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europaan



telecom



testing



certification

Maritime test report 99321030

based on:

EN 61993-2, chapter 15, issue March 2002

Automatic Identification System (AIS)

Furuno

FA-100

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This report comprises of three modules. The total number of pages is: 38



Main module

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Report number: 99321030

Main module

1 Introduction

This report contains the result of tests conducted by:

Telefication bv
Utrechtseweg 310
6812 AR Arnhem
The Netherlands

Telefication bv complies with the accreditation criteria for laboratories as described in the STERLAB Criteria which contains all of the criteria from EN 45001 and ISO/IEC guide 25 and the relevant criteria from ISO 9001. The accreditation covers the quality system of the laboratory as well as the specified activities described in the accreditation certificate bearing the accreditation number L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie). An extended procedure for performing tests outside their permanent premises has been accepted by the board of STERLAB for accreditation. Telefication bv is thereby allowed to conduct tests on any suitable site by regular telefication bv staff, using suitable equipment that is property of Telefication bv or of a second party.

Ordering party:

Company name : Furuno Electric Co., Ltd.
Address : Ashihara-cho 9-52
Zipcode : 662-8580
City/town : Nishinomiya
Country : Japan
Date of order : 01 November 2001



Main module

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2 Product

A sample of the following product was submitted for testing: AIS-transceiver

Product category	:	Universal Automatic Identification System
Manufacturer	:	Furuno Electric Co., Ltd.
Trade mark	:	FURUNO
Type designation	:	FA-100
Hardware version	:	--
Software version	:	MAIN : 245-0001-000
		SUB : 245-0002-000
		H8S1 : 245-0003-000
		H8S2 : 245-0004-000
		H8S3 : 245-0005-000
Serial number	:	3539-0001
Unit designation	:	Transponder FA-100
		Connection box CB-100
		Distributor DB-1
		Combined antenna GVA-1
		AC-DC power supply PR-240

3 Test schedule

Tests were carried out in accordance with the specification detailed in chapter 6 "Summary" of this report.

Tests were carried out at the following location:

- Furuno Electric Co., Ltd.

The sample of the product was received on:

- 08 December 2001

Tests were carried out between:

- 21 January to 15 February 2002



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4 Product documentation

For production of this report the following product documentation was used:

Description	Date
User manual OME-44170	February 2002
Installation manual IME-44170	February 2002

The above mentioned documentation will be filed at Telefication bv for a period of 10 years following the issue of this report.

5 Observations and comments

Photographs are provided in a separate document, designated as: FLI 01-02-004, issued 27 February 2002.

6 Summary

The product is intended for use in the following application area:

Universal Automatic Identification System

The sample was tested according to the following specification:

EN 61993-2: (2002-3), Chapter 15.



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7 Conclusions

The sample of the product showed **ONE NON-COMPLIANCE** to the specification stated in chapter 6 of this report:

Clause 15.3.4: co-channel rejection 25 kHz.

Compliance with the indicated limit is physically impossible; a request for amendment has been instigated to IEC based on an explaining and justifying technical document.

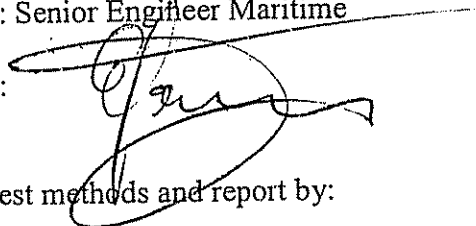
The results of the tests as stated in this report, are exclusively applicable to the product item as identified in this report. Telefication bv does not accept any responsibility for the results stated in this report, with respect to the properties of product items not involved in these tests.

All tests are performed by:

name : M.W. Jansen

function : Senior Engineer Maritime

signature :

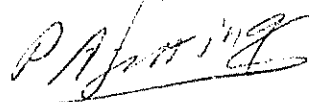


Review of test methods and report by:

name : ing. P.A. Suringa

function : Senior Engineer Radio/EMC

signature :



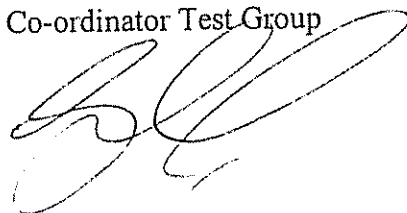
The above conclusions have been verified by the following signatory:

date : 29 April 2002

name : J.P. van de Poll

function : Co-ordinator Test Group

signature :





Test results module

Test results module

1 Summary

LIST OF VERIFICATION RESULTS

The list of measured or checked parameters called for in EN 61993-2 Clause 15 is given below.

IEC 61993-2 Clause	GENERAL REQUIREMENTS	Performed verification (yes/no/n.a)	Relevant page number of this report
15	Physical Tests		
15.1	TDMA Transmitter	yes	
15.1.1	Frequency Error	yes	
15.1.2	Carrier Power	yes	
15.1.3	Modulation Spectrum 25 kHz channel mode	yes	
15.1.4	Modulation Spectrum 12.5 kHz channel mode	yes	
15.1.5	Transmitter Attack Time	yes	
15.1.6	Transmitter Release Time	yes	
15.2	DSC Transmissions		
15.2.1	Frequency error of the DSC Signal	yes	
15.2.2	Modulation Rate	yes	
15.3	TDMA Receivers		
15.3.1	Sensitivity - 25 kHz Operation	yes	
15.3.2	Sensitivity - 12.5 kHz Operation	yes	
15.3.3	Error Behavior at High Input Levels	yes	
15.3.4	Co-Channel Rejection - 25 kHz Operation	yes	
15.3.5	Co-Channel Rejection - 12.5 kHz Operation	yes	
15.3.6	Adjacent Channel selectivity - 25 kHz Operation	yes	
15.3.7	Adjacent Channel selectivity - 12.5 kHz Operation	yes	
15.3.8	Spurious Response Rejection	yes	
15.3.9	Intermodulation response rejection and blocking	yes	
15.3.10	Transmit to receive switching time	yes	
15.4	DSC Receiver		
15.4.1	Maximum sensitivity	yes	
15.4.2	Error Behavior at High Input Levels	yes	
15.4.3	Co-Channel Rejection	yes	
15.4.4	Adjacent Channel selectivity	yes	
15.4.5	Spurious Response Rejection	yes	
15.4.6	Intermodulation response Rejection	yes	
15.4.7	Blocking or Desensitisation	yes	
15.5	Conducted Spurious Emissions conveyed to the antenna		
15.5.1	Spurious Emissions from the Receiver	yes	
15.5.2	Spurious Emissions from the Transmitter	yes	

2 Test results

15 Physical Tests

15.1 TDMA Transmitter

15.1.1 Frequency Error

Date of test: 21 Jan. 2002	Ambient temp.: 22 °C	R.H.: 50 %
Date of test: 12 Feb. 2002	Ambient temp.: 23 °C	R.H.: 41 %
Date of test: 14 Feb. 2002	Ambient temp.: 24 °C	R.H.: 40 %

TEST CONDITIONS		FREQUENCY ERROR (Hz)							
		156.025 MHz		157.4125 MHz		160.6375 MHz		162.025 MHz	
Temperature	Voltage	H.P.	L.P.	H.P.	L.P.	H.P.	L.P.	H.P.	L.P.
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0 V)	+118	+154	+121	+157	+130	+161	+133	+163
<i>T_{min}</i> (-15 °C)	<i>V_{min}</i> (21.6 V)	- 658	- 568	- 665	- 568	- 645	- 561	- 632	- 560
	<i>V_{max}</i> (31.2 V)	- 658	- 568	- 665	- 568	- 645	- 561	- 632	- 560
<i>T_{max}</i> (+55 °C)	<i>V_{min}</i> (21.6 V)	+ 507	+ 507	+ 507	+ 507	+ 513	+ 513	+ 517	+ 517
	<i>V_{max}</i> (31.2 V)	+ 507	+ 507	+ 507	+ 507	+ 513	+ 513	+ 517	+ 517
Measurement uncertainty		±9 Hz							
Limits		≤ +0.5 kHz under normal conditions, ≤ +1 kHz under extreme conditions.							

H.P. = Output carrier power set at its nominal High: 12.5 W

L.P. = Output carrier power set at its nominal Low: 2 W

Measuring equipment used: 08, 12, 18



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15.1.2 Carrier Power

Date of test: 21 Jan. 2002
 Date of test: 12 Feb. 2002
 Date of test: 14 Feb. 2002

Ambient temp.: 22 °C
 Ambient temp.: 23 °C
 Ambient temp.: 24 °C

R.H.: 50 %
 R.H.: 41 %
 R.H.: 40 %

Rated output carrier power H.P.: 12.5 W
 L.P.: 2 W

TEST CONDITIONS		CARRIER POWER (W)							
		156.025 MHz		157.4125 MHz		160.6375 MHz		162.025 MHz	
Temperature	Voltage	H.P.	L.P.	H.P.	L.P.	H.P.	L.P.	H.P.	L.P.
T_{nom} (+22 °C)	V_{nom} (24.0 V)	12.1	2.2	11.9	2.2	11.6	2.1	11.6	2.1
T_{min} (-15 °C)	V_{min} (21.6 V)	12.7	2.3	12.7	2.3	12.4	2.3	12.3	2.2
	V_{max} (31.2 V)	12.7	2.3	12.7	2.3	12.4	2.3	12.3	2.2
T_{max} (+55 °C)	V_{min} (21.6 V)	9.9	1.8	9.1	1.8	9.6	1.7	9.1	1.7
	V_{max} (31.2 V)	9.9	1.8	9.1	1.8	9.6	1.7	9.1	1.7
Measurement uncertainty		0.7 dB							
Limits		<u>Normal test conditions:</u> => H.P.: - between 8.8 and 17.7 W => L.P.: - between 1.4 and 2.8 W - within ± 1.5 dB of the rated carrier power <u>Extreme test conditions:</u> => H.P.: - between 6.3 and 19.8 W => L.P.: - between 1.0 and 3.2 W - within +2.0 & -3.0 dB of the rated carrier power							

H.P. = Output carrier power set at its nominal High: 12.5 W

L.P. = Output carrier power set at its nominal Low: 2 W

Measurement equipment used: 01, 12, 18



15.1.3 Modulation Spectrum 25 kHz channel mode

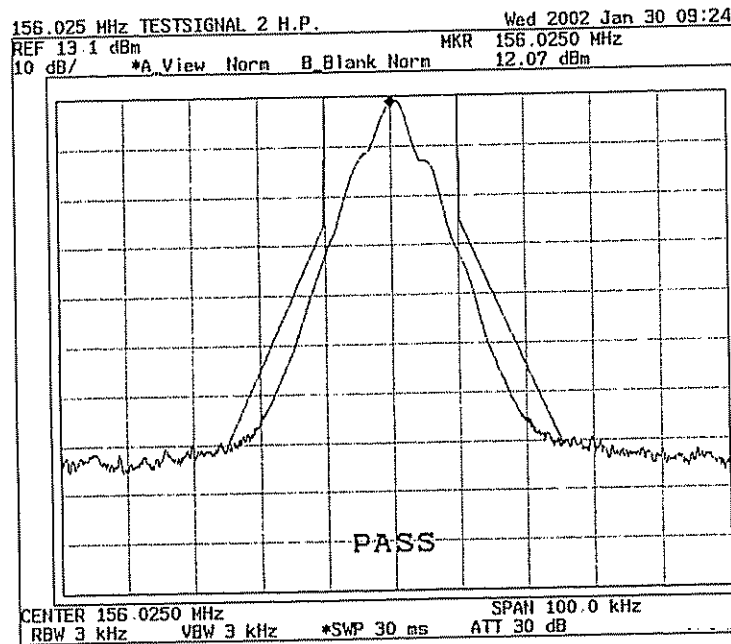
Date of test: 22 Jan. 2002

Ambient temp.: 23 °C

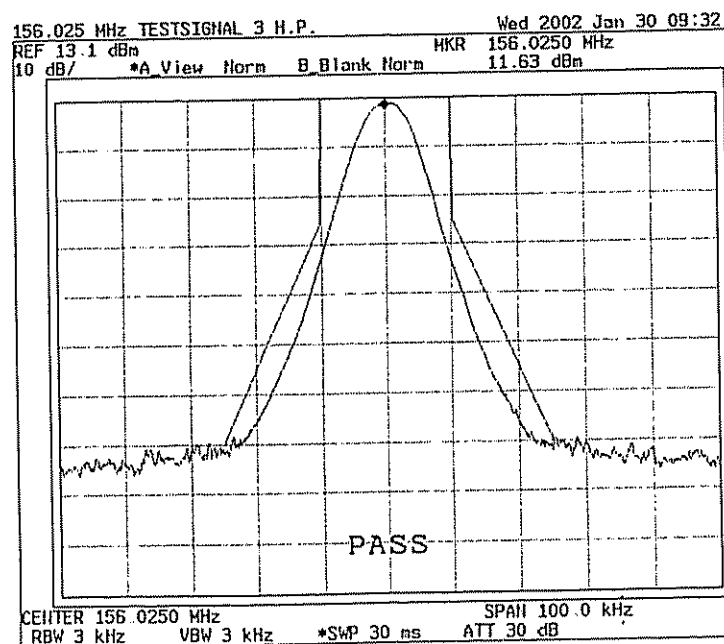
R.H.: 38 %

TX freq.: 156.025 MHz Carrier power: H. P.

(1) TDMA Type 1 mode (Standard Test Signal Number 2):



(2) TDMA Type 2 ((Standard Test Signal Number 3):

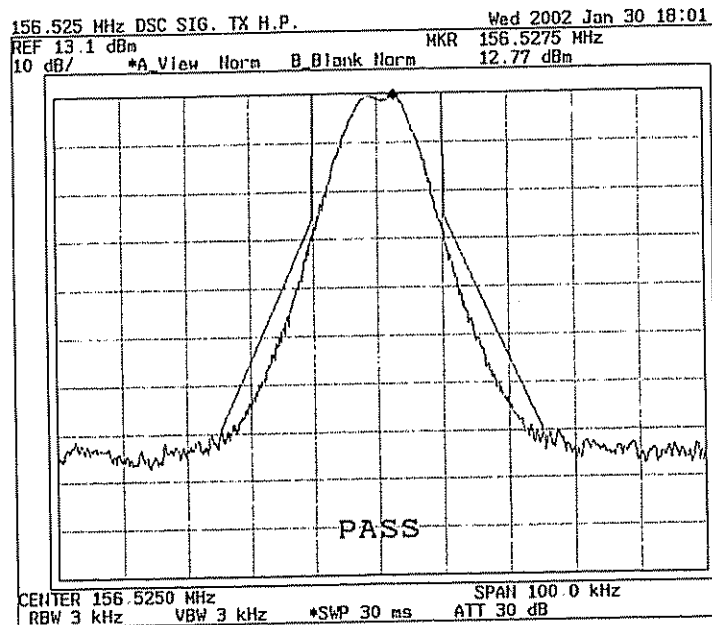




(3) DSC mode (standard Test Signal Number 1):

TX freq.: 156.525 MHz

Carrier power: H P



Limit : within the mask specified in figure 4, Clause 15.1.3, EN 61993-2.

(Emission mask):

- At ± 10 kHz removed from the carrier, the modulation sidebands is below -25 dBc.
- At ± 25 kHz removed from the carrier, the modulation sidebands is below -70 dBc, without any need to be below 0.25 μ W.

In the region between + 10 kHz and + 25 kHz removed from the carrier, the modulation sidebands is below a line specified between these two points.

Measurement equipment used: 01, 12, 18

15.1.4 Modulation Spectrum 12.5 kHz channel mode

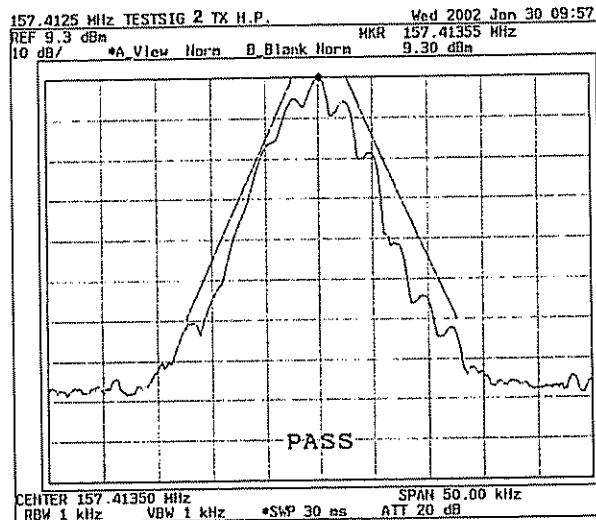
Date of test: 30 Jan. 2002

Ambient temp.: 23 °C

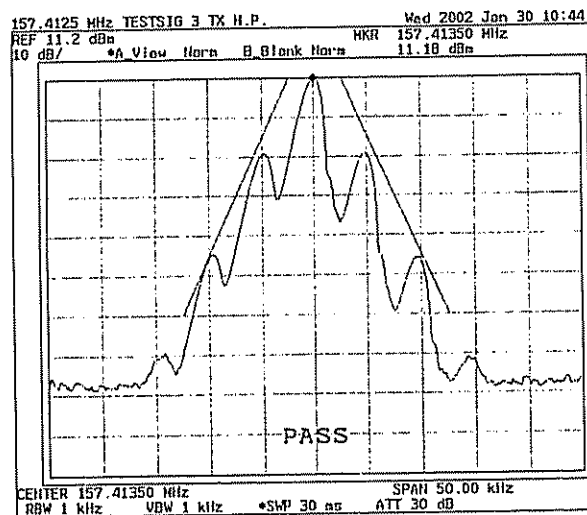
R.H.: 38 %

TX freq.: 157.4125 MHz Carrier power: H. P.

(1) TDMA Type 1 mode (Standard Test Signal Number 2):



(2) TDMA Type 2 (Standard Test Signal Number 3):



Limit: within the mask specified in figure 5, Clause 15.1 4, IEC 61993-2.

(Emission mask):

- At ± 12.5 kHz removed from the carrier, the modulation sidebands is below -60 dBc.

In the region between ± 2.5 kHz and ± 12.5 kHz removed from the carrier, the modulation sidebands is below a line starting at 0 dBc / ± 2.5 kHz and ending at -60 dBc / ± 12.5 kHz without any need to be below 0.25 μ W.

Measurement equipment used: 01, 12, 18

15.1.5 Transmitter Attack Time

Date of test: 22 Jan. 2002

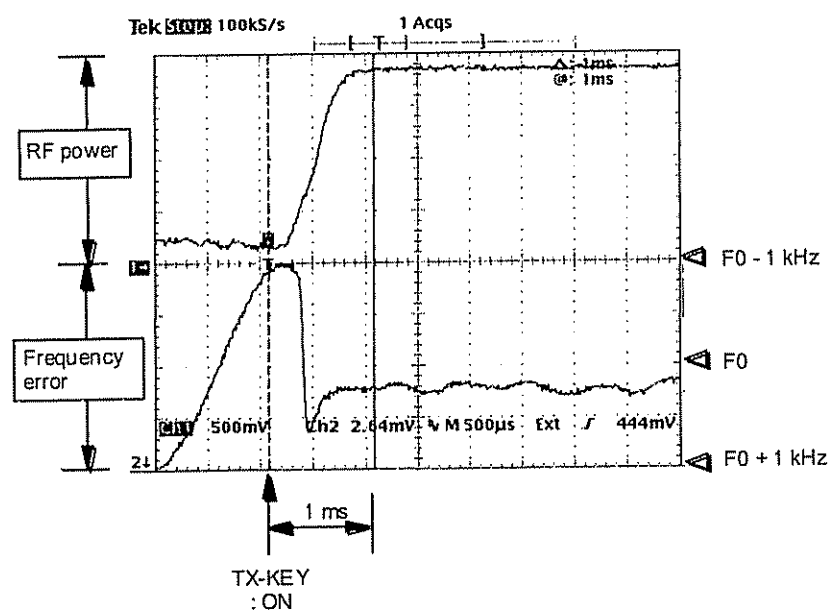
Ambient temp.: 23 °C

R.H.: 38 %

TX freq.: 156.025 MHz

Carrier power: H. P.

PLOTS OF FREQUENCY DIFFERENCE/ OUT PUT POWER VERSUS TIME



Measurement Uncertainty: ± 2 %

Limit:

- Transmitter attack time T_0 : within 1 ms,
- Transient power level: within +1.5 dB of its final value at any time,
- Carrier frequency F_c : within ± 1 kHz of its required value after 1 ms.

Measuring equipment used: 01, 05, 06, 10, 12, 15, 17, 18



Test results module

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15.1.6 Transmitter Release Time

Date of test: 22 Jan 2002

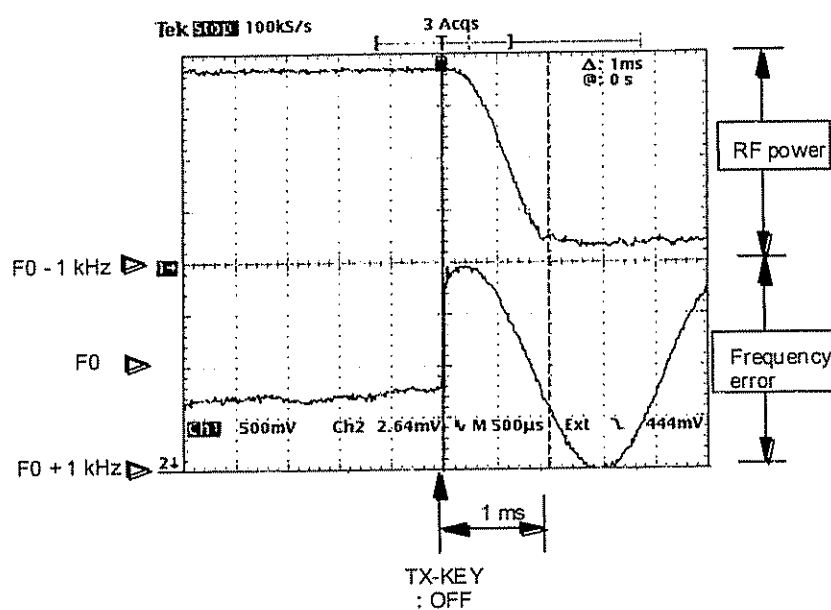
Ambient temp.: 23 °C

R.H.: 38 %

TX freq.: 156.025 MHz

Carrier power: H. P.

PLOTS OF FREQUENCY DIFFERENCE/ OUT PUT POWER VERSUS TIME

Measurement Uncertainty: $\pm 2\%$

Limit:

- Transmitter release time T_P : within 1 ms,

Measuring equipment used: 01, 05, 06, 10, 12, 15, 17, 18



Test results module

15.2 DSC Transmissions

15.2.1 Frequency error of the DSC Signal

Date of test: 22 Jan 2002

Ambient temp.: 23 °C

R.H.: 38 %

Date of test: 12 Feb 2002

Ambient temp.: 23 °C

R.H.: 41 %

Date of test: 14 Feb 2002

Ambient temp.: 24 °C

R.H.: 40 %

CHANNEL 70

$F_n = 156.525 \text{ MHz}$

TEST CONDITIONS		FREQUENCY ERROR (Hz)	
Temperature	Voltage	B-STATE (2100 Hz)	Y-STATE (1300Hz)
T_{nom} (+20 °C)	V_{nom} (24.0 V)	-0.53	+0.65
T_{min} (-15 °C)	V_{min} (21.6 V)	-0.54	+0.64
	V_{max} (31.2 V)	-0.54	+0.64
T_{max} (+55 °C)	V_{min} (21.6 V)	-0.52	+0.65
	V_{max} (31.2 V)	-0.52	+0.65
Limits		$\leq \pm 1\%$	

Measuring equipment used: 06, 08, 12, 18



Test results module

15 2.2 Modulation Rate

Date of test: 22 Jan. 2002

Ambient temp.: 23 °C

R.H.: 38 %

CHANNEL 70

$F_n = 156.525 \text{ MHz}$

TEST CONDITIONS		Error of Modulation Rate (ppm)
Temperature	Voltage	
T_{nom} (+20 °C)	V_{nom} (24 0 V)	-5.45
Limits		$\pm 30 \text{ ppm at } 1200 \text{ bits/s}$

Measuring equipment used: 06, 07, 08, 12, 18, 23



15.3 TDMA Receivers

15.3.1 Sensitivity - 25 kHz Operation

Date of test: 31 Jan. 2002

Ambient temp.: 22 °C

R.H.: 40 %

Date of test: 12 Feb 2002

Ambient temp.: 23 °C

R.H.: 41 %

Date of test: 14 Feb 2002

Ambient temp.: 24 °C

R.H.: 40 %

TEST CONDITIONS		SENSITIVITY LEVEL	
		Fn: 156.025 MHz	Fn: 162.025 MHz
Temperature	Voltage	RF level (dBm)	RF level (dBm)
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0 V)	-111 dBm at 12% PER	-110 dBm at 15% PER
<i>T_{min}</i> (-15 °C)	<i>V_{min}</i> (21.6 V)	- 110 dBm at 15% PER	- 111 dBm at 9% PER
	<i>V_{max}</i> (31.2 V)	- 110 dBm at 15% PER	- 111 dBm at 9% PER
<i>T_{max}</i> (+55 °C)	<i>V_{min}</i> (21.6 V)	- 108 dBm at 12% PER	- 108 dBm at 10% PER
	<i>V_{max}</i> (31.2 V)	- 108 dBm at 12% PER	- 108 dBm at 10% PER
Measurement uncertainty		±1 dB	
Limits		≤ - 107 dBm with a PER of ≤ 20% under normal test conditions,	
		≤ - 101 dBm with a PER of ≤ 20% under extreme test conditions,	

Measuring equipment used: 02, 18, 20, 21, 22



Test results module

Report number: 99321030

15.3.2 Sensitivity - 12.5 kHz Operation

Date of test: 31 Jan. 2002

Ambient temp.: 22 °C

R.H.: 40 %

Date of test: 12 Feb. 2002

Ambient temp.: 23 °C

R.H.: 41 %

Date of test: 14 Feb. 2002

Ambient temp.: 24 °C

R.H.: 40 %

TEST CONDITIONS		SENSITIVITY LEVEL	
		Fn: 157.4125 MHz	Fn: 160.6375 MHz
Temperature	Voltage	RF level (dBm)	RF level (dBm)
T_{nom} (+20 °C)	V_{nom} (24.0 V)	-107 dBm at 10% PER	-107 dBm at 9% PER
T_{min} (-15 °C)	V_{min} (21.6 V)	- 109 dBm at 16% PER	- 109 dBm at 11% PER
	V_{max} (31.2 V)	- 109 dBm at 16% PER	- 109 dBm at 11% PER
T_{max} (+55 °C)	V_{min} (21.6 V)	- 106 dBm at 18% PER	- 106 dBm at 17% PER
	V_{max} (31.2 V)	- 106 dBm at 18% PER	- 106 dBm at 17% PER
Measurement uncertainty		±1 dB	
Limits		≤ - 98 dBm with a PER of ≤ 20% under normal test conditions,	
		≤ - 92 dBm with a PER of ≤ 20% under extreme test conditions,	

Measuring equipment used: 02, 18, 20, 21, 22



Test results module

15.3.3 Error Behavior at High Input Levels

Date of test: 15 Feb. 2002

Ambient temp.: 23 °C

R.H.: 41 %

TEST CONDITIONS		Packet Error Rate (%)	
		Fn = 156.025 MHz (CH 60)	
Standard Test Signal		Test #2 & #3	
Input signal (dBm)		-77	-7
Temperature	Voltage	2.2	1.2
<i>Tnom</i> (+20 °C)	<i>Vnom</i> (24.0 V)		
Limits		Difference ≤ 1%	

Measuring equipment used: 02, 18, 20, 21, 22



Test results module

15.3.4 Co-channel Rejection - 25 kHz Operation

Date of test: 31 Jan. 2002

Ambient temp.: 23 °C

R.H.: 42 %

TEST CONDITIONS		CO-CHANNEL REJECTION RATIO (dB)	
		Unwanted signal	Fn = 156.025 MHz
Standard Test Signal		Test #2 & Test #3	
Temperature	Voltage	Fn +3 kHz	-11 dB at 15% PER
<i>T_{nom}</i>	<i>V_{nom}</i>	Fn	-10 dB at 18% PER
(+20 °C)	(24.0 V)	Fn -3 kHz	-13 dB at 10% PER
Measurement uncertainty		±2 dB	
Limits		Between -10.0 dB and 0 dB at ≤ 20 % PER. Any positive value is also acceptable.	

Measuring equipment used: 02, 03, 15, 18, 20, 21, 22



Test results module

15.3.5 Co-channel Rejection - 12.5 kHz Operation

Date of test: 31 Jan. 2002

Ambient temp.: 23 °C

R.H.: 42 %

TEST CONDITIONS		CO-CHANNEL REJECTION RATIO (dB)	
			Fn = 160.6375 MHz
Standard Test Signal		Unwanted signal	Test #2 & Test #3
Temperature	Voltage	Fn +2 kHz	-11 dB at 19% PER
Tnom	Vnom	Fn	-10 dB at 5% PER
(+20 °C)	(24.0 V)	Fn -2 kHz	-13 dB at 18% PER
Measurement uncertainty		+2 dB	
Limits		Between -18.0 dB and 0 dB at ≤ 20 % PER. Any positive value is also acceptable.	

Measuring equipment used: 02, 03, 15, 18, 20, 21, 22

15.3.6 Adjacent Channel selectivity - 25 kHz Operation

Date of test: 7 Feb. 2002
Date of test: 12 Feb. 2002
Date of test: 14 Feb. 2002

Ambient temp.: 23 °C
Ambient temp.: 23 °C
Ambient temp.: 24 °C

R.H.: 44 %
R.H.: 41 %
R.H.: 40 %

TEST CONDITIONS		ADJACENT CHANNEL SELECTIVITY (dB)			
		Fn: 156.025 (MHz)		Fn: 162.025 (MHz)	
Temp.	Voltage	Upper Channel	Lower Channel	Upper Channel	Lower Channel
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0V)	77d B at 18% PER	77d B at 10% PER	77d B at 18% PER	77d B at 17% PER
<i>T_{min}</i> (-15 °C)	<i>V_{min}</i> (21.6 V)	76 dB at 15% PER	76 dB at 10% PER	76 dB at 12% PER	76 dB at 15% PER
	<i>V_{max}</i> (31.2 V)	76 dB at 15% PER	76 dB at 10% PER	76 dB at 12% PER	76 dB at 15% PER
<i>T_{max}</i> (+55 °C)	<i>V_{min}</i> (21.6 V)	77 dB at 16% PER	77 dB at 13% PER	76 dB at 12% PER	76 dB at 9% PER
	<i>V_{max}</i> (31.2 V)	77 dB at 16% PER	77 dB at 13% PER	76 dB at 12% PER	76 dB at 9% PER
Measurement uncertainty		±2 dB			
Limits		≥ 70.0 dB at ≤ 20 % PER under normal test conditions, ≥ 60.0 dB at ≤ 20 % PER under extreme test conditions.			

Measuring equipment used: 02, 03, 15, 18, 20, 21, 22

15.3.7 Adjacent Channel selectivity - 12.5 kHz Operation

Date of test: 7 Feb. 2002
Date of test: 12 Feb. 2002
Date of test: 14 Feb. 2002

Ambient temp.: 23 °C
Ambient temp.: 23 °C
Ambient temp.: 24 °C

R.H.: 44 %
R.H.: 41 %
R.H.: 40 %

TEST CONDITIONS		ADJACENT CHANNEL SELECTIVITY (dB)			
		Fn = 157.4125 MHz		Fn = 160.6375 MHz	
Temp.	Voltage	Upper Channel	Lower Channel	Upper Channel	Lower Channel
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0V)	58 dB at 11% PER	62 dB at 12% PER	59 dB at 14% PER	62 dB at 6% PER
<i>T_{min}</i> (-15 °C)	<i>V_{min}</i> (21.6 V)	59 dB at 17% PER	60 dB at 12% PER	60 dB at 15% PER	64 dB at 17% PER
	<i>V_{max}</i> (31.2 V)	59 dB at 17% PER	60 dB at 12% PER	60 dB at 15% PER	64 dB at 17% PER
<i>T_{max}</i> (+55 °C)	<i>V_{min}</i> (21.6 V)	59 dB at 8% PER	61 dB at 7% PER	64 dB at 12% PER	65 dB at 19% PER
	<i>V_{max}</i> (31.2 V)	59 dB at 8% PER	61 dB at 7% PER	64 dB at 12% PER	65 dB at 19% PER
Measurement uncertainty		±2 dB			
Limits		≥ 50.0 dB at ≤ 20 % PER under normal test conditions, ≥ 50.0 dB at ≤ 20 % PER under extreme test conditions.			

Measuring equipment used: 02, 03, 15, 18, 20, 21, 22

15.3.8 Spurious Response Rejection

Date of test: 7 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CH A (161.975 MHz)

Funw (MHz)	SPURIOUS RESPONSE REJECTION RATIO (dB)
125.988	73 dB at 18% PER
152.985	80 dB at 17% PER
162.880	86 dB at 11% PER
*	

CH B (162.025 MHz)

Funw (MHz)	SPURIOUS RESPONSE REJECTION RATIO (dB)
126.009	73 dB at 18% PER
153.002	82 dB at 1% PER
162.897	88 dB at 13% PER
*	
Measurement uncertainty	+2 dB
Limit	≥ 70 dB with ≤ 20 % PER at $ \text{Funw} - \text{Fn} \geq 50$ kHz

Funw = unwanted frequency

* : Rejection on other spurious responses was 90 dB.

(1) Frequency of the Receiver (f_R): 161.975 MHz and 162.025 MHz

(2) Frequency of the local oscillator signal applied to the 1st mixer of the Receiver (f_{LO}): 206.975 and 207.125 MHz

(3) Intermediate frequencies (f_{I1} , f_{I2}): f_{I1} = 45.0 and 45.1 MHz, f_{I2} = 455 kHz

(4) Switching range of the Receiver (sr): 156 to 163 MHz

Measuring equipment used: 02, 03, 15, 18, 20, 21, 22

15.3.9 Intermodulation response rejection and blocking

Date of test: 7 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

TEST CONDITIONS		PACKET ERROR RATE (%)	
		Fn = 156.025 MHz	Fn = 162.025 MHz
Temperature	Voltage	Test #1	Test #2
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0 V)	2	18
Limits		≤ 20% PER	

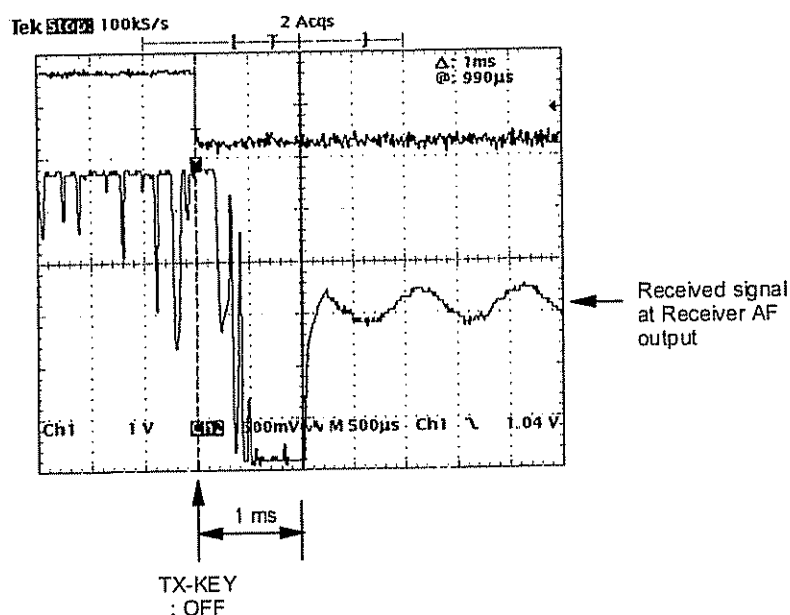
Measuring equipment used: 02, 03, 04, 05, 16, 18, 20, 21, 22

15.3.10 Transmit to receive switching time

Date of test: 15. Feb. 2002

Ambient temp.: 23 °C

R.H.: 42 %



Note: Following test method was applied instead of the method specified by the Standard IEC 61993-2 Clause 15.3.10:

- 1) TX and RX frequencies were set to 156.025 MHz.
- 2) Test signal from Signal generator at the RF input of the EUT Receiver modulated by 1 kHz with a deviation of +/- 3 kHz was set to -80 dBm.
- 3) The demodulated signal at the AF output of the EUT Receiver was monitored by using a dual trace oscilloscope.
- 4) The time which elapsed between the initiation of the "Transmitter off" function (TX-KEY OFF) and the moment when the received demodulated signal (1 kHz) at the AF output reached the steady state level was measured.
- 5) The measured time of 1 ms was found within the specified Transmitter Release Time.

Measuring equipment used: 02, 10, 12, 18

15.4 DSC Receiver

15.4.1 Maximum sensitivity

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

Date of test: 12 Feb 2002

Ambient temp.: 23 °C

R.H.: 41 %

Date of test: 14 Feb. 2002

Ambient temp.: 24 °C

R.H.: 40 %

TEST CONDITIONS		SENSITIVITY LEVEL (dBm)		
		Fn: 156.525 MHz (CH 70)		
Temperature	Voltage	Fn	Fn -1.5 kHz	Fn + 1.5 kHz
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24.0 V)	-111 dBm at 0.1% BER	-110 dBm at 0.1% BER	-109 dBm at 0.1% BER
<i>T_{min}</i> (-15 °C)	<i>V_{min}</i> (21.6 V)	- 107 dBm at 0.4% BER	- 106 dBm at 0.1% BER	- 106 dBm at 0.1% BER
	<i>V_{max}</i> (31.2 V)	- 107 dBm at 0.4% BER	- 106 dBm at 0.1% BER	- 106 dBm at 0.1% BER
<i>T_{max}</i> (+55 °C)	<i>V_{min}</i> (21.6 V)	- 105 dBm at 0.8% BER	- 104 dBm at 0.2% BER	- 102 dBm at 0% BER
	<i>V_{max}</i> (31.2 V)	- 105 dBm at 0.8% BER	- 104 dBm at 0.2% BER	- 102 dBm at 0% BER
Measurement uncertainty		±1 dB		
Limits		≤ - 107 dBm at ≤ 1% BER under normal test conditions, ≤ - 101 dBm at ≤ 1% BER under extreme test conditions,		

Measuring equipment used: 03, 18, 19, 20



Test results module

Report number: 99321030

15.4.2 Error Behavior at High Input Levels

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CHANNEL 70: Fn: 156.525 MHz

TEST CONDITIONS		BIT ERROR RATE (%)
Temperature	Voltage	RF input -7 dBm / Standard Test Signal #1
T_{nom} (+20 °C)	V_{nom} (24.0 V)	0
Limits		≤ 1% BER

Measuring equipment used: 03, 18, 19, 20



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Test results module

Report number: 99321030

+15.4.3 Co-Channel Rejection

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CHANNEL 70: Fn: 156.525 MHz

TEST CONDITIONS		CO-CHANNEL REJECTION RATIO (dB)	
		Standard Test Signal #1/ -104 dBm	
		Unwanted signal (Fn: 156.525 MHz)	
Temperature	Voltage	Unwanted signal	
<i>T_{nom}</i> (+20 °C)	<i>V_{nom}</i> (24 0 V)	Fn + 3 kHz	- 5 dB at 0% BER
		Fn + 2 kHz	- 5 dB at 0% BER
		Fn + 1 kHz	- 5 dB at 0% BER
		Fn	- 5 dB at 0% BER
		Fn – 1 kHz	- 4 dB at 0% BER
		Fn – 2 kHz	- 4 dB at 0.1% BER
		Fn - 3 kHz	- 5 dB at 0% BER
Measurement uncertainty		+2 dB	
Limits		Between -10.0 dB and 0 dB at ≤ 1% BER	

Measuring equipment used: 03, 04, 15, 18, 19, 20



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Test results module

15.4.4 Adjacent Channel selectivity

Date of test: 8 Feb. 2002
Date of test: 12 Feb. 2002
Date of test: 14 Feb. 2002

Ambient temp.: 23 °C
Ambient temp.: 23 °C
Ambient temp.: 24 °C

R.H.: 44 %
R.H.: 41 %
R.H.: 40 %

TEST CONDITIONS		ADJACENT CHANNEL SELECTIVITY (dB)	
		Fn = 156.525 MHz (CH 70)	
Temp.	Voltage	Upper Channel	Lower Channel
Tnom (+20 °C)	Vnom (24.0V)	70 dB at 0% BER	70 dB at 0% BER
Tmin (-15 °C)	Vmin (21.6 V)	78 dB at 0% BER	75 dB at 0% BER
	Vmax (31.2 V)	78 dB at 0% BER	75 dB at 0% BER
Tmax (+55 °C)	Vmin (21.6 V)	71 dB at 0.5% BER	70 dB at 0.2% BER
	Vmax (31.2 V)	71 dB at 0.5% BER	70 dB at 0.2% BER
Measurement uncertainty		±2 dB	
Limits		≥ 70.0 dB at ≤ 1% BER under normal test conditions, ≥ 60.0 dB at ≤ 1% BER under extreme test conditions.	

Measuring equipment used: 03, 04, 15, 18, 19



15.4.5 Spurious Response Rejection

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CHANNEL 70: Fn: 156.525 MHz

Funw (MHz)	SPURIOUS RESPONSE REJECTION RATIO (dB)
113.725	87 dB at 0.1% BER
145.825	82dB at 0% BER
156.615	87 dB at 0.1% BER
291.650	≥ 90 dB
246.608	≥ 90 dB
210.567	≥ 90 dB
111.408	≥ 90 dB
66.442	≥ 90 dB
21.400	≥ 90 dB
*	
Measurement uncertainty	+2 dB
Limit	> 70 dB with ≤ 1% BER at $ \text{Funw} - \text{Fn} \geq 50 \text{ kHz}$

Funw = unwanted frequency

* : Rejection on other spurious responses is ≥ 90 dB.

- (1) Frequency of the Receiver (f_R): 156.525 MHz
- (2) Frequency of the local oscillator signal applied to the 1st mixer of the Receiver (f_{LO}): 135.125 MHz
- (3) Intermediate frequencies (f_{I1}, f_{I2}): $f_{I1} = 21.4 \text{ MHz}$, $f_{I2} = 455 \text{ kHz}$
- (4) Switching range of the Receiver (sr): 156 to 163 MHz

Measuring equipment used: 03, 04, 18, 19, 20



15.4.6 Intermodulation response Rejection

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CHANNEL 70: Fn: 156.525 MHz

TEST CONDITIONS		Intermodulation response rejection ratio (dB)	
Temperature	Voltage	Upper	Lower
T_{nom} (+20 °C)	V_{nom} (24.0 V)	69 dB at 0% BER	69 dB at 0% BER
Measurement uncertainty		±2 dB	
Limits		65.0 dB at ≤ 1% BER	

Measuring equipment used: 03, 04, 05, 14, 18, 19, 20

15.4.7 Blocking or Desensitization

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

CHANNEL 70: Fn: 156.525 MHz

Funw (MHz)	BER (%)
Fn - 10	0
Fn - 9	0
Fn - 8	0
Fn - 7	0
Fn - 6	0
Fn - 5	0
Fn - 4	0
Fn - 3	0
Fn - 2	0
Fn - 1	0
Fn + 1	0
Fn + 2	0
Fn + 3	0
Fn + 4	0
Fn + 5	0
Fn + 6	0
Fn + 7	0
Fn + 8	0
Fn + 9	0
Fn + 10	0
Measurement uncertainty	+2 dB
Limit	≥ 84 dB at ≤ 1% BER except spur. response frequencies

Funw = unwanted frequency

Measuring equipment used: 03, 04, 15, 18, 19, 20

15.5 Conducted Spurious Emissions conveyed to the antenna

15.5.1 Spurious Emissions from the Receiver

Date of test: 8 Feb. 2002

Ambient temp.: 23 °C

R.H.: 44 %

(1) TDMA Receiver and DSC Receiver,

$F_n = 156.025, 162.025 \text{ MHz and } 156.525 \text{ MHz}$

SPURIOUS EMISSIONS POWER LEVEL	
Spurious frequency (MHz)	Power level (dBm)
281.132	- 81.2
1141.770	- 68.6
1206.150	- 65.2
1407.175	- 75.1
1671.120	- 67.9
1809.226	- 72.9
*	
Measurement uncertainty	+1 dB
Limit (150 kHz - 2 GHz)	$\leq - 57 \text{ dBm (2 nW) for } 150 \text{ kHz} - 1 \text{ GHz,}$ $\leq - 47 \text{ dBm (20 nW) for } 1 \text{ GHz} - 2 \text{ GHz.}$

* : other spurious emissions were at least 30 dB below the limit.

Measuring equipment used: 01, 18



15.5.2 Spurious Emissions from the Transmitter

Date of test: 15 Feb. 2002

Ambient temp.: 23 °C

R.H.: 42 %

SPURIOUS EMISSIONS POWER LEVEL		
Fn = 156.025 MHz	High power	Low power
Spurious frequency (MHz)	Power level (dBm)	Power level (dBm)
312.050	- 54.4	- 71.3
468.075	- 40.4	- 64.1
*		
Measurement uncertainty		+1 dB
Limit (150 kHz - 2 GHz)		$\leq - 36$ dBm (0.25 μ W) for 150 kHz - 1 GHz, $\leq - 30$ dBm (1 μ W) for 1 GHz - 2 GHz.

* : other spurious emissions were at least 30 dB below the limit.

SPURIOUS EMISSIONS POWER LEVEL		
Fn = 162.025 MHz	High power	Low power
Spurious frequency (MHz)	Power level (dBm)	Power level (dBm)
324.050	- 55.9	- 73.7
486.075	- 41.4	- 65.2
*		
Measurement uncertainty		+1 dB
Limit (150 kHz - 2 GHz)		$\leq - 36$ dBm (0.25 μ W) for 150 kHz - 1 GHz, $\leq - 30$ dBm (1 μ W) for 1 GHz - 2 GHz.

* : other spurious emissions were at least 30 dB below the limit.

Measuring equipment used: 01, 12, 18



Used test equipment module

This module contains the total list of test equipment used.



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TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

No.	Instrument/Ancillary	Type	Serial No.	Manufacturer	Calibration Due date
01	Spectrum analyzer	R3273	101003561	ADVANTEST	02. 2003
02	Vector Signal generator	SMIQ03B	1125.5555.03	R& S	02. 2002
03	Signal generator	8664A	3744A02535	Agilent	02. 2003
04	Signal generator	8664A	3744A02527	Agilent	02. 2003
05	Signal generator	2041	119864/055	Marconi	07. 2002
06	Modulation analyzer	8901B	3028A03046	H P	08. 2002
07	Modulation analyzer	8901B	2718A01184	H P	08. 2002
08	Frequency counter	5385A	2730A05114	H P	08. 2002
09	Audio analyzer	8903B	2818A04215	H P	08. 2002
10	Oscilloscope	TDS380P	J300711	Tektronix	04. 2002
11	Digital Multimeter	E2377A	3651J18669	H P	03. 2003
12	Attenuator (30dB)	8498A	1801A04084	H P	08. 2002
13	Printer	PM-2000C	ANF0025191	EPSON	----
14	RF combiner	ZFSC-3-1	09642	Mini-Circuit	----
15	Hybrid	CB722S	----	TDK	----
16	RF combiner	ZFSC-4-1	09810	Mini-Circuit	----
17	SWR bridge	60NF50	----	WILLTRON	----
18	Power supply	PAN55-20	AK003307	KIKUSUI	----
19	DSC signal generator	FMJ-0201	----	Furuno	----
20	Personal Computer	Endeavor NT-1400	139000724	EPSON DIRECT	----
21	Personal Computer	Endeavor NT-1400	139000725	EPSON DIRECT	----
22	AIS Transponder	AS-100	----	Furuno	----
23	Freq. Converter & SSB modulator	----	----	Furuno	----