steward Observatory University of Arizona - (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD		TUBE ORDER	SOST.IL		OBTAINED	
Cardan Joint			SOST.DA		CO.	
Cross piece			400774 A			
Item 08						

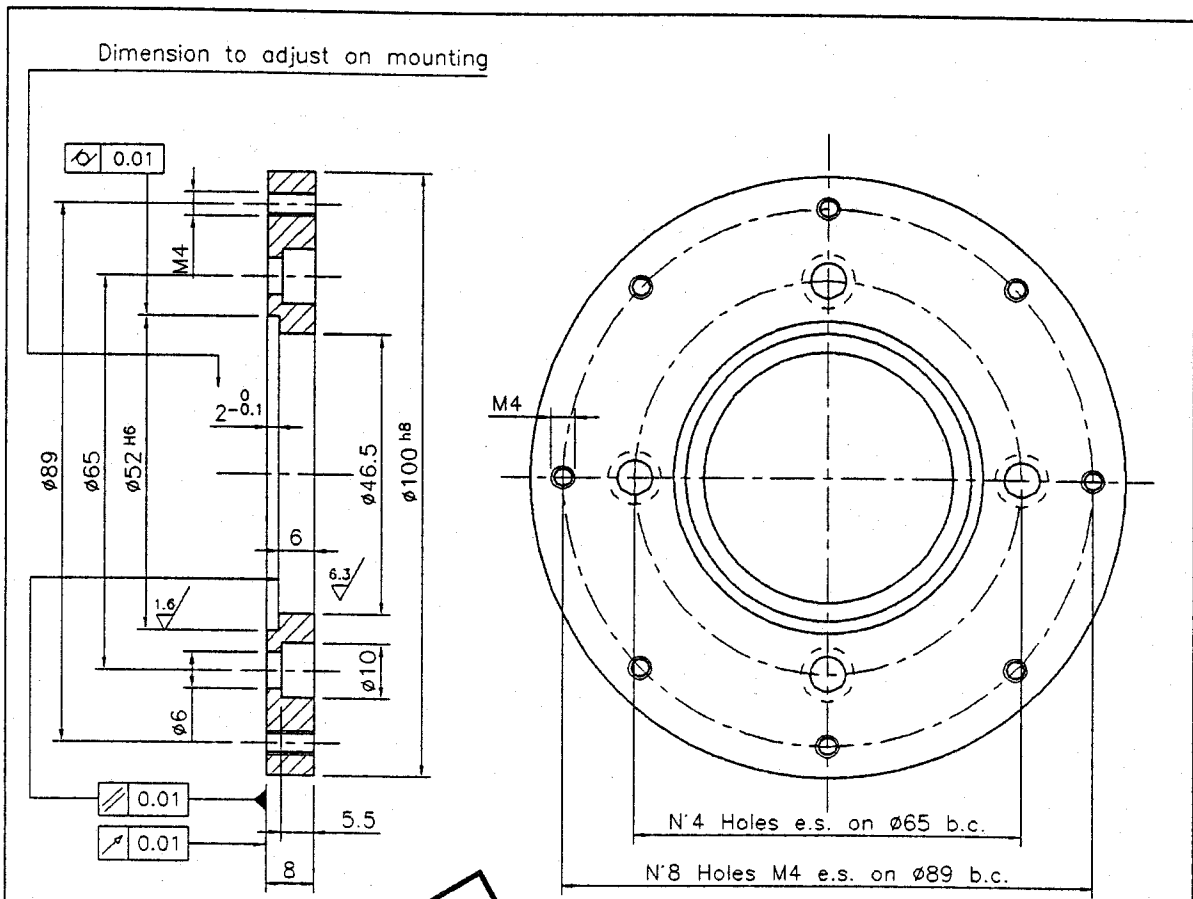


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Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



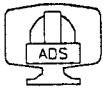
**AS BUILT**

General tolerance  $\pm 0.1$   $\nabla 3.2$  ( $\nabla 1.6$   $\nabla 6.3$ )

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09	7	COVER	AISI 303		0.37	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	1:1
ISS.	SIGN.	DATE	MODIFICATION			
D						
C						
B	A.E.	05-05-00	General Revision			
VARIATION				CHECKED	APPROVED	DATE
						05 05 2000
		<b>ADS S.R.L.</b> C.so Promessi Sposi 23/d - 23900 Lecco Phone +39 0341 259231 - Fax +39 0341 259235 e-mail: information@ads-int.com - http://www.enet.it/ads		 <b>Steward Observatory</b> University of Arizona - (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD COVER			WORK ORDER	SOST.IL	OBTAINED	
Item 09				SOST.DA	CO.	
			400736 B			



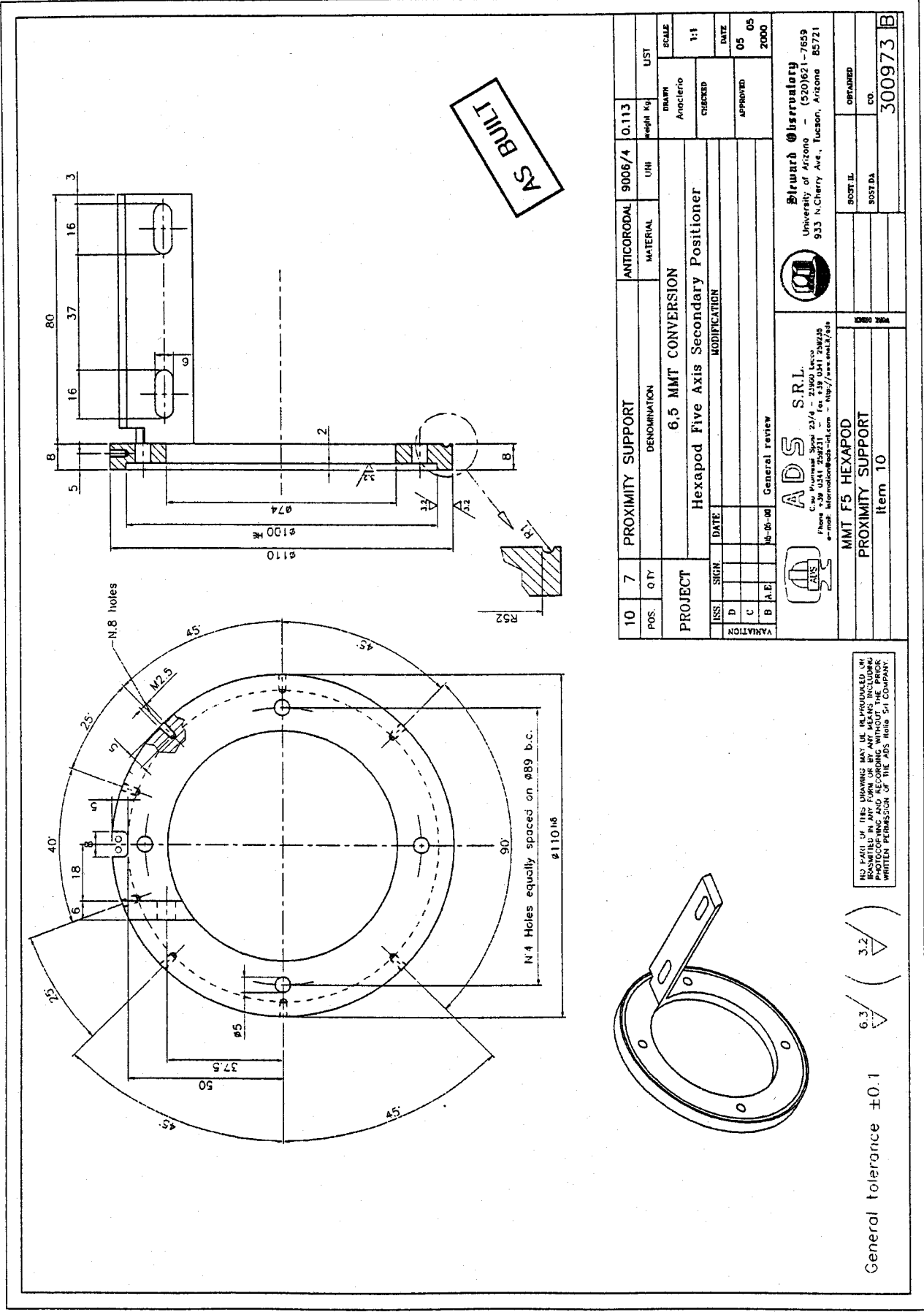


# MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



10	7	PROXIMITY SUPPORT	ANTICORODAL	9006/4	0.113	LIST
POS.	QTY	DENOMINATION	MATERIAL	UHM	weight kg	SCALE
		6.5 MMT CONVERSION				1:1
PROJECT		Hexapod Five Axis Secondary Positioner				DATE
		MODIFICATION				05 05
VARIATION		ISS	SIGN	DATE	APPROVED	2000
D						
C						
B	A.E.	General review				

**Steward Observatory**  
 University of Arizona - (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

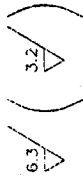
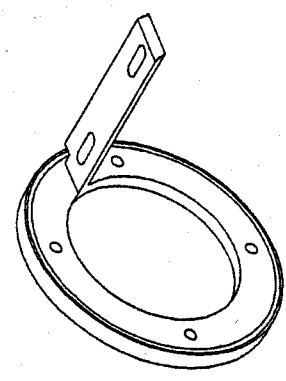


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SCOTT IL  
 SCST DA  
 CO  
 300973 B

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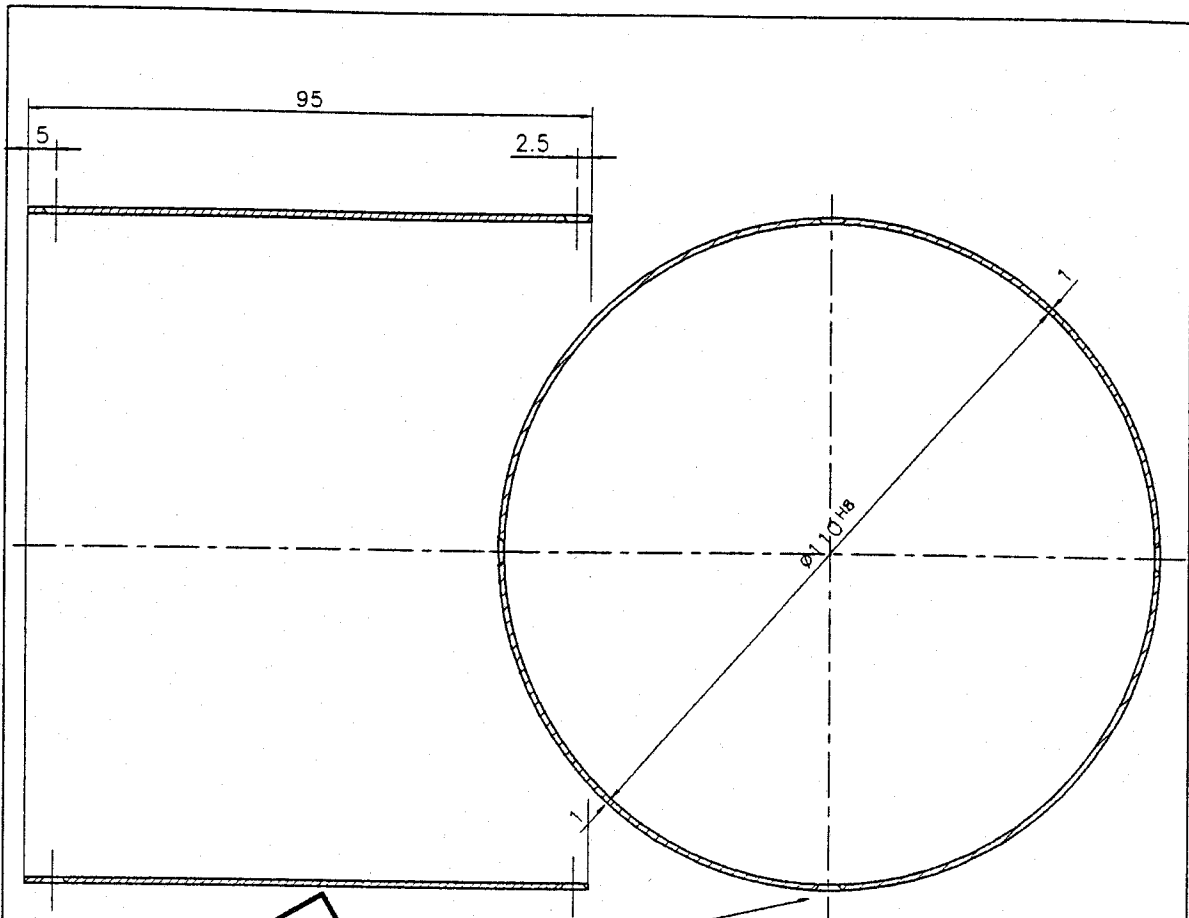
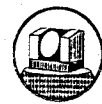


General tolerance ±0.1



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



**AS BUILT**

N°4+4 Holes ø3 countersink 90° equally spaced

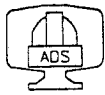
General tolerance  $\pm 0.1$

6.3

NO PART OF THIS DRAWING MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS INCLUDING PHOTOCOPYING AND RECORDING WITHOUT THE PRIOR WRITTEN PERMISSION OF THE ADS Italia Srl COMPANY.

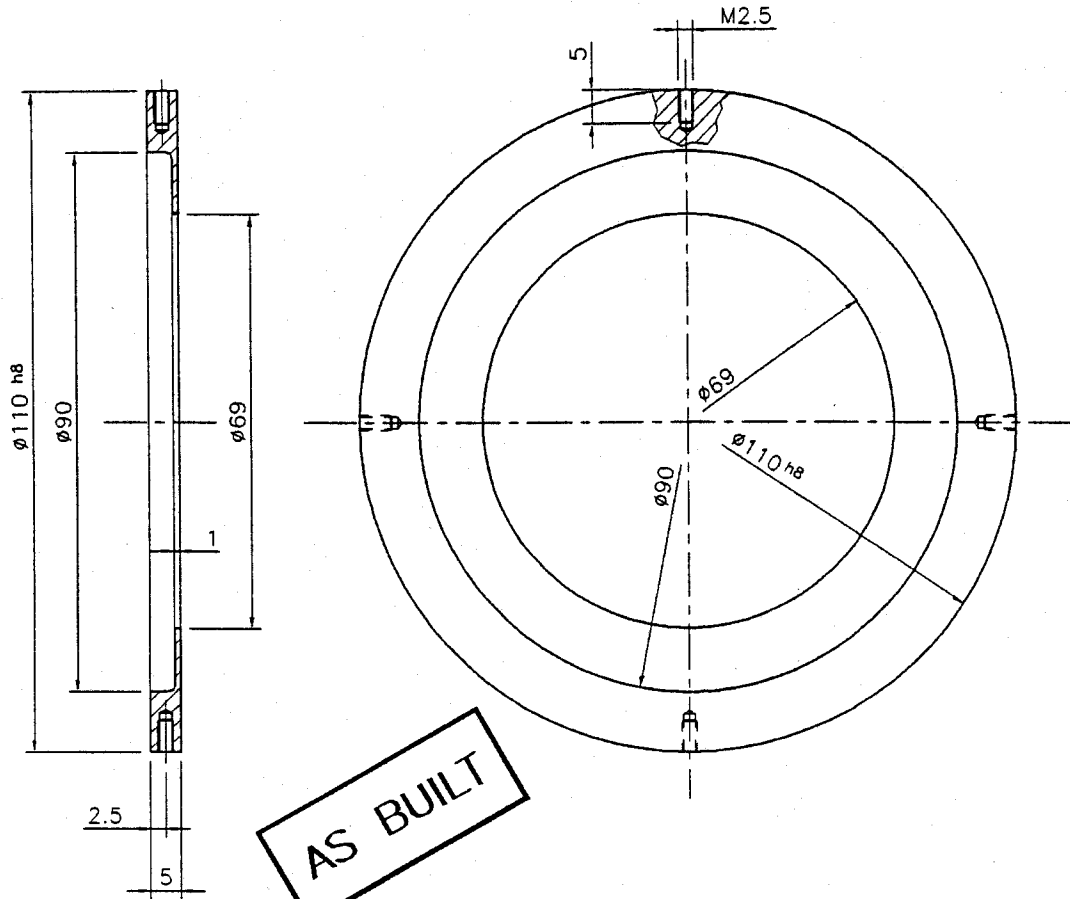
11	7	PROTECTION	ANTICORODAL	9006/4	0.08	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	1:1
		MODIFICATION			CHECKED	DATE
VARIATION	D				APPROVED	06 05 2000
	C					
	B	A.E.	05-05-00	Change total lenght to 95mm		

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		PROTECTION	
		POS. 11	
		SOST.IL	OBTAINED
		SOST.DA	CO.
		400737 B	



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001

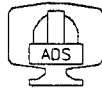


**AS BUILT**

General tolerance  $\pm 0.1$   $\nabla 3.2$

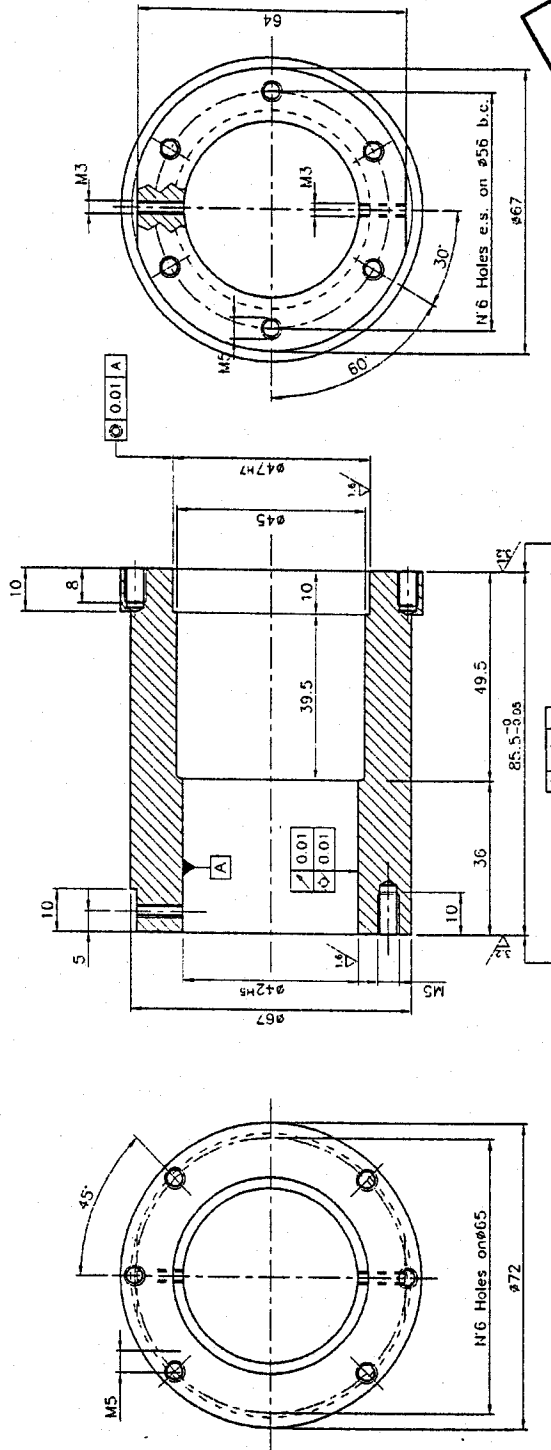
NO PART OF THIS DRAWING MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS INCLUDING PHOTOCOPYING AND RECORDING WITHOUT THE PRIOR WRITTEN PERMISSION OF THE ADS Italia Srl COMPANY.

12	7	PROTECTION RING	ANTICORODAL	9006/4	0.05	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg.	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			ADS-C.Pesco	1:1
		MODIFICATION			CHECKED	DATE
ISS.	SIGN.	DATE				
VARIATION	D					
	C					
	B					
					APPROVED	03 05 2000
		<b>ADS S.R.L.</b>				
		C.so Promessi Sposi 23/d - 23900 Lecco		Steward Observatory		
		Phone +39 0341 259231 - Fax +39 0341 259235		University of Arizona - (520)621-7659		
		e-mail: information@ads-int.com - http://www.enet.it/ads		933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD				SOST.IL		OBTAINED
PROTECTION RING				SOST.DA		CO.
POS. 12				400738 A		



# MMT CONVERSION

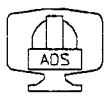
Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



AS BUILT

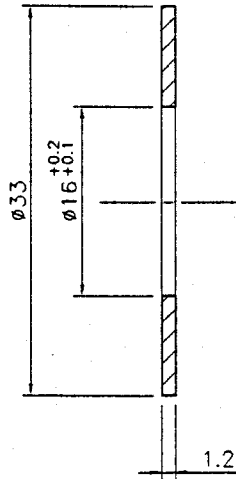
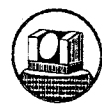
1.3	7	SATELLITE ROLLER SCREW SUPPORT	ANTICORRODAL	9006/4	0.45	LIST
PROJECT		6.5 MMT CONVERSION		DRAWN		SCALE
ISS. SIGN		DATE		CHECKED		1:1
D				APPROVED		DATE
C						05 05
B						2000
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VARIATION		10-05-04		Change total length		
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# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



**AS BUILT**

General tolerance  $\pm 0.1$   $\sqrt{3.2}$

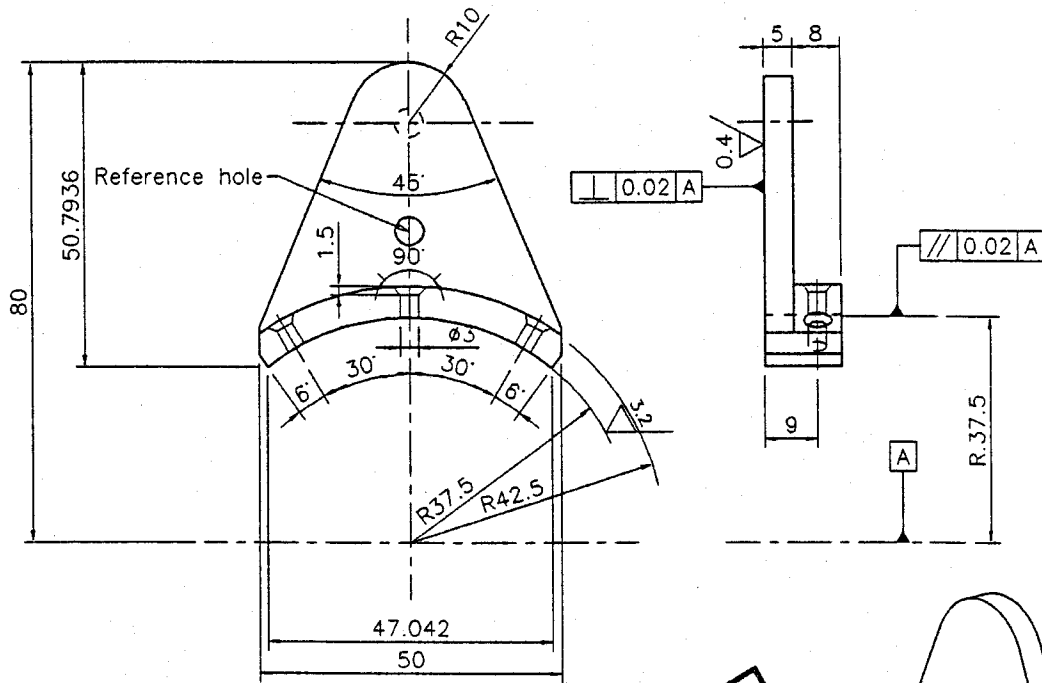
NO PART OF THIS DRAWING MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS INCLUDING PHOTOCOPYING AND RECORDING WITHOUT THE PRIOR WRITTEN PERMISSION OF THE ADS Srl COMPANY.

15	14	RING	AISI 303		0.005	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			ADS-C.Pesca	2:1
VARIATION		MODIFICATION			CHECKED	DATE
D						
C						
B					APPROVED	03 12 1997
		<b>ADS S.R.L.</b>				
		C.so Promessi Sposi 23/d - 23900 Lecco		Steward Observatory		
		Phone +39 0341 259231 - Fax +39 0341 259235		University of Arizona - (520)621-7659		
		e-mail: information@ads-int.com - http://www.enel.it/ads		933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD		WORK ORDER	SOST.IL		OBTAINED	
RING			SOST.DA		CD.	
POS. 15			400739 A			

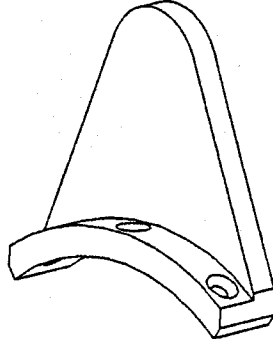


# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



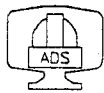
**AS BUILT**



General tolerance  $\pm 0.1$   $\nabla 6.3$  /  $\left( \nabla 0.4 \quad \nabla 3.2 \right)$

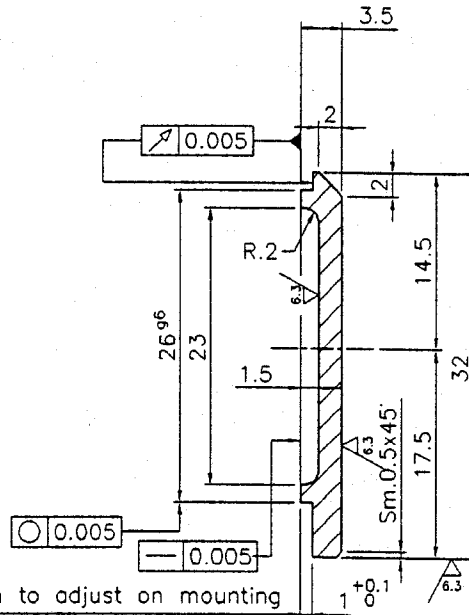
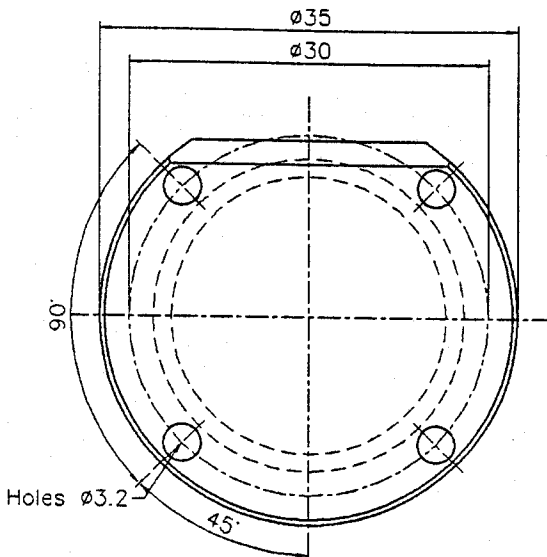
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16	7	STRIKER PLATE	ISI 303	0.07	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg LIST
PROJECT		6,5 MMT CONVERSION		DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner		Anaclerio	1:1
		MODIFICATION		CHECKED	DATE
ISS.	SIGN.	DATE		APPROVED	12 05 2000
VARIATION	C				
	B				
	A				
<b>ADS S.R.L.</b> C.so Promessi Sposi 23/d - 23900 Lecco Phone +39 0341 259231 - Fax +39 0341 259235 e-mail: information@ads-int.com - http://www.enet.it/ads			<b>Steward Observatory</b> University of Arizona - (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD			SOST.II	OBTAINED	
Striker plate			SOST.DA	CO.	
Item - 16			400775 B		

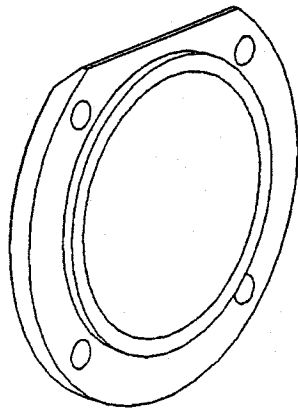


# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



Dimension to adjust on mounting



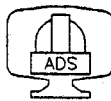
**AS BUILT**

3.2 / ( 1.6 )

General tolerance  $\pm 0.1$

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17	56	Cover	AISI 303		0.017	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg.	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	1:1
		MODIFICATION			CHECKED	DATE
ISS.	SIGN.	DATE				
D						
C						
B						
					APPROVED	12 05 2000



**ADS S.R.L.**

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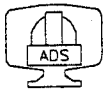


**Steward Observatory**

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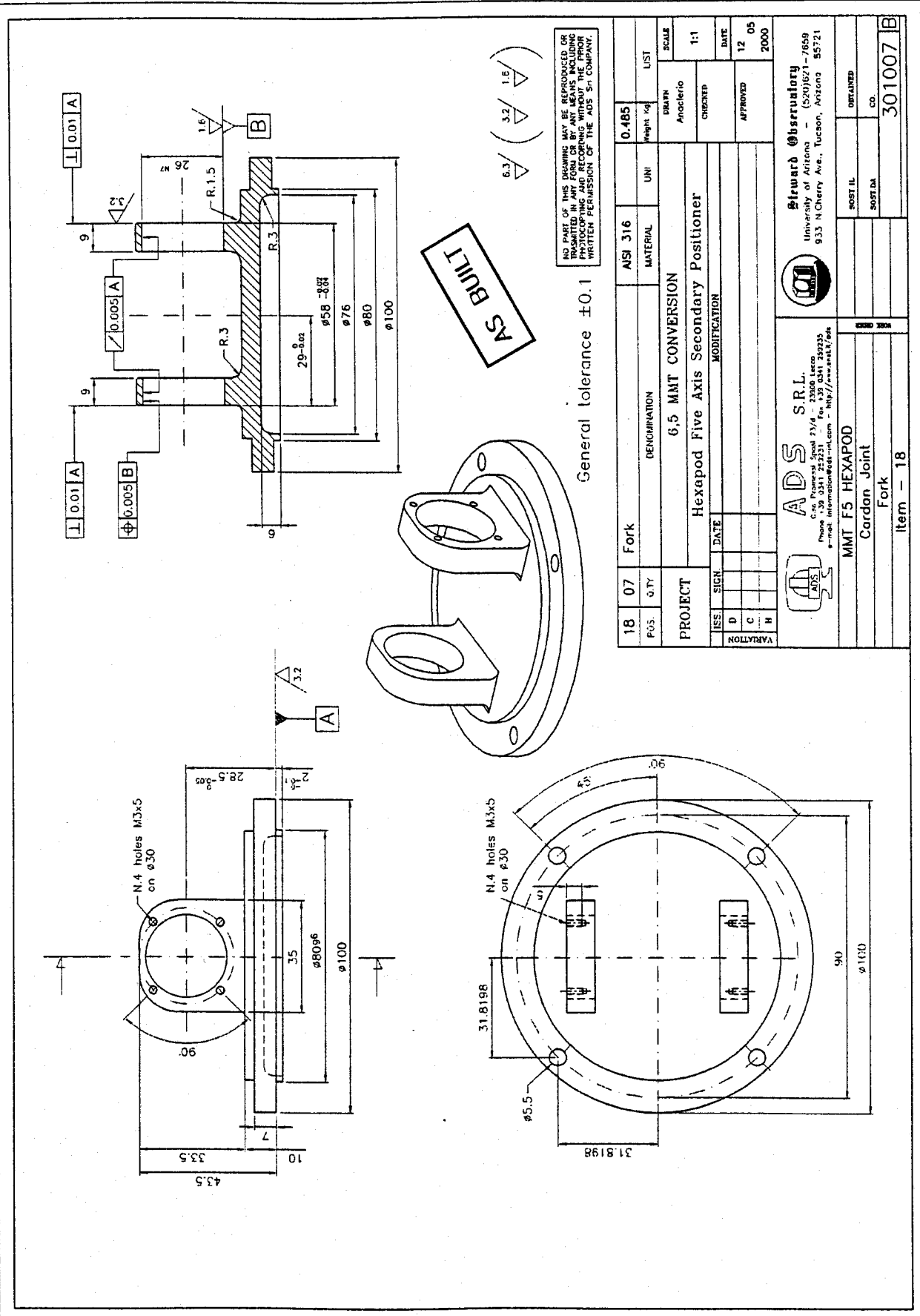
MMT F5 HEXAPOD		WORK ORDER	SOST.IL	OBTAINED
Linear Actuator			SOST.DA	CO.
Cover			400776 B	
Item - 17				





# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



General tolerance  $\pm 0.1$

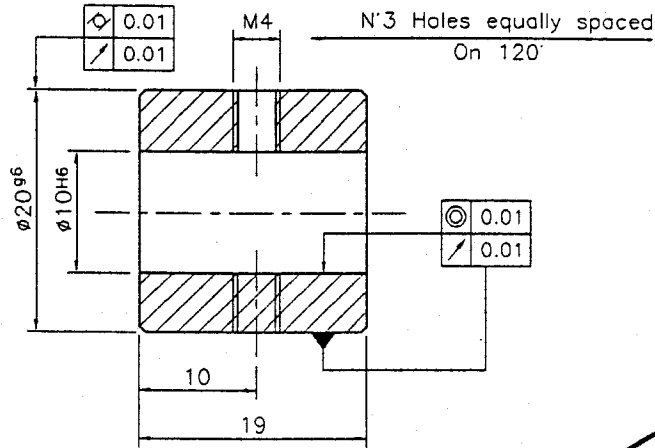
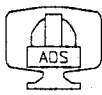
18	07	Fork	ASI 316	MATERIAL	UNI	0.485	Weight kg	LIST
PROJECT		6.5 MMT CONVERSION		Hexapod Five Axis Secondary Positioner		SCALE 1:1		
ISS. SIGN.		DATE		MODIFICATION		CHECKED APPROVED		
D						DATE 12 05 2000		
C								
H								
VARIATION								

**ADS S.R.L.**  
 C.so Promessi Sposi 23/d - 23900 Lecco - Italy  
 Phone: +39 0342 502235  
 e-mail: information@ads-rl.com - http://www.ads-rl.com

**Steward Observatory**  
 University of Arizona - (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

MMT F5 HEXAPOD  
 Cardan Joint  
 Fork  
 Item - 18

POST IL CO. 301007 B



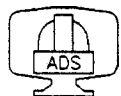
**AS BUILT**

General tolerance  $\pm 0.1$



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19	7	BUSHING	AISI 303	0.03		
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg. LIST	
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	2:1
		MODIFICATION			CHECKED	DATE
VARIATION	ISS.	SIGN.	DATE		APPROVED	12 05 2000
	D					
	C					
	B					

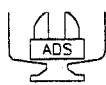


**ADS S.R.L.**  
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 Phone +39 0341 259231 - Fax +39 0341 259235  
 e-mail: information@ads-int.com - http://www.enet.it/ads



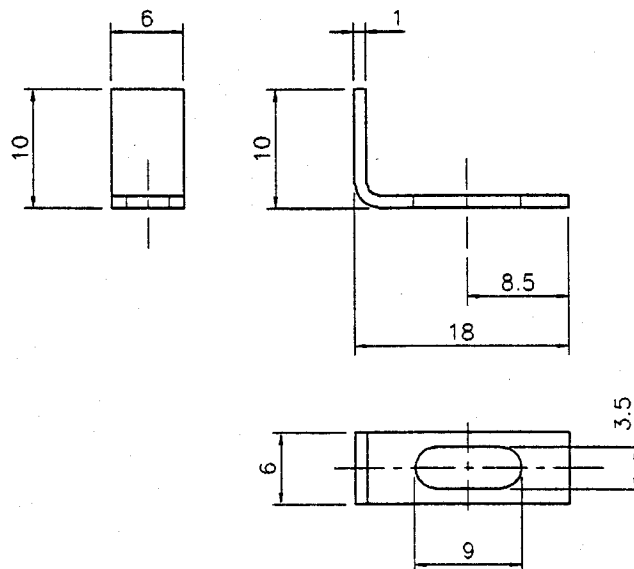
**Steward Observatory**  
 University of Arizona - (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

MMT F5 HEXAPOD		WORK ORDER	SOST.IL	OBTAINED
BUSHING			SOST.DA	CC.
POS. 19			400743 A	



# MMT CONVERSION

DOC.NO : HD-DF-AD-01001  
Issue : A  
Date : 27 April - 2001



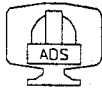
**AS BUILT**

General tolerance  $\pm 0.1$



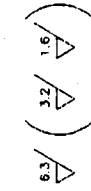
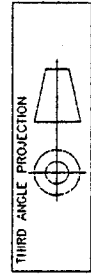
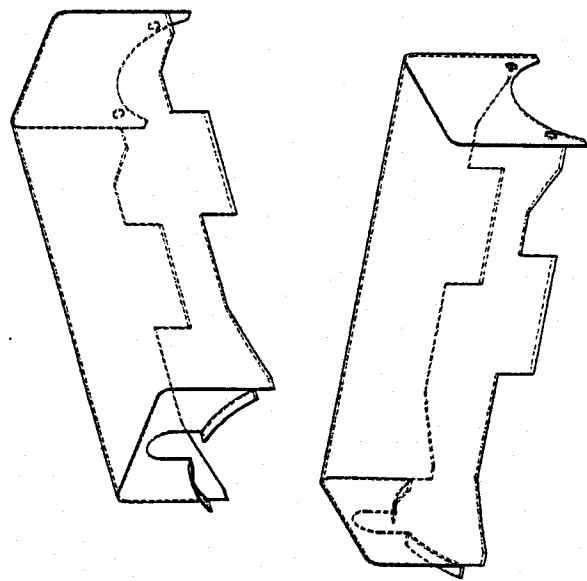
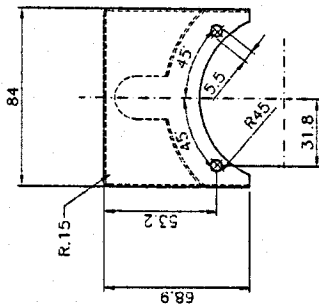
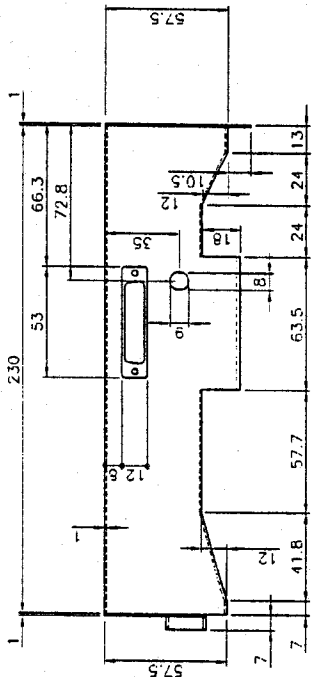
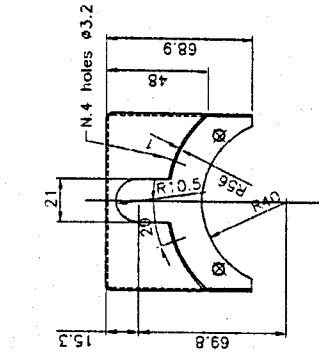
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20	7	PLAQUE PROXIMITY	AISI 303		0.001	
POS.	Q.TY	DENOMINATION	MATERIAL	UNI	Weight Kg	LIST
PROJECT		6,5 MMT CONVERSION			DRAWN	SCALE
		Hexapod Five Axis Secondary Positioner			Anaclerio	2:1
		MODIFICATION			CHECKED	DATE
VARIATION	ISS.	SIGN.	DATE		APPROVED	12 05 2000
	D					
	C					
<b>ADS S.R.L.</b> C.so Promessi Sposi 23/d - 23900 Lecco Phone +39 0341 259231 - Fax +39 0341 259235 e-mail: information@ads-int.com - http://www.enet.it/ads			<b>Steward Observatory</b> University of Arizona - (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721			
MMT F5 HEXAPOD			WORK ORDER	SOST.IL	OBTAINED	
PLAQUE PROXIMITY				SOST.DA	CO.	
Item - 20				400744   A		



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



**AS BUILT**

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General tolerance  $\pm 0.1$

21	07	Cable Protection	ASIS 303	MATERIAL	UHI	Weight Kg	0.405	LIST
PROJECT		6.5 MMT CONVERSION		Hexapod Five Axis Secondary Positioner		SCALE	1:2	
ISS. SIGN		DATE		MODIFICATION		CHECKED	APPROVED	DATE
D		C		R		15	05	2000
VARIATION						<b>ADS S.R.L.</b> Via S. Maria 5239 21/A Phone +39 0441 204231 Fax +39 0441 204235 e-mail: inform@ads-rl.com - http://www.ads-rl.com <b>Steward Observatory</b> University of Arizona (520)621-7659 933 N.Cherry Ave., Tucson, Arizona 85721		
MMT F5 HEXAPOD		Cable Protection		SIST. ILL.		OBTAINED		301009
Item - 21								







## MMT CONVERSION

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Issue : A  
Date : 27 April - 2001



### 5. HEXAPOD PLATFORMS

#### 5.1. *Parts and material list*









## MMT CONVERSION

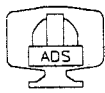
Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001

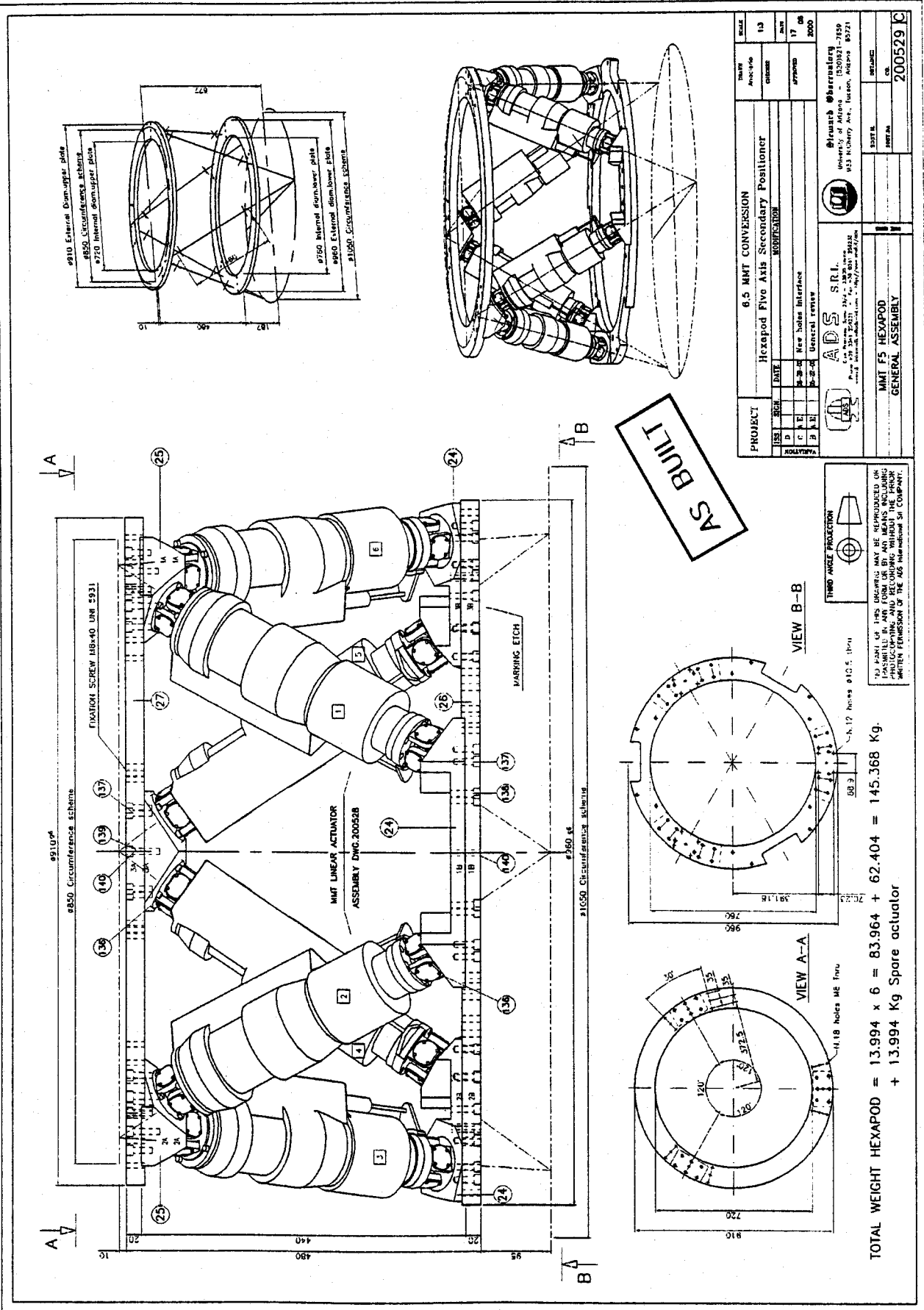


### **5.2. Assembly and Workshop Drawings**



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
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 Date : 27 April - 2001



PROJECT		SCALE	
Hexapod Five Axis Secondary Positioner		DATE	1:3
MODIFICATION		ISSUE	17
		DATE	2000
		APPROVED	

PROJECT	6.5 MMT CONVERSION
ISSUE	17
DATE	2000
APPROVED	
DESIGNED BY	ADS S.R.I.
CHECKED BY	ADS S.R.I.
DRAWN BY	ADS S.R.I.
DATE	2000
APPROVED	

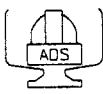
PROJECT	MMT F5 HEXAPOD
ISSUE	17
DATE	2000
APPROVED	

THIRD ANGLE PROJECTION

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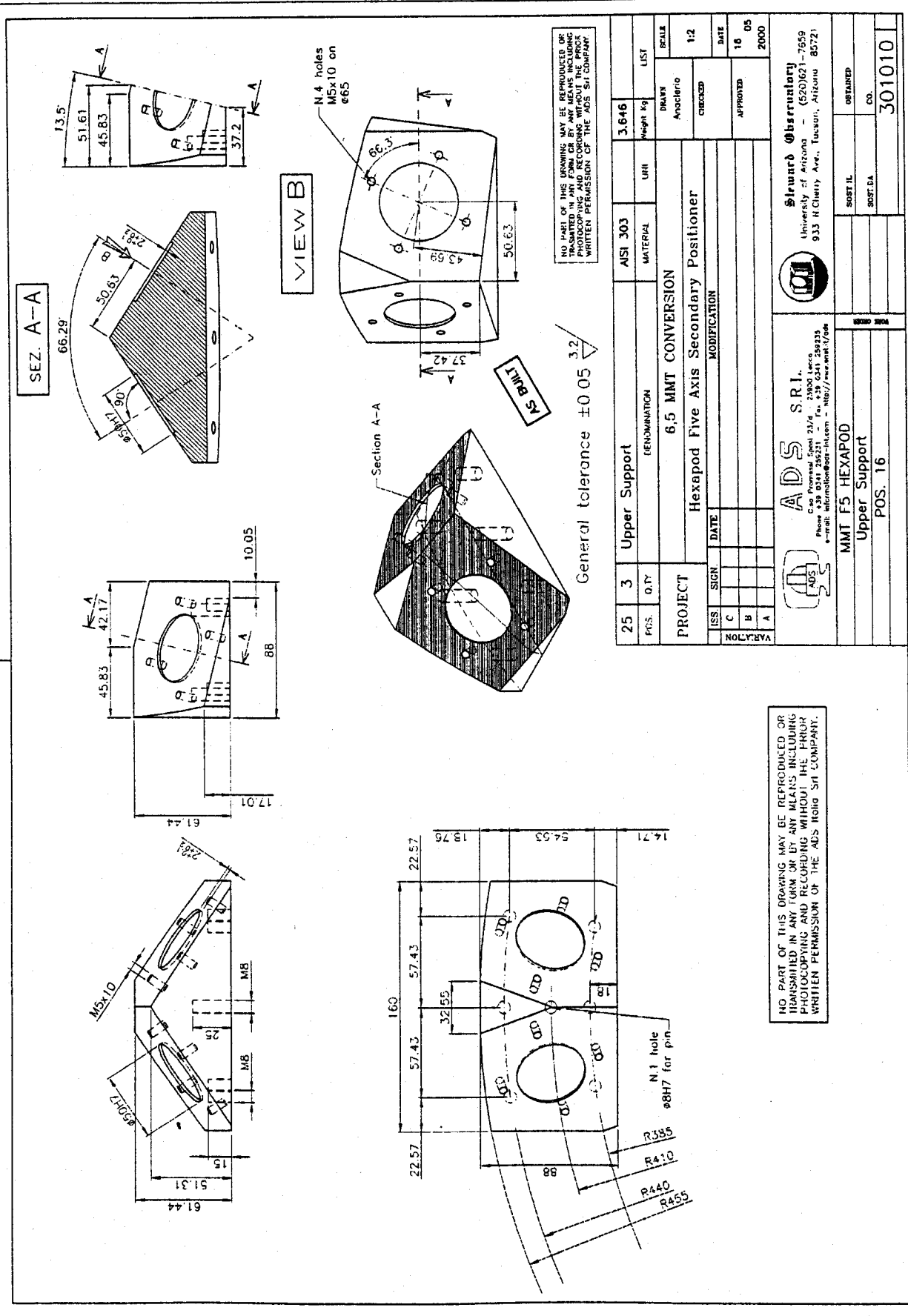
TOTAL WEIGHT HEXAPOD = 13.994 x 6 = 83.964 + 62.404 = 145.368 Kg.  
 + 13.994 Kg Spare actuator





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25	3	Upper Support	3.646	Weight Kg	LIST
POC.	D.T.Y	DESIGNATION	URI	MATERIAL	SCALE
PROJECT		6,5 MMT CONVERSION		Hexapod	1:2
ISS.		DATE	CHECKED	APPROVED	DATE
C					10 05
B					2000
A					
MODIFICATION					
Hexapod Five Axis Secondary Positioner					

**ADS S.R.L.**  
 Via S. Maria 31/2 - 20124 Milano, Italy  
 Phone +39 02 41 25221 - Fax +39 02 41 25225  
 e-mail: [information@ads-int.com](mailto:information@ads-int.com) - <http://www.ads-int.com>

**Steward Observatory**  
 University of Arizona - (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

MMT F5 HEXAPOD  
 Upper Support  
 POS. 16

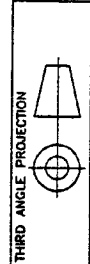
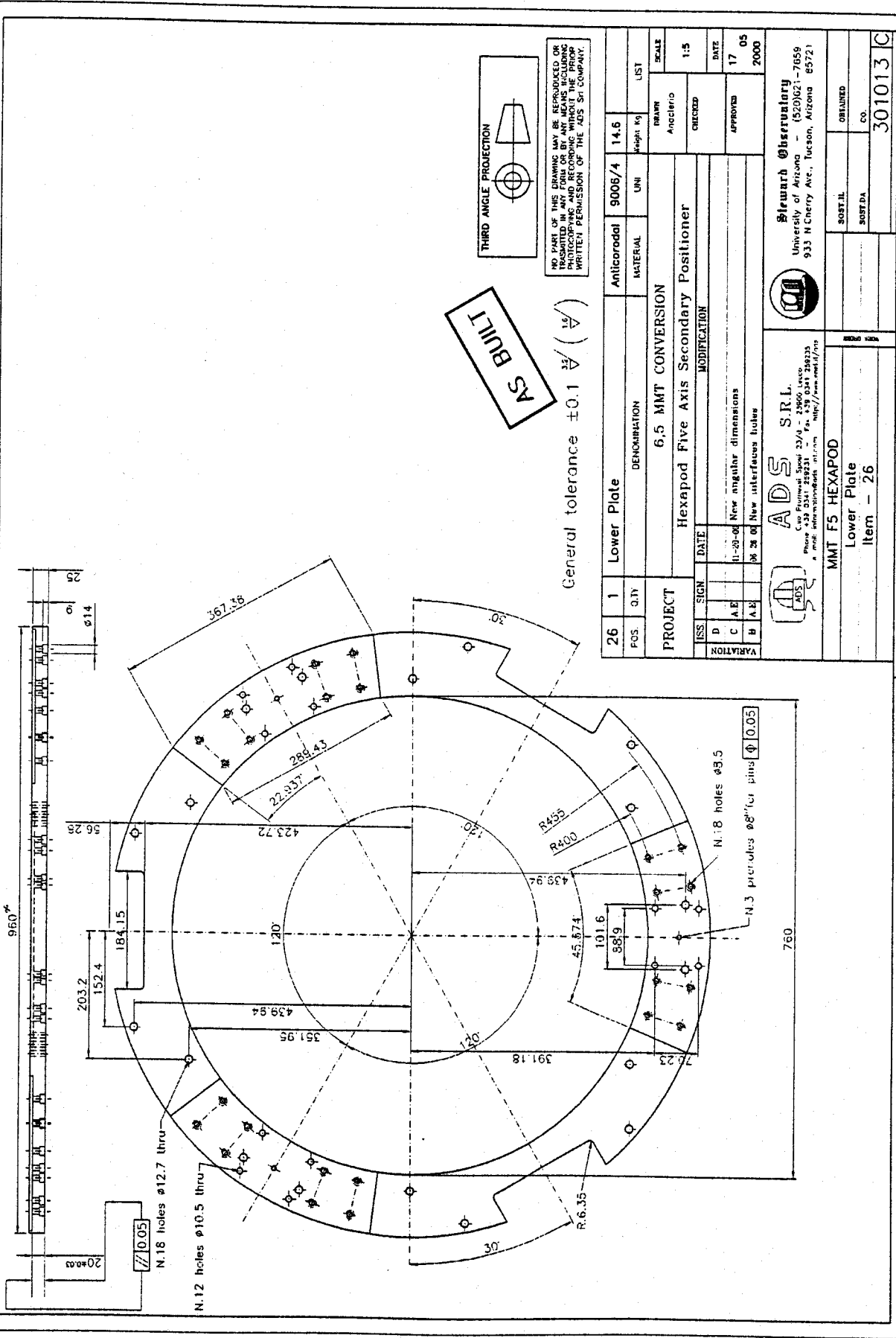
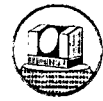
STANDARD  
 CO. 301010

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 Issue : A  
 Date : 27 April - 2001



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**AS BUILT**

General tolerance  $\pm 0.1$   $\sqrt{A}$  (15)

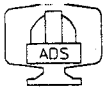
26	1	Lower Plate	Anticorodal	9006/4	UNI	14.6	LIST
POS.	QTY	DENOMINATION	MATERIAL	UNI	UNIT	WEIGHT KG	LIST
PROJECT							
Hexapod Five Axis Secondary Positioner							
MODIFICATION							
ISS.	SIGN.	DATE					
D		11-29-01	New angular dimensions				
C	A.E.	06-28-01	New interfaces holes				
B	A.E.						
VARIATION							
SCALE 1:5							
DATE 17 05							
APPROVED 2000							

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 e-mail: info@ads-int.com http://www.ads-int.com

**Steward Observatory**  
 University of Arizona (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

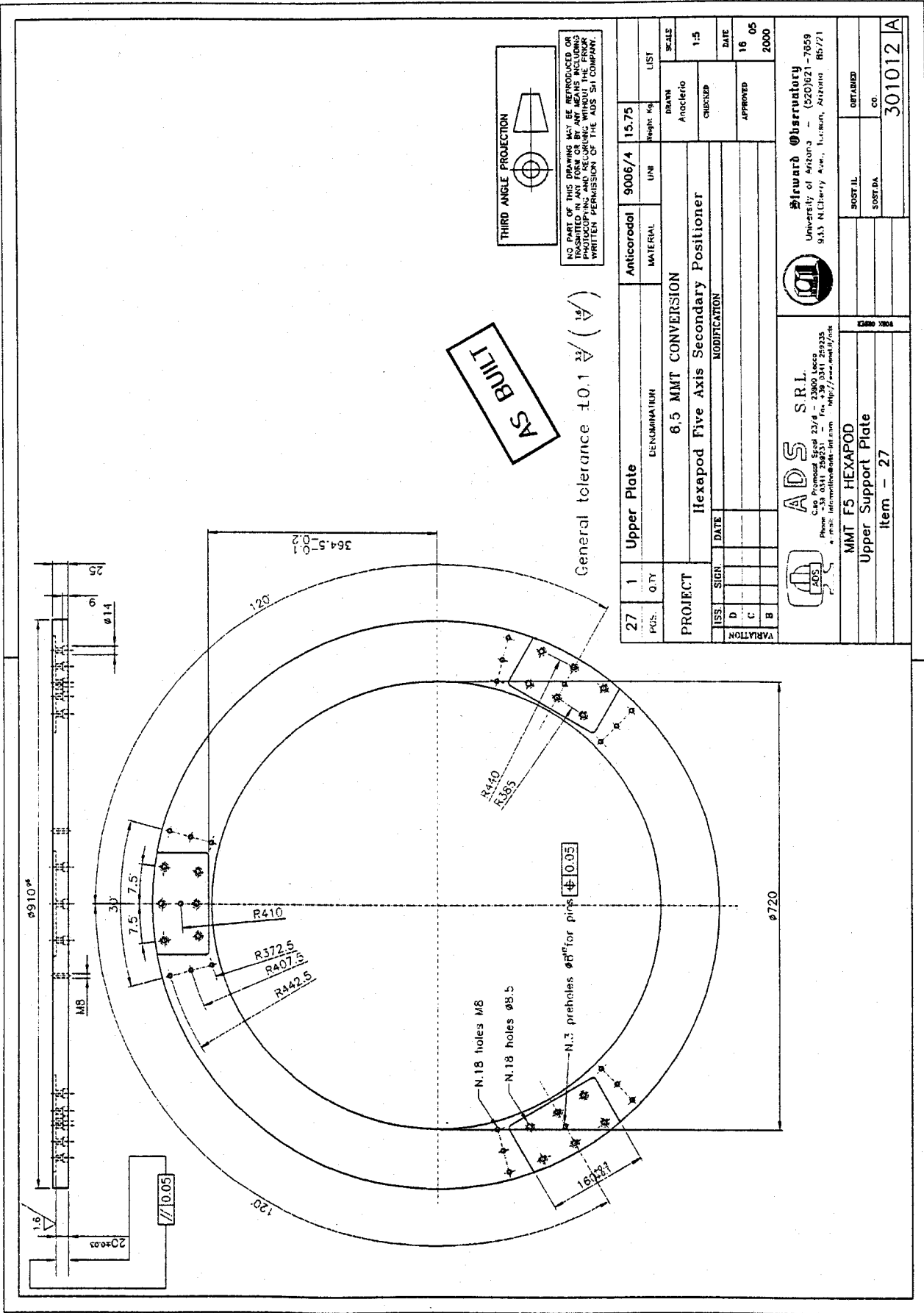
MMT F5 HEXAPOD  
 Lower Plate  
 Item - 26

SIST.IL. OBTAINED  
 SIST.DA. CO.  
 301013 C



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001



27	1	Upper Plate	Anticorodal	9006/4	15.75
PQS.		QTY.	MATERIAL	UNI	Weight Kg.
LIST					
SCALE					
DRAWN					
Anticorodal					
CHECKED					
DATE					
APPROVED					
16 05					
2000					

**PROJECT**  
6.5 MMT CONVERSION  
Hexapod Five Axis Secondary Positioner

**MODIFICATION**

ISS	SIGN	DATE
D		
C		
B		

**ADDITIONAL INFORMATION**

Steward Observatory  
 University of Arizona (520)621-7659  
 933 N.Cherry Ave., Tucson, Arizona 85721

ADS S.R.L.  
 Via Promessi Sposi 23/d - 23900 Lecco  
 Phone +39 0341 29622-34 Fax +39 0341 291335  
 e-mail: info@ads-international.com http://www.ads-int.com

MMT F5 HEXAPOD  
 Upper Support Plate  
 Item - 27

SUST ILL  
 SUST DA

OBTAINED  
 CO.

301012 A

## 6. COMPONENTS SELECTIONS AND MANUFACTURING DATA SHEETS

### 6.1. *Roller screw*

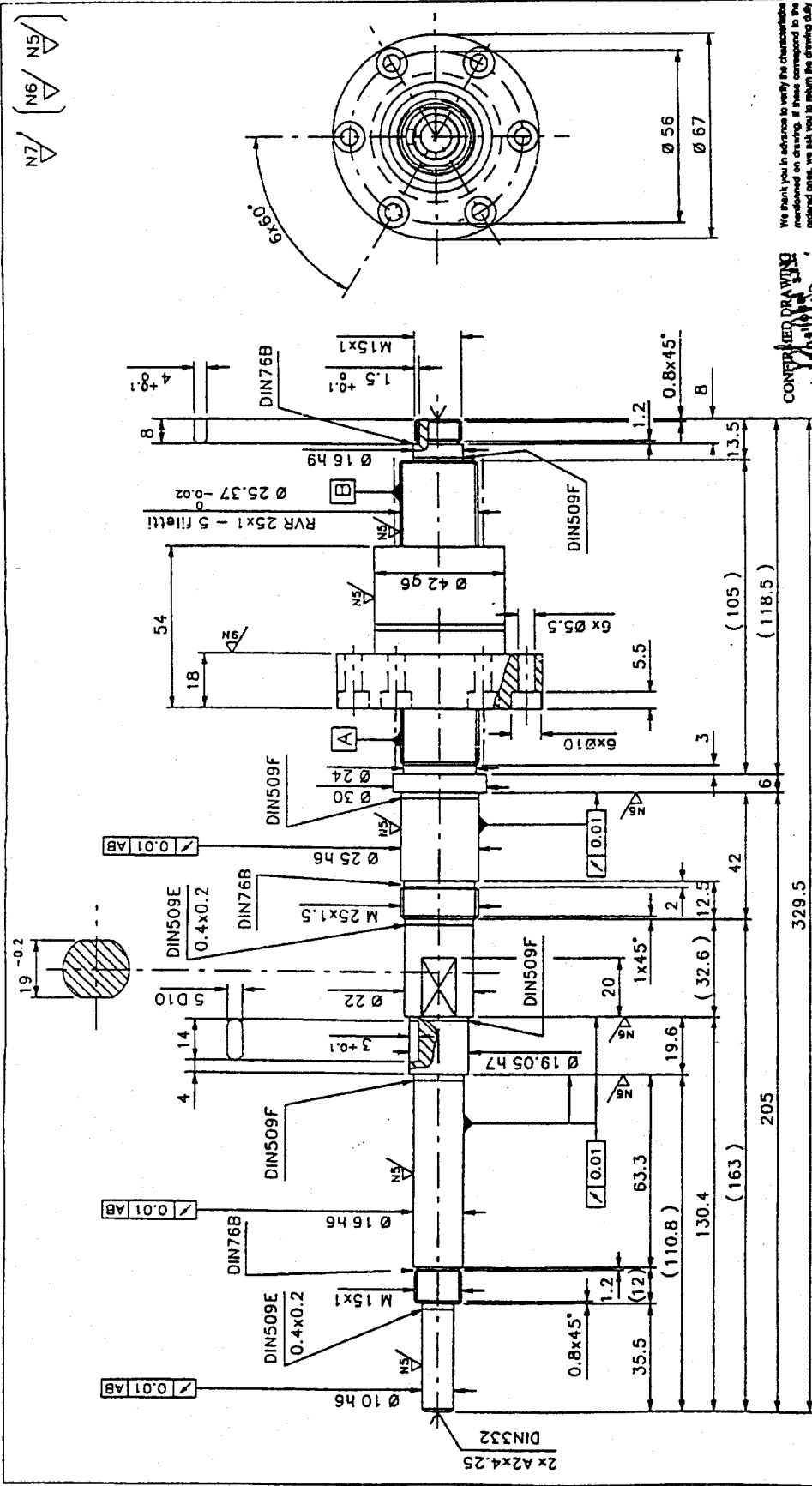
Manufacturer	ROLLVIS (Swiss)
Screw Diameter	25 mm
Screw Lead	1 mm
Number of Thread Starts	1
Lead Error	Tolerance class G1 : $V_{300p}=6\mu\text{m}$ , $e_p=6\mu\text{m}$
Type of screw	Satellite roller screw with recycling rollers
Nut Type	Split nut preloaded flanged at one end
Nut Preload	3500 N
Direct Efficiency (lifting)	$\eta_1=0.71$
Indirect Efficiency (lowering)	$\eta_2=0.61$
Static Load Capacity	18.9 KN
Dynamic Load Capacity	12.2 KN
Nut Axial Stiffness	605 N/ $\mu\text{m}$
Material	Stainless steel X46Cr13
Lubrication	KLUBER ISOFLEX TOPAS NCA 52 (Rollvis roller screw standard grease)





# MMT CONVERSION

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We thank you in advance to verify the characteristics mentioned on drawing. If these correspond to the ordered ones, we ask you to return the drawing duly signed.  
 Without answer, from your side within 10 days, we consider it as accepted and will carry on the fabrication.

CONFIRMED DRAWING  
 ADS in *[Signature]*  
 Date: 4/10/2000

Gewinderschraubtriebe Technische Daten Nenn Durchmesser do 25 mm Tragzahl dynamisch C 19,20 KN Tragzahl statisch Co 35,00 KN Steigungsrichtung Right Muttervorspannung (werkseitig) 350e N Steigungsnutenhöhe 0,008 mm / 300 mm Genauigkeitsklasse / Kategorie G1 Anzahl Rollen 12 Schmierung ISO FLEX TOPAS NCA 52 Kunden-Zeichn.-Nr. 300966 B Allgemeine Toleranzen DIN 7168 m Konte gebrochen		Besetzung President 22-09-00 Canova Expert 22-09-00 Davillaz Anweisung Zeichnung 600142/1 Zeichen
Gewinderschraubtrieb RVR260/25.1.R1.600142		Zeichnung 600142/1
Rollvis S.A. GENÈVE		



## 6.2. Ball Bearings

- Screw central support bearings - part number 112 (see actuator assembly drawing):
  - Manufacturer : SNFA
  - Type : E 225 7PE3 DDF high preloaded (nominal value 870 N) angular contact ball bearings pair in "O" configuration.
  - Axial rigidity : 156 N/um (pair)
  - Radial rigidity : 318 N/um (pair)
  - Preload class : High
  - Preload value : 870 N
  - Dynamic load capacity : 16400 N
  - Static load capacity : 12300 N
  - Tolerance class : high precision (ABEC 7).
  - Material : carbon chrome steel for rings and balls.
  - Cage : made of bakelized cloth guided along outer ring.
  - Non separable and without shields.
  
- Cardan joint bearings - part number 129 (see actuator assembly drawing):
  - Manufacturer : SNFA
  - Type : EX 10 7CE3 DDF high preloaded (nominal value 220 N) angular contact ball bearings pair in "O" configuration.
  - Axial rigidity : 71 N/um (pair)
  - Radial rigidity : 142 N/um (pair)
  - Preload class : High
  - Preload value : 220 N
  - Dynamic load capacity : 4160 N
  - Static load capacity : 2300 N
  - Tolerance class : high precision (ABEC 7).
  - Material : carbon chrome steel for rings and balls.
  - Cage : made of bakelized cloth guided along outer ring.
  - Non separable and without shields.
  
- Screw end support bearing - part number 102:
  - Manufacturer : FAG.
  - Type : radial ball bearing.
  - Tolerance class : P4 with reduced radial play (ISO class 4).
  - Material : carbon chrome steel for rings and balls.
  - Cage : made of steel.
  - Non separable and without shields.

All the bearings were lubricated with KLUBER ISOFLEX NBU 15.



**CUSCINETTI A SFERE DI ALTA PRECISIONE**



**SUPER PRECISION BEARINGS**



**The Group**



**SNFA SA**  
Zone Industrielle No 2 - Batterie 800 - 58309 VALENCIENNES CEDEX  
Téléphone 3 27235212 - Téléc 132276 - Télécopie 3 27235207



**SNFA Bearings Ltd**  
Quarfield Wotton-under-Edge - Gloucestershire GL12 8SP  
Telephone (01453) 843601 - Fax (01453) 842577



**SNFA s.m.b.H.**  
Mollenhuthstrasse 14 - 71229 LEONBERG - Germany 1727 - 71229 LEONBERG  
Telephone (07142) 9751-0 - Telefax (07142) 9751-25



**SNFA S.A. Fribourg**  
Route de Pully 5a, P.O. Box 34 - CH-1752 Villars-sur-Glâne  
Phone (026) 4020786 - Fax (026) 4020614

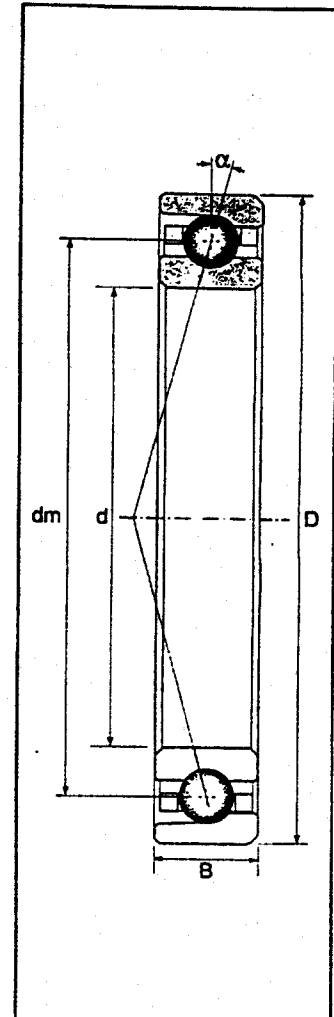


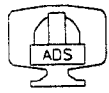
**SOMECAT S.p.A.**  
Via Savonarola-Druento 15 - 10044 PIANEZZA (TO) - Italy  
Telephone +39-11-994.14.07 (ra) - Fax +39-11-994.58.04

**Simboli ed unità di misura / Symbols and Units**

<b>d</b>	: Diametro del foro del cuscinetto / <i>Bearing bore diameter</i>	mm
<b>D</b>	: Diametro esterno del cuscinetto / <i>Bearing outer diameter</i>	mm
<b>B</b>	: Spessore del cuscinetto / <i>Bearing width</i>	mm
$\alpha$	: Angolo di contatto / <i>Contact angle</i>	gradi/degrees
<b>dm</b>	: Diametro medio del cuscinetto / <i>Bearing pitch diameter</i>	mm
<b>C<sub>33</sub></b>	: Capacità di carico dinamico / <i>Dynamic load capacity</i>	daN
<b>C<sub>0</sub></b>	: Capacità di carico statico / <i>Static load capacity</i>	daN
<b>R<sub>a</sub></b>	: Rigidità assiale / <i>Axial rigidity</i>	daN/ $\mu$ m
<b>V<sub>h</sub></b>	: Velocità massima cuscinetto singolo, precaricato con molle, con lubrificazione ad olio, $\alpha = 15^\circ$ <i>Maximum speed of single bearing, spring preloaded, with oil lubrication, <math>\alpha = 15^\circ</math></i>	giri/min rpm
<b>C<sub>r</sub></b>	: Coppia di rotolam. a bassa veloc. per un gruppo di cuscinetti <i>Low speed rolling torque for bearing group</i>	daN • mm
<b>M</b>	: Massa/Weight	Kg
<b>n</b>	: Velocità di rotazione <i>Speed</i>	giri/min rpm
<b>ndm</b>	: Fattore di velocità <i>Speed factor</i>	giri • mm/min rpm • mm

Ulteriori simboli presenti nel testo sono specificati nei rispettivi paragrafi.  
*Any other symbols mentioned on this catalogue are specified in the paragraph they refer to.*





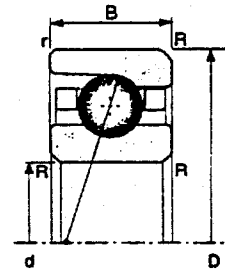
# MMT CONVERSION

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Date : 27 April - 2001



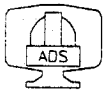
# EX

## ISO 10



SNFA	d	D	B	R <sub>min</sub>	r <sub>min</sub>	α = 15°		α = 25°		V <sub>h</sub> (ABEC 7)
						C <sub>33</sub>	C <sub>0</sub>	C <sub>33</sub>	C <sub>0</sub>	
EX 6	6	17	6	0.3	0.15	160	61	155	59	160 000
EX 7	7	19	6	0.3	0.15	198	77	191	75	141 500
EX 8	8	22	7	0.3	0.15	311	150	300	145	121 000
EX 9	9	24	7	0.3	0.15	341	176	328	169	109 500
EX 10	10	26	8	0.3	0.15	433	240	416	230	100 500
EX 12	12	28	8	0.3	0.15	507	280	488	270	90 500
EX 15	15	32	9	0.3	0.15	576	360	550	350	76 500
EX 17	17	35	10	0.3	0.15	761	480	728	460	69 000
EX 20	20	42	12	0.6	0.3	967	640	924	610	58 000
EX 25	25	47	12	0.6	0.3	1 261	890	1 203	850	50 000
EX 30	30	55	13	1.0	0.3	1 520	1 110	1 450	1 060	42 500
EX 35	35	62	14	1.0	0.3	1 950	1 730	1 846	1 650	31 500
EX 40	40	68	15	1.0	0.3	2 015	1 900	1 885	1 810	28 000
EX 45	45	75	16	1.0	0.3	2 770	2 510	2 630	2 400	25 000
EX 50	50	80	16	1.0	0.3	2 860	2 730	2 700	2 600	23 000
EX 55	55	90	18	1.1	0.6	3 720	3 680	3 520	3 510	20 500
EX 60	60	95	18	1.1	0.6	3 835	3 980	3 630	3 780	19 000
EX 65	65	100	18	1.1	0.6	3 940	4 270	3 740	4 060	18 000
EX 70	70	110	20	1.1	0.6	5 160	5 500	4 880	5 200	16 500
EX 75	75	115	20	1.1	0.6	5 290	5 900	5 000	5 600	15 500
EX 80	80	125	22	1.1	0.6	6 360	7 000	6 010	6 700	14 000
EX 85	85	130	22	1.1	0.6	6 540	7 500	6 180	7 100	13 500
EX 90	90	140	24	1.5	1.0	6 790	8 400	6 400	7 900	12 500
EX 95	95	145	24	1.5	1.0	8 020	9 700	7 590	9 200	12 000
EX 100	100	150	24	1.5	1.0	8 255	10 300	7 760	9 800	11 500
EX 105	105	160	26	2.0	1.0	9 700	11 800	9 150	11 200	10 500
EX 110	110	170	28	2.0	1.0	11 400	13 900	10 780	13 200	10 000
EX 120	120	180	28	2.0	1.0	11 620	14 800	10 970	14 100	9 000
EX 130	130	200	33	2.0	1.0	15 020	19 000	14 180	18 000	8 500
EX 140	140	210	33	2.0	1.0	15 340	20 200	14 480	19 100	7 500
EX 150	150	225	35	2.1	1.0	17 370	23 100	16 390	22 000	7 000
EX 160	160	240	38	2.1	1.0	19 500	26 300	18 400	25 000	6 500
EX 170	170	260	42	2.1	1.0	21 190	29 800	19 990	28 300	6 000
EX 180	180	280	46	2.1	1.0	23 630	35 000	22 290	33 300	5 500
EX 190	190	290	46	2.1	1.0	24 120	36 900	22 750	35 100	5 200
EX 200	200	310	51	2.1	1.0	30 290	46 600	28 600	44 400	4 800
EX 220	220	340	56	3.0	1.5	34 140	55 600	32 240	52 900	4 250
EX 240	240	360	56	3.0	1.5	35 930	62 000	33 930	58 900	3 900

Per dimensioni superiori consultare il ns. servizio tecnico commerciale. / For larger sizes consult our Technical Department.



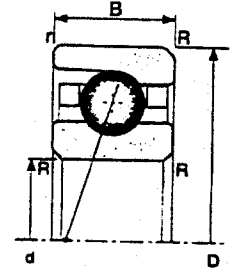
# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
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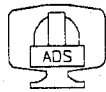
# E 200

## ISO 02



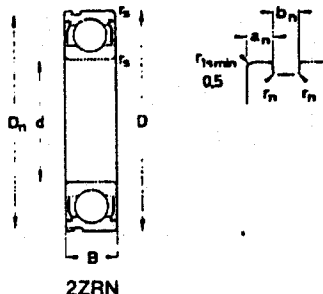
SNFA	d	D	B	R <sub>min</sub>	r <sub>min</sub>	α = 15°		α = 25°		Vh (ABEC 7)
						C33	C0	C33	C0	
						E 207	7	22	7	
E 208	8	24	8	0.3	0.15	455	230	440	220	98 500
E 209	9	26	8	0.3	0.15	550	320	530	300	90 000
E 210	10	30	9	0.6	0.3	655	370	640	360	78 500
E 212	12	32	10	0.6	0.3	720	440	695	420	71 500
E 215	15	35	11	0.6	0.3	915	570	885	550	62 500
E 217	17	40	12	0.6	0.3	1 140	720	1 090	700	55 000
E 220	20	47	14	1.0	0.6	1 315	940	1 260	910	46 500
E 225	25	52	15	1.0	0.6	1 720	1 290	1 640	1 230	40 000
E 230	30	62	16	1.0	0.6	2 350	1 850	2 250	1 770	33 500
E 235	35	72	17	1.1	0.6	2 600	2 270	2 480	2 170	28 500
E 240	40	80	18	1.1	0.6	3 430	3 050	3 280	2 920	25 500
E 245	45	85	19	1.1	0.6	3 590	3 350	3 410	3 200	23 000
E 250	50	90	20	1.1	0.6	4 370	4 010	4 150	3 830	21 500
E 255	55	100	21	1.5	1.0	5 560	5 000	5 300	4 830	19 000
E 260	60	110	22	1.5	1.0	5 770	5 600	5 490	5 300	17 500
E 265	65	120	23	1.5	1.0	6 800	6 800	6 490	6 500	16 000
E 270	70	125	24	1.5	1.0	7 085	7 400	6 730	7 100	15 000
E 275	75	130	25	1.5	1.0	7 345	8 000	6 980	7 600	14 000
E 280	80	140	26	2.0	1.0	8 960	9 600	8 490	9 100	13 000
E 285	85	150	28	2.0	1.0	9 830	10 700	9 330	10 200	12 000
E 290	90	160	30	2.0	1.0	12 490	13 200	11 920	12 700	11 500
E 295	95	170	32	2.1	1.1	11 780	13 400	11 190	12 800	10 500
E 200/100	100	180	34	2.1	1.1	14 740	16 400	14 050	15 700	10 000
E 200/105	105	190	36	2.1	1.1	17 030	18 600	16 190	17 800	9 300
E 200/110	110	200	38	2.1	1.1	17 670	20 100	16 760	19 100	9 000
E 200/120	120	215	40	2.1	1.1	17 900	21 700	16 900	20 700	8 200
E 200/130	130	230	40	3.0	1.5	20 400	25 600	19 400	24 400	7 500
E 200/140	140	250	42	3.0	1.5	23 140	30 400	21 900	29 000	6 700

Per dimensioni superiori consultare il ns. servizio tecnico commerciale.  
 For larger sizes consult our Technical Department.



## Cuscinetti radiali rigidi a sfere

ad una corona



2ZRN

Albero	Dimensioni							Coeff. di carico		Velocità di riferimento		Sigla	Massa ~		
	d	D	B	r <sub>n</sub> min	D <sub>n</sub>	a <sub>n</sub>	b <sub>n</sub>	r <sub>n</sub>	din. C	stal. C <sub>0</sub>	grasso			olio	Cusci- netto FAG
<b>8</b>	8	16	4	0,2					1,5	0,64	36000	43000	618/8		0,003
	8	22	7	0,3					3,25	1,37	30000	36000	608		0,013
	8	22	7	0,3					3,25	1,37	19000		608RSR		0,013
	8	22	7	0,3					3,25	1,37	19000		608.2RSR		0,013
	8	22	7	0,3					3,25	1,37	19000		608.2RSR.C3		0,013
	8	22	7	0,3					3,25	1,37	30000		608ZR		0,013
	8	22	7	0,3					3,25	1,37	30000		608.2ZR		0,013
	8	22	7	0,3					3,25	1,37	30000		608.2ZR.C3		0,013
<b>9</b>	9	24	7	0,3					3,65	1,63	30000	36000	609		0,015
	9	24	7	0,3					3,65	1,63	18000		609RSR		0,015
	9	24	7	0,3					3,65	1,63	18000		609.2RSR		0,015
	9	24	7	0,3					3,65	1,63	30000		609ZR		0,015
	9	24	7	0,3					3,65	1,63	30000		609.2ZR		0,015
	9	24	7	0,3					3,65	1,63	30000		609.2ZR.C3		0,015
	9	26	8	0,6					4,55	1,96	28000	34000	629		0,02
	9	26	8	0,6					4,55	1,96	19000		629RSR		0,02
	9	26	8	0,6					4,55	1,96	19000		629.2RSR		0,02
	9	26	8	0,6					4,55	1,96	19000		629.2RSR.C3		0,02
	9	26	8	0,6					4,55	1,96	28000		629ZR		0,02
	9	26	8	0,6					4,55	1,96	28000		629.2ZR		0,02
	9	26	8	0,6					4,55	1,96	28000		629.2ZR.C3		0,02
	<b>10</b>	10	19	5	0,3					1,73	0,83	34000	40000	61800T	
10		26	8	0,3					4,55	1,96	28000	34000	6000		0,019
10		26	8	0,3					4,55	1,96	28000	34000	6000.C3		0,019
10		26	8	0,3					4,55	1,96	17000		6000RSR		0,019
10		26	8	0,3					4,55	1,96	17000		6000.2RSR		0,019
10		26	8	0,3					3,45	1,46	28000	34000	6000Z15		0,019
10		26	8	0,3					3,45	1,46	17000		6000Z15.2RSR		0,019
10		26	8	0,3					4,55	1,96	28000		6000ZR		0,019
10		26	8	0,3					4,55	1,96	28000		6000.2ZR		0,019
10		26	8	0,3					4,55	1,96	28000		6000.2ZR.C3		0,019
10		28	8	0,3					4,55	1,96	26000	32000	16100		0,023
10		30	9	0,6					6	2,6	26000	32000	6200		0,03
10		30	9	0,6					6	2,6	26000	32000	6200.C3		0,03
10		30	9	0,6					6	2,6	17000		6200RSR		0,03
10		30	9	0,6					6	2,6	17000		6200.2RSR		0,03
10		30	9	0,6					6	2,6	17000		6200.2RSR.C3		0,03
10		30	9	0,6					4,5	1,96	26000	32000	6200Z15		0,03
10		30	9	0,6					4,5	1,96	17000		6200Z15.2RSR		0,03
10		30	9	0,6					6	2,6	26000		6200ZR		0,03
10		30	9	0,6	28,17	2,06	1,35	0,4	6	2,6	26000		6200ZRN	SP30	0,03
10	30	9	0,6					6	2,6	26000		6200.2ZR		0,03	
10	30	9	0,6					6	2,6	26000		6200.2ZR.C3		0,03	
10	30	9	0,6	28,17	2,06	1,35	0,4	6	2,6	26000		6200.2ZRN	SP30	0,03	



### 6.3. DC Motor

Manufacturer	KOLLMORGEN Inland Motor
Type	Direct Drive Torque Motor in frameless configuration with embedded Hall sensor for phases commutation : • QT-2603-E
Number of Poles	10
Peak Torque	6.78 Nm
Peak power at stall	313 W
Motor Constant	0.38 Nm/ $\sqrt{W}$

More details about the QT-2603-E are reported in the attached data sheet.

# DIRECT DRIVE DC MOTORS

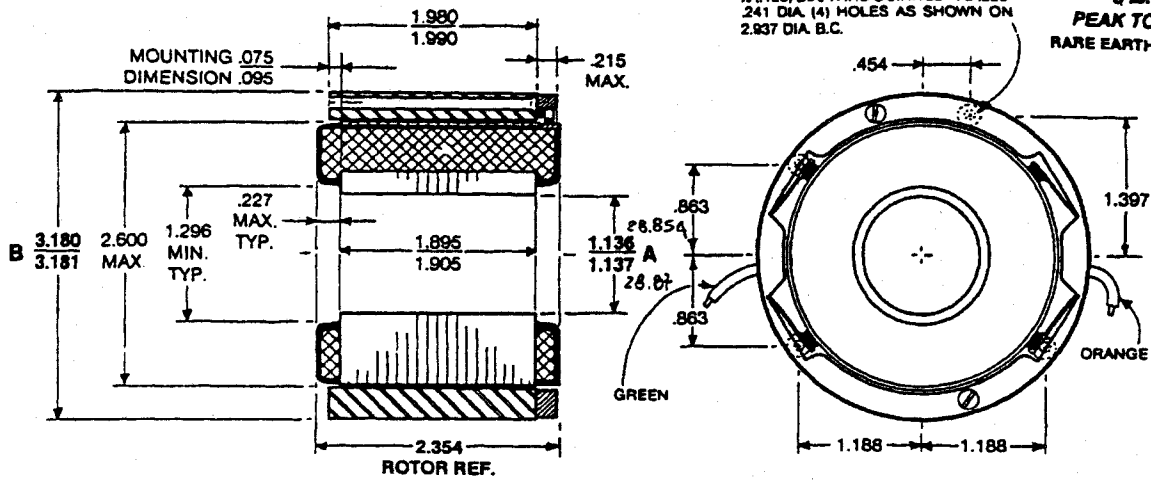
Kollmorgen Inland Motor

501 First Street Radford, VA 24141 703-639-9045 FAX 703-731-4193





**QT-2603**  
 5 D. R.  
**PEAK TORQUE**  
 RARE EARTH MAGNETS



- NOTES:  
 1. - MOTOR TO BE SHIPPED AS THREE SEPARATE COMPONENTS: BRUSH RING ASSEMBLY, ROTOR ASSEMBLY, AND STATOR ASSEMBLY.  
 2. - MOUNTING REQUIREMENTS. DIAMETERS "A" AND "B" TO BE CONCENTRIC WITHIN .002 (.004 T.I.R.) WHEN MOUNTED.  
 3. - WITH POSITIVE CURRENT APPLIED TO GREEN LEAD, WITH RESPECT TO ORANGE LEAD, ROTATION SHALL BE C.C.W. FACING BRUSH RING END.  
 4. - TYPICAL BRUSH LIFE > 10' REVS.

LEADS:  
 #20 AWG TYPE "E" TEFLON COATED  
 PER MIL W-16878, 8" MIN. LENGTH.

**SIZE CONSTANTS**

Value Units

Peak Torque Rating - $T_p$	5	LB. FT.
Power Input, Stalled at $T_p(25^\circ\text{C})$ - $P_p$	313	WATTS
Motor Constant - $K_M$	0.28	LB. FT./ $\sqrt{\text{WATT}}$
No Load Speed, Theoretical @ $V_p$ - $\omega_{NL}$	46	RAD/S
Electrical Time Constant - $\tau_E$	2.1	MS
Static Friction (Max.) - $T_f$	0.10	LB. FT.
Viscous Damping Coefficients		
Zero Impedance - $F_0$	0.108	LB. FT. PER RAD/S
Infinite Impedance - $F_i$	0.0014	LB. FT. PER RAD/S
Maximum Winding Temperature	155	$^\circ\text{C}$
Temperature Rise per Watt - TPR	4.3	$^\circ\text{C}/\text{WATT}$
Ripple Torque (Average to Peak) - $T_R$	5	PERCENT
Ripple Frequency (Fundamental)	39	CYCLES/REV.
Number of Poles	10	
Rotor Inertia - $J_M$	$4.0 \times 10^{-4}$	LB. FT. $^2$
Motor Weight	3.5	LB.

**WINDING CONSTANTS**

**Winding Designation**

	UNITS	TOLERANCES	A	B	C	D	E	F	G
Voltage, Stalled at $T_p(25^\circ\text{C})$ - $V_p$	VOLTS	Nom.	50.0	19.8	39.7	31.5	25.0	63.2	
Peak Current - $I_p$	AMPERES	Rated	6.25	16.1	8.04	9.78	12.5	4.90	
Torque Sensitivity - $K_T$	LB. FT./AMP	$\pm 10\%$	0.800	0.310	0.622	0.511	0.400	1.02	
Back EMF Constant - $K_B$	V per RAD/S	$\pm 10\%$	1.08	0.420	0.842	0.693	0.542	1.38	
DC Resistance (25 $^\circ\text{C}$ ) - $R_M$	OHMS	$\pm 12.5\%$	8.00	1.23	4.94	3.22	2.00	12.9	
Inductance - $L_M$	mH	$\pm 30\%$	17	2.6	10	6.9	4.2	27	



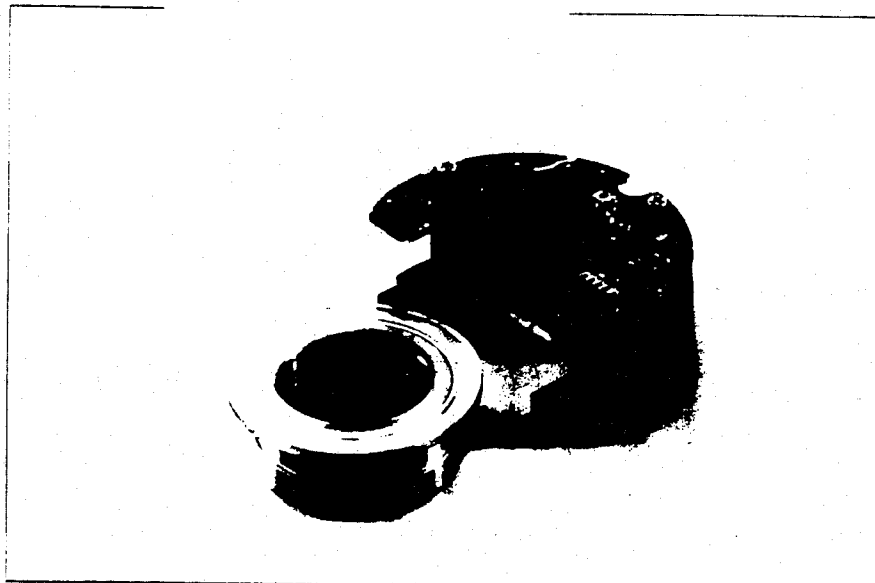
#### 6.4. Optical Incremental Encoder

Manufacturer	HEIDENHAIN (Germany)
Type	Optical incremental encoder in frameless configuration : ERO 1324.
Line Counts	3600 sine-cosine (incremental) and reference signals, analog output.

More details about the ERO 1324 are reported in the attached data sheet.



### Incremental Modular Rotary Encoders ERO 1324



Manufacturers are increasingly calling for rotary encoders for mounting on through shafts with comparatively large diameters and which allow fast mounting times. The modular rotary encoders of the ERO 1300 series are directed at such applications.

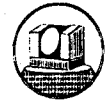
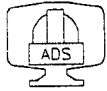
These encoders consist of a graduated disk/hub assembly and a scanning unit. The graduated disk/hub assembly, with line counts of 100 to 5000, is installed directly on the shaft. The scanning unit is centered on the mounting surface with a centering collar. The scanning gap is set with a spacer foil by sliding the disk/hub assembly on the motor shaft. Depending on the line count, the scanning gap ranges from 0.2 mm to 0.3 mm.

The ERO 1324 with its outside diameter of 75 mm allows through shafts with diameters up to 30 mm. For shaft diameters up to 40 mm the ERO 1325 or ERO 1355 can be employed, although this requires a scanning unit with a larger outside diameter of 88 mm. The overall length of the ERO 1324 is approximately 39 mm, that of the ERO 1325 and ERO 1355 approximately 44 mm.

Direct mounting of the graduated disk/hub assembly on the shaft assures high connection rigidity since only the torsion spring rate of the shaft between the graduated disk and the scanning unit has any influence. Furthermore, the ERO family encoders produce no additional starting torque. Since the encoders

of the ERO 1300 series are exposed optical measuring systems, the user must provide a cover to prevent extraneous light from falling on the photovoltaic cells and to protect the encoder from contamination.

The output signals are either TTL square-wave signals or 11  $\mu$ App sinusoidal signals and a reference mark signal. With sinusoidal output signals it is possible to increase the resolution as against square-wave signals through the use of external interpolation electronics units. The encoders receive current through a PCB connector. The maximum scanning frequency for square-wave pulse trains is 160 kHz, although optional electronics with 400 kHz or 800 kHz maximum scanning frequency are also available.



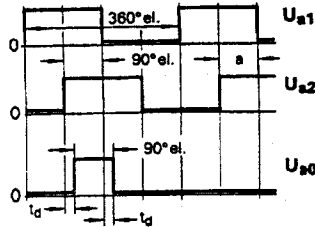
Electrical Data

ERO 1324

Power supply

5 V ± 5 %/max. 160 mA (with no load)  
Light source: LED

Output signals



**Incremental signals** TTL square wave pulse trains  $U_{a1}$ ,  $U_{a2}$  and their inverted pulse trains  $\overline{U_{a1}}$  and  $\overline{U_{a2}}$ .  $U_{a2}$  lags  $U_{a1}$  with clockwise rotation (when viewing mounting surface at the scanning unit)

**Edge separation**  $a \geq 0.14 \mu s$  with scanning freq. 800 kHz (ERO 1324 .□008)  
 $a \geq 0.28 \mu s$  with scanning freq. 400 kHz (ERO 1324 .□004)  
 $a \geq 0.7 \mu s$  with scanning freq. 160 kHz (ERO 1324 .□000 and ERO 1325 .□000)

**Reference signal** One square-wave pulse  $U_{a0}$  per revolution and its inverted pulse  $\overline{U_{a0}}$   
Width: 90° el.  
 $t_d \leq 50 ns$

**Error signal** One square-wave pulse  $\overline{U_{aS}}$   
(only with ERO 1324 .□004 and ERO 1324 .□008)  
 $\overline{U_{aS}}$  = High: proper function  
 $\overline{U_{aS}}$  = Low: error condition

**Signal levels**  $U_{High} \geq 2.5 V$  at  $-I_{High} \leq 20 mA$   
 $U_{Low} \leq 0.5 V$  at  $I_{Low} \leq 20 mA$   
(with supply voltage + 5 V at encoder)

**Load capacity**  $-I_{High} \leq 20 mA$   
 $I_{Low} \leq 20 mA$   
 $C_{Load} \leq 1000 pF$

**Switching times** Rise time  $t_r \leq 100 ns$   
Fall time  $t_f \leq 100 ns$

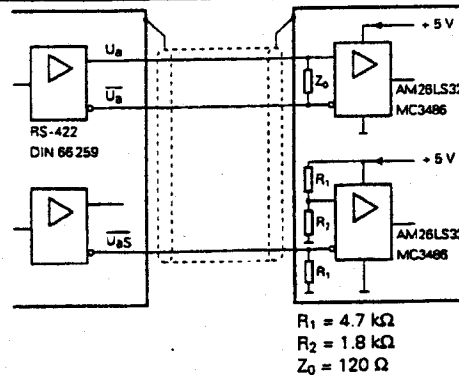
Scanning frequency f

$f \leq 800 kHz$  (ERO 1324 .□008)  
 $f \leq 400 kHz$  (ERO 1324 .□004)  
 $f \leq 160 kHz$  (ERO 1324 .□000 and ERO 1325 .□000)

Electrically permissible speed n

$n \leq \frac{\text{Scanning frequency } f \text{ in kHz}}{z} \cdot 60 \cdot 10^3 \text{ rpm}$  z = line count

Recommended input circuitry of the subsequent electronics



**Cable length** to subsequent electronics Max. 100 m (329 ft) with HEIDENHAIN cable [4(2x0.14)+(4x0.5)]mm<sup>2</sup>



# HEIDENHAIN

**DR. JOHANNES HEIDENHAIN GmbH**  
 Dr.-Johannes-Heidenhain-Straße 5  
 D-83301 Traunreut, Deutschland  
 ☎ (0 86 69) 31-0  
 ☎ (0 86 69) 50 61  
 e-mail: info@heidenhain.de

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☎ **Service** (086 69) 31-12 72  
 ☎ TNC-Service (086 69) 31-14 46  
 ☎ (086 69) 98 99  
 e-mail: service@heidenhain.de

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http://www.heidenhain.de



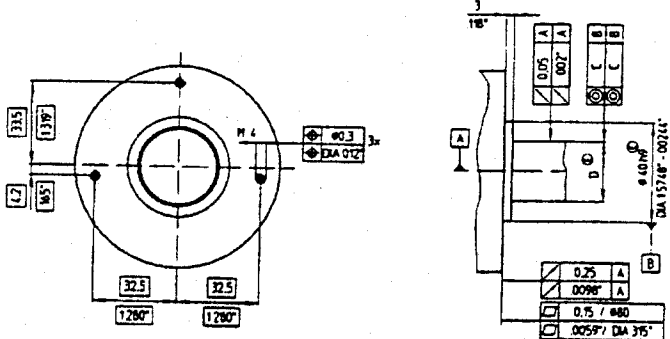
**Montageanleitung**  
**Mounting Instructions**  
**Instructions de montage**  
**Istruzioni di montaggio**  
**Instrucciones de montaje**

**ERO 1324**  
**ERO 1325**

9/99

## ERO 1324

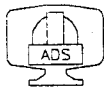
mm/inches  
  
 DIN ISO 8015  
 ISO 2768 - m H



**A** = Lagerung  
 Bearing  
 roulement  
 cuscinetto  
 rodamiento

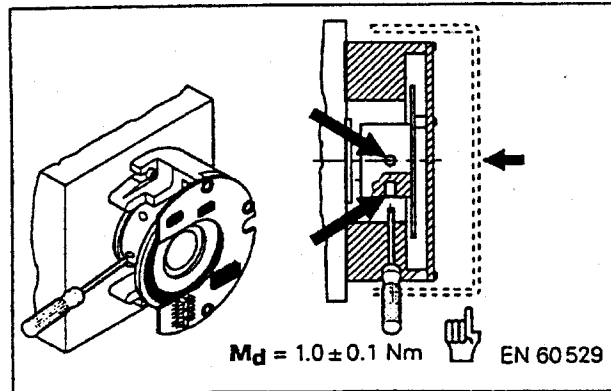
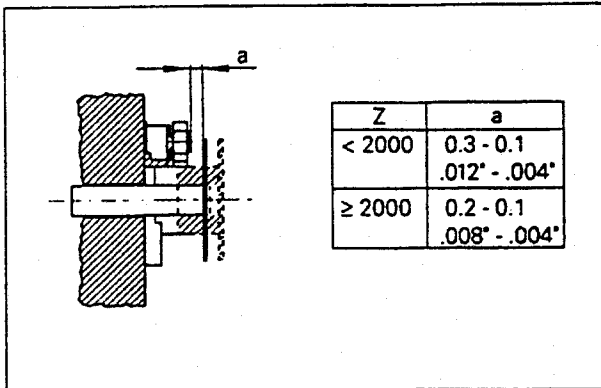
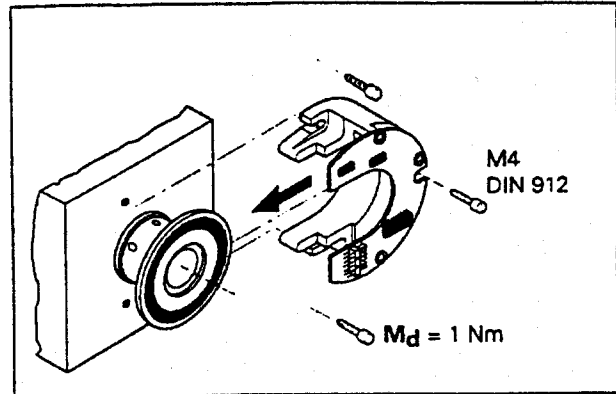
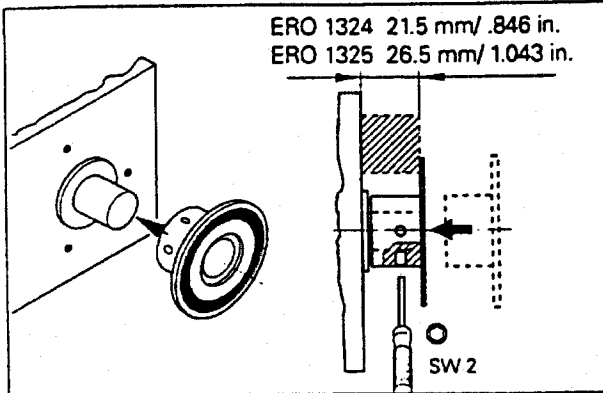
Z	c
< 1000	∅ 0.02 DIA .0008"
≤ 1000	∅ 0.05 DIA .002"

D
∅ 10h6 DIA .3937 - .00035"
∅ 20h6 DIA .7874 - .00051"
∅ 24h6 DIA .94488 - .00051"
∅ 30h6 DIA 1.1811 - .00051"



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001

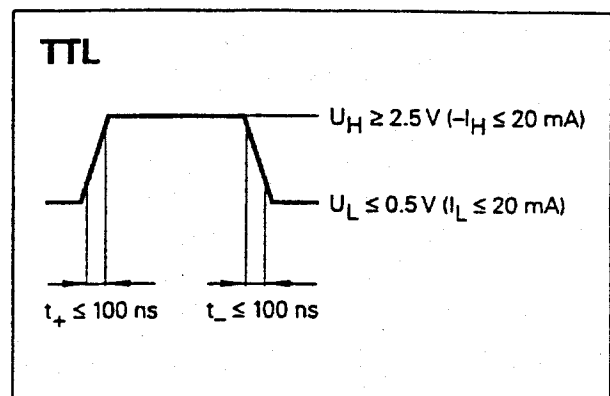
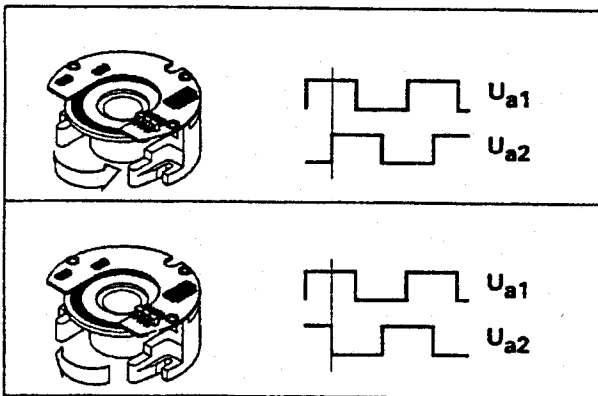
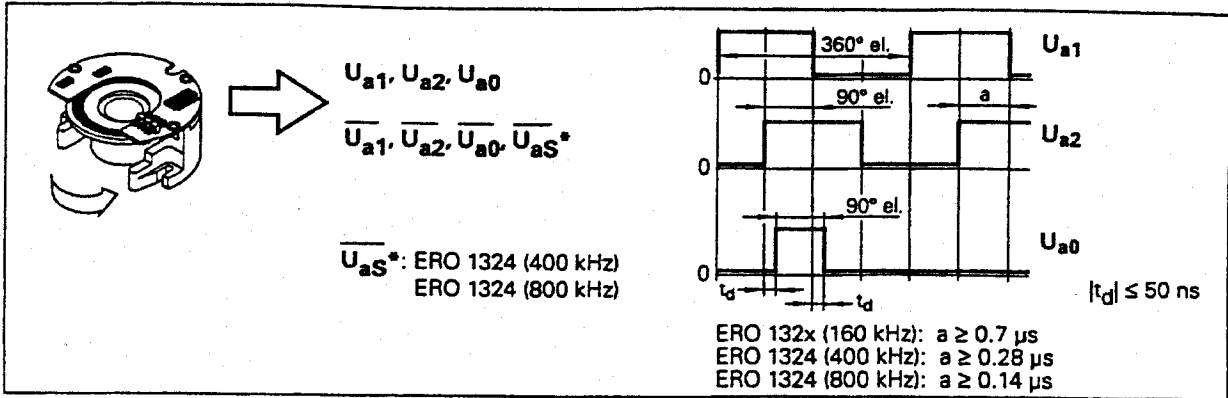


$\varnothing 6 \text{ mm}$ DIA .236 in.	$R_1 \geq 20 \text{ mm}$ $R_1 \geq .8 \text{ in.}$	$R_2 \geq 75 \text{ mm}$ $R_2 \geq 3 \text{ in.}$
$\varnothing 8 \text{ mm}$ DIA .315 in.	$R_1 \geq 40 \text{ mm}$ $R_1 \geq 1.6 \text{ in.}$	$R_2 \geq 100 \text{ mm}$ $R_2 \geq 4 \text{ in.}$

 °C (°F)	 0 ... 80° C (32 ... 176° F)
	 -30 ... 80° C (-22 ... 176° F)

$U_p = 5V \pm 10\%$   
 (max. 160 mA)

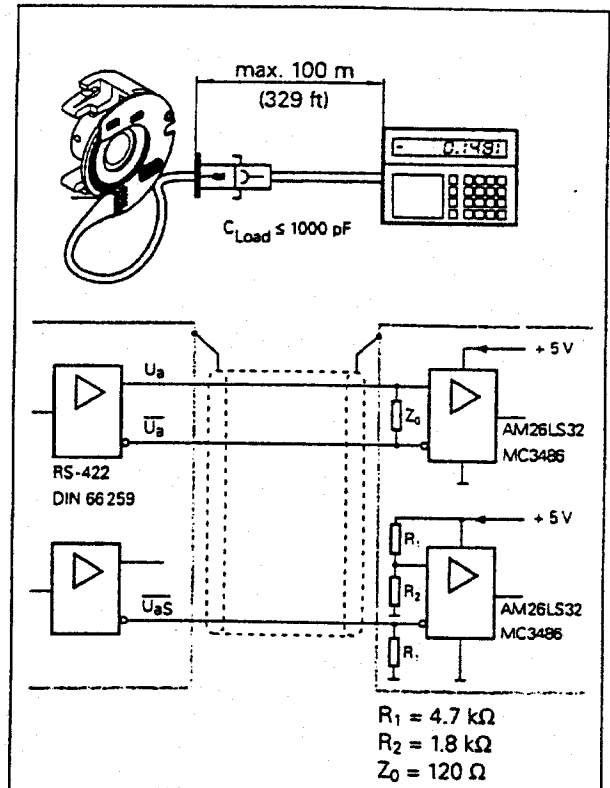
IEC 742  
 EN 50 178

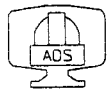


**ERO 1324 (400 kHz)**  
**ERO 1324 (800 kHz)**

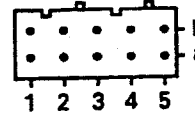
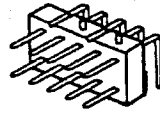
$\overline{U_{aS}}$ : Störungssignal  
*Fault detection signal*  
*signal de perturbation*  
*segnale di malfunzionamento*  
*señal de avería*

$\overline{U_{aS}}$  = High: ✓  
 $\overline{U_{aS}}$  = Low: ⚠



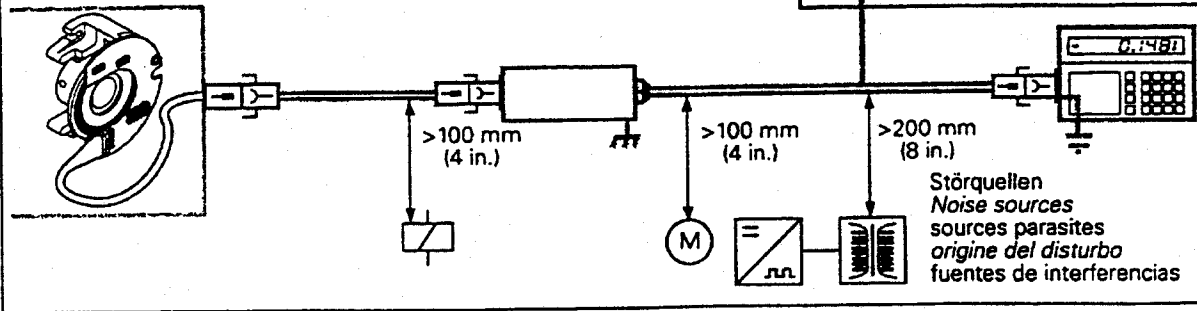


**ERO 1324 (160 kHz)**  
**ERO 1325**

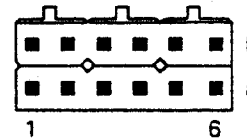
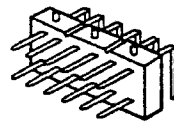


2a	2b	3b	3a	5b	5a	4b	4a	Schirm Shield blindage schermo blindaje	1a	1b
0V sensor	5V sensor	$U_{a0}$	$\overline{U}_{a0}$	$U_{a1}$	$\overline{U}_{a1}$	$U_{a2}$	$\overline{U}_{a2}$			0V $U_N$
weiß white blanc bianco blanco	blau blue bleu azzurro azul	rot red rouge rosso rojo	schwarz black noir nero negro	braun brown brun marrone marrón	grün green vert verde verde	grau gray gris grigio gris	rosa pink rose rosa rosa		weiß/grün white/green blanc/vert bianco/verde blanco/verde	braun/grün brown/green brun/vert marrone/verde marrón/verde

IEC 742 EN 50 178

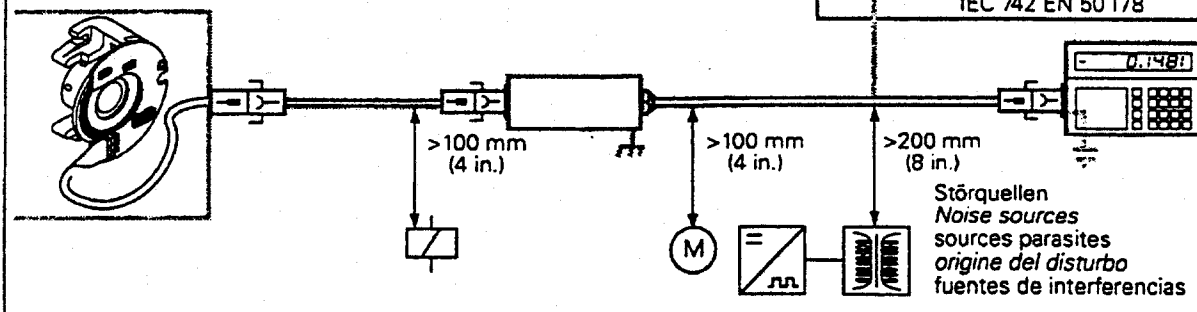


**ERO 1324 (400 kHz)**  
**ERO 1324 (800 kHz)**



1b	2b	3a	3b	4a	4b	5a	5b	6a	6b	Schirm Shield blindage schermo blindaje	1a	2a
0V sensor	5V sensor	$U_{aS}$	-	$\overline{U}_{a0}$	$U_{a0}$	$\overline{U}_{a2}$	$U_{a2}$	$\overline{U}_{a1}$	$U_{a1}$			0V $U_N$
weiß white blanc bianco blanco	blau blue bleu azzurro azul	violett violet violet viola violetta		schwarz black noir nero negro	rot red rouge rosso rojo	rosa pink rose rosa rosa	grau gray gris grigio gris	grün green vert verde verde	braun brown brun marrone marrón		weiß/grün white/green blanc/vert bianco/verde blanco/verde	braun/grün brown/green brun/vert marrone/verde marrón/verde

IEC 742 EN 50 178





### 6.5. LVDT and conditioning board

**0.25% F.S. NON-LINEARITY**

**±.01" TO ±18.5" RANGE**

**-58°F TO 257°F TEMP.**

SENSOTEC manufactures a wide range of LVDT type displacement transducers. These sensors are manufactured as standard, modified standard, and custom transducers to provide the quickest possible delivery. Many units can ship from our extensive stocking program within 24 hours. These LVDT transducers are designed to meet requirements of most single and multiple point industrial gaging applications as well as micro-displacement instruments in research and scientific laboratories.

SENSOTEC offers a wide range of models so that your sensor will provide the best measurements possible given the conditions encountered in your application. Models are available with free unguided, captive spring return, and captive guided armatures. Non-linearity of 0.25% F.S and measuring ranges from ±0.1" to ±18.5" are available. Electrically, SENSOTEC offers both AC and DC models to match your power requirement needs. These units operate in temperatures as low as -58°F and as high as 257°F.

SENSOTEC's welded, stainless steel construction and submersible, underwater connectors are combined to offer units that are perfect for offshore drilling, mining, marine, and hydraulic engineering applications.

**SENSOTEC 1-800-848-6564**

### PRODUCT INDEX

APPLICATION	Model	PAGE#
<b>PRECISION</b>		
Captive Guided Spring .....	*PLVX .....	LV-2
Captive Guided Spring .....	*S5 .....	LV-2
<b>LONG STROKE</b>		
Free Unguided .....	MVL7 .....	LV-4
Captive Guided Spring .....	*VL7A .....	LV-4
Captive Guided .....	MVL7C .....	LV-5
Free Unguided .....	MDL .....	LV-6
Captive Guided Spring .....	*DLA .....	LV-6
Captive Guided .....	MDLC .....	LV-7
Free Unguided .....	DLB .....	LV-8
Captive Guided .....	DLE .....	LV-8
Captive Guided Spring .....	DLF .....	LV-8
<b>SUBMERSIBLE</b>		
Captive Guided Spring .....	LW7S .....	LV-10
Captive Guided .....	LW7C .....	LV-10
Free Unguided .....	LW7U .....	LV-10
Captive Guided Spring .....	DW7S .....	LV-12
Captive Guided .....	DW7C .....	LV-12
Free Unguided .....	DW7U .....	LV-12
Free Unguided .....	MS7A .....	LV-14
Captive Guided Spring .....	S7C .....	LV-14
<b>MINIATURE</b>		
Free Unguided .....	MS2 .....	LV-15
Captive Guided Spring .....	* S2C .....	LV-15
Solder Pins .....	M-5P .....	LV-16
Cable Termination .....	M-5C .....	LV-16
<b>LVDT SELECTION CONSIDERATIONS .....</b>		<b>LV-17</b>

\*Many ranges in stock.





# DC-DC Long Stroke LVDTs

## Models MDL and DLA

STAINLESS STEEL

VOLTAGE REGULATION

REVERSE POLARITY PROTECTED



Model MDL Free Unguided



Model DLA Captive Guid Spring Return

SENSOTEC'S Models MDL (free unguided armature) and DLA (captive guided spring return) DC-DC Long Stroke LVDTs utilize an improved internal circuit which incorporates both reverse polarity protection and voltage regulation. These features eliminate the danger of permanent damage if supply voltage is accidentally reversed, and ensure that sensitivity will remain constant over large variations in supply voltage. These models require no further conditioning, thus permitting easy operation. Model MDLC (captive guided armature) provides stroke ranges to 18.5" and is presented on the next page.

SENSOTEC 1-800-848-6564

PERFORMANCE

ENVIRONMENTAL

ELECTRICAL

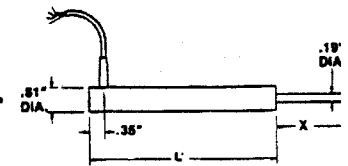
MECHANICAL

	Model MDL	Model DLA
Stroke Ranges .....	±0.5" to 8"	±0.5" to 3"
Non-linearity (max) .....	±0.25% F.S.	±0.25% F.S.
Output Sensitivity .....	±5VDC F.S.	±5VDC F.S.
Resolution .....	Infinite	Infinite
Temperature, Operating .....	-58° F to 158° F	-58° F to 158° F
Temperature Effect		
- Zero (max) .....	.006% F.S./°F	.006% F.S./°F
- Span (max) .....	.017% Rdg./°F	.017% Rdg./°F
Element Type .....	DC-DC LVDT	DC-DC LVDT
Input Supply .....	±10V to ±20VDC unregulated or 20V to 40V floating	±10V to ±20VDC unregulated or 20V to 40V floating
Output Impedance .....	2 ohms	2 ohms
Output Load (min.) .....	2K ohms w/3-wire supply, 20K ohms w/floating supply	2K ohms w/3-wire supply, 20K ohms w/floating supply
Output Ripple .....	30mv peak to peak	30mv peak to peak
Reverse Polarity Protection .....	Yes	Yes
Wiring Code (std) .....	#33 or #31	#33 or #31
Electrical Termination	Multiconductor shielded cable (6 ft.)	Multiconductor shielded cable (6 ft.)
Case Material .....	Stainless steel	Stainless steel
Probe Material .....	Stainless steel	Stainless steel
Armature Type .....	Free unguided	Captive guided spring return
Probe Thread .....	M5 x 0.8	N/A
Spring Force (max) .....	N/A	4 oz./in.

### Dimensions

#### Model DLA (Order Code BY132)

Available Order Code W/Range	Stroke Ranges	L"	X"	Approx. Unit Wt. (oz.)
BY132HP	±0.5"	7.5	1.5	8.0
BY132HQ	±1.0"	8.25	2.5	10.0
BY132HR	±2.0"	12.85	3.0	14.0
BY132HS	±3.0"	17.25	4.5	18.0



Model DLA Captive Guided Spring Ret

# SENSOTEC®

(800) 848-6564

2080 Arlingate Lane  
Columbus, Ohio 43228  
Tel: 614-850-5000  
Fax: 614-850-1111  
E-mail: sales@sensotec.com  
www.sensotec.com



# Setting Up A Transducer and Its Instrument In The Field

The most common method for quick field calibration is the "shunt calibration" technique. This method applies a known, accurate resistance across one leg of the transducer, which simulates an actual physical stimulus when one is not present. Upon application of this resistance, the output of the transducer changes exactly as it would if a known pressure or load were applied.

In performing shunt calibration, the transducer should have no pressure or load applied, so that it is at "zero" initially. The data instrument's ZERO control can then be adjusted to give a zero output on its indicator, or a zero voltage on its output terminals. (In the case of 4-20 milliampere outputs, this value would be a 4 milliamperes.) The shunt calibration circuitry may then be activated by use of the front-panel SHUNT CAL button. A step change in amplifier out put or reading will occur. If the amount of the step change does not agree with the expected change as indicated by the Transducer Calibration Data sheet, adjust the SPAN or GAIN control until it does. This will insure that the amplification given by the data device will be correct, so that an actual stimulus will give correct readings.

It is advisable to recheck the zero when the shunt calibration resistance is removed, since there may be some interaction if the GAIN or SPAN control adjustments were large.

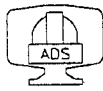
Strain gage transducers with internal amplifiers usually have a shunt calibration resistor installed. The shunt calibration resistor may be activated by interconnecting two terminals on the connector. The wiring code section of the Transducer Calibration Data sheet will indicate which terminals are to be interconnected to activate the shunt calibration. For current output units (4-20 milliamperes), several full cycles of adjusting the ZERO and SPAN controls may be required, since these controls interact greatly in such units.

Below is a typical Transducer Calibration Data sheet. This sheet will be used as an example to illustrate the setup procedure for both unamplified transducers, as well as instruments with an amplified output. The calibration record for amplified transducers includes the "amplified" shunt cal value so no calculation is required.

SENSOTEC 1-800-848-6564

Calibration Data Sheet

<b>SENSOTEC</b>	
230 ALBUQUERQUE BLVD. ALBUQUERQUE, NM 87101-5000 INTERNET URL: <a href="http://www.sensotec.com">http://www.sensotec.com</a>	
<b>CERTIFICATE OF CALIBRATION</b>	
MODEL: T7E/9Z78-03T/D	CAPACITY: 30 PSID PRESSURE
SERIAL NUMBER: 597642	CALIBRATED AT: 30 PSID
CALIBRATION DATE: Dec 03/1998	EXCITATION: 10.0 VOLTS
INPUT RESISTANCE: 358.0	CALIBRATION FACTOR: 2.0065 MV/V
OUTPUT RESISTANCE: 352.0	SHUNT RESISTOR: 59KΩ
LEAKAGE: ∞	SHUNT CAL FACTOR: 1.5090 MV/V
WIRING CODE	
UNAMPLIFIED	
PIN	DESIGNATION
A	(+) EXCITATION
B	(-) SIGNATURE
C	(-) EXCITATION
D	(-) SIGNATURE
E	(-) OUTPUT
F	(+) OUTPUT
Accepted and Certified by: <i>Michael A. Stanley</i>	
Date Printed: 6/2/1999	



### Step-by-Step Procedure for Shunt Cal

1. Make all required connections between the transducer and the instrument.
2. Apply power and allow 10 to 20 minutes for stabilization.
3. Turn the ZERO adjustment so that the indicator reads zero. (If you are working with a PSIA transducer, the transducer must be evacuated to get zero. However, the unit can be shunt calibrated at atmosphere, and the atmospheric reading added to the shunt calibration reading.)
4. From the Transducer Calibration Data sheet, obtain the transducer full scale output in millivolts per volt, and the shunt calibration output in millivolts per volt.
5. Select and perform the proper calculation from the discussion below.
6. Depress the SHUNT CAL switch and turn the SPAN or GAIN adjustment to obtain the value calculated in step 5.

### Unamplified Transducers

Transducers with millivolt outputs usually do not have internal shunt calibration circuitry, but the effect of a known shunt calibration resistor being connected across the leads will be noted on the Transducer Calibration Data sheet. To determine the output of an unamplified transducer under shunt calibration conditions, perform the following calculation:

$$\text{(Shunt Cal Value in mv/v)} \times \text{Excitation Voltage} = \text{Output Voltage}$$

Substituting the values from the sample Transducer Calibration Data sheet into the above equation provides the following:

$$1.4848 \text{ mv/v} \times (10 \text{ V}) = 14.848 \text{ millivolts}$$

### Instrument with 0 to 5 Volt Output

Consider next an amplified transducer with a 0 to 5 volt output, or an instrument which has been factory calibrated with a transducer. Determining the output under shunt calibration conditions is done with the following equation:

$$\frac{\text{Shunt Cal Output in mv/v}}{\text{Full-Scale Output in mv/v}} \times \text{Full-Scale Output} = \text{Output Voltage}$$

Using the same data sheet as before, and assuming an amplified transducer with a 5 volt full scale provides:

$$\frac{(1.4848 \text{ mv/v})}{(3.0057 \text{ mv/v})} \times 5 \text{ volts} = 2.469 \text{ volts}$$

### Instrument with 4-20 Milliampere Output

Consider next the case of a 4-20 milliampere output from an amplified transducer. Notice that this represents a span of 16 milliamperes, offset upward by 4 milliamperes. To calculate the shunt cal output, use the following equation:

$$\text{Shunt Cal Output in mv/v} \times \text{Full-Scale Output in mv/v} \times 16 \text{ ma.} + 4 \text{ ma.} = \text{Output Current}$$

Using the same data sheet again, and assuming a 4-20 ma. case,

$$\frac{(1.4848 \text{ mv/v})}{(3.0057 \text{ mv/v})} \times 16 \text{ ma.} + 4 \text{ ma.} = 11.904 \text{ ma.}$$

### Instrument Display

The following equation applies to instruments with a display:

$$\frac{\text{Shunt Cal Output in mv/v}}{\text{Full-Scale Output in mv/v}} \times \frac{\text{Full-Scale Display Value}}{\text{Value}} = \frac{\text{Shunt Cal Display Value}}{\text{Value}}$$

Since the transducer shown on the Transducer Calibration Data sheet is a 1,000-pound unit, the display should read:

$$\frac{(1.4848 \text{ mv/v})}{(3.0057 \text{ mv/v})} \times 1,000 \text{ lbs.} = 494 \text{ lbs.}$$

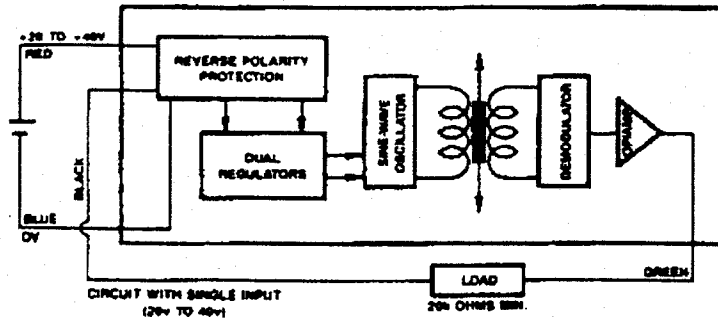


**#31 DC/DC LVDT (single power supply)  
Reverse polarity protected w/voltage regulator**

Wire	Designation
Red	(+) Supply (+20 to +40VDC)
Blue	Supply return
Green	(+) Output +/- 5VDC (Min. 20K ohm load across Black and Green)
Black	(-) Output
Yellow	Inverted output (Alternative to Green)
Brown	No connection

**Note:** Either blue or black must float. If both are grounded, the unit will be destroyed.

**Note:** Cable shield is not connected to transducer.





# Troubleshooting Guide

## Unamplified Transducers

Symptom/Problem

No Output

### Action/Troubleshooting

Verify correct wiring  
Verify excitation per calibration sheet.  
make sure pressure, load, etc. is being applied.  
Check strain gage bridge for continuity per calibration sheet.

Erratic/Intermittent Output or Zero Drift

Check electrical connections for discontinuity or damage.  
Check for isolation resistance between bridge wiring and transducer body.  
Make sure pressure, load, etc. is constant.  
Check stability of excitation power supply.  
Check millivolt output with volt meter.  
Check for RFI/EMI interface.  
Make sure there are no rapid changes in temperature.

Incorrect Output

Check actual input and output resistance against calibration sheet data for possible change or open bridge.  
Check Zero offset to see if high.

High Zero Offset

Usually indicates transducer was overranged beyond specifications. Overranged transducers should be recalibrated.  
Check actual input and output resistance measurements against calibration sheet for possible changes or open bridge.  
Check for possible mechanical preload or damping on transducer body.

## Amplified Transducers

Symptom/Problem

No Output

### Action/Troubleshooting

Make sure power supply voltage meets transducer requirements.  
Check wiring connections and wiring code.  
Check transducer specifications for type of output provided (i.e. voltage, frequency, etc.)  
Make sure pressure, load, etc. is being applied.  
make sure that the output load is not shorted.

Incorrect Zero Level

Check for pre-load on transducer.  
Adjust zero or balance control.  
For load cells check mounting fixture bias.  
For pressure transducers, check for orientation bias.

Erratic/Intermittent Output or Zero Drift

Make sure pressure, load, etc. is constant.  
Make sure power supply remains within specifications.  
Check for RFI interference.  
Make sure there are no rapid changes in temperature.  
Check electrical connections for discontinuity or damage.  
Check output with volt meter.  
Check for insulation resistance between amplifier wiring and transducer shell.

Incorrect Output

Check "shunt" calibration output value against calibration sheet and adjust span control per instructions.  
Verify that transducer is being operated within its temperature compensated range.  
Check transducer range on label.  
Check for insulation resistance between amplifier wiring and transducer shell.

## Transducers with Instrument Readout

Symptom/Problem

Erratic Display

No Display/No Output Voltage

### Action/Troubleshooting

Check electrical connections for continuity and wiring code for pin layout.

Check powerline fuse per instrument instructions.

Blinking Display

Indicated overload; make sure wires are all connected, and transducer is within its range.

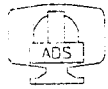
Incorrect Readout Value

Check transducer range on label.  
Verify that system was set-up per instructions. Review set-up procedure.  
Refer to transducer troubleshooting guide and verify that transducer operates properly.  
Use Shunt-Cal to verify calibration.

**6.6. Inductive Proximity Switch**

Manufacturer	BAUMER ELECTRIC (Swiss)
Type	inductive proximity switch normally open (NO) with LED, type IFR 05.26.25/L
Voltage supply	10÷30 VDC
Temperature Range	(-25°C,+75°C)

More details about the switch are reported in the attached data sheet.

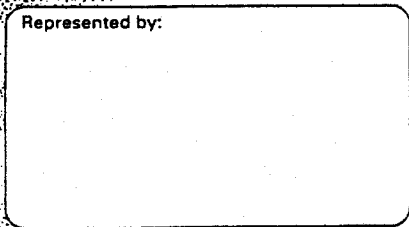


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- **Motor Sensor Interface AS-i**
- **Capacitive Sensors**
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- **Encoders**
- **Glass and Plastic fibers**
- **Inductive Sensors**
- **Laser Sensors**
- **Micro and Programmable Limit Switches**
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- **Precision Limit Switches My-Com**
- **Pressure Sensors**
- **Resolvers**
- **Tag Identification Systems**
- **Ultrasonic Sensors**

Technical data has been fully checked, but accuracy of printed matter not guaranteed.  
Printed in Switzerland TTY 0599 No. 802126

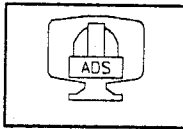
Represented by:



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Internet: <http://www.baumerelectric.com>

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GB-Watchfield  
Swindon, SN6 8TZ  
United Kingdom  
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Fax +44 179 37 83 814  
E-Mail sales.uk@baumerelectric.com



### Cylindrical design DC version / cable connection

**Dimensions**

5 mm

0,8 mm

PNP	normally open	NO	IFR 05.26.35/L
	normally closed	NC	IFR 05.26.45/L
NPN	normally open	NO	IFR 05.26.15/L
	normally closed	NC	IFR 05.26.25/L

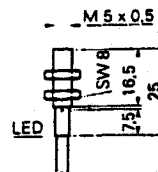
**technical data**

voltage supply range	10 - 30 VDC
supply current	< 18 mA
max. switching current	100 mA
voltage drop	< 2,5 V
max. switching frequency	5 kHz
sensing distance S <sub>n</sub>	0,8 mm
switching hysteresis (as % of S <sub>n</sub> )	3...20 %
output indicator	red LED
short circuit protection	yes
reverse polarity protection	yes
temperature range	-25...+75 °C
housing material	stainless steel (1.4305)
protection class	IP 67



remarks: cable PUR

- Sn shielded
- Sn unshielded

**Preferential types**



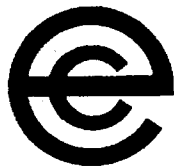


	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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### 6.7. Brake

Manufacturer	ELECTROID COMPANY
Type	EFSB-35-12-28V MOD.B
Torque	3.95 Nm
Weight	12 N
Inertia of rotating armature	3.5 e <sup>-5</sup> Kgm <sup>2</sup>

More details about the EFSB-35 are reported in the attached data sheet.



## ELECTROID COMPANY

A DIVISION OF VALCOR ENGINEERING CORP.  
 45 Fadem Road • Springfield, NJ 07081  
 201/467-8100 Fax: 201/467-5656



I.P.S.

INTERNATIONAL PROMOTION SERVICES s.r.l.

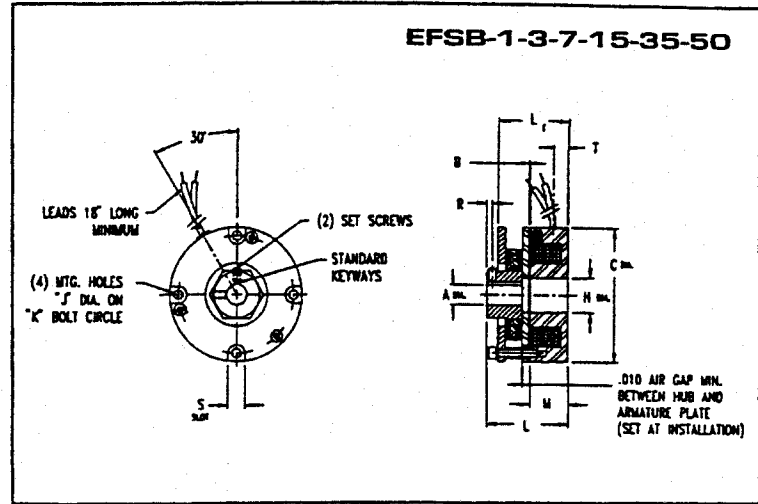
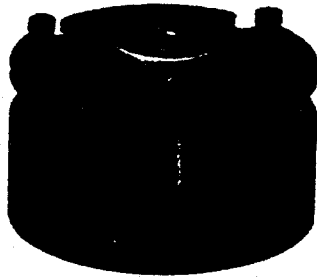
Via Gide, 33 - 00143 Roma

Tel: +39-6-5020321 (3 linee)

Telefax: +39-6-5005069



# EFSB SERIES

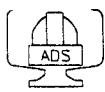


MODEL #	A DIA.	B AIR GAP	C DIA.	H DIA.	J	K	L	L <sub>1</sub>	M	R	S
EFSB-1	$\frac{1}{8} \cdot \frac{3}{16} \cdot \frac{1}{4}$	.003 TO .006	1.375	.280	(3) .126 DIA.	1.180 B.C.	.88	.73	.44	.09	.19
EFSB-3	$\frac{3}{16} \cdot \frac{1}{4} \cdot \frac{3}{8}$	.006 TO .010	1.750	.410	(3) .126 DIA.	1.545 B.C.	1.06	.87	.53	.11	.20
EFSB-7	$\frac{1}{4} \cdot \frac{3}{8} \cdot \frac{1}{2}$	.005 TO .015	2.44	.625 .627	(4) .172 DIA.	2.125 B.C.	1.45	1.25	.69	.10	.31
EFSB-15	$\frac{1}{4} \cdot \frac{3}{8} \cdot \frac{1}{2}$	.005 TO .015	2.44	.625 .627	(4) .172 DIA.	2.125 B.C.	1.45	1.25	.69	.10	.31
EFSB-35	$\frac{1}{2} \cdot \frac{5}{8} \cdot \frac{3}{4}$	.005 TO .015	3.50	1.000 1.002	(4) .203 DIA.	3.125 B.C.	1.89	1.63	1.00	.17	.34
EFSB-50	$\frac{1}{2} \cdot \frac{5}{8} \cdot \frac{3}{4}$	.005 TO .015	3.50	1.000 1.002	(4) .203 DIA.	3.125 B.C.	1.89	1.63	1.00	.17	.34

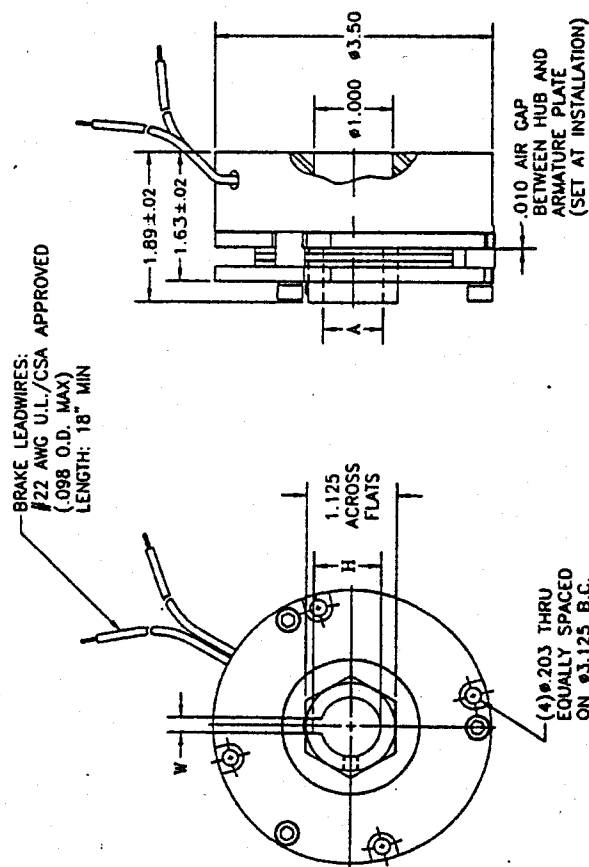
**NOTES:**

1. Attachment of armature hub is secured by key (where noted) and two set screws.
2. Maximum rated speed 7500 RPM.
3. 90 & 24/28 Volt DC are standard, built-in rectifiers for direct A.C. use. (Other voltages available upon request)
4. These models are also available with ZERO BACKLASH spring release armature assemblies. Consult ELECTROID for details.

MODEL #	MECHANICAL				ELECTRICAL		
	RATED STATIC TORQUE (IN - LBS.)	UNIT WEIGHT (LBS.)	INERTIA OF ROTATING ARMATURE (LBS.-IN. <sup>2</sup> )	RESPONSE TIME (MILLI-SEC.)	COIL #	RATED VOLTAGE (V.D.C.)	CURRENT (AMPERES)
EFSB-1	1	0.3	.001	25	1	90	.05
					2	24/28	.13
EFSB-3	3	0.4	.004	35	1	90	.05
					2	24/28	.13
EFSB-7	7	1.2	.012	45	1	90	.07
					2	24/28	.20
EFSB-15	15	1.2	.012	45	1	90	.12
					2	24/28	.30
EFSB-35	35	2.7	.127	95	1	90	.06
					2	24/28	.25
EFSB-50	50	2.7	.127	95	1	90	.09
					2	24/28	.39



REVISIONS	DATE	APPR



MODEL B NO ZERO BACKLASH

- NOTES:
1. STATIC TORQUE \_\_\_\_\_ 35 IN-LB MIN
  2. POWER CONSUMPTION \_\_\_\_\_ SEE TABLE
  3. RATED CURRENT \_\_\_\_\_ SEE TABLE

CUSTOMER INSTALLATION DRAWING

UNAPPROVED USE, REPRODUCTION OR MODIFICATION OF THIS DRAWING IS STRICTLY PROHIBITED WITHOUT THE WRITTEN PERMISSION OF ELECTROID COMPANY	DATE	SIGNATURES	TITLE
DESIGN: M. J. H.	5.4.98	E. REYESCANJAN	POWER-OFF BRAKE
COMP. NUMBER	5.2.88	16554	SEE TABLE
CODE IDENT	DWG. NO.	C	EFSB-35-X-V
SCALE	1:1	LIMIT WT.	SHEET 1 OF 3

SEP 08 2000

PART NO.	POWER	RATED CURRENT	A MORE	H: .388	W: .888
EFSB-35-B-24V	6.2 WATTS	.256 AMPS	.501/.500	.565	.126
EFSB-35-B-90V	5.4 WATTS	.060 AMPS	.501/.500	.565	.126
EFSB-35-10-12V	5.6 WATTS	.464 AMPS	.626/.625	.714	.188
EFSB-35-10-24V	6.2 WATTS	.256 AMPS	.626/.625	.714	.188
EFSB-35-10-90V	5.4 WATTS	.060 AMPS	.626/.625	.714	.188
EFSB-35-12-24V	6.2 WATTS	.256 AMPS	.751/.750	.842	.188
EFSB-35-12-90V	5.4 WATTS	.060 AMPS	.751/.750	.842	.188

(4) Ø 2.03 THRU EQUALLY SPACED ON Ø 3.125 B.C.

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## 6.8. Connectors

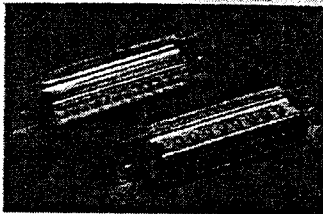
More details about the connectors used are reported in the attached sheet.

PREZZI PER QUANTITÀ SUPERIORI  
NELL'INDICE CODICE

## Connettori - Elettronica/Circuiti stampati 1-197

	Specif. prim.	Industriale	Commerciale (contatti realizzati a macchina)	Commerciale di messa a terra	Commerciale di messa a terra contatti sagomati	Contatti sagomati migliorati ad angolo retto	Plastico	A griffare di messa a terra
Involucro	Acciaio	Acciaio	Acciaio	Acciaio	Acciaio	Acciaio	Poliestere	Acciaio
Finitura involucro (standard)	Zincato cromato passivato	(Come specif. prim.)	(Come specif. prim.)	-	-	-	Naturale	-
Naturale (di messa a terra)	-	Stagnato	-	Stagnato	Stagnato	Stagnato	-	-
Isolamento*	GF dialit - fisaleto	GF - poliesteri	GF - poliesteri	GF - poliesteri	GF - poliesteri	GF - termoplastico	GF - poliesteri	GF - nylon
Isolamento max.	UL94V-0	UL94V-0	UL94V-0	UL94V-0	UL94V-0	UL94V-0	UL94V-0	UL94V-0
Contatti	Leghe di rame	Leghe di rame	Leghe di rame	Leghe di rame	Leghe di rame	Leghe di rame	Bronzo	Leghe di rame
Placcature contatti	Oro da 2,5 µm	Oro 0,7 µm	Oro 0,2 µm	Oro 0,2 µm	Oro 0,1 µm	Oro 0,1 µm	Oro su nichel	Oro su nichel
Corrente di alimentazione	5 A	5 A	5 A	5 A	5 A	3 A	1 A	5 A
Tensione di alimentazione	750 V = o - picco	(Come specif. prim.)	750 V - V <sub>eff</sub>	500 V - V <sub>eff</sub>	500 V - V <sub>eff</sub>	350 V = o - picco	350 V = o - picco	750 V = o - picco
Resistenza:								
Contatti (max.)	5 mΩ	5 mΩ	5 mΩ	10 mΩ	15 mΩ	15 mΩ	5 mΩ	5 mΩ
Isolamento (min.)	5 x 10 <sup>9</sup> MΩ	5 x 10 <sup>9</sup> MΩ	10 <sup>9</sup> MΩ	5 x 10 <sup>9</sup> MΩ	10 <sup>9</sup> MΩ	5 x 10 <sup>9</sup> MΩ	5 x 10 <sup>9</sup> MΩ	10 <sup>9</sup> MΩ
Temperatura di funzionamento	a +125°C	a +125°C	a +125°C	da -55°C a +125°C	da -55°C a +125°C	da -55°C a +105°C	da -55°C a +105°C	da -55°C a +125°C
Categorizz. ambientale	55/125/56	55/125/21	-	-	-	-	-	-
Ciclo di accoppiamento (min.)	500	500	250	250	100	100	50	250

\* GF = vetroinforzato

Commerciale  
(contatti forgiati)

Connettori a "D" a basso costo per applicazioni commerciali. L'involucro e le terminazioni si conformano alle specifiche MIL-C-24308.

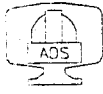
Le prese/involucro sono stagnati e svasati per garantire una buona continuità di messa a terra. Le terminazioni a "bucket" di saldatura sono stagnate per la saldatura ad inumidamento. I parametri di esercizio sono indicati nella tavola 1 riportante le specifiche tecniche e nei dati aggiuntivi.

- Contatti placcati in oro da 0,1 µm
- Stampati e foggiate per bassi costi
- Garantisce una buona protezione da EMI/RFI

Involucro a saldare con  
messa a terra

Confezione da: 5 pezzi

Modello	Codice	Prezzo/conf. L.
Spina a 15 poli	465-378	6.370 5.830
Spina a 25 poli	465-407	9.360 8.140
Spina a 25 poli	465-390	8.210 6.850
Spina a 37 poli	465-413	14.200 13.100
Spina a 50 poli	465-441	29.700 27.300



PREZZI PER QUANTITÀ SUPERIORI  
NELL'INDICE CODICE

# Connettori - Multipolari 1-299

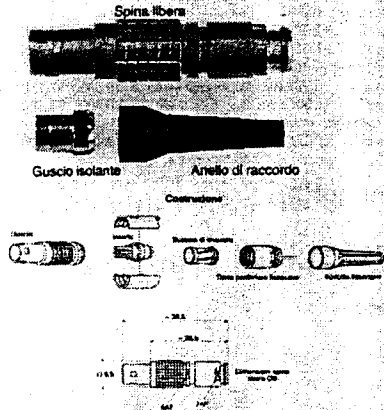
## Connettori OB autobloccanti

Serie compatta di spine libere (diam. 9,5mm) che si accoppiano con prese montate su pannello o su circuito stampato; tutte realizzate con materiale isolante PEEK. Le spine libere e le prese per pannello contengono contatti con fossetta a saldare.

	2 poli	3 poli	4 poli	5 poli	6 poli	7 poli
Corrente nom. (per piedino)	10A	8A	7A	6,5A	2,5A	2,5
Tensione nom. (c.a.)	660V	600V	660V	400V	320V	320V
Tensione nom. (c.c.)	460V	420V	460V	260V	220V	220V
Ø filo accettato (mm)	0,75	0,75	0,55	0,55	0,35	0,35
Resistenza ai contatti (mΩ)	4,1	4,1	5,8	5,8	5,3	5,3
Resistenza dielettrica (PEEK) (kV mm)	-19					
Materiale dell'involucro	Ottone (ASTM C 385)					
Rivestimento corpo	Nichel (a cromo sui punti d'usura)					
Materiale dei contatti	Spina: ottone, Presa: bronzo					
Rivestimento dei contatti	Oro a norma MIL-G-4520C modello 1					
	Classe 1					

## Connettori volanti

LEMO

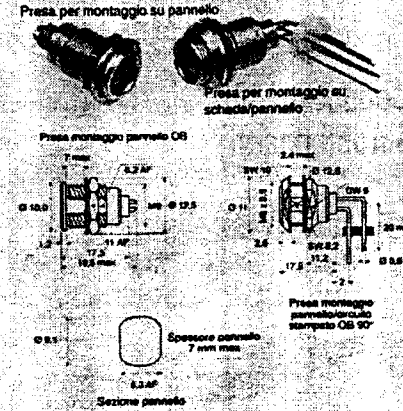


Le spine e prese libere OB sono fornite con un grosso anello per cavi fino a 5mm di diametro esterno e sono fornite di dado posteriore bloccacavo. Anelli più piccoli e gusci serracavo neri sono disponibili separatamente.

Mod.	Codice LEMO	Codice	Prezzo cad. L.
<b>Spine libere OB</b>			
2 poli	FGG08302CLA05Z	215-6972	31.400 29.200
3 poli	FGG08303CLA05Z	215-6988	32.600 30.400
4 poli	FGG08304CLA05Z	215-6904	34.500 32.300
5 poli	FGG08305CLA05Z	215-6010	36.200 33.900
6 poli	FGG08306CLA05Z	248-3473	38.400 35.800
7 poli	FGG08307CLA05Z	248-3889	39.900 37.900
<b>Prese libere OB</b>			
2 poli	PHG08302CLLD5Z	248-3895	28.800 26.800
3 poli	PHG08303CLLD5Z	248-3902	30.200 28.100
4 poli	PHG08304CLLD5Z	248-3952	32.000 29.700
5 poli	PHG08305CLLD5Z	248-3946	34.500 32.200
6 poli	PHG08306CLLD5Z	248-3930	35.900 33.200
<b>Anelli OB (mm)</b>			
da 2,1 a 3,0	FGG08731DN	215-6026	3.110 2.840
da 3,1 a 4,0	FGG08742DN	215-6032	3.110 2.840
<b>Gusci serracavo OB (mm)</b>			
da 2,5 a 2,9	GMA08025DN	215-6048	3.730 3.440
da 3,5 a 3,9	GMA08035DN	215-6054	3.730 3.440
da 4,5 a 5,2	GMA08045DN	215-6076	3.730 3.440



## Montaggio a pannello e circuito stampato

LEMO



Le prese per montaggio su pannello professionali serie OB sono disponibili con fossetta a saldare o terminali a 90° per scheda circuito stampato. Sulla versione per scheda il dado frontale è regolabile.

Modello	N. rif. LEMO	Codice	Prezzo cad. L.
<b>Presse per montaggio su pannello OB</b>			
2 poli	EGG08302CLL	130-5542	23.500 21.900
3 poli	EGG08303CLL	130-5564	24.900 23.000
4 poli	EGG08304CLL	130-5570	25.500 24.800
5 poli	EGG08305CLL	215-6082	28.300 26.400
6 poli	EGG08306CLL	248-3518	30.300 28.200
7 poli	EGG08307CLL	248-3924	31.300 29.400
<b>Presse per scheda/pannello OB 90°</b>			
5 poli	EEG08305CLV	215-6088	58.200 46.900
2 poli	EPG08302HLN	130-5627	35.200 33.700
3 poli	EPG08303HLN	130-5637	40.700 37.800
4 poli	EPG08304HLN	130-5643	45.100 41.900
5 poli	EPG08305HLN	204-8803	49.500 45.900

	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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### **6.9. Structural Parts**

All the structural parts such as the actuator housing and joints forks are made of aluminium alloy ANTICORODAL alloy 6082 UNI 9006/4 with ALODINE 1200 anodising treatment.

The joints crosses and covers and other rings are made of stainless steel AISI 304 for stiffness reasons.

All the fixation screws are made of stainless steel in accordance to UNI classes.

More details about the certificate material are reported in the attached sheet.



# MMT CONVERSION

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## ogne CIAI SPECIALI



**Cogne Acciai Speciali s.r.l.**  
SEDE LEGALE: 11108 ACOSTA - VIA PARAVERA, 16  
TELEFONO 01858821 - TELEX 228048 - TELEFAX 018520413  
CAPITALE SOCIALE L. 480.000.000 INTERAMENTE VERSATO

PARTITA IVA 0367128078  
CODICE FISCALE 0216728078  
REG. COM. TRIB. DI ACOSTA N. 729461  
REG. CITTE C.C.I.A.A. DI ACOSTA N. 2047

(A92) CERTIFICATO DI COLLAUDO 3.1.B (EN 10204 : 1991)

(A63) N. 99/71051  
PAGINA 1 / 1

66) COMMITTENTE ..... PDATO F.LLI DI R. PINATO  
 67) ORIGINAZIONE DEL COMMITTENTE .....  
 68) STABILIMENTO PRODUTTORE ..... COGNE ACCIAI SPECIALI - ACOSTA, VIA PARAVERA 16  
 65) REDATTORE DEL DOCUMENTO ..... SERVIZIO QUALITA' EMESSO DA COGNE DEPOSITO DI CORNAREDO  
 68) CONFERMA D'ORDINE DEL PRODUTTORE ..... 80062242 081 (A94) STELLA STABILIMENTO PRODUTTORE ..... :COGNE!  
 69) AVVISO DI SPEDIZIONE .....

SPECIFICA ..... 316/316L-N.4401/4404  
 61) PRODOTTO ..... TONDI SERRIATO DI PELAT.  
 64) STATO DI FORNITURA ..... STABILIZZATO  
 62) DIMENSIONI DEL PRODOTTO (MM)..... 105,00  
 62) QUALITA' ACCIAIO ..... N.4401/N.4404 MARCA COGNE ..... F316L  
 63) NUMERO DI COLATA ..... 879065 (B67) NUMERO DI SCHEDA ..... 81587  
 64) MARCATURA DEL PRODOTTO .....  
 14) PESO ..... 756 (KG)

### 71) COMPOSIZIONE CHIMICA - ANALISI DI COLATA

ELEMENTI	C	SI	MN	P	S	N	CR	MO	NI	CU
OTTENUTO	0,025	0,400	1,490	0,024	0,021	0,041	16,750	2,030	11,200	0,360

### PROVA DI TRAZIONE ALLO STATO DI FORNITURA

NORMA EN 10002 (C62) ORIENTAMENTO DELLE PROVETTE L

	RP (N/MP2)	RM	A (Z)	Z
	0,260 Z	(N/MP2)	5,0 D	(Z)
OTTENUTO	248,0	535,0	56,60	77,00

### PROVA DI DUREZZA ALLO STATO DI FORNITURA

NORMA EN 3/79-2/80 (C30) METODO DI PROVA HB

—OTTENUTO—  
137,0

DIST. NE. 5555 DEL 2000

FABBRICAZIONE AL FORNO ELETTRICO + AOD  
 LA FORNITURA E' CONFORME ALLE PRESCRIZIONI CONTRATTUALI  
 AZIENDA CON SISTEMA DI GARANZIA DELLA QUALITA' CERTIFICATO DA ISO SECONDO  
 UNI EN ISO 9002:94 E QS-7000 EDIZ. FEBBRAIO 1995.  
 CONFORMITA' ALLA SPECIFICA ASTM A276-95, A479/A479M-95A  
 CONFORMITA' ALLA NORMA EN 10088/3

PROVENIENTE DA CERTIFICATO NUMERO : 98 16437

F.LLI PINATO & C. 835

Patrizia

COPIA CONFORME  
ALL'ORIGINALE

800060 104323

31) DATA 27 04 99

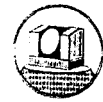
FIRMA AUTORIZZATA

COGNE ACCIAI SPECIALI s.r.l.



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**Ugine-Savoie**  
249544  
249555 FRANCE 249557

4 N. Nr Mo 19404  
11 N. de commande autre-Work order number  
FUGE FUG2 1/1 IDM11000 T

CERTIFICATO COLLAUDO DI ACCETTAZIONE B  
CERTIFICAT DE RECEPTION 3.1.B  
INSPECTION CERTIFICATE B

UGINE  
F 73403 UGINE CEDEX  
Tél : 71.88.30.30  
Mél : ugin@mmt.com

EN 10204 / 3.1.B DIN 50049 / 3.1.B

Produit / Erzeugnis / Product  
**TONDO LAMINATO TOL.13 SOLUBILIZZATO DECAPATO**

Client ou destinataire - Besteller und/oder Empfänger - Purchaser and/or Consignee  
UGINE SRL

Norme et spécifications techniques - Normen und Prüfbedingungen - Quality and Specifications  
UGIMA 4307 EN 10088-3 1.4307  
ASTM A182-A276-A479 TYPE 304L/304 + EUROSTORE P.2 7 0395

Etat de livraison - Lieferzustand - Arrived (1)  
SOLUBILIZZATO

Identification du produit Erzeugnis Benennung-Product Identification N. de code usine - N. de poste N. de Code Werkstatt-Nr. Post Nr. Schicht Nr. Works order number Item No. Heat No.	Quantité Stückzahl Pieces Nbr	Profil Profil Shape	Longueur Länge Length	Masse Gewicht Weight
1DM11 000 604065	4 TONDO	19-20	125,000	2038 KG

V. de Prélevement Probennummer Test N.	Diamètre Nominal Nominale Nominal N. de Code Schicht Nr. Heat N.	Température Température Temperature Température Température	Traction - Zugversuch - Tensile test		Allongement Elongation Elongation Elongation Elongation	Dureté Dureté Hardness Dureté Dureté	Résilience - Kerbschlagenergie - Notch Toughness			Moyenne Mittelwert Average	Dureté Hardness Hardness
			Limite d'Elasticité Streckgrenze Yield strength	Résistance à la traction Zugfestigkeit Tensile strength			Type Form Type	Température Température Temperature Température Température	Température Température Temperature Température Température		
38 B	Min Max	RT	0,2 % 28 A	1 % 28 B	27	30	31	32	33	34	35
			N/MM2 205	N/MM2 515 650	45 50						
(4)			300	620	58	81					

V. de Prélevement Probennummer Test N.	Diamètre Nominal Nominale Nominal N. de Code Schicht Nr. Heat N.	Analyse Analyse Analysis Analyse Analyse	C	SI	MN	NI	CR	N	S	P
			604065	0,030	0,75	2,00	9,00	18,00	0,100	0,015
			0,017	0,45	1,07	9,05	18,17	0,053	0,030	0,030

Mode d'élaboration Erzeugnis Erzeugnis Erzeugnis	Température Température Temperature Température Température	32	33	34	35

NF A 35-574 Z3CN19-09 & Z7CN18-09 ASTM A182 A276 A479 GRADES 304L & 304  
DIN 17440 NMR 1.4301 BS 970 PART 1 & 3 GRADES 304S11 & 304S12 & 304S31  
VALORE MINIMO GARANTITO DELLA RESILLENZA ISO-V = 160 J (LUNG.)  
RESISTENTE ALLA CORROSIONE INTERCRISTALLINA SECONDO EUROENORM 114

TOUGHNESS: GUARANTEED MINIMAL IMPACT ISO-V VALUE = 160 J (LENGTH)  
INTERCRYSTAL CORROSION RESISTANT ACC. TO EUROENORM 114 / ANTIMIXING TESTED

TONDO LAMINATO TOL.13 SOLUBILIZZATO DECAPATO

F.LLI PINATO & C. S.p.A.  
COPIA  
ALL'ORIGINALE

(1) L - Long / Länge - Long / Y - Transvers / Quer-Transvers  
(2) TE - Température & Form / Wärmeverfahren - Wärmeverfahren / TH - Température & Profil - Cisionen - Öl Quersch / A - Hypertempéré - Lösungsgelöst - Solution annealed  
A - Flammé - Anlassen - Tempéré / RT - Recuit - Geführt - Annelé / TPM - Recuit mou - Weichgeglüht - Mild annealed  
Ugine, le 20-02-96  
L'Agent Responsable de l'Usine / Der Werkverantwortliche / The Work Inspector

(4) A Fñal de référence / Zero Being Zustand / At reference condition  
(5) A Fñal de livraison / In Lieferzustand / In state of delivery  
Contrôle de livraison, d'aspect et de dimensions satisfaisants / Beschreibung, Beschätzung und Ausmessung / ohne Beanstandung / Marking, inspection and measurement: without objection  
Nous certifions que les produits livrés et/ou ceux qui sont conformes aux prescriptions de la commande / Wir bestätigen hiermit dass die abgenommenen Erzeugnisse den Bestelldaten entsprechen / We certify hereby that the above mentioned products are consistent with the order specifications  
D. Thivellie





MMT CONVERSION

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ALZ
L'AMBIENTE VERDE
MILANO
Via S. Sofia, 27 - Tel. 02 861 22 80

Certificate of test - Mill certificate No 96/0050144
Certificat de Réception C.C.F.U. Nr.
Abnahmeprüfzeugnis B nach DIN 50048/3.1.8 - NF. 10001/3.1.8 - EN 10204/3.1.8



Der TÜV Rheinland hat mit Schreiben vom 11. März 1996 auf die Gegenzeichnung vorstehend
SUPERVISOR MARK
L'EXPERT
STÄMPEL DES WERKSACHVERSTÄNDIGEN

Approved by supplier under 1.8
AD/VO
Manufacture of Manufacturer
LAC/AG-VO
year order 1996 1 20 02 1996
LOT 1:3432/96
LAC/3S/MAG96

VOD PRODEL, Sintered Arc Furnace - VOD - Continuous Casting
- QC FABRIC, Four & Six - VOD - Coils Casting
- S' CUNCIARL, Sinter-Lichtbogen Ofen - VOD - Strangguß

63060/594/30

ACIER INOXYDABLE, COILS, LAMINES A CHAUD REC. 75
ET DECAPES

Inspection No N618078
Serial No 81807834

Table with columns: Specifications - Specifications - Normation, Trade Name, Quantity, and various standards like ASTM A 240-94, BS 1449 PART2-1983, AFNOR NFA 36209-05/90, TYPE 304L, 304S11, Z3 CN 18-10, and ASTM A262 E - 93A.

Table with columns: Dimensions - Abmessungen, Material Code Designation, and Quantities like 10.00, 1500.00, 0.0, and ASTM A240 1050°C.

Large table with columns: CHEMICAL ANALYSIS, MECHANICAL PROPERTIES, and TESTS. Includes rows for ELEMENTS (C, Mn, P, S, Cr, Ni, Mo, Cu, N), TENSILE TEST, and VISUAL INSPECTION.

Table with columns: PACKAGE NO, QTY, NET WEIGHT, and GROSS WEIGHT. Includes a stamp: 'THIS IS A TRUE COPY OF AN ORIGINAL CERTIFICATE' and 'ALZ'.

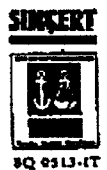
SO GE PAR. SPA
VIA S. SOFIA, 27
20122 MILANO
ITALIE
F.LLI PINATO & C.
COPIA CONFORME ALL'ORIGINALE

ALZ
THE SUPERVISOR - L'EXPERT - DER WERKSACHVERSTÄNDIGER
Date: 07.06.1996
H. JANSSEN

Date of issue : 11-09-96
Customer : F.LLI PINATO SAS
Order number :
Item number : 375
Quantity : 60.5659
Delivery note : Dated 12/09/96
Quality : 304L
Dimension : 10X1500
Heat : N618078

This present document is issued by optical disk filing system under computerized and controlled Quality Assurance procedure.

Stainless Steel Service





MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



**CANALI METALLI S.A.S.**  
**VIA MOLINARA, 13**  
**22031 ALBAVILLA (CO)**

Albavilla, 31-10-2001

Spett. DE CAPITANI ROBERTO.

ATTESTATO DI CONTROLLO

Ns. Rif. D.D.T. 7528 del 24-10-2000

Con il presente Canali Metalli S.A.S. certifica, sulla base della documentazione rilasciata dal produttore, che i prodotti di seguito elencati ed ai quali questa dichiarazione si riferisce, sono conformi a quanto concordato alla ordinazione.

Posizione	Prodotto	Peso	
1	Piastre inox aisi 304 mm.375x155x70 e 165x95x70	kg.142	
2	Piastre inox aisi 304 mm.60x900x25		
3	Piastre inox aisi 304 mm.60x440x20		
	%Al    %Cr    %C    %Fe    %Mg    %Mn    %Mo    %Ni    %P    %Si    %Zn		
1	18,59 0,02 resto	1,76	10,10 0,02 0,48
2	18,26 0,04 resto	1,43	8,05 0,02 0,45
3	18,13 0,02 resto	1,29	8,05 0,02 0,51

Copia conforme a quella originale rilasciata dal produttore.

Canali Metalli s.a.s.



# AIROLDI METALLI SpA

ESTRUSI E LAMINATI IN ALLUMINIO  
 RAME OTTONE BRONZO INOX  
 MOLITENO (L) VLE GRANDI SA  
 TEL 091-5674111 P.A. - TELEFAX 091-5672.077  
 CAPITALE SOGGINO 1.000.000.000 LY.

Certificato di conformità n. 431AC del 16/09/2000

SPETTI.19  
 DE CAPITANI ROBERTO  
 VIA POSTALE VECCHIA, 27  
 OLGINATE 22057

MMT CONVERSION

Doc.No : H5-DP-AD-01001  
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 Date : 27 April - 2001



Vo ORDINE	2000.T	del .	Riferimento M.D.D.T n° 8559 del 16/09/2000	Quantità	120 KG							
Descrizione articolo	ANTICORRODAL TAGL. A MISURA SP. 50	LEGA	8082	Norma Norme	EN 573-3							
				Stato di fornitura	TESTI							
%	Si	Mg	Cu	Fe	Mn	Ti	Cr	Zn	Ni	Zr	Pb	Al
Min	0.7	0.6										0.4
Max	1.5	1.2	0.10	0.5	1.0	0.1	0.25	0.2				
Caratteristiche MECCANICHE	(EN 485-2-3-4)											
	Rm (N/mm <sup>2</sup> ) Rp0.2 (N/mm <sup>2</sup> ) A5%											
DA sp.	12,5 mm											
LA sp.	60,0 mm											

AIROLDI METALLI S.P.A.  
 COME DA QUALITÀ

1) Le proprietà meccaniche sono riportate in funzione del tipo di semilavorato dello stato di fornitura e dello stato fisico in cui è fornito.  
 2) Distanza tra barre  
 3) Spessore di parete.  
 4) Se la sezione di un profilo composta spessori differenti, si considerano i valori specifici riferiti alla sezione meccanica, vanno considerati come validi per l'intera sezione del prodotto i valori minori specifici.



MMT CONVERSION

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**ELIIRE** s.a.s.  
di Giovanni Schianracelli & C.  
Galvanica e Verniciatura dal 1911

**GALVANICA:**  
Argentatura, Doratura, Nichelatura chimica e elettrolitica,  
Alodine 600 - 1000 - 1200, Ramatura, Scagnatura, Zincatura,  
Cromatura, Brillantatura leghe di rame.

**VERNICIATURA:** Smalti, Epossidici, Poliuretanic, Sinterici.

CERTIFICATO DI CONFORMITÀ	
Certificato Nr. No. certificate	560
Anno year	2000
Data Date	12.12.2000
Cliente Customer	MECC. DE CAPITANI ROBERTO
Vs Documento di Consegna Your delivery note	215/L
Vs Ordine Your order	
Descrizione materiale MATERIAL DESCRIPTION	N° 2 DISCHI + HD PARTICOLARI VARI IN ALLUMINIO ANTICORRODAL
CODICE DI RIFERIMENTO	
ALODINE 1200 SECONDO NORME MIL-5511	
DATI DI CONTROLLO	
Spessore riscontrato Thickness	
Brillantezza Brightness	
Aderenza Adhesion	
Note : Note	Firma R.C.Q. 

## 7. ACTUATOR COMPONENTS TESTING AT MANUFACTURERS PREMISES

### 7.1. Roller Screw

All the seven (7) roller screws were tested at the manufacturer premises (Rollvis, Geneve) to verify the static lead accuracy and the friction torque due to the applied preload (torque without load).

The following table reports the roller screws serial number and the corresponding tests executed for acceptance of components (roller screws test matrix):

Actuator ADS S/N	Roller Screw S/N (spindle-nut)	Static Lead Accuracy	Torque without Load
01	2653 - 005117	✓	✓
02	2654 - 005120	✓	✓
03	2651 - 005122	✓	✓
04	2649 - 005123	✓	✓
05	2662 - 005121	✓	✓
06	2650 - 005114	✓	✓
07	2655 - 005118	✓	✓

The following pages report the results of the following tests:

- measurement of the static lead accuracy,
- measurement of the preload torque,

performed by the manufacturer on each one of the seven screws.



## MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

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## ROLLER SCREWS PERFORMANCE TESTING



MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001

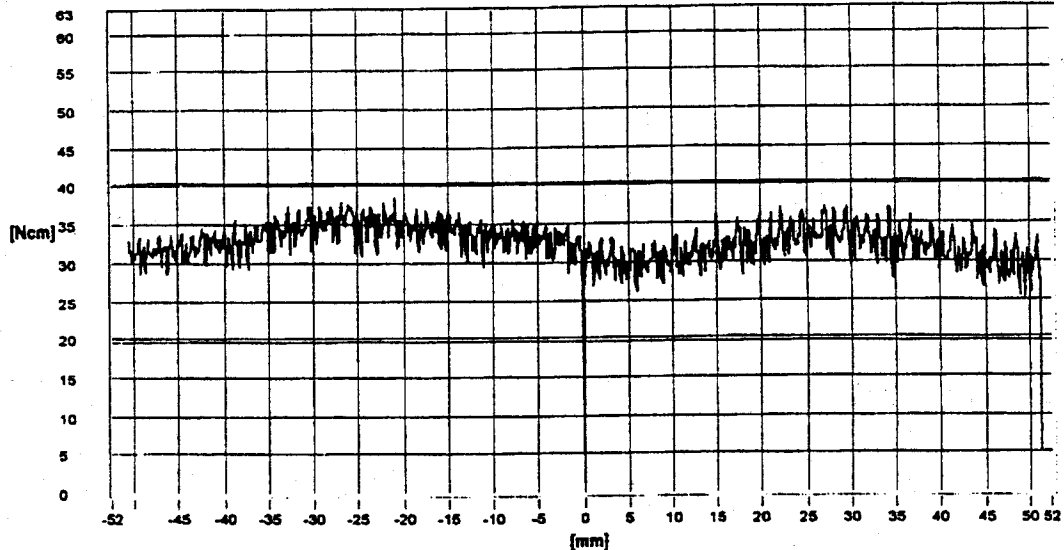


## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)  
(valable pour les couples supérieurs à 0.2 Nm)

Produit	: <b>VIS A ROULEAUX SATELLITES</b>		
No de dessin	: <b>600142/1</b>		
Type de vis	: <b>RVR260/25.1.R1.600142</b>		
No de commande	: <b>C00668</b>	Date	: <b>17.11.00</b>
No de client	: <b>1655</b>	No d'écrou	: <b>005117</b>
No de protocole	: <b>005117</b>	No de vis	: <b>2653</b>
Diamètre	[mm] : <b>25.00</b>	Classe de précision	: <b>G1</b>
Pas	[mm] : <b>1.00</b>	Force de précharge demandée [N]	: <b>3500.00</b>
Longueur totale	[mm] : <b>329.50</b>	Couple de précharge demandé [Ncm]	: <b>30.00</b>
Longueur fileté	[mm] : <b>102.00</b>	Couple maximum admis [Ncm]	: <b>40.50</b>
Course	[mm] : <b>50.00</b>	Couple minimum admis [Ncm]	: <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs	: <b>Non montés</b>
Vitesse de rotation de la vis	[T/Min] : <b>150.00</b>
Lubrification	: <b>TOPAS NCA 52</b>
Nombre de mesure par mm	: <b>10.00</b>

#### Rolvis SA

37, Route du Velodrome	- CH-1228 Plans-les-Ouates	- Genève	- Suisse
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**ROLLVIS S.A. GENEVE**  
 =====

3-KOORDINATEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR.: 2653

KONTROLLE DER STEIGUNG  
 \*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT.: 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

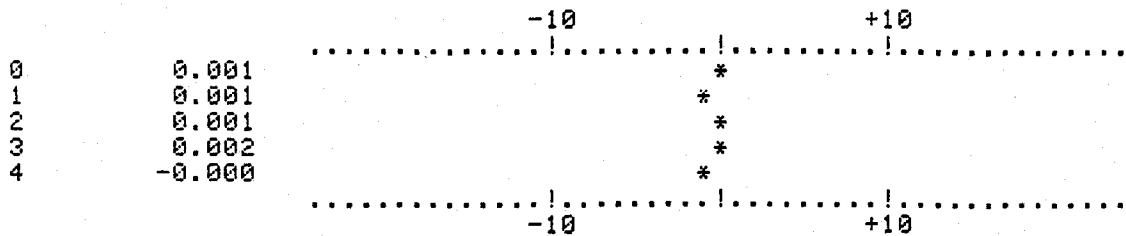
KUNDEN NR.: 1655

DATUM : 13 / 11 / 2000

SACHBEARBEITER : *Saulnier*

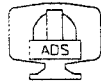
MES.NO.    STEIGUNG F.(MM)  
 =====

GRAFIK DER STEIGUNG  
 =====



.. = 0.001 MM.





# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001

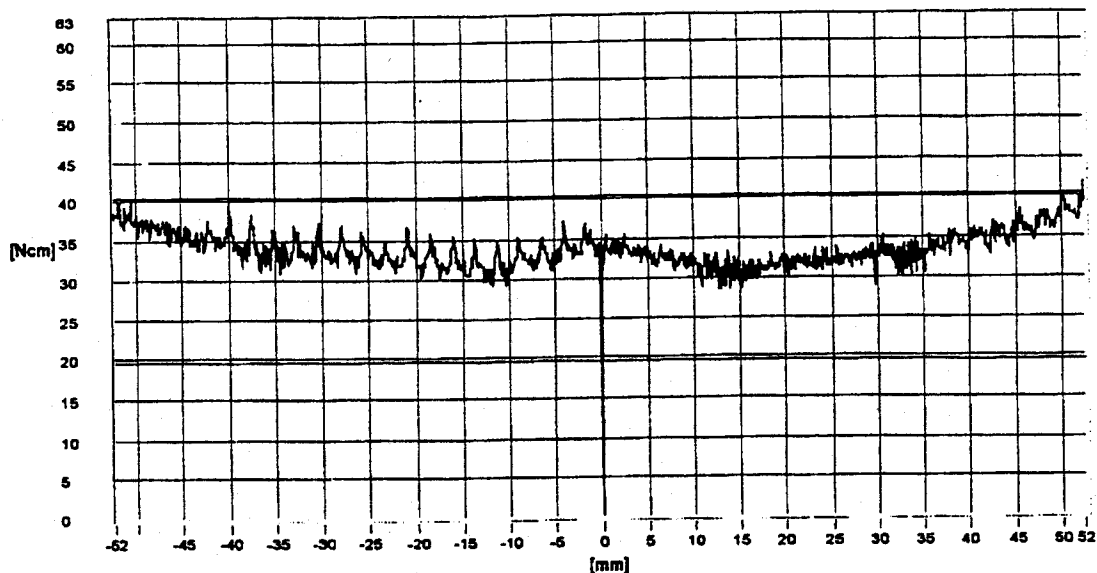


## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)  
 (valable pour les couples supérieurs à 0.2 Nm)

Produit	:	<b>VIS A ROULEAUX SATELLITES</b>	
No de dessin	:	<b>600142/1</b>	
Type de vis	:	<b>RVR260/25.1.R1.600142</b>	
No de commande	:	<b>C00668</b>	Date : <b>17.11.00</b>
No de client	:	<b>1655</b>	No d'écrou : <b>005120</b>
No de protocole	:	<b>00520</b>	No de vis : <b>2654</b>
Diamètre	[mm] :	<b>25.00</b>	Classe de précision : <b>G1</b>
Pas	[mm] :	<b>1.00</b>	Force de précharge demandée [N] : <b>3500.00</b>
Longueur totale	[mm] :	<b>329.50</b>	Couple de précharge demandé [Ncm] : <b>30.00</b>
Longueur filetée	[mm] :	<b>102.00</b>	Couple maximum admis [Ncm] : <b>40.50</b>
Course	[mm] :	<b>50.00</b>	Couple minimum admis [Ncm] : <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs : **Non montés**  
 Vitesse de rotation de la vis [T/Min] : **150.00**  
 Lubrification : **TOPAS NCA 52**  
 Nombre de mesure par mm : **10.00**

#### Rollvis SA

37, Route du Vélodrome - CH-1228 Plans-les-Ouates - Genève - Suisse  
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MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



ROLLVIS S.A. GENEVE

3-KOORDINATEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR. : 2654

KONTROLLE DER STEIGUNG  
\*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT. : 20.00 MM

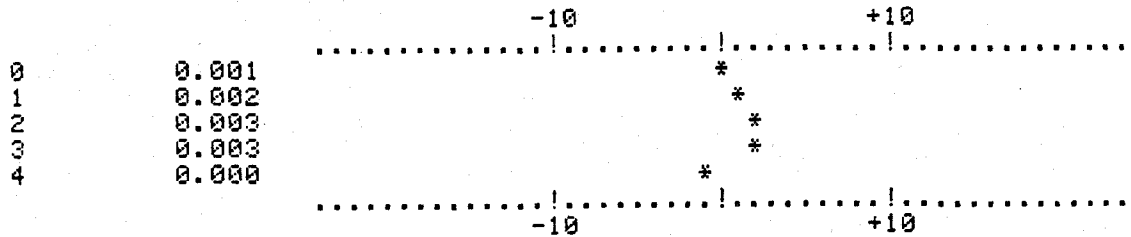
TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM KUNDEN NR. : 1655

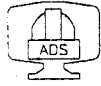
DATUM : 13 / 11 / 2000 SACHBEARBEITER : *Saulnier*

MES.NO. STEIGUNG F.(MM)  
=====

GRAFIK DER STEIGUNG  
=====

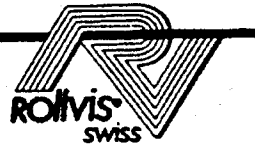


.. = 0.001 MM.



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
 Issue : A  
 Date : 27 April - 2001

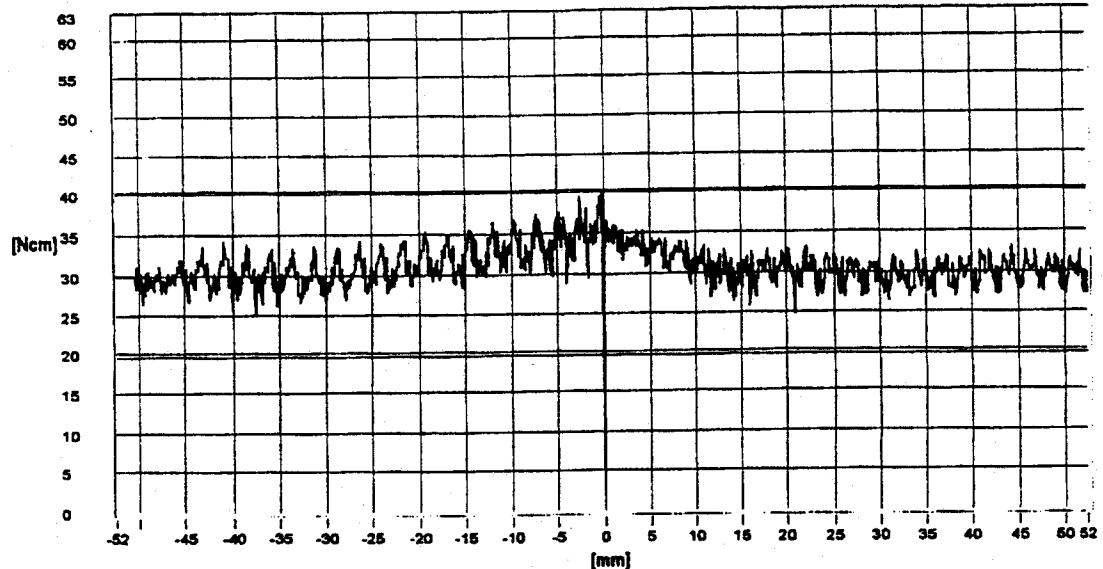


## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)  
 (valable pour les couples supérieurs à 0.2 Nm)

Produit	:	<b>VIS A ROULEAUX SATELLITES</b>	
No de dessin	:	<b>600142/1</b>	
Type de vis	:	<b>RVR260/25.1.R1.600142</b>	
No de commande	:	<b>C00668</b>	Date : <b>17.11.00</b>
No de client	:	<b>1655</b>	No d'écrou : <b>005122</b>
No de protocole	:	<b>005122</b>	No de vis : <b>2651</b>
Diamètre	[mm] :	<b>25.00</b>	Classe de précision : <b>G1</b>
Pas	[mm] :	<b>1.00</b>	Force de précharge demandée [N] : <b>3500.00</b>
Longueur totale	[mm] :	<b>329.50</b>	Couple de précharge demandé [Ncm] : <b>30.00</b>
Longueur filetée	[mm] :	<b>102.00</b>	Couple maximum admis [Ncm] : <b>40.50</b>
Courses	[mm] :	<b>50.00</b>	Couple minimum admis [Ncm] : <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Raccords : **Non montés**  
 Vitesse de rotation de la vis [T/Min] : **150.00**  
 Lubrification : **TOPAS NCA 52**  
 Nombre de mesure par mm : **10.00**

#### Rollvis SA

37, Route du Vélodrome - CH-1228 Plain-Joux - Genève - Suisse  
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**ROLLVIS S.A. GENEVE**  
 =====

3-KOORDINAETEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR. : 2651

KONTROLLE DER STEIGUNG  
 \*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT. : 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

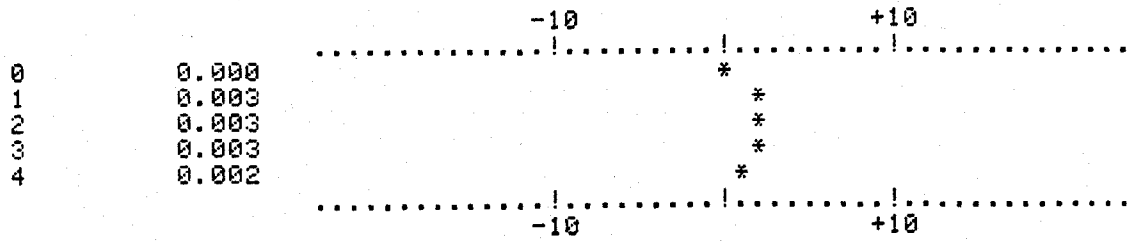
KUNDEN NR. : 1655

DATUM : 13 / 11 / 2000

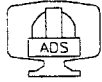
SACHBEARBEITER : *Saulnier*

MES.NØ. STEIGUNG F.(MM)  
 =====

GRAFIK DER STEIGUNG  
 =====



.. = 0.001 MM.



# MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



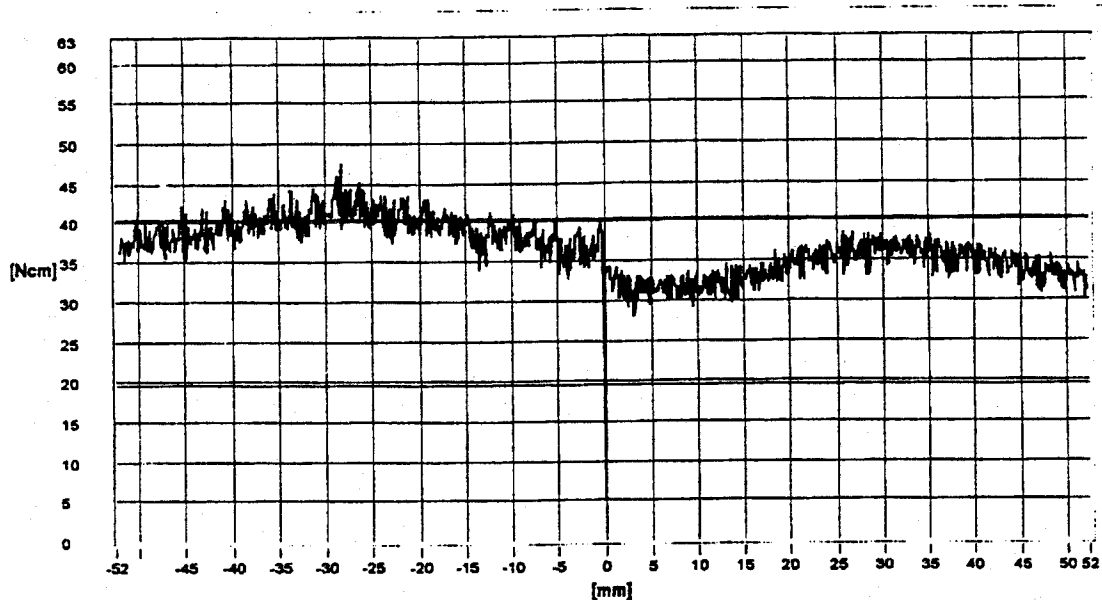
## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)

(valable pour les couples supérieurs à 0.2 Nm)

Produit	:	<b>VIS A ROULEAUX SATELLITES</b>	
No de dessin	:	<b>600142/1</b>	
Type de vis	:	<b>RVR260/25.1.R1.600142</b>	
No de commande	:	<b>C00668</b>	Date : <b>17.11.00</b>
No de client	:	<b>1655</b>	No d'écrou : <b>005123</b>
No de protocole	:	<b>00523</b>	No de vis : <b>2649</b>
Diamètre	[mm] :	<b>25.00</b>	Classe de précision : <b>G1</b>
Pas	[mm] :	<b>1.00</b>	Force de précharge demandée [N] : <b>3500.00</b>
Longueur totale	[mm] :	<b>329.50</b>	Couple de précharge demandé [Ncm] : <b>30.00</b>
Longueur fileté	[mm] :	<b>102.00</b>	Couple maximum admis [Ncm] : <b>40.50</b>
Course	[mm] :	<b>50.00</b>	Couple minimum admis [Ncm] : <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs	:	<b>Non montés</b>
Vitesse de rotation de la vis	[T/Min] :	<b>150.00</b>
Lubrification	:	<b>TOPAS NCA 52</b>
Nombre de mesure par mm	:	<b>10.00</b>

### Rollvis SA

37, Route du Vélodrome - CH-1228 Plans-les-Ouates - Genève - Suisse  
 Tel: (#41 22) 706 90 40 - Fax: (#41 22) 706 90 49 - Email: info@rollvis.com

ADS International Srl - Corso Promessi Sposi, 23/d - 23900 Lecco - ITALY

Steward Observatory - University of Arizona - 933 N.Cherry Ave., Tucson Arizona 85721 - USA



MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



ROLLVIS S.A. GENEVE  
=====

3-KOORDINAETEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR. : 2649

KONTROLLE DER STEIGUNG  
\*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT. : 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

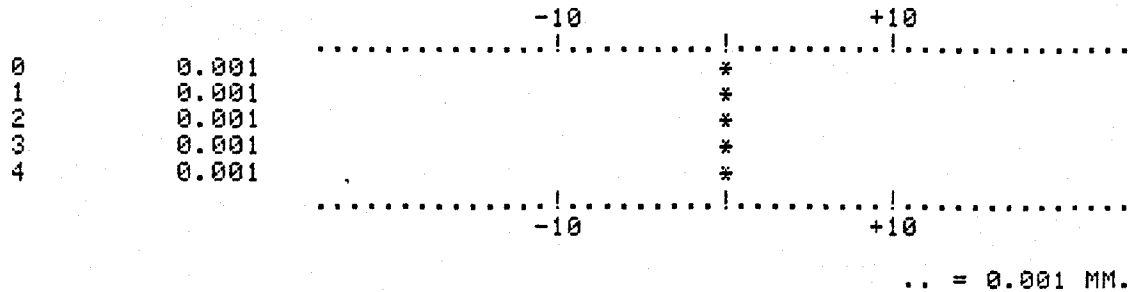
KUNDEN NR. : 1655

DATUM : 13 / 11 / 2000

SACHBEARBEITER : *Sauvies*

MES.NØ. STEIGUNG F.(MM)  
=====

GRAFIK DER STEIGUNG  
=====





# MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



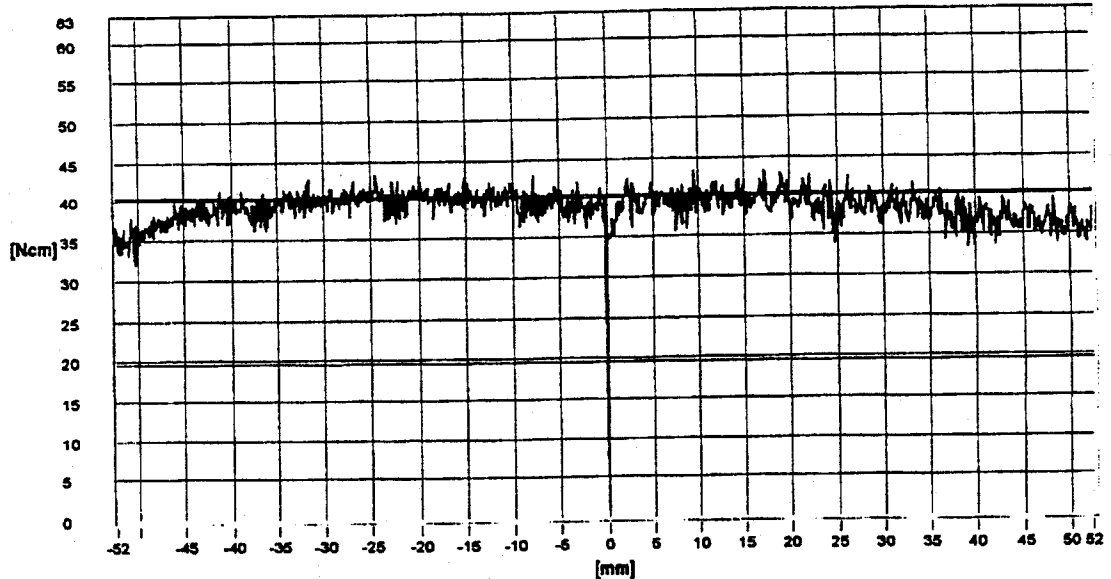
## Mesure dynamique de couple

Ref.: norme ISO 3406-3: 1992 (F)

(valable pour les couples supérieurs à 0.2 Nm)

Produit	:	<b>VIS A ROULEAUX SATELLITES</b>	
No de dessin	:	<b>600142/1</b>	
Type de vis	:	<b>RVR260/25.1.R1.600142</b>	
No de commande	:	<b>C00668</b>	Date : <b>17.11.00</b>
No de client	:	<b>1655</b>	No d'écrou : <b>005121</b>
No de protocole	:	<b>00521</b>	No de vis : <b>2662</b>
Diamètre	[mm] :	<b>25.00</b>	Classe de précision : <b>G1</b>
Pas	[mm] :	<b>1.00</b>	Force de précharge demandée [N] : <b>3500.00</b>
Longueur totale	[mm] :	<b>329.50</b>	Couple de précharge demandé [Ncm] : <b>30.00</b>
Longueur filetée	[mm] :	<b>102.00</b>	Couple maximum admis [Ncm] : <b>40.50</b>
Course	[mm] :	<b>50.00</b>	Couple minimum admis [Ncm] : <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs	:	<b>Non montés</b>
Vitesse de rotation de la vis	[T/Min] :	<b>150.00</b>
Lubrification	:	<b>TOPAS NCA 52</b>
Nombre de mesure par mm	:	<b>10.00</b>

### Rollvis SA

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Page

ROLLVIS S.A. GENEVE  
 =====

3-KOORDINATEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR.: 2662

KONTROLLE DER STEIGUNG  
 \*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT.: 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

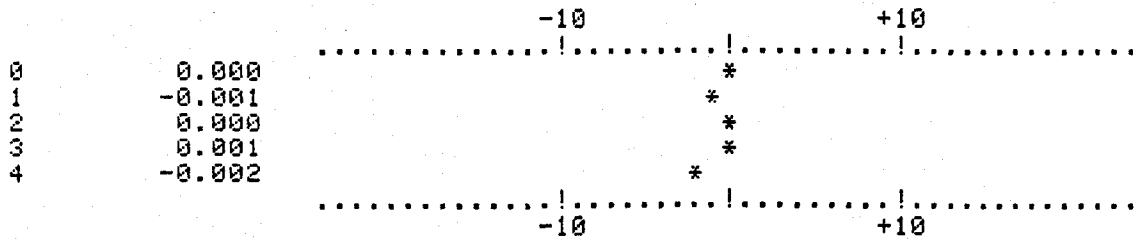
KUNDEN NR.: 1655

DATUM : 13 / 11 / 2000

SACHBEARBEITER : *Saulnier*

MES.NO.    STEIGUNG F.(MM)  
 =====    =====

GRAFIK DER STEIGUNG  
 =====



.. = 0.001 MM.



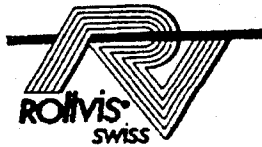


# MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



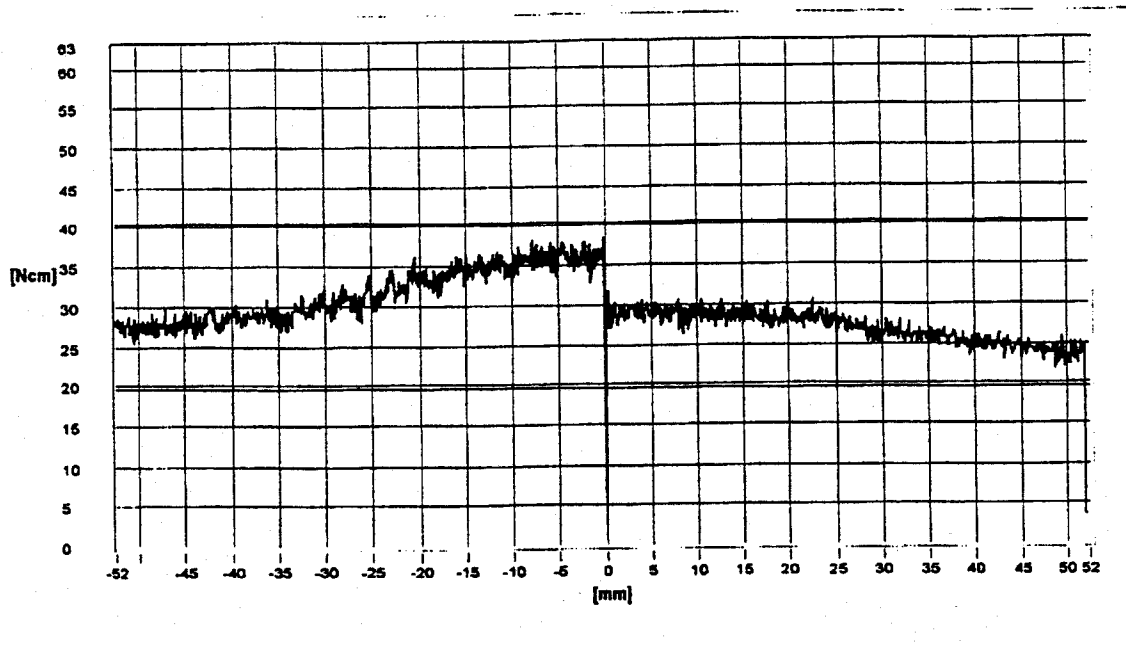
## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)

(valable pour les couples supérieurs à 0.2 Nm)

Produit	: <b>VIS A ROULEAUX SATELLITES</b>		
No de dessin	: <b>600142/1</b>		
Type de vis	: <b>RVR260/25.1.R1.600142</b>		
No de commande	: <b>C00668</b>	Date	: <b>17.11.00</b>
No de client	: <b>1655</b>	No d'écrou	: <b>005114</b>
No de protocole	: <b>005114</b>	No de vis	: <b>2650</b>
Diamètre	[mm] : <b>25.00</b>	Classe de précision	: <b>G1</b>
Pas	[mm] : <b>1.00</b>	Force de précharge demandée [N]	: <b>3500.00</b>
Longueur totale	[mm] : <b>329.50</b>	Couple de précharge demandé [Ncm]	: <b>30.00</b>
Longueur filetée	[mm] : <b>102.00</b>	Couple maximum admis [Ncm]	: <b>40.50</b>
Course	[mm] : <b>50.00</b>	Couple minimum admis [Ncm]	: <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs	: <b>Non montés</b>
Vitesse de rotation de la vis	[T/Min] : <b>150.00</b>
Lubrification	: <b>TOPAS NCA 52</b>
Nombre de mesure par mm	: <b>10.00</b>

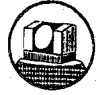
### Rollvis SA

37, Route du Vélodrome - CH-1228 Plans-les-Ouates - Genève - Suisse  
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MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



ROLLVIS S.A. GENEVE  
=====

3-KOORDINATEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR.: 2650

KONTROLLE DER STEIGUNG  
\*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT.: 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

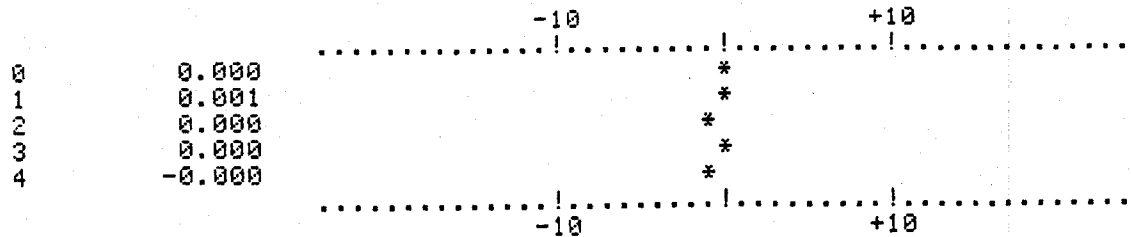
KUNDEN NR.: 1655

DATUM : 13 / 11 / 2000

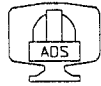
SACHBEARBEITER : *Saulnier*

MES.NØ. STEIGUNG F.(MM)  
=====

GRAFIK DER STEIGUNG  
=====



.. = 0.001 MM.



# MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



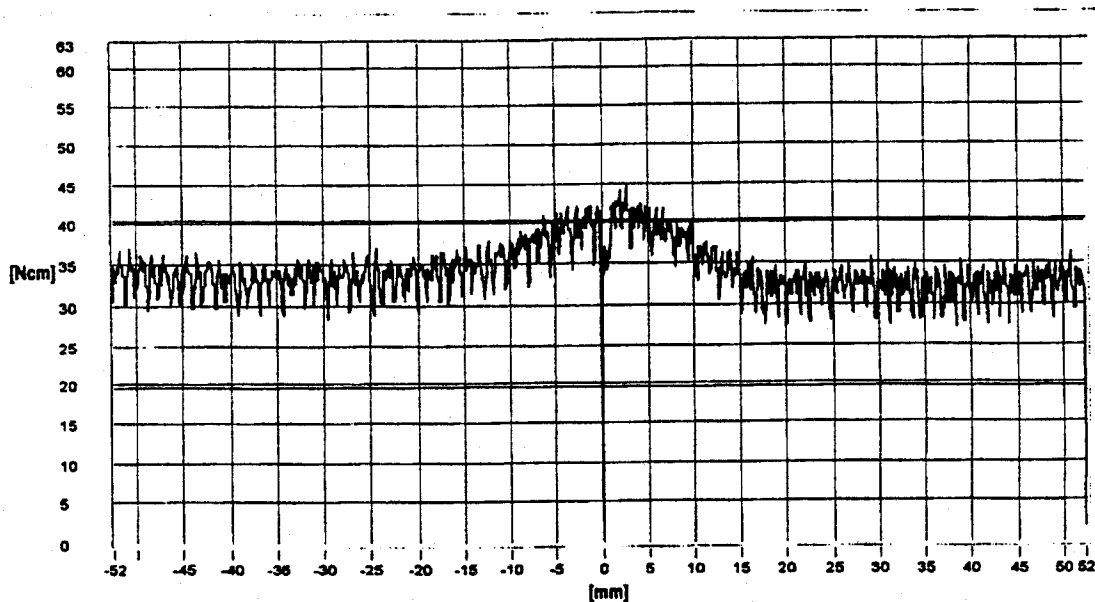
## Mesure dynamique de couple

Ref.: norme ISO 3408-3: 1992 (F)

(valable pour les couples supérieurs à 0.2 Nm)

Produit	:	<b>VIS A ROULEAUX SATELLITES</b>	
No de dessin	:	<b>600142/1</b>	
Type de vis	:	<b>RVR260/25.1.R1.600142</b>	
No de commande	:	<b>C00668</b>	Date : <b>17.11.00</b>
No de client	:	<b>1655</b>	No d'écrou : <b>005118</b>
No de protocole	:	<b>005118</b>	No de vis : <b>2655</b>
Diamètre	[mm] :	<b>25.00</b>	Classe de précision : <b>G1</b>
Pas	[mm] :	<b>1.00</b>	Force de précharge demandée [N] : <b>3500.00</b>
Longueur totale	[mm] :	<b>329.50</b>	Couple de précharge demandé [Ncm] : <b>30.00</b>
Longueur filetée	[mm] :	<b>102.00</b>	Couple maximum admis [Ncm] : <b>40.50</b>
Course	[mm] :	<b>50.00</b>	Couple minimum admis [Ncm] : <b>19.50</b>

### Diagramme de couple



### Conditions de mesures

Racleurs	:	<b>Non montés</b>
Vitesse de rotation de la vis	[T/Min] :	<b>150.00</b>
Lubrification	:	<b>TOPAS NCA 52</b>
Nombre de mesure par mm	:	<b>10.00</b>

### Rolvis SA

37, Route du Vélodrome	-	CH-1228 Plans-les-Ouates	-	Genève	-	Suisse
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ROLLVIS S.A. GENEVE  
=====

3-KOORDINATEN MESSMASCHINE S.I.P.-422-M

SPINDEL TYP : RVR 260 / 25.1 R 1 600142 NR. : 2655

KONTROLLE DER STEIGUNG  
\*\*\*\*\*

ABSTAND ZWISCHEN 2 PKT. : 20.00 MM

TOT.L.GEMESSEN : 80.00 MM

ANFANG DER MESSUNG : 10 MM

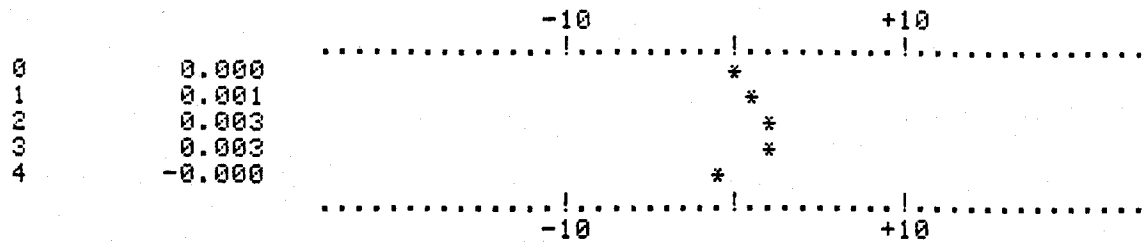
KUNDEN NR. : 1655

DATUM : 13 / 11 / 2000

SACHBEARBEITER : *Sauluis*

MES.NØ. STEIGUNG F.(MM)  
=====

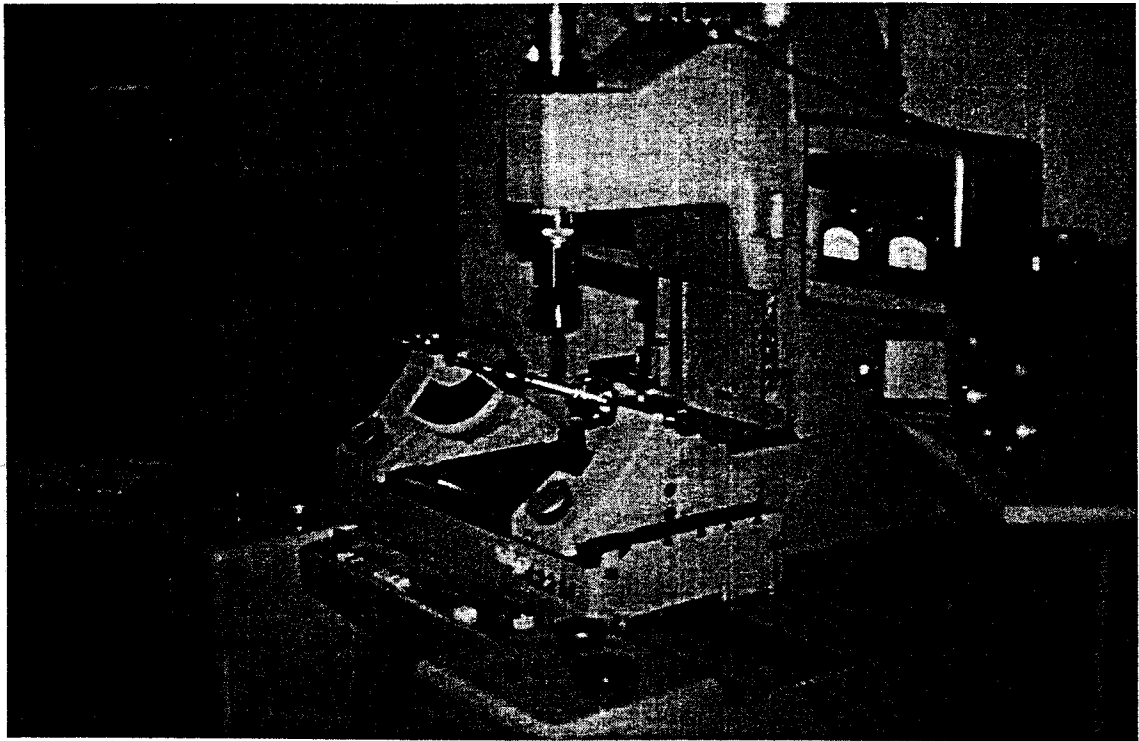
GRAFIK DER STEIGUNG  
=====



.. = 0.001 MM.



**Measurement of Roller Screw Static Accuracy at Rollvis premises:**



### 7.2. INALND MOTOR performance testing

KOLLMORGEN CORPORATION, INLAND MOTOR DIVISION  
Radford, Va

TP-1005/5989  
Rev. B

**TEST DATA SHEET**

Customer Number \_\_\_\_\_ Inland Model QT-2603-E TL 11488 Date 10/27/00  
 Serial Number 00K30802 Job Number 047528 Tester HS

Peak Test Current (Amperes) 12.500 Low Test Current (Amperes) 3.100

Visual OK Y Brush force grams 43.000 45.000 41.000 42.000

Megger reading 10K Meg Ohms Dielectric VAC 500.00  
Megger Reading 10K Meg Ohms

Resistance: Rm Temp 72.000 °F Volts 6.410 5.700 6.380 6.350 6.420

Temp Conv Factor 1.011 Ohms 2.090 1.859 2.080 2.071 2.093  
Avg. Res. 2.039

Rotation Direction CCW ; positive to GREEN  
Stabilization performed -----N/A-----

Performance (Units	Lb	at	6.000	inch radius)
a. Max	<u>10.800</u>	Min	<u>10.300</u>	
b. Max	<u>9.900</u>	Min	<u>9.400</u>	
c. Max	<u>2.900</u>	Min	<u>2.700</u>	
d. Max	<u>2.500</u>	Min	<u>2.200</u>	
e. Max	<u>10.700</u>	Min	<u>10.200</u>	
f. Max	<u>9.900</u>	Min	<u>9.400</u>	
g. Max	<u>2.800</u>	Min	<u>2.600</u>	
h. Max	<u>2.500</u>	Min	<u>2.200</u>	

Sensitivity (Conversion factor to LbFt/Amp is 0.500 )  
 i. (a(max)+b(min)) / (2 x peak test current) x Conv factor = 0.404  
 j. (c(max)+d(min)) / (2 x low test current) x Conv factor = 0.411  
 k. (e(max)+f(min)) / (2 x peak test current) x Conv factor = 0.402  
 l. (g(max)+h(min)) / (2 x low test current) x Conv factor = 0.403

Ripple (Conversion factor to LbFt is 0.500 )  
 m. (b(max)-b(min)) / 2 x Conv factor = 0.125  
 o. (f(max)-f(min)) / 2 x Conv factor = 0.125

Linearity: q. i/j = 0.982  
r. k/l = 0.997

Shorted turns: Amps 0.300 @ 200 RPM

Friction: Amps 0.190 Static: lb-ft 0.077 CW 0.195 Static: lb-ft 0.080 CCW

Inductance: Amps(or volts) 1.000 A Hz 60.0 Bridge 1633-A  
 a. mHenrys 4.100 Rotor Locked (Yes/No) Y  
 b. L/R = 2.011 mSec

For office use only: 4210681 99F21



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



KOLLMORGEN CORPORATION, INLAND MOTOR DIVISION  
Radford, Va

TP-1005/5989  
Rev. B

### TEST DATA SHEET

Customer Number                      Inland Model QT-2603-E TL 11488 Date 10/20/00  
Serial Number 00K2944 Job Number 047528 Tester HS

Peak Test Current (Amperes) 12.500 Low Test Current (Amperes) 3.100  
Visual OK Y Brush force grams 42.000 41.000 39.000 40.000

Megger reading 10K Meg Ohms Dielectric VAC 500.00  
Megger Reading 10K Meg Ohms

Resistance: Rm Temp 72.000 °F Volts 6.490 5.650 6.480 6.440 5.810  
Temp Conv Factor 1.011 Ohms 2.116 1.842 2.113 2.100 1.894  
Avg. Res. 2.013

Rotation Direction CCW ; positive to GREEN  
Stabilization performed -----N/A-----

Performance (Units	Lb	at	6.000	inch radius)
a. Max	<u>10.500</u>	Min	<u>10.000</u>	
b. Max	<u>9.000</u>	Min	<u>8.500</u>	
c. Max	<u>2.750</u>	Min	<u>2.550</u>	
d. Max	<u>2.200</u>	Min	<u>2.000</u>	
e. Max	<u>10.500</u>	Min	<u>10.000</u>	
f. Max	<u>9.000</u>	Min	<u>8.500</u>	
g. Max	<u>2.750</u>	Min	<u>2.550</u>	
h. Max	<u>2.200</u>	Min	<u>2.000</u>	

Sensitivity (Conversion factor to LbFt/Amp is 0.500 )  
i. (a(max)+b(min)) / (2 x peak test current) x Conv factor = 0.380  
j. (c(max)+d(min)) / (2 x low test current) x Conv factor = 0.383  
k. (e(max)+f(min)) / (2 x peak test current) x Conv factor = 0.380  
l. (g(max)+h(min)) / (2 x low test current) x Conv factor = 0.383

Ripple (Conversion factor to LbFt is 0.500 )  
m. (b(max)-b(min)) / 2 x Conv factor = 0.125  
o. (f(max)-f(min)) / 2 x Conv factor = 0.125

Linearity: q. i/j = 0.992  
r. k/l = 0.992

Shorted turns: Amps 0.285 @ 200 RPM

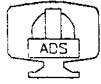
Friction: Amps 0.200 Static: lb-ft 0.077 CW 0.205 Static: lb-ft 0.078 CCW

Inductance: Amps(or volts) 1.000 A Hz 60.0 Bridge 1633-A  
a. mHenrys 3.900 Rotor Locked (Yes/No) Y  
b. L/R = 1.937 mSec

For office use only: 2818902 99F21







# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



## KOLLMORGEN

### Inland Motor

#### Critical Dimension Certification

Inspector N. Loy Inland Model No. QT-2603-A Job No. 047528  
Date 10/23/00 Inland Dwg. No. C-40543 Customer Dwg. No. \_\_\_\_\_ Rev. \_\_\_\_\_  
SERIAL NUMBERS 00K-

ITEM	SPECIFICATION	29414	29415	29416	29417	29418	29419
1	3.180-3.181	3.1803	3.1803	3.1801	3.1802	3.1804	3.1803
2	1.136-1.137	1.1367	1.1366	1.1366	1.1366	1.1369	1.1368
3	2.600 MAX.	✓	✓	✓	✓	✓	✓
4	.227 MAX.	✓	✓	✓	✓	✓	✓
5	.227 MAX.	✓	✓	✓	✓	✓	✓
6	3.175 MAX.	✓	✓	✓	✓	✓	✓
7	.215 MAX.	✓	✓	✓	✓	✓	✓
8	2.357 MAX. ROTOR	✓	✓	✓	✓	✓	✓
9	1.296 MIN. TYP.	✓	✓	✓	✓	✓	✓
10							
11							
12							
13							
14	Identification	✓	✓	✓	✓	✓	✓
15	Visual	✓	✓	✓	✓	✓	✓

ITEM	SPECIFICATION						
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14	Identification						
15	Visual						

I certify that the dimensions listed on this sheet are actual dimensions and further that the dimensions meet the specification requirements for that feature.

Certified by: N. Loy Title: Inspector Date: 10/23/00



Form # OCP 3 5/98



# MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



## KOLLMORGEN Inland Motor

### Critical Dimension Certification

Inspector RL Inland Model No. QT-2603-E Job No. 47428  
Date 10-27-00 Inland Dwg. No. C-40543 Customer Dwg. No. \_\_\_\_\_ Rev. \_\_\_\_\_

SERIAL NUMBERS 00K

ITEM	SPECIFICATION						
1	3.180 - 3.181	3.1802					
2	2.600 MAX	3.1802					
3	.227 MAX	/					
4	.227 MAX	/					
5	1.136 - 1.137	1.1364					
6	3.175 MAX	/					
7	.215 MAX	/					
8	2.357 MAX MOTOR	/					
9	1.296 MAX TYP	/					
10							
11							
12							
13							
14	Identification	/					
15	Visual	/					

ITEM	SPECIFICATION						
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14	Identification						
15	Visual						

I certify that the dimensions listed on this sheet are actual dimensions and further that the dimensions meet the specification requirements for that feature.



Certified by: RL

Title: Inspector Date: 10-27-00

Form # OCP 3 5/98





MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



# SENSOTEC

2080 ARLINGATE LANE COLUMBUS, OHIO 43228 (614) 850 - 5000

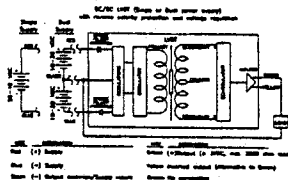
## CERTIFICATE OF CALIBRATION

MODEL: 060-3621-02  
SERIAL NUMBER: L3038300  
CALIBRATION DATE: 09/22/2000  
ACTUATOR N.03

RANGE: +/- 1.000 INCHES  
SUPPLY: 30.0 VDC  
CALIBRATION FACTOR: 5.1820 V/INCH  
LINEARITY: 0.0500%



WIRING CODE



Accepted and Certified by: *Michael A. Stanley*  
Date Printed: 10/19/2000

# SENSOTEC

2080 ARLINGATE LANE COLUMBUS, OHIO 43228 (614) 850 - 5000

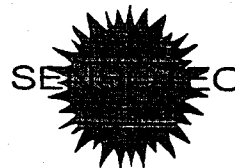
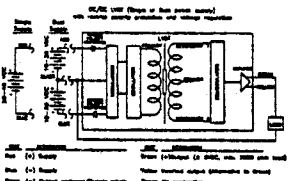
## CERTIFICATE OF CALIBRATION

MODEL: 060-3621-02  
SERIAL NUMBER: L3038900  
CALIBRATION DATE: 09/22/2000  
ACTUATOR N.04

RANGE: +/- 1.000 INCHES  
SUPPLY: 30.0 VDC  
CALIBRATION FACTOR: 5.1750 V/INCH  
LINEARITY: 0.1800%



WIRING CODE



Accepted and Certified by: *Michael A. Stanley*  
Date Printed: 10/19/2000



MMT CONVERSION

Doc.No : H5-DP-AD-01001

Issue : A

Date : 27 April - 2001



# SENSOTEC

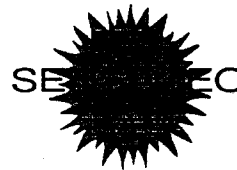
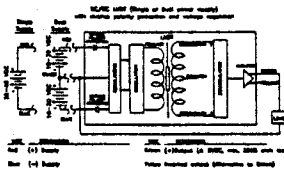
2080 ARLINGATE LANE COLUMBUS, OHIO 43228 (614) 850 - 5000

## CERTIFICATE OF CALIBRATION

MODEL: 060-3621-02  
SERIAL NUMBER: L3038600  
CALIBRATION DATE: 09/22/2000  
ACTUATOR N.05

RANGE: +/- 1.000 INCHES  
SUPPLY: 30.0 VDC  
CALIBRATION FACTOR: 5.1700 V/INCH  
LINEARITY: 0.1500%

### WIRING CODE



Accepted and Certified by: Michael A. Stanley  
Date Printed: 10/19/2000

# SENSOTEC

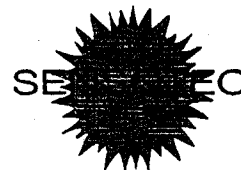
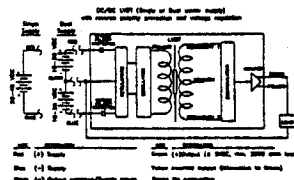
2080 ARLINGATE LANE COLUMBUS, OHIO 43228 (614) 850 - 5000

## CERTIFICATE OF CALIBRATION

MODEL: 060-3621-02  
SERIAL NUMBER: L3037900  
CALIBRATION DATE: 09/22/2000  
ACTUATOR N.06

RANGE: +/- 1.000 INCHES  
SUPPLY: 30.0 VDC  
CALIBRATION FACTOR: 5.1940 V/INCH  
LINEARITY: 0.2000%

### WIRING CODE



Accepted and Certified by: Michael A. Stanley  
Date Printed: 10/19/2000



MMT CONVERSION

Doc.No : H5-DP-AD-01001  
Issue : A  
Date : 27 April - 2001



# SENSOTEC

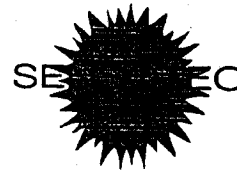
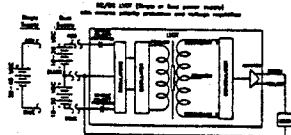
2080 ARLINGGATE LANE COLUMBUS, OHIO 43228 (614) 850 - 5000

## CERTIFICATE OF CALIBRATION

MODEL: 060-3621-02  
SERIAL NUMBER: L3038500  
CALIBRATION DATE: 09/22/2000  
ACTUATOR N.07



RANGE: +/- 1.000 INCHES  
SUPPLY: 30.0 VDC  
CALIBRATION FACTOR: 5.2000 V/INCH  
LINEARITY: 0.2200%

WIRING CODE



Accepted and Certified by: Michael A. Stanley

Date Printed: 10/19/2000

	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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## 8. DIMENSIONAL CONTROL OF HEXAPOD MECHANICAL ASSEMBLY AND COMPONENTS

### 8.1. *Linear Actuators*

The linear components were subjected to a dimensional control screening as part of the acceptance procedure (incoming inspection at delivery from workshop).

After completion of the accuracy performances testing campaign the linear actuators were positioned at nominal length (see Dwg. 200505) of  $(460 \pm 0.1)$  mm using the test bench and control electronics for commanding the actuator and a caliper for the length measurement (accuracy of  $\pm 0.05$  mm).

The linear actuator length at integration is  $(460 \pm 0.05)$  mm.

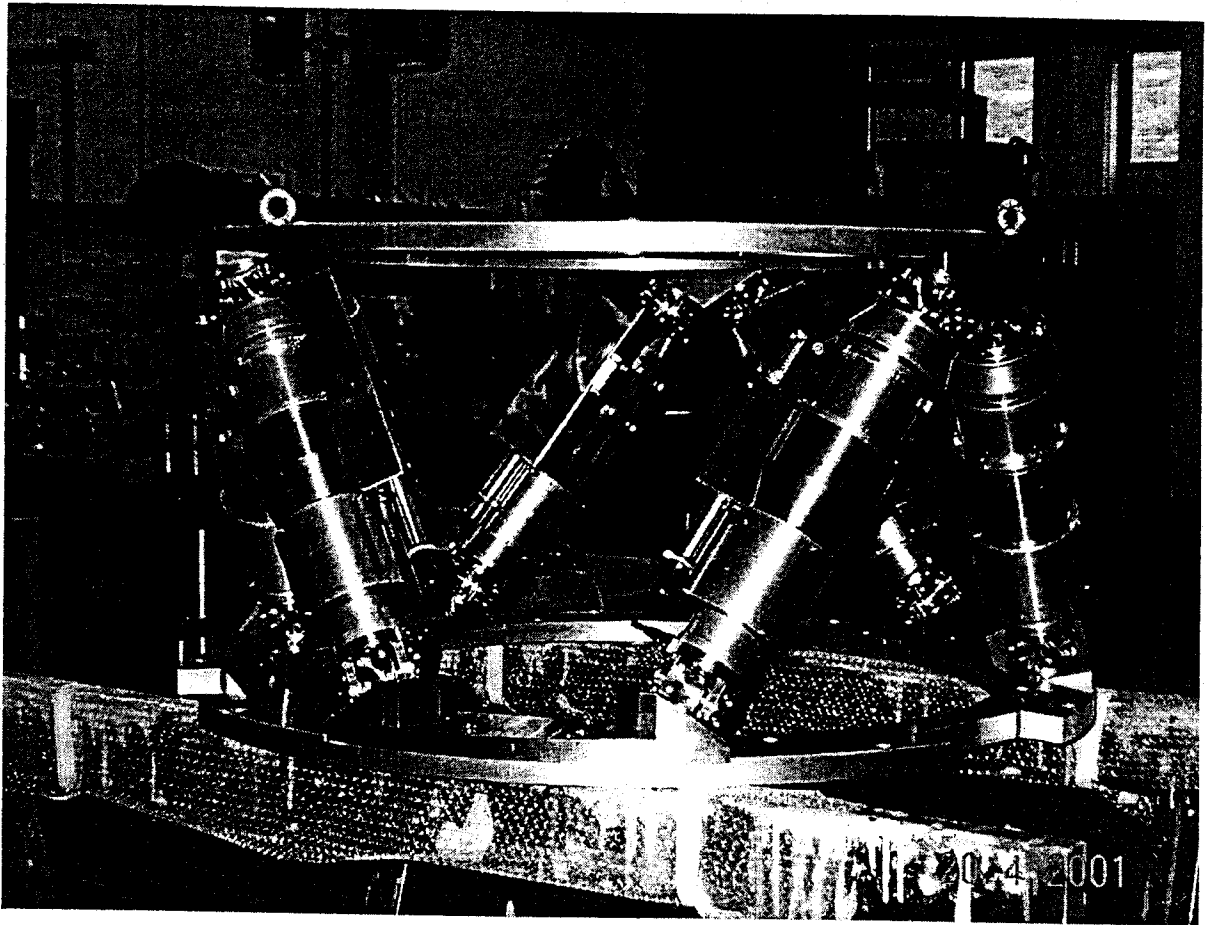
### 8.2. *Mechanical Assembly*

The complete mechanical assembly as been integrated with the actuators calibrated at  $460 \pm 0.1$  mm length.

All the mechanical actuator as been integrated as dwg ADS 200528 and has been all the interfaces with lower and upper platform. (see picture)



## Mechanical Assembly





### 9. WEIGHT OF HEXAPOD MECHANICAL ASSEMBLY AND COMPONENTS

The following table reports the measured weight of the Mechanical Assembly components:

Item Description	Drawing N°	Estimated Weight [kg]	Measured Weight [kg]
Linear Actuator S/N 01	200505	13.994	14.34
Linear Actuator S/N 02	200505	13.994	14.34
Linear Actuator S/N 03	200505	13.994	14.34
Linear Actuator S/N 04	200505	13.994	14.34
Linear Actuator S/N 05	200505	13.994	14.34
Linear Actuator S/N 06	200505	13.994	14.34
Linear Actuator S/N 07	200505	13.994	14.34
Upper Platform (with 3 support)	N.A.	26.96	-
Lower Platform (with 3 support)	N.A.	35.01	-
Eyebolt M24	N.A.	0.60	0.500
<b>TOTAL :</b>		<b>160.528</b>	<b>162.85</b>

## 10. ACTUATOR INTEGRATION PROCEDURE

The integration procedure of the single actuator for the "MMT Secondary Hexapod f/5" is hereafter described.

### 10.1. References

- DWG ADS 200529 "General assembly"
- DWG ADS 200528 "Linear actuator"

### 10.2. Operative Procedures

For all the following activities, it is advised to wear rubber gloves (surgery type).

#### 1.0 - Subassembly stator

- 1.1 - Wear the antistatic bracelet for all the 1.X operations.
- 1.2 - Look for p/n and s/n of the motor and write them on the event sheet.
- 1.3 - Insert four pulling M3 for 100mm as frameless motor guide (item 04).
- 1.4 - Heat the frameless motor support (item 04) at 50°C.
- 1.5 - Insert the stator into the frameless motor support (item 04), taking care of the direction of the cables of the brush holder ring and push the stator against the end stop.
- 1.6 - Fix the frameless brushed stator (item 107) to the frameless motor support (item 04) with screws (item 123), and lock.

#### 2.0 - Subassembly screw/scroll



- 2.1 - Check the p/n and s/n of the screw.
- 2.2 - Mount the pair of Belleville washers (item 113), on the screw, positioning them among the rings (item 15) and lock with the locking ring nut (item 131), close the securing washer (item 132). Use socket spanner.

#### 3.0 - Subassembly central bearing

- 3.1 - Grease the axial radial bearings (item 112) with Kluber Isoflex NBU15, 0.7 cmc each.
- 3.2 - Mount the two axial radial bearings (item 112) in the satellite roller screw (item 100) in configuration < > and close with a self locking ring nut (item 111). Use socket spanner.

#### 4.0 - Subassembly flange terminal bearing

- 4.1 - Grease the ball bearing (item 102) with Kuber Isoflex NBU15, 0.35 cmc.
- 4.2 - Mount the ball bearing (item 102) in the encoder/bearing support (item 03), locking it with two outside Snap rings (item 103).



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**5.0 - Subassembly screw/brake/rotor**

- 5.1 - Wear the antistatic bracelet for all the operations of the paragraph **5.X**.
- 5.2 - Prepare a double electrical 24V DC power supplier to test brake and motor simultaneously.
- 5.3 - Mount the scroll of the satellite roller screw (item 100) with the satellite roller screw support (item 13) using the screws (item 117). To make the following assembling easier, position cylinder/screws vertically. Mount the key (item 110) in the seat of the screw.
- 5.4 - Mount the satellite roller screw in the brake bearing support (item 07) and close with a cover (item 09) using the screw (item 116) checking that in the cove (item 09) the preload for pack the bearings could be minimum 0.05mm.
- 5.5 - Mount the spacer bush and verify the coupling with the brake.
- 5.6 - Mount the brake (item 108, 109) on the its key, lock with the screws (item 119) interfacing it with the subassembly central bearing seat (5.4) taking care of the direction of the feeding cable, feed the brake and verify that no friction is present between brake and screw. Close the grub screw on the key.
- 5.7 - Mount the bush (item 06) on the screw, wear the frameless brushed motor/rotor (item 106), the distance ring (item 05) and lock with the self-locking ring nut (item 104). Use socket spanner.
- 5.8 - Mount the subassembly screw/brake/rotor, interfacing it to the subassembly stator seat (1.0) using the screws (item 117) and lock.
- 5.9 - Mount the brush holder ring to the stator (item 107) and lock the screws, check the direction of the cables with respect to the vertical axis - 20°.
- 5.10 - Put a heatshrink sleeve on the feeding cables of the stator.

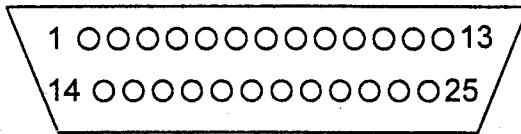
**6.0 - Actuator assembling**

- 6.1 - Wear the antistatic bracelet for all the **6.X** operations.
- 6.2 - Mount the subassembly flange terminal bearing seat (4.0), in the subassembly stator seat (1.0) using the shorter screws
- 6.3 - Mount the bush (item 19) on the terminal part of the screw, lock the three grub screws (item 105).
- 6.4 - Look for p/n and s/n of the Encoder and write them on the event sheet attached to the work order.
- 6.5 - Mount the rotor of the Encoder (item 101) without fixing it.
- 6.6 - Mount the stator of the Encoder (item 101) (horseshoe shaped) without touching the rotor, the screws and fix it definitely.
- 6.7 - Check very carefully the gap between stator/rotor of the Encoder, which has to be 0.15 mm. Turn the screw by hand and verify that no interferences or centring mistakes are present. Lock the rotor fixing grub screw of the Encoder.
- 6.8 - Connect the wiring of the Encoder into the proper socket.
- 6.9 - Mount the encoder housing (item 02) taking care of the direction of the passage for the Encoder cable, fixing it with screws (item 118).
- 6.10 - Mount the Proximity support (item 10) to the cover (item 09) and fix with screws (item 120).
- 6.11 - As regards the sequence for the Proximity assembling, see section. B-B, of the drawing 200528
- 6.12 - Mount the two Proximity (item 115) with proper nuts (item 125) and washers, Proximity will be regulated afterwards.

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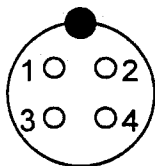
- 6.13 - Mount the plaque proximity (item 20) using screws (item 128).
- 6.14 - Insert in the satellite roller screw the protection ring (item 12)
- 6.15 - Mount the support (item 13) using screws (item 117)
- 6.16 - The protection (item 11) with the relative screws (item 120) have to be mounted after verification of the actuator stroke ( $23.5^{+0.0}_{+1.0}$  mm).
- 7.0 - Subassembling cardan joint**
- 7.1 - Insert the crosspiece (item 08) into the external fork piece (item 01) without the bearings (item 129).
- 7.2 - Insert the bearings in configuration >< in both side of the fork centering the pin/crosspiece.
- 7.3 - Now insert in both sides the shims and close the pack with the two covers (item 17) with the relative screws (item 127). **WARNING:** the joint preload has been set by adding a number of shims on each bearings pair to force them by 0.15 mm wito the fork piece.
- 7.4 - Proceed to insert the other internal fork piece (item 18) and fix at same the bearings with the shims and the covers
- 7.5 - To integrate the other cardan joints use the same procedure (7.01) with the pieces (item 01) and (item 14).
- 8.0 - Final Assembling**
- 8.1 - Fix the two cardan joint one in the item 02 and the other in the item 13 with the screws (item 116).
- 8.2 - Look for p/n and s/n of the LVDT and write it on the event sheet attached to the work order.
- 8.3 - Insert the protection cover (item 11) and fix it to the support (item 09) and the protection ring (item 12) with the screw (item 120).
- 8.4 - Mount in the cardan joint fork (item 14) the striker plate (item 16) with the screws (item 126).
- 8.5 - Mount the LVDT (item 114) to the brake-bearings support (item 07) with the grub screws (item 124).
- 8.6 - The last operation is to remove the LVDT rubber cover
- 9.0 - Electrical integration**
- 9.1 - Cut the wire electrical at proper length
- 9.2 - Weld all the cable following the connectors pinout reported in next page
- 9.3 - Close the protection cover (item 21) with the screw (item 116 – 120)

**25 PINS MALE CONNECTOR ON THE ACTUATOR - FRONT SIDE VIEW**





PIN	ITEM	COLOR
1	Heidenhain ERO	White
2		Blue
3		Purple
4		Black
5		Red
6		Pink
7		Gray
8		Green
9	Sensotec LVDT	Yellow
10		Red
11		Black
12		Blue
13	Green	
14	Heidenhain ERO	Brown
15		White/Green
16		Brown/Green
17	Yellow (N.C.)	
18	Sensotec LVDT	Brown (N.C.)
19	-	-
20	Sensotec LVDT	Ground = Act. frame
21	Heidenhain ERO	Ground = Act. frame
22	Baumer prox.	Black INTERNAL prox.
23		Black EXTERNAL prox.
24		Blue
25		Brown

**4 PINS FEMALE CONNECTOR ON THE ACTUATOR - FRONT SIDE VIEW**



PIN	ITEM	COLOR
1	Motor -	Green
2	Motor +	Orange
3	Brake (no polarity)	White
4	Brake (no polarity)	White

	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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## 11. HEXAPOD INTEGRATION PROCEDURE

The procedure of assembling of the Hexapod system for the MMT secondary Mirror is hereafter described.

### 11.1. Reference

DWG ADS 200529 "General Assembly"  
 DWG ADS 200528 "Linear Actuator"

### 11.2. Operative Instruction

For all the activities below described it is advised to wear gloves to minimise contamination of the components.

Before attempting to assemble the device it should be noted that at least two persons will be needed for the final assembly.

### 11.3. Actuators



The actuators have been pre-adjusted to a length of  $460 \pm 0.05$ mm, be careful not change this length and avoiding rotating single parts of the actuator.

### 11.4. Lower interface ring assembly (DWG ADS 301013)

Three lower slope supports (item 24) have been pre-assembled to the interface ring (item 26) by using the bolts and pin (item 138 – 137 - 140).  
 Place the lower interface ring assembly on a granite table (or similar solid, level surface)  
 Note the position of the X and Y axis marked on the interface ring.

### 11.5. Upper interface ring assembly (DWG ADS 301012)

Three lower slope supports (item 25) have been pre-assembled to the interface ring (item 27) by the bolts and pin (item 137 – 139 - 140).  
 Suspend the upper interface ring from a crane or controlled hoisting device using the three ring bolts (see packing list) mounted three of the available threaded holes.  
 Note the position of the X and Y axis marked on the ring.

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### **11.6. Hexapod final assembly (DWG ADS 200529)**

At least three persons are needed to perform this operation.

Position the upper interface plate assembly aligned with the vertical axis of the lower interface ring assembly at height about 400 mm.

Mount the six actuators on the lower interface ring assembly without closing the screws (item 136), ensuring that all actuators are the correct way up.

Keep the position of the six actuators, (two persons are needed) lower the upper interface ring and align the actuators to the holes of the slope supports ensuring correct alignment of the X and Y axis of the upper and lower interface rings.

Mount and close all of the 48 screws (item 136) and washers

Fix the electrical cables in a manner that will avoid thigh bending and consequent damage by fatigue.

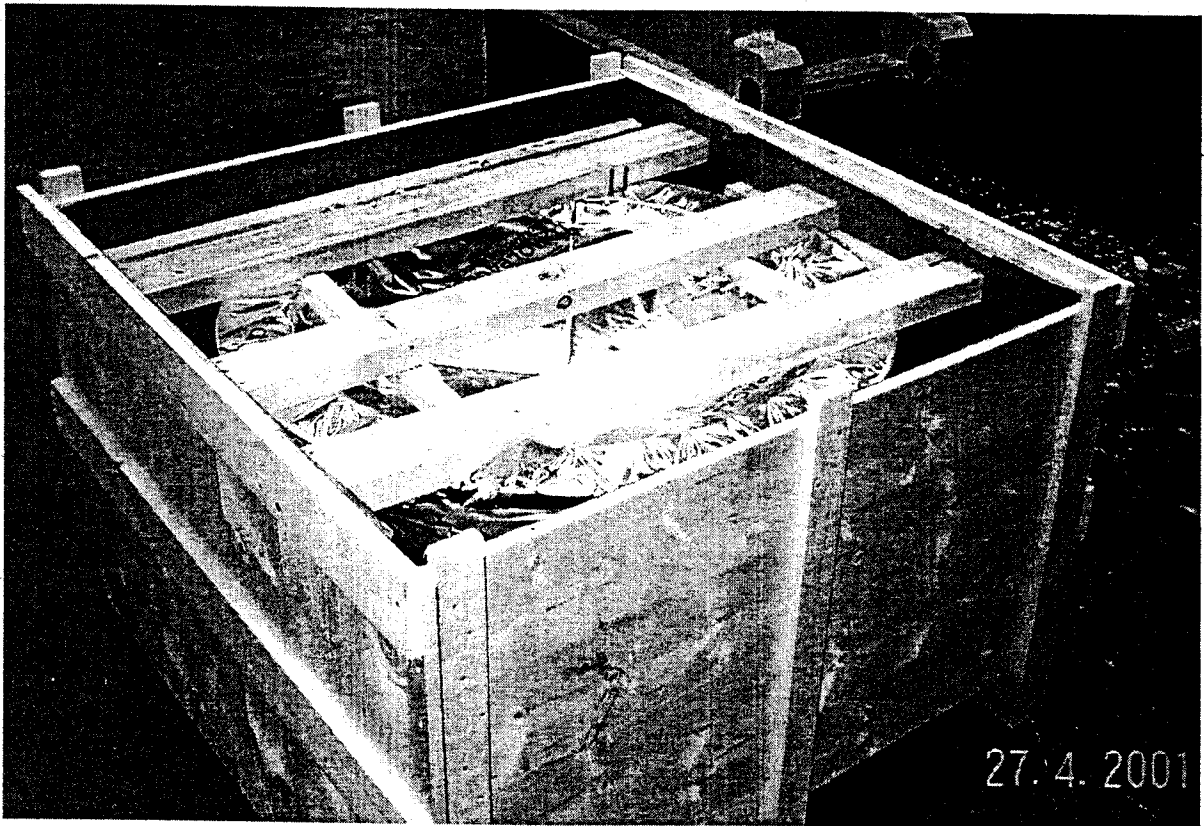


## 12. HANDLING, PACKING LIST



### 12.1. *Handling and transportation*

The integrated hexapod + one spare actuator is delivered to Steward packed in an aluminium bag to prevent contamination, and then closed in a wooden box where it is blocked by means of screwed wooden bars to the box sides.

### Shipping container





	<b>MMT CONVERSION</b>	Doc.No : H5-DP-AD-01001 Issue : A Date : 27 April - 2001	
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### 12.2. Packing list

Full description of goods	Encoder HEIDENHAIN s/n	Brake ELECTROID s/n	Drive INLAND s/n	Screw ROLLVIS s/n	LVDT SENSOTEC s/n
<b>Actuator n.01</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 30802	RVR 260/25.1.R1 05117-2653	060-3621-01 L3038800
<b>Actuator n.02</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29416	RVR 260/25.1.R1 05120-2654	060-3621-02 L3038700
<b>Actuator n.03</b>	345333-08 10268479	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29415	RVR 260/25.1.R1 05122-2651	060-3621-02 L3038300
<b>Actuator n.04</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29419	RVR 260/25.1.R1 05123-2649	060-3621-02 L3038900
<b>Actuator n.05</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29414	RVR 260/25.1.R1 05121-2662	060-3621-02 L3038600
<b>Actuator n.06</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29418	RVR 260/25.1.R1 05114-2650	060-3621-02 L3037900
<b>Actuator n.07</b>	345333-08	0285-0039-0 EFSB35 B 12-28V gap 0.15	QT2603 E 00K - 29417	RVR 260/25.1.R1 05118-2655	060-3621-02 L3038500
	<b>ADS DWG N.</b>	<b>Qty.</b>	<b>Item</b>		
<b>Lower plate with support and plate</b>	301013	1	26		
	301011	3	24		
<b>Upper plate with support and plate</b>	301010	1	27		
	301012	3	25		
<b>Eyebolt M6</b>		3			