BECKER
AVIONIC SYSTEMS

ADF - Receiver

RA 3502 - ( )

Installation and Operation

Manual		DV 60604.03
Issue	2	April 2004

Becker Flugfunkwerk GmbH • Baden Airpark • 77836 Rheinmünster • Germany
Telephone +49 (0) 7229 / 305-0 • Fax +49 (0) 7229 / 305-217
http://www.becker-avionics.com • Email : info@becker-avionics.de

FIRST ISSUE AND CHANGES

Issue . . . . . 1 . . . . . July 1997
Issue . . . . . 2 . . . . . April 2004

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Section 1 GENERAL INFORMATION

1.1 Introduction

This Manual DV 60604.02 describes the RA 3502 - ( ) ADF receiver. This ADF receiver is controlled by a CU 5502 - ( ) control unit (or equivalent)

The manuals DV 60604.03 “Installation and Operation” and DV 60604.04 “Maintenance and Repair” contain the following sections :

Section		DV 60604.03	DV 60604.04
1	General Information	X	X
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1.2 Purpose of equipment

The ADF receiver operates in the 190 kHz to 1799.5 kHz and 2182 kHz ± 5 kHz frequency range and has been developed for use in aircraft.

The receiver was designed in accordance to the requirements of JTSO-2C41d (RTCA DO-179). RTCA DO-160C was used for the requirements under environmental conditions. A maximum operating altitude of 50.000 ft. was verified in the suitability test. The RA 3502 - ( ) ADF receiver and the CU 5502 - ( ) control unit are part of the ADF 3500 system.

1.2.1 Overview of variants

Part- No.	Article-No.:	Frequency range 190 -1799.5 MHz	additional 2182 kHz
RA 3502 - (01) mounting plate included	0505.757-912	X	
RA 3502 - (02) mounting plate included	0506.133-912	X	X

1.3 General description of ADF receiver RA 3502 - ( )

The navigation receiver is designed for installation in the avionics compartment.

On the front side are mounted :.

The equipment connector for connecting to the aircraft system.
The antenna socket for connecting the ADF 3500 - ( ) antenna.

The electronic system of the unit consists of the following circuit boards, which are connected to each other by connectors.

- 1. Chassis board
- 2. Receiver board
- 3. Processor board
- 4. Interface board

The interface board and processor board are plugged into each other and held together by five bolts. Both together are then secured to the front panel by three bolts.

The microcontroller as well as the necessary storage and peripheral components are located on the processor board.

The receiver board is mounted over the chassis board and secured to it by four bolts.

The receiver is designed as a single superheterodyne receiver and operates in the 190.0 to 1799.5 kHz frequency range with a channel separation of 500 Hz. The oscillator frequency for the receiver is generated in a VCO (voltage control oscillator). The VCO is controlled by a digital frequency processing circuit on the chassis board. The digital frequency processing and storage are processor-controlled.

The RA 3502 - ( ) receiver can also receive on the 2182 kHz emergency frequency.

1.3.1 AN 3500 - ( ) antenna

The AN 3500 - ( ) contains the LOOP antenna, the SENSE antenna and the associated amplifier and electronic switch. They are mounted in an aerodynamically-designed, weather-resistant plastic housing.

1.4 Technical Data

1.4.1 General Data

Power supply voltage	+ 27.5 V DC
Current consumption of	
RA 3502 - ( )	650 mA
AN 3500 - ( )	≤ 50 mA
Recommended external overcurrent protection	1 A
Operating temperature range receiver	- 20° C ... + 55° C (short-time to + 70° C)
Storage temperature range	- 55° C ... + 85° C
Interface	RS 422
Max. operating altitude	50 000 ft.
Dimensions	
with mounting plate	330 x 190 x 54 mm H x B x T
Weight of	
receiver	approx. 1.00 kg
antenna	approx. 1.70 kg

1.4.2 Receiver data

Receiver type	Single superheterodyne receiver
Frequency range	190 kHz - 1799.5 kHz in addition 2182 kHz ± 5 kHz
Frequency setting	500 Hz

Selectivity	1 kHz ≤ 1 dB 1,5 kHz ≥ 6 dB 2 kHz ≥ 12 dB 3 kHz ≥ 30 dB 4 kHz ≥ 45 dB 5 kHz ≥ 60 dB 6 kHz ≥ 75 dB 7 kHz ≥ 80 dB
REC sensitivity	70 µV/m for ≥ 6 dB $\frac{S + N}{N}$
Direction finding accuracy	≤ 3^o at 70 µV/m 190 kHz - 850 kHz ≤ 8^o at 70 µV/m ≥ 850 kHz
Control response	≤ 8 dB from 100 µV/m - 0.5 V/m
Audio frequency response relative to 700 Hz	≥ 6 dB from 350 Hz - 1100 Hz
Audio output voltage	≥ 5.5 V at 300 Ω

1.5 Certification

LBA-No.:	10.921/53 JTSO
BAPT	A132 880 J

1.6 Software

Frequency processing, frequency storage and frequency display are controlled by a microprocessor.

The associated software is classified as software level C according to the EUROCAE/RTCA ED-12A/DO-178B guidelines.

1.7 Regulations

JTSO-2C41d

RTCA DO-179 Kategorie A

EUROCAE/RTCA	ED-14C/DO-160C
EUROCAE/RTCA	ED-12A/DO-178B

1.8 Environmental Qualification Form RA 3502 - ( )

The following performance standards under environmental test conditions have been established in accordance with the procedures set forth in EUROCAE/RTCA Document No. ED-14C/DO-160C

Environmental condition	ED - 14C DO - 160C	Category	Performance
Temperature	4.0	A1D1	
Low operating temperature	4.5.1		- 20° C
Low ground survival (storage temperature)			- 55° C
High short-time operating temperature	4.5.2		+ 70° C
High operating temperature	4.5.3		+ 55° C
High ground survival (storage) temperature			+ 85° C
Min. operating pressure (equivalent altitude)	4.6.1		50.000 ft.
Pressure drop	4.6.2		from 8.000 ft. altitude to 50.000 ft.
Positive pressure	4.6.3		- 15.000 ft.
Temperature variation	5.0	B	
Humidity	6.0	A	48 hrs at up to 50° C and 95% relative humidity
Shock :	7.0		
Operational shocks	7.2		11 ms at 6 G for all three dimensional axes
Crash safety shocks	7.3		11 ms at 15 G for all three dimensional axes
Vibration	8.0	MN	
Magnetic effect	15.0	Z	Deflection of 1° of compass at a distance of ≥ 30 cm
Power input variation	16.0	B	The equipment functions on a 20 volt emergency power supply
Resistance to voltage spikes on equipment power leads	17.0	A	
Audio-frequency conducted susceptibility	18.0	B	
Susceptibility to induced magnetic and electric • fields at 400 Hz	19.0	A	
Radio-frequency interference susceptibility	20.0	T	
Spurious RF emissions	21.0	Z	

1.9 Environmental Qualification Form AN 3500 - ( )

The following performance standards under environmental test conditions have been established in accordance with the procedures set forth in EUROCAE/RTCA Document No. ED-14C/DO-160C

Environmental condition	ED - 14C DO - 160C	Category	Performance
Temperature	4.0	D2	
Low operating temperature	4.5.1		- 55° C
Low ground survival (storage temperature)			- 55° C
High short-time operating temperature	4.5.2		+ 70° C
High operating temperature	4.5.3		+ 55° C
High ground survival (storage) temperature			+ 85° C
Min. operating pressure (equivalent altitude)	4.6.1		50.000 ft.
Temperature variation	5.0	B	
Humidity	6.0	A	48 hrs at up to 50° C and 95% relative humidity
Shock :	7.0		
Operational shocks	7.2		11 ms at 6 G for all three dimensional axes
Crash safety shocks	7.3		11 ms at 15 G for all three dimensional axes
Vibration	8.0	MN	
Magnetic effect	15.0	Z	Deflection of 1° of compass at a distance of ≥ 30 cm
Power input variation	16.0	B	The equipment functions on a 20-volt emergency power supply
Resistance to voltage spikes on equipment power leads	17.0	A	
Audio-frequency conducted susceptibility	18.0	B	
Susceptibility to induced magnetic and electric • fields at 400 Hz	19.0	A	
Radio-frequency interference susceptibility	20.0	T	
Spurious RF emissions	21.0	Z	

1.10 Accessories ADF- Receiver RA 3502 - (xx)

ADF- Receiver RA 3502 - (01) mounting plate included	Article-No.: 0505.757-912
ADF- Receiver RA 3502 - (01) without mounting plate	Article-No.: 0576.786-912
ADF- Receiver RA 3502 - (02) mounting plate included	Article-No.: 0506.133-912
ADF- Receiver RA 3502 - (02) without mounting plate	Article-No.: 0576.794-912
Mounting plate	Article-No.: 0821.128-283

Connector kits

CK 3501-S for RA/AD 3502-(xx), soldering	Article-No.: 0835.374-954
includes:	
cable connector 37 pin	Article-No.: 0211.184-277
Connector shell with sliding closure 1	Article-No.: 0775.231-277
Coding pin	Article-No.: 0782.211-277
Coax Plug	Article-No.: 0725.706-277
Label ”ADF”	Article-No.: 0711.136-258
CK 3501-A for RA/AD 3502-(xx), crimp	Article-No.: 0523.925-954
includes:	
cable connector 37 pin	Article-No.: 0780.677-277
Connector shell with sliding closure 1	Article-No.: 0775.231-277
Coding pin	Article-No.: 0782.211-277
Coax Plug	Article-No.: 0725.706-277
Label ”ADF”	Article-No.: 0711.136-258

Handbooks

Installation and Operation DV 60604.03	Article-No.: 0511.641-071
Maintenance and Repair DV 60604.04	Article-No.: 0511.651-071

1.11 Antenna AN 3500

Antenna AN 3500 (mounting kit included) Article-No.: 0832.601-912

Antenna AN 3500 (mounting kit not included) Article-No.: 0576.816-912

Mounting kit MK-AN3500-(1) with Gasket Article-No.: 0354.759-954

The mountink consist of:

Mounting washer metal	3 pieces
Head Screw M5x40	3 pieces
Gasket	1 pieces
Stencil	1 pieces

Mounting kit MK-AN3500-(2) without Gasket Article-No.: 0580.392-954

The mountink consist of:

Mounting washer metal	3 pieces
Head Screw M5x40	3 pieces
Stencil	1 pieces

Connector kits:

CK 3504-S for AN 3500, soldering Article-No.: 0518.468-954
includes:
Cable connector Article-No.: 0715.492-277

CK 3504-C for AN 3500, crimp Article-No.: 0576.824-954
includes:
Cable connector Article-No.: 0858.188-277

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Section 2 INSTALLATION

2.1 General

The installation of the ADF receiver depends upon the type of aircraft and its equipment and therefore only general information can be given in this section.

2.2 Pre-installation check

Prior to installing the ADF receiver in an aircraft, a visual inspection should be carried out to determine whether any damage has been caused during transport. The following should be checked for defects :

1. Soiling, dents, scratches, rust, broken fasteners, chipped paint coat on housing or housing parts.

2. Missing screws.

2.3 Mechanical installation

The ADF receiver is designed for installation in an avionics compartment. To do this, the mounting plate must first be secured to an appropriate point in the avionics compartment using five bolts. The installation dimensions are given in Fig. 2-1. The ADF receiver is then pushed into the mounting plate and locked in place by two quick-release bolts.

2.4 Installation of the AN 3500 antenna

Installing the Antenna AN 3500
The aircraft manufacturer usually provides information concerning the location of a loop antenna, which is equally suitable for locating the AN 3500 antenna. It is mandatory that the following requirements are checked prior to installing the antenna in the absence of any other information:

The AN 3500 antenna can be mounted either above or below the fuselage, however, as near as possible to the aircraft centreline. In addition, the selected location should be away from airframe projections (fixed undercarriage, tail plane or radar) and as far away as possible from other antennas. This is essential to avoid signal distortion and thus inaccurate bearing indication. Furthermore, the antenna and its feeders must not be located in the vicinity of sources of RF interference such as inverters, motors, regulators, generators and their wiring. It should also be noted that inverters can give rise to magnetic interference and thus be detrimental to reception even though good screening may be provided.

- The AN 3500 antenna is designed to correct a quadrantal error of approx. 7° to 8°. If this built-in correction is not achieved after installation, additional correction of up to ± 20 ° can be provided by means of an infinitely variable adjustment on the indicator.

- In aircraft with a wooden or plastic airframe, an electric counterweight plate or panel must be located within the fuselage at the antenna location with a minimum dimension of 80 x 80 cm. A good connection between the electrical counterweight plate or panel and aircraft ground is required.

The installation dimensions is given in Fig. 2-3.

2.5 Installation wiring

The installation wiring of the ADF receiver with the control unit, RMI converter and indicator are shown in Fig. 2-4 and 2-5.

WARNING

- No HF cables shall be included in the cable harness of the equipment. Furthermore, the connecting cables shall not be laid together with cables which transmit Audio power or impulses (IFCS, DME, XPR, Slaved Gyro). The same also applies to the supply and control cables of autopilots.

- Installation dimensions and information for the control unit, RMI converter and the indicator are given in the separate manuals for the individual components.

2.5.1 Pin connection P2 ADF receiver

Pin	Description
1	+18V
20	+18V
2	Audio (HI)
3	Audio (LO)
4	Ground
23	Ground
5	n.c.
6	n.c.
7	n.c.
8	/BFO
9	ILLUM. 28V
10	ILLUM 14 V
11	/ON
12	TX-A
13	RX-A
14	RX-B
31	TX-B
15	LED (ADF)
16	+ADF
17	ON/OFF

Pin	Description
18	SUPPL. VOLT. +27,5V
36	SUPPL. VOLT. +27,5V
19	SUPPL. VOLT. +27,5V SWIT.
37	SUPPL. VOLT. +27,5V WIT.
21	n.c.
22	n.c.
24	n.c.
25	n.c.
26	AUDIO/CU
27	Ground
28	CONN.CODING
29	Ground
30	n.c.
32	/Audio NAV
33	Audio NAV
34	C-Contr.
35	AGC

2.6 Post-installation Check

2.6.1 General

After installation of the system, the accuracy of the bearing has to be checked to determine whether it is necessary to correct the Q.E. error. The correction of the Q.E. error should be part of the presetting but in any case also has to be carried out during the flight. It is also necessary to determine whether parts of the aircraft electrical system are causing interference.

2.6.2 Functional test

1. Position the aircraft on a compensation platform and align the radio compass with a beacon at the limit of the range.
2. Switch on the ADF, set the frequency and observe the bearing indicator in the ADF mode. The bearing indicator shall go to 0^{o}.
3. Rotate the aircraft about the vertical axis to a greater heading, the bearing indicator shall move to the left.
4. Rotate the aircraft about the vertical axis to a smaller heading, the bearing indicator shall move to the right.

If there is a faulty reading or a movement in the wrong direction, check the aircraft wiring again against the wiring diagram and correct as necessary (antenna up or down).

If, with the aircraft aligned exactly in the direction of the NDB the relative bearing direction from 0^{o} is not indicated, it is probable that the antenna is not correctly fitted. Check the antenna again for alignment with the center line of the aircraft and correct as necessary.

2.6.3 Test for interference from the aircraft supply system

With the engines running and electrical consumers switched on, check whether a beacon can still be received at its given limit ranges (compare with the aforementioned test after installation).

If the direction finding function is impaired, determine which device is causing the interference by systematically switching off electronic equipment, generators etc. Interference suppression is then necessary.

The following are typical sources of interference.

1. Generators, regulators

   The following suppression measures are suggested.

a) When fitting the antenna and the associated wiring ensure that these parts of the system are installed as far as possible away from the positive cable (positive cable from the generator to the battery).

b) Block the positive cable from the generator to the regulator, at the regulator, using a capacitor (electrolytic up to 500 mF).

c) For 3-phase generators fit a filter (10 mH - 50 mH, 10 nF - 100 nF, e.g. Bosch 0290 002 002) in the supply cable from the regulator to the exciting winding of the generator.

d) Fit a filter in the positive cable from the generator to the battery, close to the generator, (e.g. Bosch 0290 003 009/75 A).

The interference suppression measures should be carried out in the sequence a) to d) and only until there is no further interference with the direction finding function.

2. Transistor converters, choppers, DC converters

   A recommended suppression measure is to fit a filter (e.g. Bosch 0290 003 006/6 A) in the positive cable to the equipment causing the interference, close to the equipment itself, to protect the aircraft wiring from interfering harmonics of the chopper frequency.

3. HF interference

   Interference from transponders, DME or RT equipment can occur if the associated antenna does not have a good connection to ground and the shield of the antenna lead-in cable is radiating.

In all cases, the procedures are to be in accordance with FAA AC 43.13-1A and FAA AC 43.13-2A.

2.6.3.1 Quadrantal error correction

Ground procedure

1. Align the aircraft on the ground with a beacon so that the bearing indicator shows a 0^o relative bearing.
2. Set the aircraft directional gyro to 0^o.
3. Rotate the aircraft to a 45^o relative heading. The bearing indicator shall indicate 315^o.
4. Rotate the aircraft to a relative heading of 315^o. The bearing indicator shall show a relative bearing of 45^o.

If the indicated bearing deviates from the set bearing by more than 3^o when the aircraft is rotated by 45^o, carry out a Q.E. correction using the trimming resistor.

RMI Converter unit AC 3503 - ( ) / AC 3504 - ( ) R 79
Converter and indicator unit ID 3502 - ( ) R 60

The variable resistor R 60 (ID 3502) can be reached through the front panel of the indicator if the top left attaching bolt of the inner attaching hole circle has not been bolted in.

Flight checking procedure

Due to ground influence or effects from the undercarriage, the quadrantal error correction in flight can be different from that found on the ground, particularly if the DF antenna is mounted underneath the fuselage.

1. Align the aircraft on an NDB approximately 60 km away (bearing indicator = 0^o relative bearing).
2 Set the directional gyro to a relative bearing of 0^o.
3. Fly to a pattern such as described in Fig. 2-1. The total deviation shall not exceed $\pm 5^o$. The table on pages 2-7 can be used with this method.

Changes to the quadrantal error correction relative to the ground test can be carried out in flight on the converter and indication unit using variable resistor R 60 or R 79 (RMI converter unit).

As described in the Ground Test, this variable resistor can be reached through the hole for the top left attaching bolt, provided the bolt is removed before the test flight.

4. Approach the beacon and observe the behavior of the bearing indicator as the beacon is overflown. The bearing indicator should continuously swing through 90^o or 270^o to a back bearing during a close flypast.

During a direct overflight bad bearings can occur for a certain period depending on the height above the NDB. These are caused by the cone of silence of the NDB. No reception is possible within this cone of silence. After the overflight the indicator immediately returns to the set heading.

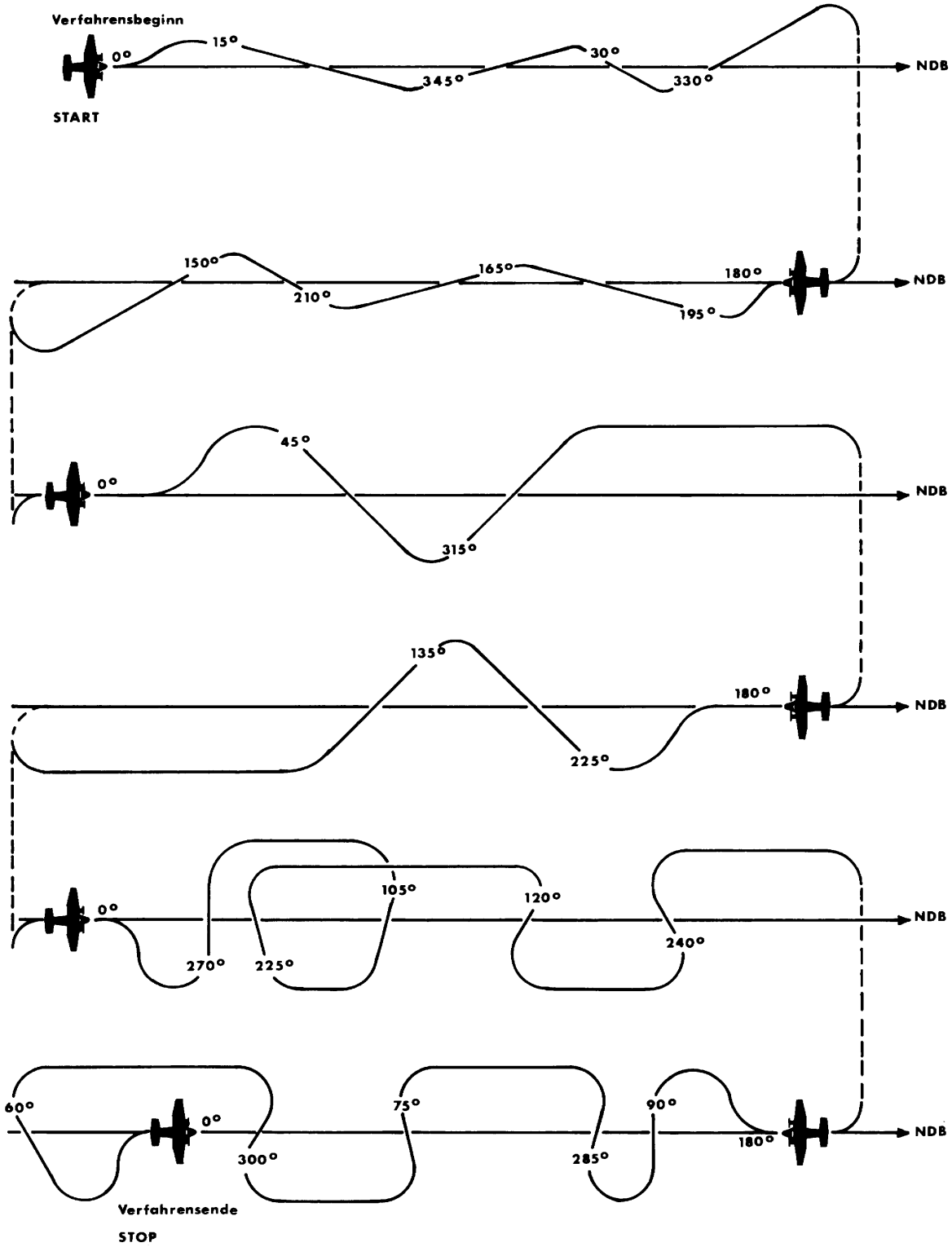

Fig. 2-1 Flight test procedure

Tabelle Quadrantenkorrektur
Q. E. Correction Table

NDB Station Used _____	Frequenz Frequency _____
Pilot Pilot _____	Prüfer Recorder _____
Bezugspunkt Reference Point _____	Datum Date _____
Luftfahrzeug-Muster Aircraft-Type_____	Kennzeichen Aircraft No. _____

Peilanzeige vor Quadrantenkorrektur Bearing before Q. E. Correction		Peilanzeige nach Quadrantenkorrektur Bearing after Q. E. Correction	
Relativer Kompaßkurs Relative Heading	Relative Peilung Relative Bearing	Peilanzeige Indicator Reading	Peilanzeige Compensated Indicator Reading
0	360		
15	345		
30	330		
45	315		
60	300		
75	285		
90	270		
105	255		
120	240		
135	225		
150	210		
165	195		
180	180		
195	165		
210	150		
225	135		
240	120		
255	105		
270	90		
285	75		
300	60		
315	45		
330	30		
345	15		
360	0		

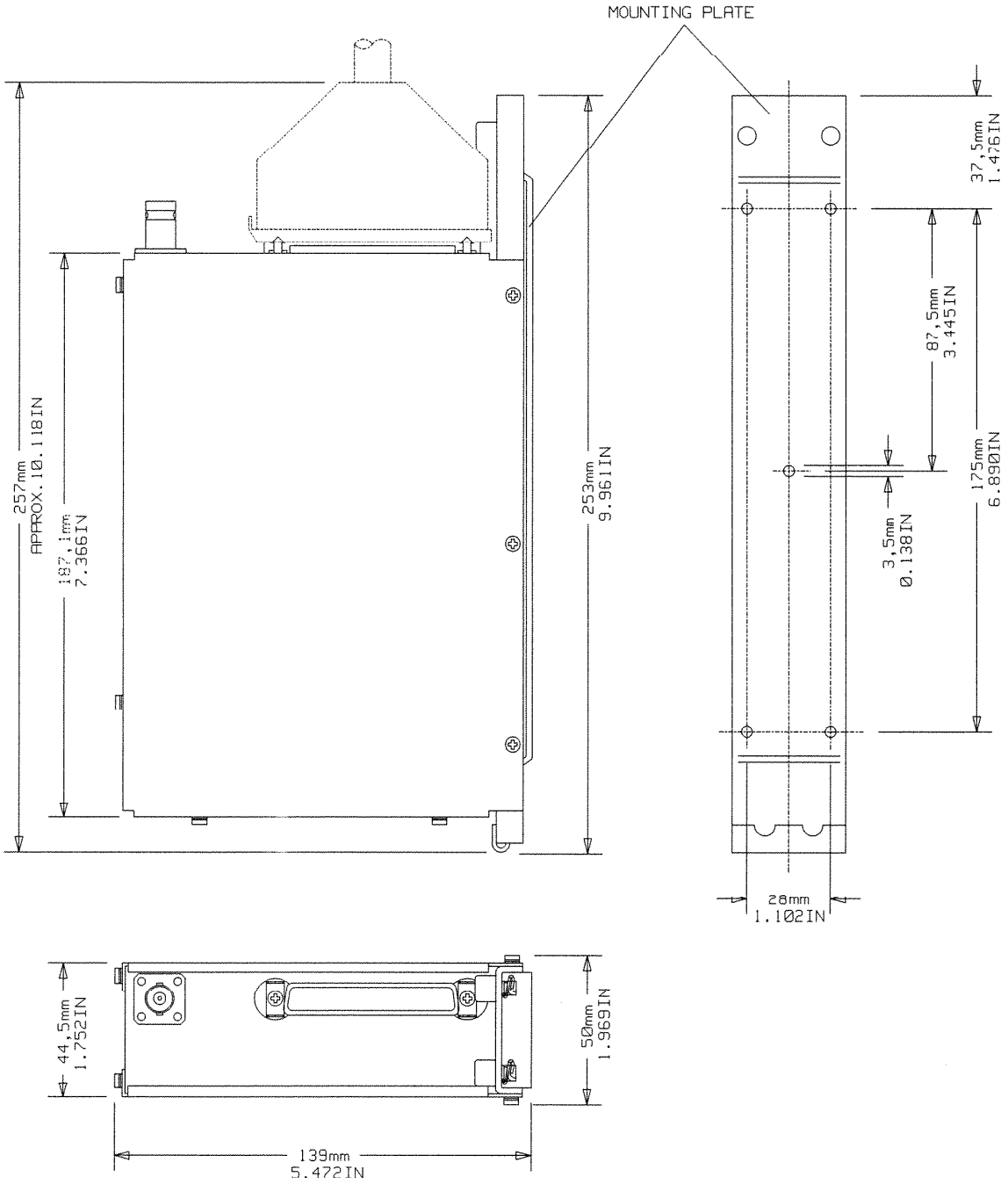

Fig. 2-2 Dimensions RA 3502 - ( )

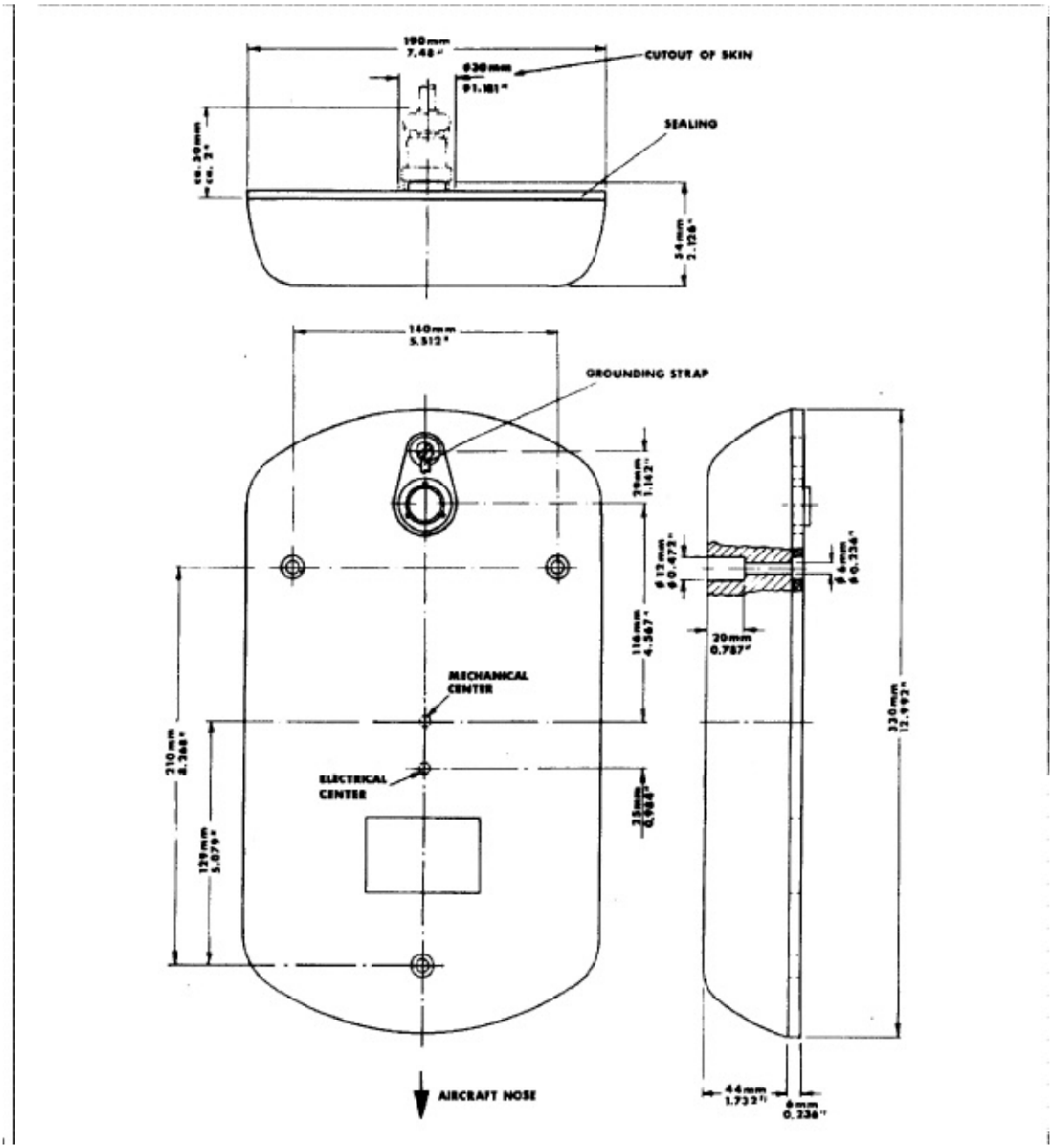

Fig. 2-3 Dimensions Antenna AN 3500 - ( )

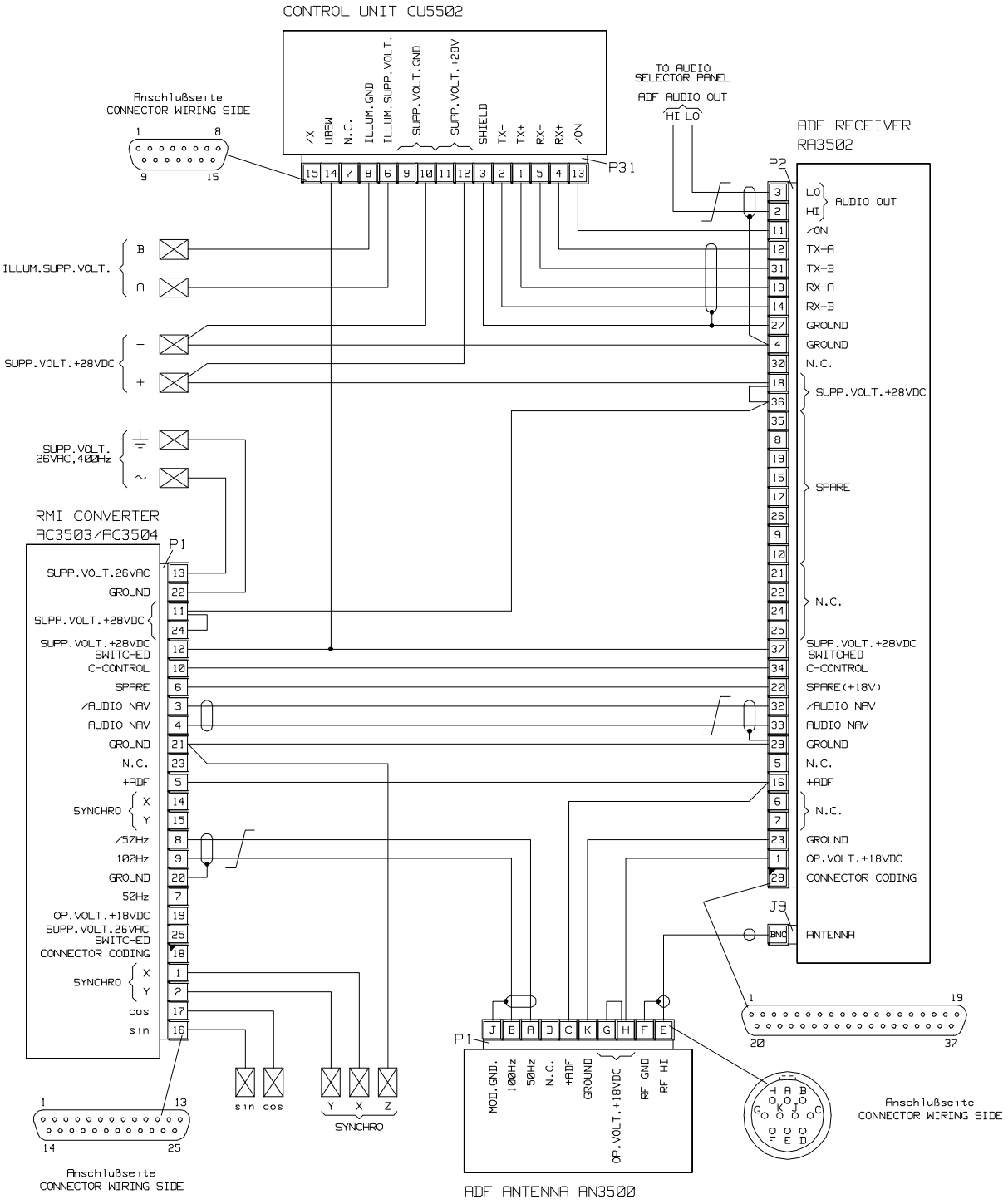

Fig. 2-4 Interwiring diagram ADF-Receiver, Control unit and RMI Converter

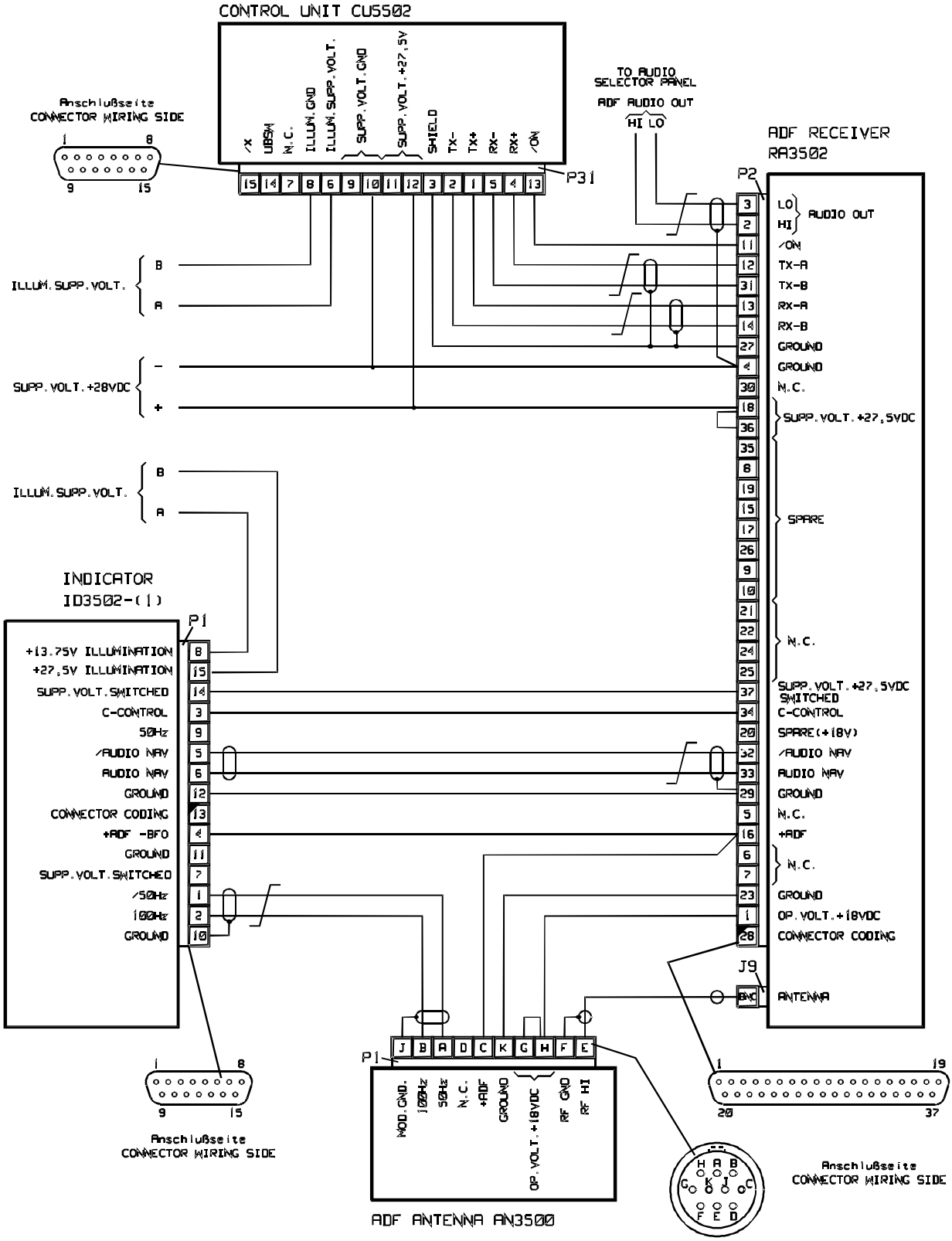

Fig. 2-5 Interwiring diagram ADF-Receiver, Control unit and Converter and Indicator

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