LABOTECH

TECHNICAL INFORMATION

TEST REPORT ON THE PERFORMANCE OF

Universal Automatic Identification System

Trade Name : FURUNO

Model : FA-100

Report no.: FLI 12-02-046

Date of issue: October 4, 2002

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All tests were performed in Furuno Labotech International Co., Ltd.
All data herein contained is true and correct to our best knowledge.

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Function : Manager, QA

Signature 瀬川俊郎

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Date : October 4, 2002

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Function : Manager, Technical Section

Signature : M. Komori

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1 General Information

1.1 GENERAL

(a) Manufacturer: Furuno Electric Co., Ltd.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan

(b) Model: FA-100

	Type	Serial Number
Transponder unit	FA-100	3539-0101
GPS Antenna	GSC-001	
VHF Antenna	FAB-151D	
Junction Box	CB-100	

(c) Display: Monochrome STN-LCD, 60 (H) x 95 (W) mm, 120 x 64 dots

(d) Output Power: 2 W/12.5 W or 0 W exchangeable

(e) Impedance: 50 ohms

(f) DSC Receiver: CH70 fixed, 156.525 MHz, G2B, 1200 bps

(g) Band Width: 25 kHz/12.5 kHz

1.2 TRANSPONDER UNIT

(a) CPU: SH7709A, 76.0 MHz

(b) ROM: Flash ROM 1MW

(c) Menu: Target data/Plotter/Own data/Set MSG/Init Settings/System Settings/Diagnostics

1.3 GPS RECEIVER

(a) Receiving Channels: 12 channels parallel, 12 satellites tracking

(b) RX Frequency/RX Code: 157.42 MHz, C/A code

(c) Position Fixing System: All in view, 8-state Kalman fiter

(d) Position Accuracy: Approx. 10m, 95% of the time, (HDOP 4)
DGPS: approx. less than 5 m, 95% of the time

(e) Tracking Velocity: 900 kts

(f) Position-fixing Time: Warm start: 12 seconds, Cold start: 90 seconds

(g) Position Update Interval: 1 second

(h) DGPS Data Receiving: RTCM SC-104 Ver 2.1 formatted

1.4 INTERFACES

(a) Sensor 1/2/3(IEC 61162-1/2)

Input: DTM, GNS, GLL, GGA, RMC, VBW, VTG, OSD, HDT, GBS, ROT (GN>GP>GL>LC)

(b) PCI /O, EXTRA1, LR or ECDIS/RADAR (IEC 6116201/2)

Input: VSD, SSD, ABM, BBM. ACA, ACK, AIR, DTM, GBS, GGA, GLL,

		GNS, HDT, LRF, LRI, OSD, RMC, ROT, VBW, VTG
	Output:	VDM, VDO, ABK, ACA, ALR, TXT, LR1, LR2, LR3, LRF, LRI
(c)	Alarm:	Contact Closure
(d)	LAN: (10 base-T):	IEC 61162-4
(e)	AD-10:	AD-10 format

1.5 POWER SUPPLY

(a)	Transponder Unit:	12 - 24 VDC: 7 - 3.5A
(b)	AD/DC Power Supply Unit (PR-240, option)	100 - 115/200 - 230 VAC, 1 phase, 50/60 Hz

1.6 ENVIRONMENTAL CONDITION

(a)	Ambient Temperature	
	GPS Antenna Unit:	-25°C to +70°C
	Other units:	-15°C to +55°C
(b)	Relative Humidity:	95% at 40°C
(c)	Waterproof (IEC 61529)	
	Antenna Unit:	IPX6
	Other units:	IPX0
(d)	Vibration:	IEC 60945 edition 3

1.7 COATING COLOR

(a)	GPS Antenna Unit:	N9.5
(b)	Other units:	2.5GY5/1.5

2 Identification of Equipment (FCC Rule § 2.925)

The following nameplate is permanently fixed on the corresponding equipment units.

FCC ID: ADB9ZWFA100

Material of nameplate: Polyester film, 0.1 mm thick

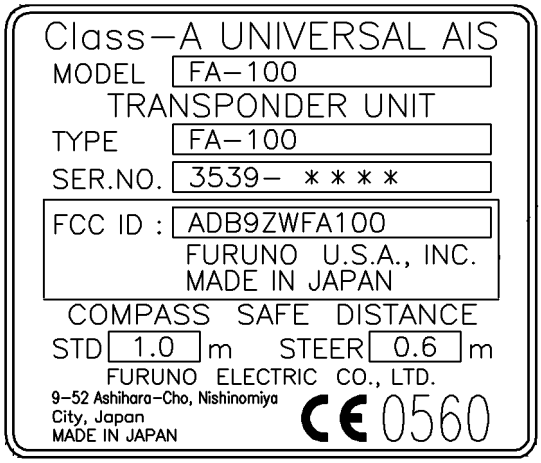
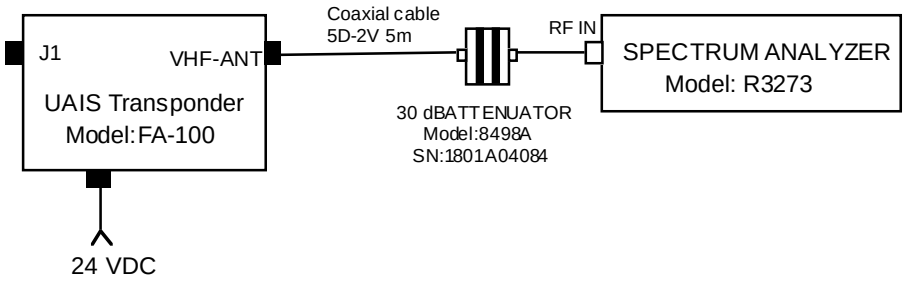


Fig 2.1 FA-100 Nameplate

3 Test data

3.1 RF Power Output (FCC Rule § 2.1046)

3.1.1 Setup for measurement



3.1.2 Measuring Equipment List:

See Attachment A [List of Test/Measuring Equipment].

3.1.3 Test Results

(1) Voltages and currents to the final RF module were measured.

(2) Carrier power was measured at HI and LO positions with a 50 ohm artificial antenna.

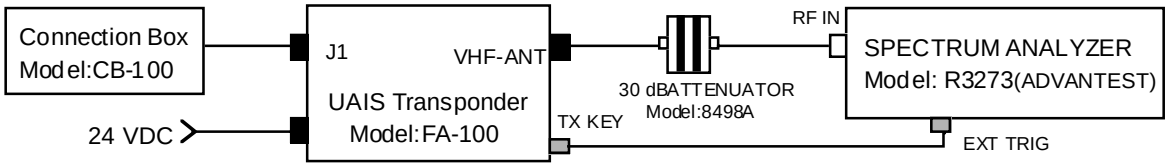
Results are shown in Table 3.1.

Table 3.1

CH	Supply (V)	Output HI (W)	Final stage at HI		Output Low (W)	Final stage at LO	
			Volt (V)	Current (A)		Volt (V)	Current (A)
1060	27.6	12.0	13.6	2.3	2.1	13.6	0.9
	24.0	12.0	13.6	2.3	2.1	13.6	0.9
	20.4	12.0	13.6	2.3	2.1	13.6	0.9
1228	27.6	12.0	13.6	2.3	2.1	13.6	0.9
	24.0	12.0	13.6	2.3	2.1	13.6	0.9
	20.4	12.0	13.6	2.3	2.1	13.6	0.9
2260	27.6	11.8	13.6	2.3	2.1	13.6	0.9
	24.0	11.8	13.6	2.3	2.1	13.6	0.9
	20.4	11.8	13.6	2.3	2.1	13.6	0.9
2088	27.6	11.8	13.6	2.3	2.0	13.6	0.9
	24.0	11.8	13.6	2.3	2.0	13.6	0.9
	20.4	11.8	13.6	2.3	2.0	13.6	0.9

3.2 Occupied Bandwidth (FCC Rule § 2.1049)

3.2.1 Setup for measurement



3.2.2 Measuring Equipment List:

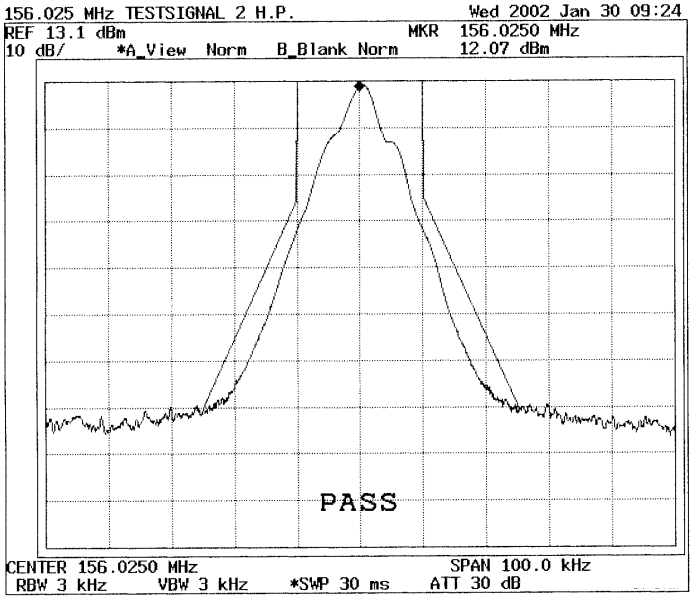
See Attachment A [List of Test/Measuring Equipment].

3.2.3 Test results

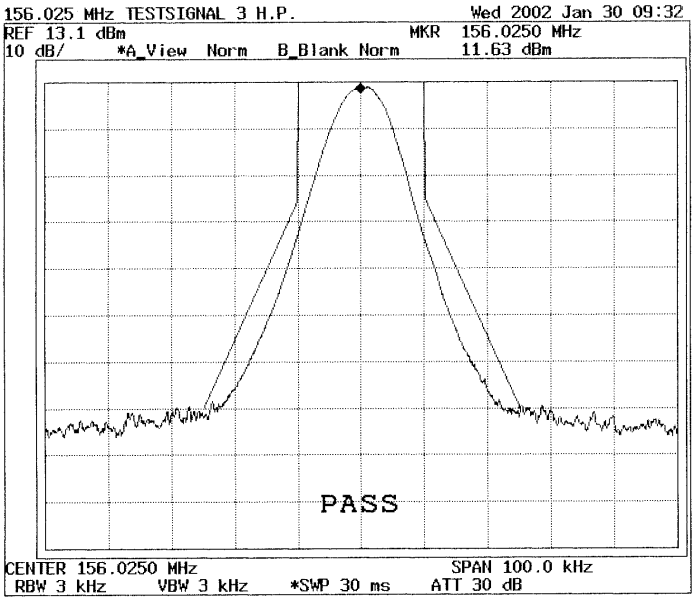
3.2.3.1 Modulation Spectrum for 25 kHz channel mode (Clause 15.1.3, IEC 61993-2)

TX freq.: 156.025 MHz Carrier power: High power

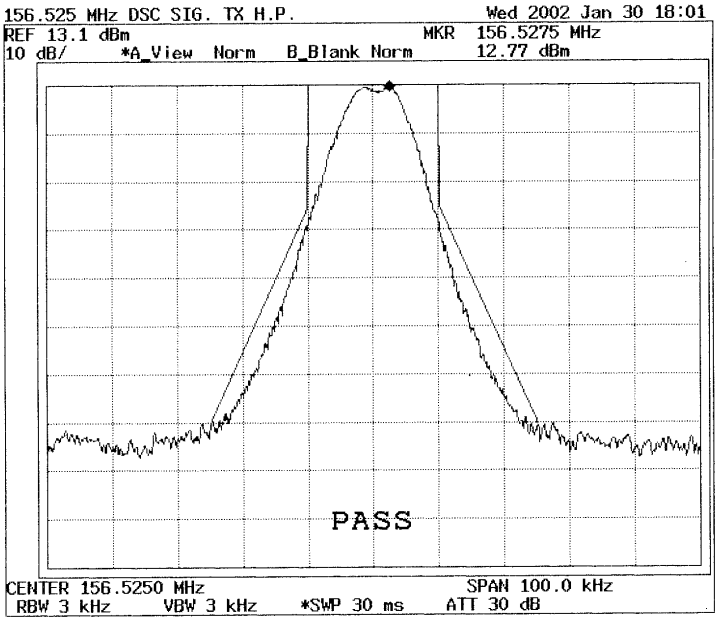
(1) TDMA Type 1 mode (Standard Test Signal Number 2):



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



Test frequency: 156.525 MHz Carrier power: High power
(1) DSC mode (standard Test Signal Number 1):

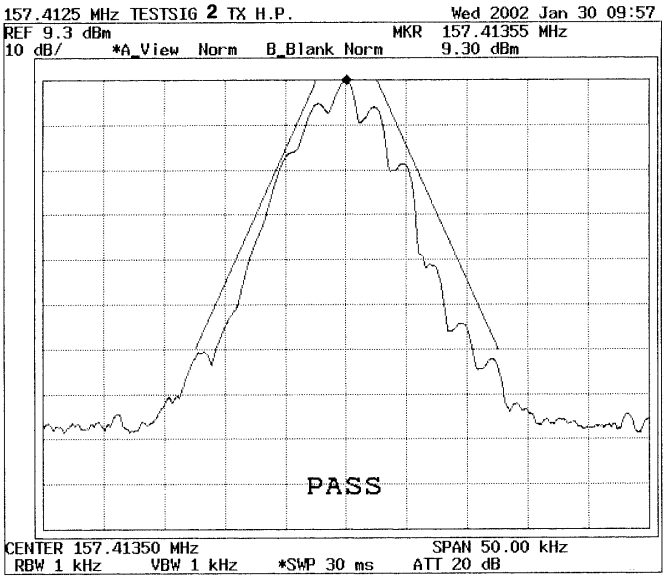


Limit : within the mask specified in figure 4, Clause 15.1.3, IEC 61993-2.
(Emission mask):
- At ± 10 kHz removed from the carrier, the modulation sidebands is below -25 dBc.
- At ± 25 kHz removed from the carrier, the modulation sidebands is below -70 dBc, without any need to be below 0.25 µW.
In the region between + 10 kHz and + 25 kHz removed from the carrier, the modulation sidebands is below a line specified between these two points.

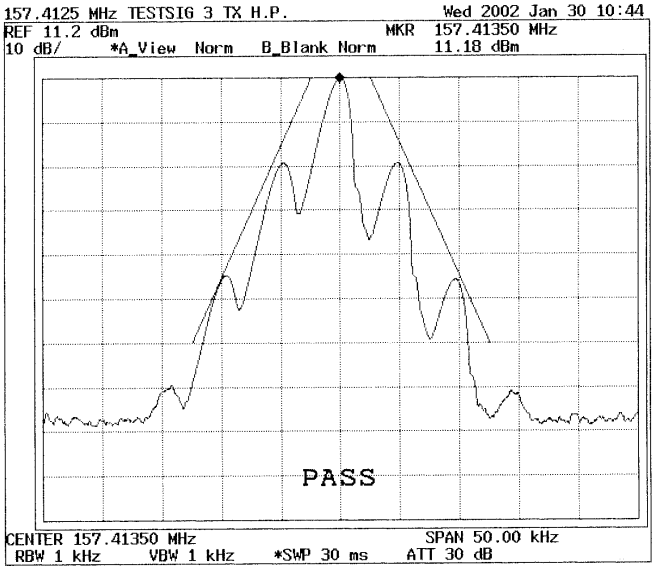
3.2.3.2 Modulation Spectrum for 12.5 kHz channel mode (Clause 15.1.4, IEC 61993-2)

TX freq.: 157.4125 MHz Carrier power: High power

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



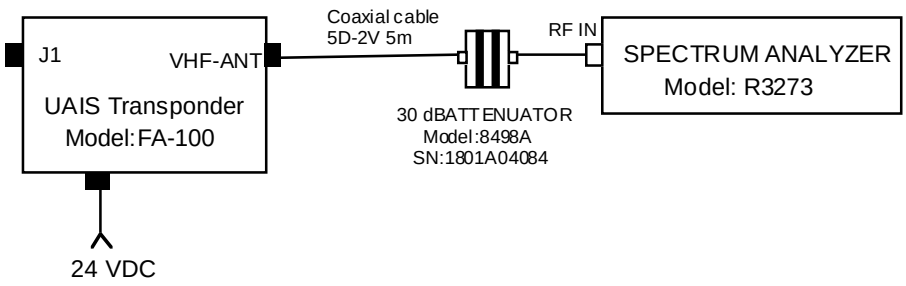
(2) TDMA Type 2 (Standard Test Signal Number 3):



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 µW.

3.3 Spurious Emissions at Antenna Terminals (FCC Rule §2.1051)

3.3.1 Test Equipment Setup:



Radio frequency voltage generated within the equipment and appearing as a spurious emission was measured at the output terminal when loaded with 50 ohm artificial antenna.

3.3.2 Measuring Equipment List:

See Attachment A [List of Test/Measuring Equipment].

3.3.3 Emission Limits:

< -54 dB below carrier at High power,

< -46 dB below carrier at Low power

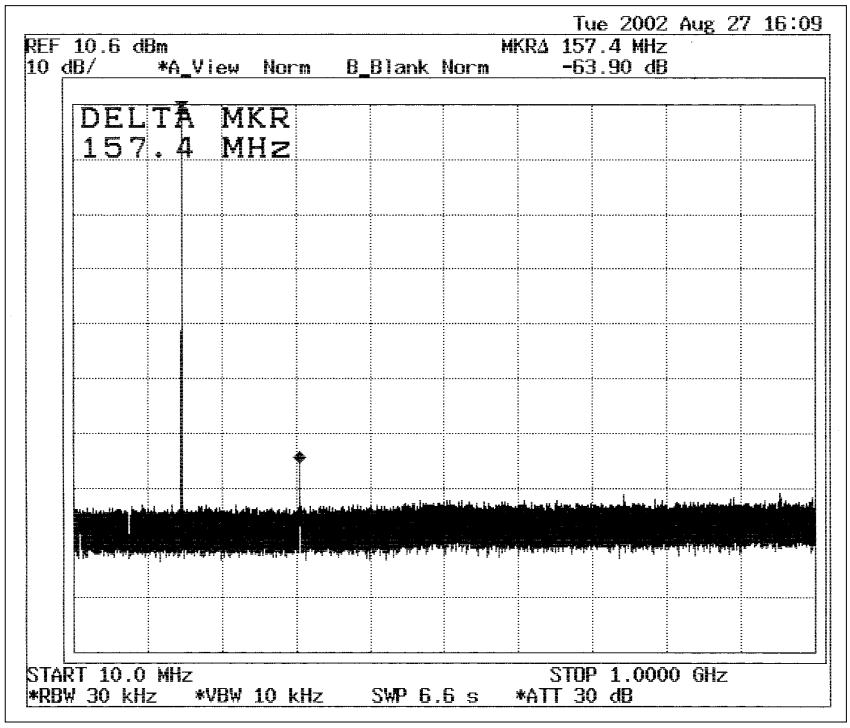
3.3.4 Test Results:

The spurious emissions at antenna terminal of EUT are found lower than the specified limits.

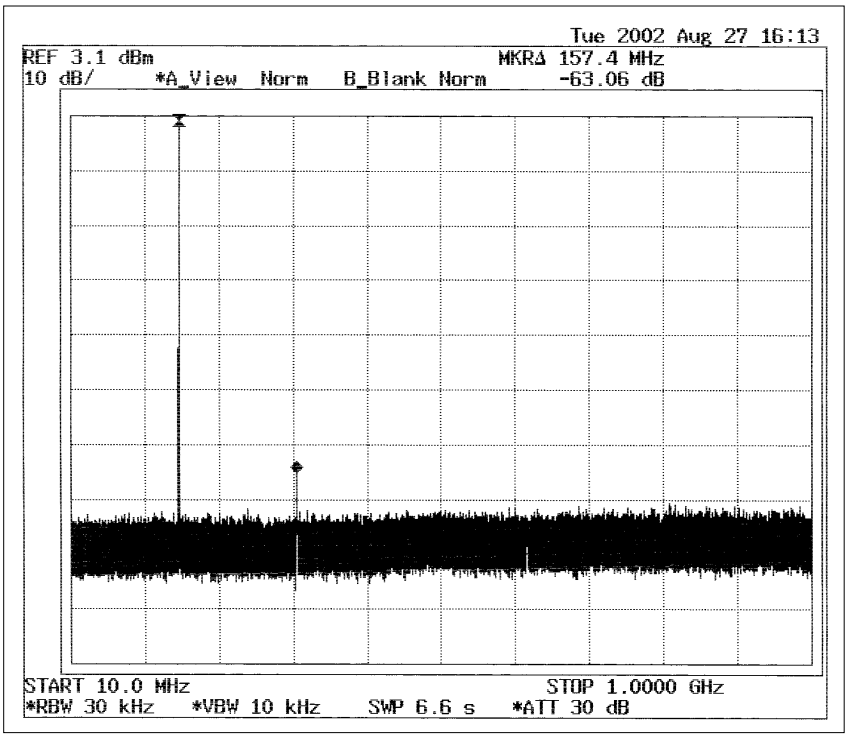
(Note: Spurious emissions at the frequencies for more than 1 GHz were not found.)

f	CH1060 (156.025 MHz)		CH2088 (162.025 MHz)	
	High power	Low power	High power	Low power
2f	-63.9 dB	-63.1 dB	-62.9 dB	-63.5 dB
3f	Not found	Not found	Not found	Not found
4f	Not found	Not found	Not found	Not found
5f	Not found	Not found	Not found	Not found

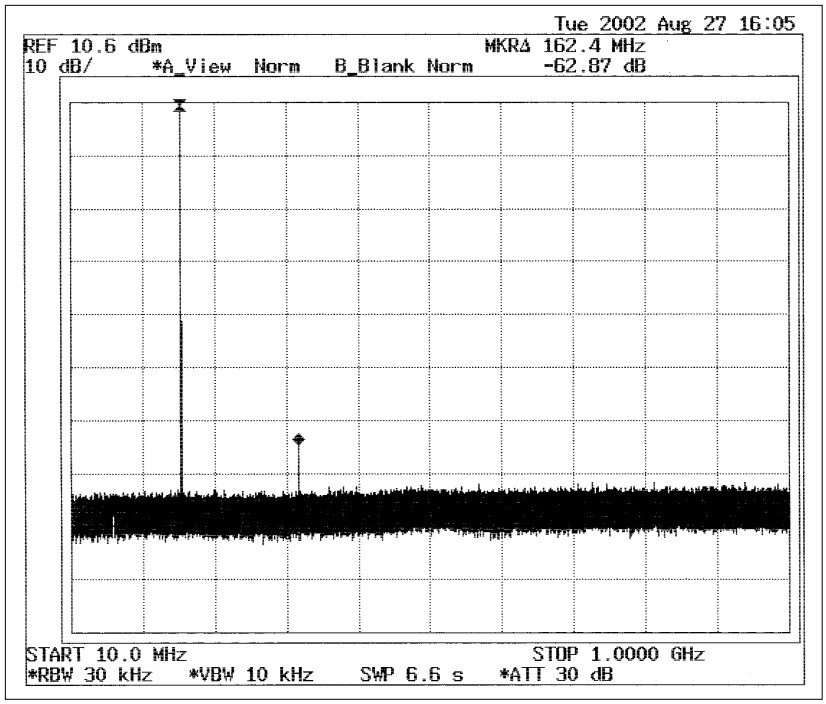
Graph 3.3a – Spurious Emissions at Antenna terminal on Channel 1060 with high power mode



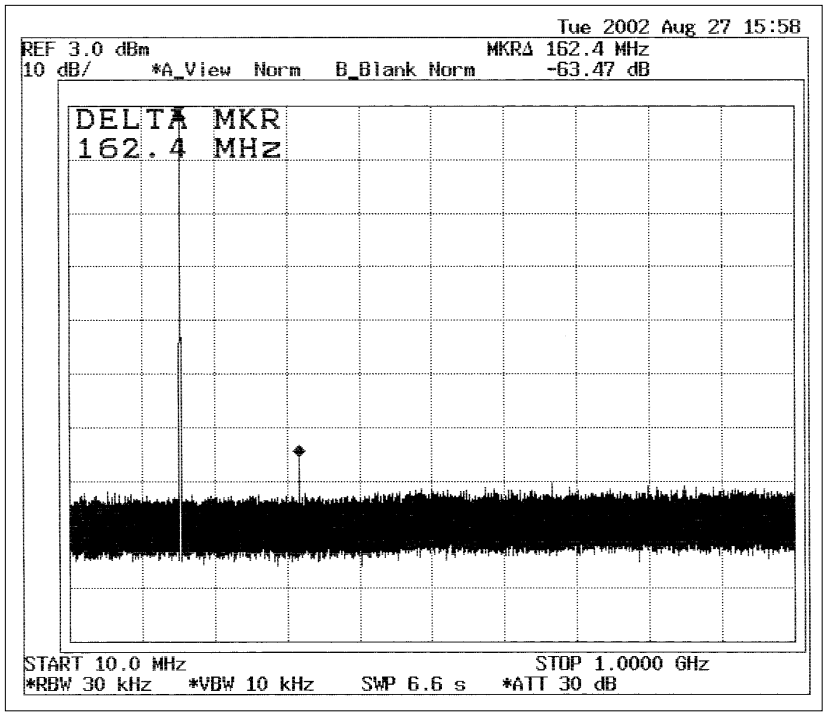
Graph 3.3b – Spurious Emissions at Antenna terminal on Channel 1060 with low power mode



Graph 3.3c – Spurious Emissions at Antenna terminal on Channel 2088 with high power mode



Graph 3.3d – Spurious Emissions at Antenna terminal on Channel 2088 with low power mode



3.4 Field Strength of Spurious Radiation (FCC Rule § 2.1053)

3.4.1 Test Site: Nishinomiya-hama site Anechoic chamber

FCC Registration Number: 90607

FURUNO LABTECH INTERNATIONAL CO., LTD.

Nishinomiya-hama 2-20, Nishinomiya-city, 662-0934 Japan

3.4.2 Distance between the EUT and measuring antenna: 3 m

3.4.3 Measuring Equipment List:

See Attachment A [List of Test/Measuring Equipment].

3.4.4 Test settings:

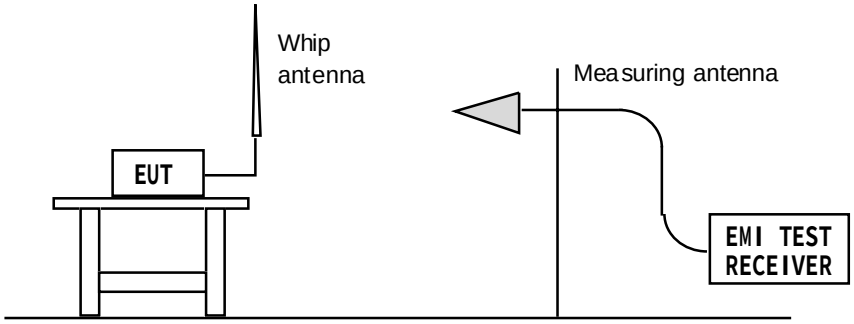


Fig 3.4A Setup for measurement of fundamental component

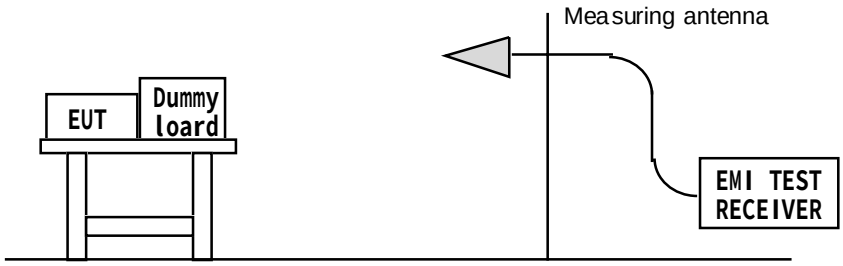


Fig 3.4B Setup for measurement of any spurious other than fundamental component

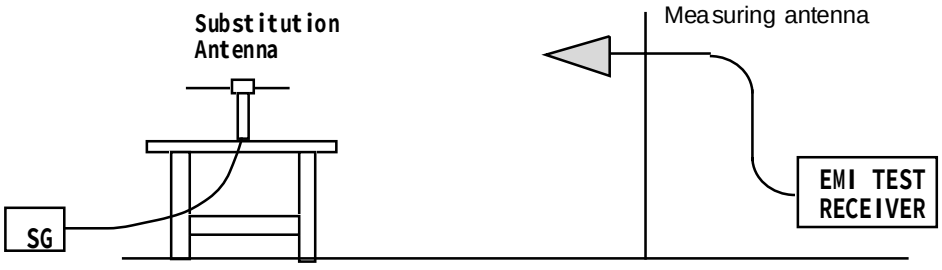


Fig 3.4C Setup for measurement of field strength with substitution antenna

3.4.5 Method of measurement

(1) With the test setup described in Fig. 3.5A, Field strength of TX fundamental component will be measured.

(2) With the test setup described in Fig. 3.5B, Field strength of each spurious component other than TX fundamental component will be measured.

(3) With the test setup described in Fig. 3.5C, Field strength generated by the Signal Generator with the substitution antenna for the fundamental and spurious frequencies will be measured. (Substitution method for calculation of the radiated power)

3.4.6 Field Strength Limits:

<-54 dB below carrier at High power,

<-46 dB below carrier at Low power

3.4.7 Measurement Results:

1. Field strength of fundamental component (Refer to Fig 3.5A)

	High power (12.5 W)		Low power (2 W)	
Test channel	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)
1060 (156.025 MHz)	108.7	114.8	106.4	110.1
2088 (162.025 MHz)	115.4	114.5	112.7	108.6

2. Field strength of each spurious components (Refer to Fig 3.5B)

Test channel	High power (12.5 W)		Low power (2 W)	
1060 (156.025 MHz)	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)
2f (312.050 MHz)	17.5	16.7	16.9	16.7
3f (468.075 MHz)	16.1	16.2	16.0	16.0
4f (624.100 MHz)	15.4	15.6	15.4	15.3

Test channel	High power (12.5 W)		Low power (2 W)	
2088 (162.025 MHz)	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)	Horizontal plane (dBμV/m)	Vertical plane (dBμV/m)
2f (324.050 MHz)	18.9	17.3	17.7	16.8
3f (486.075 MHz)	16.1	16.3	15.9	16.0
4f (648.100 MHz)	15.5	15.5	15.4	15.6

3. Field strength with substitution antenna (Refer to Fig 3.5C)

Signal generator		Radiated power with substitution antenna (dBm)	Field strength (dBμV/m)	
Frequency (MHz)	Output level (dBm)		Horizontal plane	Vertical plane
156.025	-30	-30	70.5	65.5
162.025	-30	-28.83	71.3	66.5
312.050	-40	-37.56	62.6	61.1
324.050	-40	-36.83	64.0	63.0

Signal generator		Radiated power with substitution antenna (dBm)	Field strength (dBµV/m)	
Frequency (MHz)	Output level (dBm)		Horizontal plane	Vertical plane
468.075	-40	-36.38	64.5	62.1
486.075	-40	-36.38	64.5	62.1
624.100	-40	-36.89	65.3	63.0
648.100	-40	-36.74	65.3	62.4

3.4.8 Test Results

Calculation of Spurious Attenuation by using Substitution Method:

(1) Calculation of Radiated Power (X1) of the TX fundamental component:

X1 = ((Field Strength of Fundamental Component) – (Field Strength measured with Substitution Ant.)) + (Radiated Power with Substitution Ant.)

(2) Calculation of Radiated Power (X2) of each spurious component:

X2 = ((Field Strength of Spurious Component) – (Field Strength measured with Substitution Ant.)) + (Radiated Power with Substitution Ant.)

(3) Calculation of Spurious Attenuation:

Spurious Attenuation (dB) ＝ (X1) - (X2)

(4) Results of Spurious Attenuation:

Test channel: CH1060 (156.025 MHz) on High power

	Frequency	X1 (dBm)		X2 (dBm)		Attenuation (dB)	
	(MHz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Fundamental	156.025	8.2	19.3			0	0
Spurious	312.050			-82.7	-82.0	90.9	101.3
	468.075			-84.8	-82.3	93.0	101.6
	624.100			-86.8	-84.3	95.0	103.6

Test channel: CH1060 (156.025 MHz) on Low power

	Frequency	X1 (dBm)		X2 (dBm)		Attenuation (dB)	
	(MHz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Fundamental	156.025	5.9	14.6			0	0
Spurious	312.050			-83.3	-82.0	89.2	96.6

	Frequency	X1 (dBm)		X2 (dBm)		Attenuation (dB)	
	(MHz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
	468.075			-84.9	-82.5	90.8	97.1
	624.100			-86.8	-84.6	92.7	99.2

Test channel: CH2088 (162.025 MHz) on High power

	Frequency	X1 (dBm)		X2 (dBm)		Attenuation (dB)	
	(MHz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Fundamental	162.025	15.3	19.2			0	0
Spurious	324.050			-81.9	-82.5	97.2	101.7
	486.075			-84.8	-82.2	100.1	101.4
	648.100			-86.5	-83.6	101.8	102.8

Test channel: CH2088 (162.025 MHz) on Low power

	Frequency	X1 (dBm)		X2 (dBm)		Attenuation (dB)	
	(MHz)	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Fundamental	162.025	12.6	13.3			0	0
Spurious	324.050			-83.1	-83.0	95.7	96.3
	486.075			-85.0	-82.5	97.6	95.8
	648.100			-86.6	-83.5	99.2	96.8

Results of Spurious Attenuation are found lower than the specified limits.

3.5 Frequency Stability (FCC Rule § 2.1055)

3.5.1 Setup for Measurement

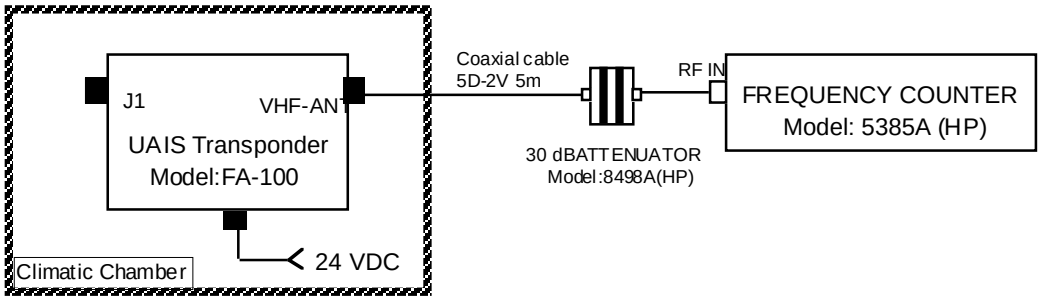


Fig. 3.6A

3.5.2 Measuring Equipment List: See Attachment A [List of Test/Measuring Equipment].

3.5.3 Frequency Tolerance Limits: 5 ppm

3.5.4 Test Results:

Frequency variation was measured on CH2088 (162.025 MHz) and results are shown in Fig. 3.6B. Variation of power supply (20.4 to 24.7 VDC) did not affect the results due to the built-in voltage regulator.

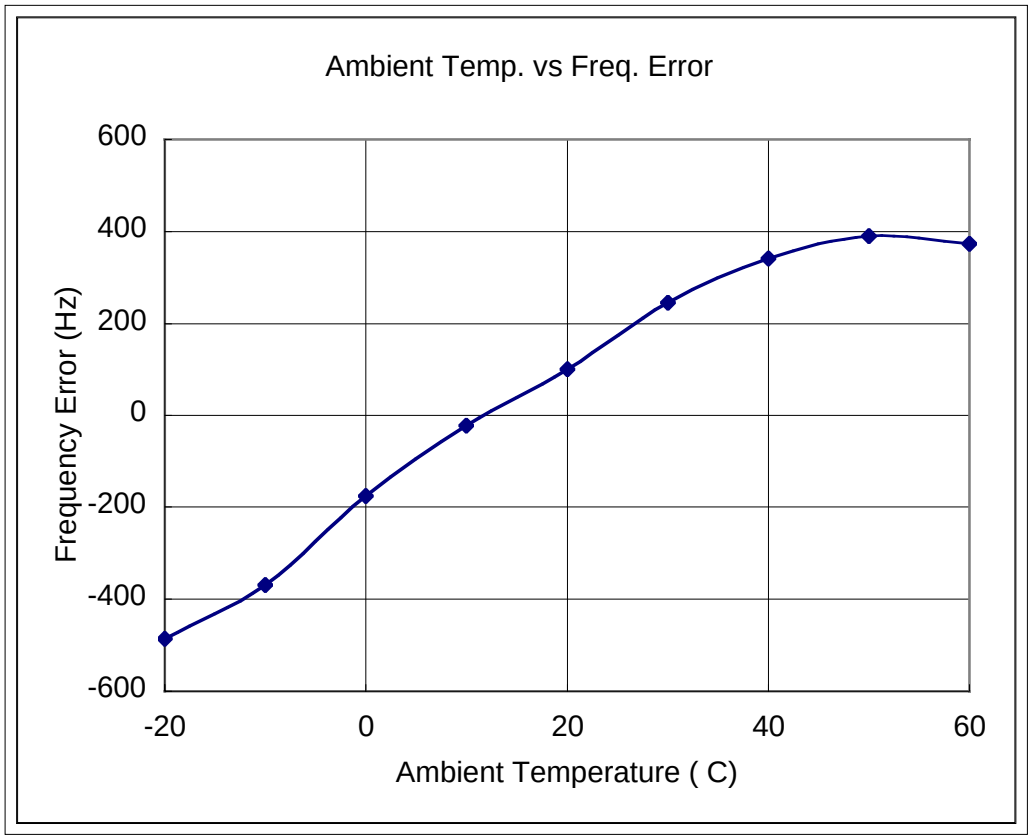


Fig. 3.6B: Frequency stability

3.6 Sensitivity Characteristics of VHF Radiotelephone Receiver (FCC Rule § 80.874)

3.6.1 TDMA Receivers
(1) Sensitivity - 25 kHz Operation

TEST CONDITIONS		SENSITIVITY LEVEL	
		Fn: 156.025 MHz	Fn: 162.025 MHz
Temperature	Voltage	RF level (dBm)	RF level (dBm)
Tnom (+20 °C)	*Vnom (24.0 V)*	-111 dBm at 12% PER	-110 dBm at 15% PER
Tmin (-15 °C)	*Vmin (21.6 V)*	- 110 dBm at 15% PER	- 111 dBm at 9% PER
	Vmax (31.2 V)	- 110 dBm at 15% PER	- 111 dBm at 9% PER
Tmax (+55 °C)	*Vmin (21.6 V)*	- 108 dBm at 12% PER	- 108 dBm at 10% PER
	Vmax (31.2 V)	- 108 dBm at 12% PER	- 108 dBm at 10% PER
Limits		≤ - 107 dBm with a PER of 20% under normal test conditions, ≤ - 101 dBm with a PER of 20% under extreme test conditions,	

(2) Sensitivity - 12.5 kHz Operation

TEST CONDITIONS		SENSITIVITY LEVEL	
		Fn: 157.4125 MHz	Fn: 160.6375 MHz
Temperature	Voltage	RF level (dBm)	RF level (dBm)
Tnom (+20 °C)	*Vnom (24.0 V)*	-107 dBm at 10% PER	-107 dBm at 9% PER
Tmin (-15 °C)	*Vmin (21.6 V)*	- 109 dBm at 16% PER	- 109 dBm at 11% PER
	Vmax (31.2 V)	- 109 dBm at 16% PER	- 109 dBm at 11% PER
Tmax (+55 °C)	*Vmin (21.6 V)*	- 106 dBm at 18% PER	- 106 dBm at 17% PER
	Vmax (31.2 V)	- 106 dBm at 18% PER	- 106 dBm at 17% PER
Limits		≤ - 98 dBm with a PER of 20% under normal test conditions, ≤ - 92 dBm with a PER of 20% under extreme test conditions,	

3.6.2 DSC Receiver
(1) Maximum sensitivity

TEST CONDITIONS		SENSITIVITY LEVEL (dBm)		
		Fn: 156.525 MHz (CH 70)		
Temperature	Voltage	Fn	Fn - 1.5 kHz	Fn + 1.5 kHz
Tnom (+20 °C)	*Vnom (24.0 V)*	-111 dBm at 0.1% BER	-110 dBm at 0.1% BER	-109 dBm at 0.1% BER
Tmin (-15 °C)	*Vmin (21.6 V)*	- 107 dBm at 0.4% BER	- 106 dBm at 0.1% BER	- 106 dBm at 0.1% BER
	Vmax (31.2 V)	- 107 dBm at 0.4% BER	- 106 dBm at 0.1% BER	- 106 dBm at 0.1% BER
Tmax (+55 °C)	*Vmin (21.6 V)*	- 105 dBm at 0.8% BER	- 104 dBm at 0.2% BER	- 102 dBm at 0% BER
	Vmax (31.2 V)	- 105 dBm at 0.8% BER	- 104 dBm at 0.2% BER	- 102 dBm at 0% BER
Limits		≤ - 107 dBm with a PER of 20% under normal test conditions, ≤ - 101 dBm with a PER of 20% under extreme test conditions,		

4 Photographs to Reveal Equipment Construction and Layout (FCC Rule § 2.1033)

(See separate covers)

5 Description of Circuitry and Devices (FCC Rules § 2.1033)

5.1 Function of Each Semiconductor or Active Device

TDMA RX1: 24P0010A

Symbol	Component	Type	Function
CR 1	DIODE	1SS184-TE85L	Protection for reverse voltage
CR 2	DIODE	1SS271-TE85L	Balanced mixer
CR 3	DIODE	1SS271-TE85L	Balanced mixer
CR 4	DIODE	1SS271-TE85L	Balanced mixer
CR 5	DIODE	1SS271-TE85L	Balanced mixer
CR 101	DIODE	1SV229-TPH2	Varactor for VCO
CR 102	DIODE	1SV229-TPH2	Varactor for VCO
CR 201	DIODE	1SS193-TE85L	Protection for reverse voltage
Q 1	FET	PMBFJ310	RF amp.
Q 3	TRANSISTOR	2SC3607-TE12L	Amp. for 1st local
Q 4	TRANSISTOR	2SC3356(M)-T1B	IF amp.
Q 5	TRANSISTOR	2SC3123	2nd oscillator
Q 101	TRANSISTOR	2SC3356(M)-T1B	VCO
Q 201	FET	PMBFJ310	DC amp.
Q 202	TRANSISTOR	DTA114EKAT146	DC switch
Q 203	TRANSISTOR	2SC2712-Y-TE85L	DC switch
U 1	IC	BA4116FV	2nd mixer/OSC/Lim/Demod
U 2	IC	NJM2904M-T1	AF amp.
U 3	IC	TA7809F-TE16L	Regulator
U 4	IC	AN78L05M-E1	Regulator
U 5	IC	NJM2904M-T1	DC amp.
U 101	IC	µPC1675G-T1	RF amp.
U 102	IC	µPC1675G-T1	RF amp.
U 201	IC	SM5158AM-ET	PLL
Y 1	Crystal OSC	TSS-2 44545KHZ	2nd local OSC

TDMA RX2: 24P0010B

Symbol	Component	Type	Function
CR 1	DIODE	1SS184-TE85L	Protection for reverse voltage
CR 2	DIODE	1SS271-TE85L	Balanced mixer
CR 3	DIODE	1SS271-TE85L	Balanced mixer
CR 4	DIODE	1SS271-TE85L	Balanced mixer
CR 5	DIODE	1SS271-TE85L	Balanced mixer

Symbol	Component	Type	Function
CR 101	DIODE	1SV229-TPH2	Varactor for VCO
CR 102	DIODE	1SV229-TPH2	Varactor for VCO
CR 201	DIODE	1SS193-TE85L	Protection for reverse voltage
Q 1	FET	PMBFJ310	RF amp.
Q 3	TRANSISTOR	2SC3607-TE12L	Amp. for 1st local
Q 4	TRANSISTOR	2SC3356(M)-T1B	IF amp.
Q 5	TRANSISTOR	2SC3123	2nd oscillator
Q 101	TRANSISTOR	2SC3356(M)-T1B	VCO
Q 201	FET	PMBFJ310	DC amp.
Q 202	TRANSISTOR	DTA114EKAT146	DC switch
Q 203	TRANSISTOR	2SC2712-Y-TE85L	DC switch
U 1	IC	BA4116FV	2nd mixer/OSC/Lim/Demod
U 2	IC	NJM2904M-T1	AF amp.
U 3	IC	TA7809F-TE16L	Regulator
U 4	IC	AN78L05M-E1	Regulator
U 5	IC	NJM2904M-T1	DC amp.
U 101	IC	μPC1675G-T1	RF amp.
U 102	IC	μPC1675G-T1	RF amp.
U 201	IC	SM5158AM-ET	PLL
Y 1	Crystal OSC	TSS-2 44645KHZ	2nd local OSC

TX EXCTR: 24P0012

Symbol	Component	Type	Function
CR 1	DIODE	1SS184-TE85L	Protection for reverse voltage
CR 101	DIODE	1SV229-TPH2	Varactor for VCO
CR 102	DIODE	1SV229-TPH2	Vractor for VCO
CR 201	DIODE	1SS193-TE85L	
CR 301	DIODE	1SS271-TE85L	Balanced mixer
CR 302	DIODE	1SS271-TE85L	Balanced mixer
CR 303	DIODE	1SS314-TPH3	RF switch
CR 304	DIODE	1SS314-TPH3	RF switch
CR 305	DIODE	1SS314-TPH3	RF switch
CR 306	DIODE	1SS314-TPH3	RF switch
CR 307	DIODE	1SV217-TPH2	Bractor for 1st local OSC
CR 308	DIODE	1SS268-TE85L	Clipper
CR 309	DIODE	1SS268-TE85L	RF switch
Q 101	TRANSISTOR	2SC3356(M)-T1B	OSC for VCO
Q 201	FET	PMBFJ310	DC amp.

Symbol	Component	Type	Function
Q 202	TRANSISTOR	DTA114EKAT146	DC amp.
Q 203	TRANSISTOR	2SC2712-Y-TE85L	DC switch
Q 204	TRANSISTOR	2SC3123	Buffer amp.
Q 301	TRANSISTOR	2SC3356(M)-T1B	RF amp.
Q 302	TRANSISTOR	2SC3356(M)-T1B	RF amp.
Q 303	TRANSISTOR	DTC114EKAT146	DC switch
Q 304	TRANSISTOR	2SC3123	1st local OSC
Q 305	TRANSISTOR	2SC3123	Buffer amp.
U 1	IC	TA7809F-TE16L	Voltage regulator
U 2	IC	AN78L05M-E1	Voltage regulator
U 3	IC	M5218AFP-600C	AF amp.
U 101	IC	μPC1675G-T1	RF amp.
U 102	IC	μPC1675G-T1	RF amp.
U 201	IC	SM5158AM-ET	PLL
Y 201	Crystal OSC	TTS12V 12.8MHZ	Reference OSC
Y 301	Crystal OSC	TSS-2 44545KHZ	1st local OSC

DSC RX: 24P0013

Symbol	Component	Type	Function
CR 1	DIODE	1SS184-TE85L	Protection for reverse voltage
CR 2	DIODE	02CZ4.3Z-TE85L	Regulator
CR 201	DIODE	1SS226-TE85L	Protection for RF voltage
Q 1	TRANSISTOR	2SC3607-TE12L	RF amp.
Q 2	FET	PMBFJ310	1st mixer
Q 3	TRANSISTOR	2SC3123	1st local OSC
Q 4	TRANSISTOR	2SC3356(M)-T1B	Buffer amp.
Q 5	TRANSISTOR	2SC3123	1st IF amp.
Q 6	TRANSISTOR	2SC3123	2nd local OSC
Q 201	FET	PMBFJ310	RF amp・
Q 202	FET	PMBFJ310	RF amp.
U 1	IC	BA4116FV	2nd mixer/OSC/Lim/Demod
U 2	IC	TA7809F-TE16L	Regulator
U 3	IC	M5218AFP-600C	AF amp.
Y 1	Crystal OSC	TOP-B 135.125MHZ	1st local OSC
Y 2	Crystal OSC	TOP-B 20.945MHZ	2nd local OSC

TDMA PA: 24P0014

Symbol	Component	Type	Function
CR 1	DIODE	GL2PR6	For DC bias
CR 2	DIODE	MA111-TX	For DC bias
CR 3	DIODE	1SS226-TE85L	For DC bias
CR 5	DIODE	1SV268-TD	RF switch
CR 6	DIODE	1SV268-TD	RF switch
CR 7	DIODE	1SS268-TE85L	Protection for RF voltage
CR 8	DIODE	MA716-TX	Detection for RF voltage
CR 9	DIODE	MA716-TX	Detection for RF voltage
CR 10	DIODE	MA716-TX	Detection for RF voltage
CR 11	DIODE	1SS184-TE85L	Protection for reverse voltage
CR 12	DIODE	MA111-TX	Protection for reverse voltage
CR 13	DIODE	MA111-TX	Protection for reverse voltage
CR 14	DIODE	MA111-TX	Clipper for voltage
CR 15	DIODE	MA111-TX	Clipper for voltage
CR 16	DIODE	MA111-TX	Protection for reverse voltage
Q 1	TRANSISTOR	2SC3356(M)-T1B	RF amp.
Q 2	FET	2SK2973-T13	RF amp.
Q 3	TRANSISTOR	DTC114EKAT146	Switching of power level
Q 4	TRANSISTOR	DTC114EKAT146	Switching of power level
Q 5	TRANSISTOR	2SA1363-T13-1E	DC switch
Q 6	TRANSISTOR	DTC114EKAT146	DC switch
Q 7	TRANSISTOR	DTA114EKAT146	DC switch
Q 8	TRANSISTOR	DTA114EKAT146	DC switch
Q 9	TRANSISTOR	2SC2712-Y-TE85L	DC switch
Q 10	TRANSISTOR	DTA114EKAT146	DC switch
Q 11	TRANSISTOR	DTC114EKAT146	DC switch
U 1	IC	M57710-A	RF pwer amp.
U 2	IC	AN78L09M-E1	Regulator
U 3	IC	TC74HC4052AF-EL	Switch
U 4	IC	NJM2904V-TE1	DC amp.
U 5	IC	NJM2904V-TE1	DC amp.
U 6	IC	NJM2904V-TE1	DC amp.
U 7	IC	AN78L05M-E1	Regulator
CR 17	DIODE	MA111-TX	DC switch
CR 18	DIODE	MA111-TX	DC switch

5.2 Circuit Description

5.2.1 System Configuration

Figure 5.2.1.1 shows the configuration of the FA-100. GPS/VHF combined antenna is connected to the distributor with the single coaxial cable. The distributor sends the signal from the antenna after separating it into GPS and VHF signals.

AC/DC power supply unit, PR-240 provides an automatic change-over switch between AC and DC ship's supply. AC ship's mains is either 115 V or 230V (jumper selectable).

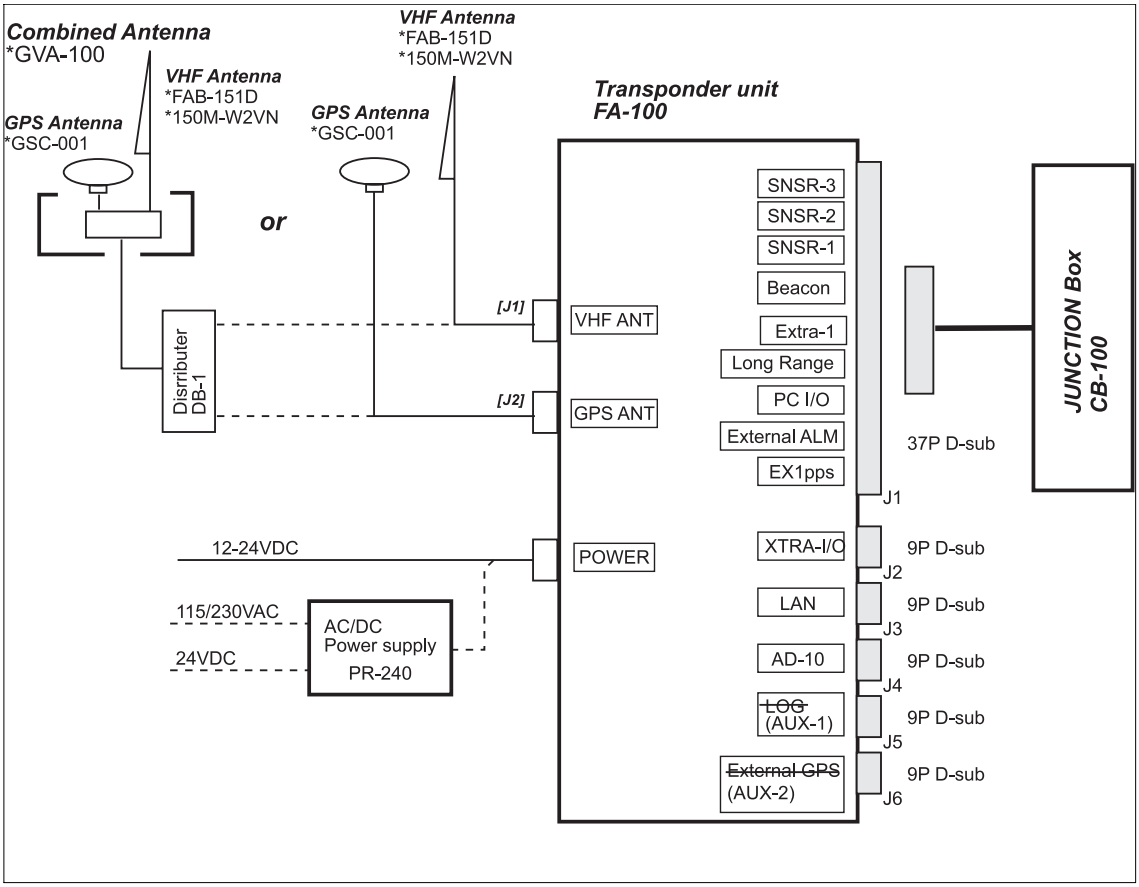


Figure 5.2.1.1 System Configuration

5.2.2 Major parts in Transponder Unit

Fig.5.2.2.1 shows the block diagram of the Transponder unit. Following describes the function of each board.

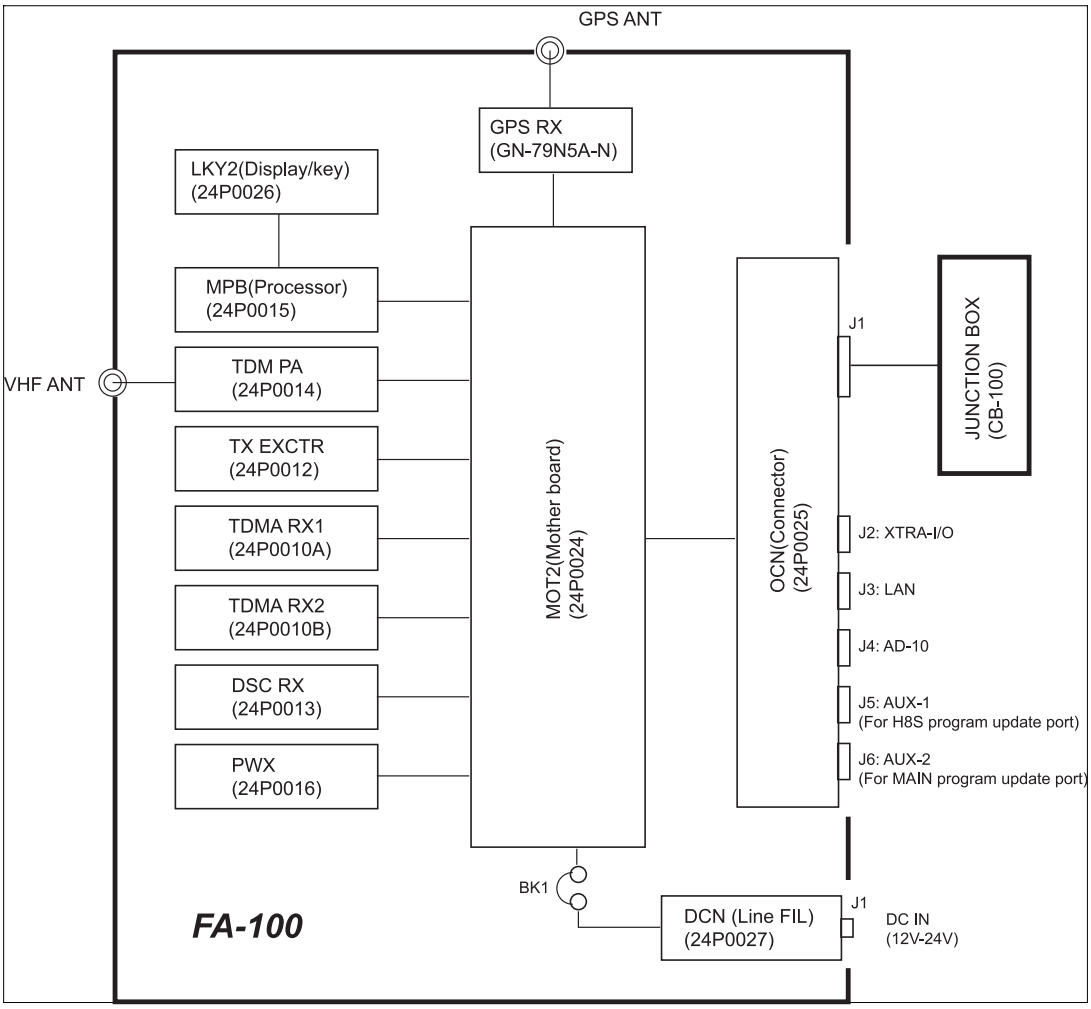


Figure 5.2.2.1

CB-100 (JUNCTION Box)
The box includes a 41 position terminal board. 37P D-Sub connector is factory-fitted to connect it with the display unit. The cable entries are 12 mm in diameter.

OCN2 (24P0025)
The connectors on the rear panel are soldered to this board which is connected to MOT2 Mother board. A noise filter locates in each line.

MOT2 (24P0024)
This board is a mother board which provides a common pathway for p.c. boards to be connected.

DCN (24P0027)
This board is a line filter located in DC power supply.

PWX (24P0016)
This board consists of switching regulators to generate +3.3 V, +5 V and +13.6 V from 12 to 24 VDC ship's main.

LKY2 (24P0026)
The board reads key status, drives the LCD, and turns on/off the power circuit. The board also includes a buzzer circuit.

GPS RX (GN-79N5A-N)
This is a 12-channel, battery-backup GPS receiver. UTC data obtained from 1575.42 MHz GPS signal is used as timing information of the AIS system. The GPS antenna cable carries +5 V to the antenna unit.

TX EXCTR (24P0012)
The TX Exciter board consists of a digital modulator, a PLL oscillator and a frequency converter. 9600 bps AIS and 1200 bps DSC signals are derived from the MPB board. These signals have Bandwidth Time (BT) Product. The board outputs GMSK (Gaussian filtered Minimum Shift Keying) FM modulated signal.

TDMA PA (24P0014)
The signal from the TX EXCTR board is boosted up to 12.5 W by power amplifier M57710 on the board. The output power is selected to either 2 W or 12.5 W by the signal from the MPB board.

TDMA RX1 (24P0010A) and TDMA RX2 (24P0010B)
These boards are VHF TDMA (Time Division Multiple Access) receivers. TDMA RX1 and RX2 receive channel A and B signals respectively.

The difference between two boards is;

	TDMA RX1	TDMA RX2
PLL frequency:	Fr + 45 MH **z**	Fr + 45.1 MH **z**
1st IF:	45 MHz	45.1 MHz
2nd Oscillator:	44.545 MHz	44.645 MHz
2nd IF:	455 kHz	455 kHz (same as RX1)

DSC RX (24P0013)
This is a DSC CH70 (156.525 MHz) receiver. The AIS signal received by the antenna is sent to the TDMA RX board via this board.

MPB (24P0015)
The MPB board consists of five CPUs. Function of each CPU is;

MAIN CPU	: Handles Log and GPS signals, and AIS communications
SUB CPU	: Handles signals on LAN port, and communication with the control panel
H8S1 CPU	: Handles signals on SNSR 1, 2 and 3 ports
H8S2 CPU	: Handles signals on EXTRA-1, BEACON and L/R ports
H8S3 CPU	: Handles signals on EXTRA-I/O and EXT DISP ports, and DSC communications

5.2.3 Functional Description

5.2.3.1 Antenna

Low loss coaxial cable 8D-FB-CV is used when the cable length is 20 meters or more. GPS and VHF combined antenna includes a printed circuit board 24P0029 consisting of 150 MHz Low Pass Filter and 1.5 GHz High Pass Filter. The filter attenuates the signal 0.8 dB or less.

The distributor DB-1 uses the same board as the antenna or 24P0029.

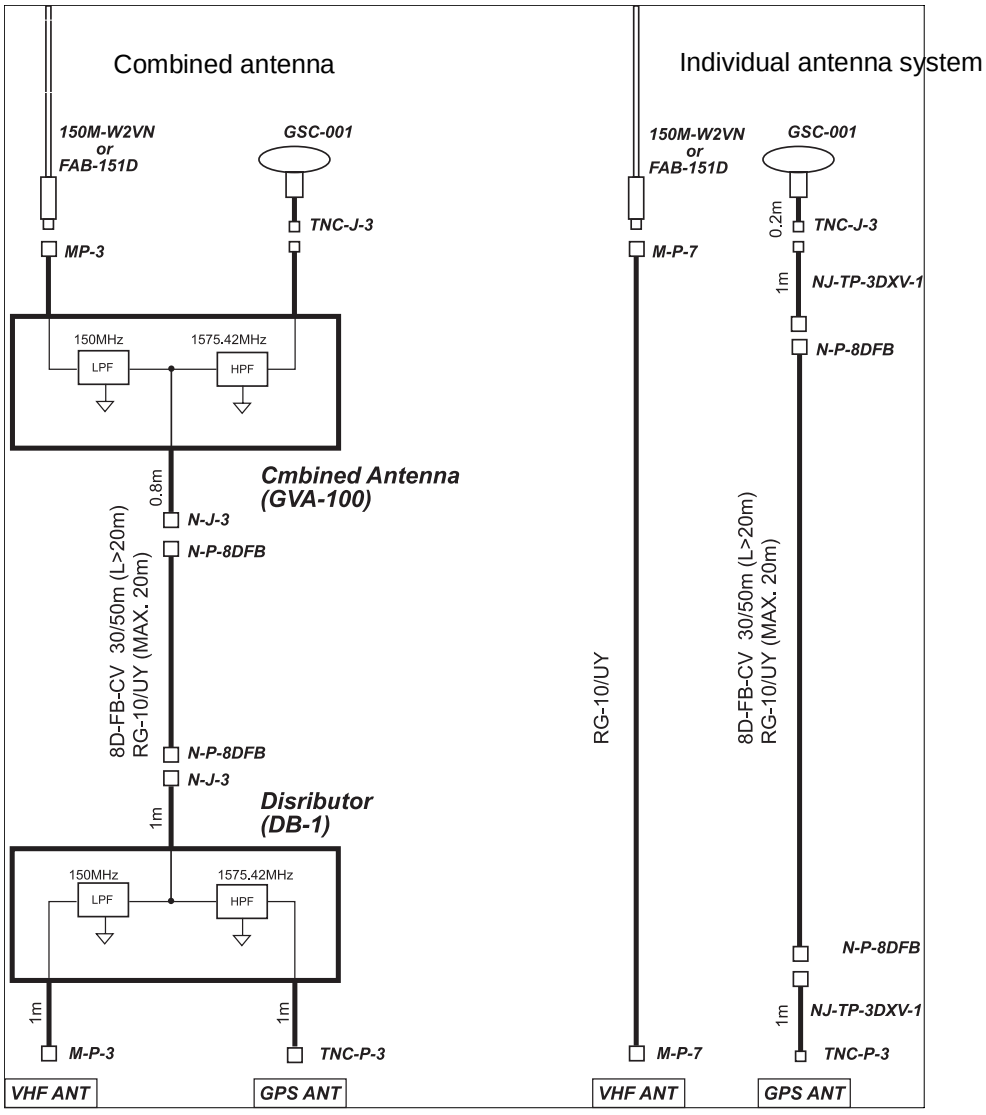


Figure 5.2.3.1 Antenna

5.2.3.2 Major Signals

Fig.5.2.3.2 shows major signals which flow in the Transponder unit.

Table 5.2.3.2 Description of signals

Signal	Description	Signal	Description
BATO	Battery backup line	IN 1pps	UTC timing signal
PTT1 and 2	TX Keying signal	PWR1and 2	TX power control signal
POL	PA monitor signal	RVSE	Reflected power (voltage)
RX SIG1 and 2	TDMA RX signal	RX DET1 and 2	TDMA RX detected signal
RX DET	DSC detected signal	DSC-RO	DSC demodulated signal

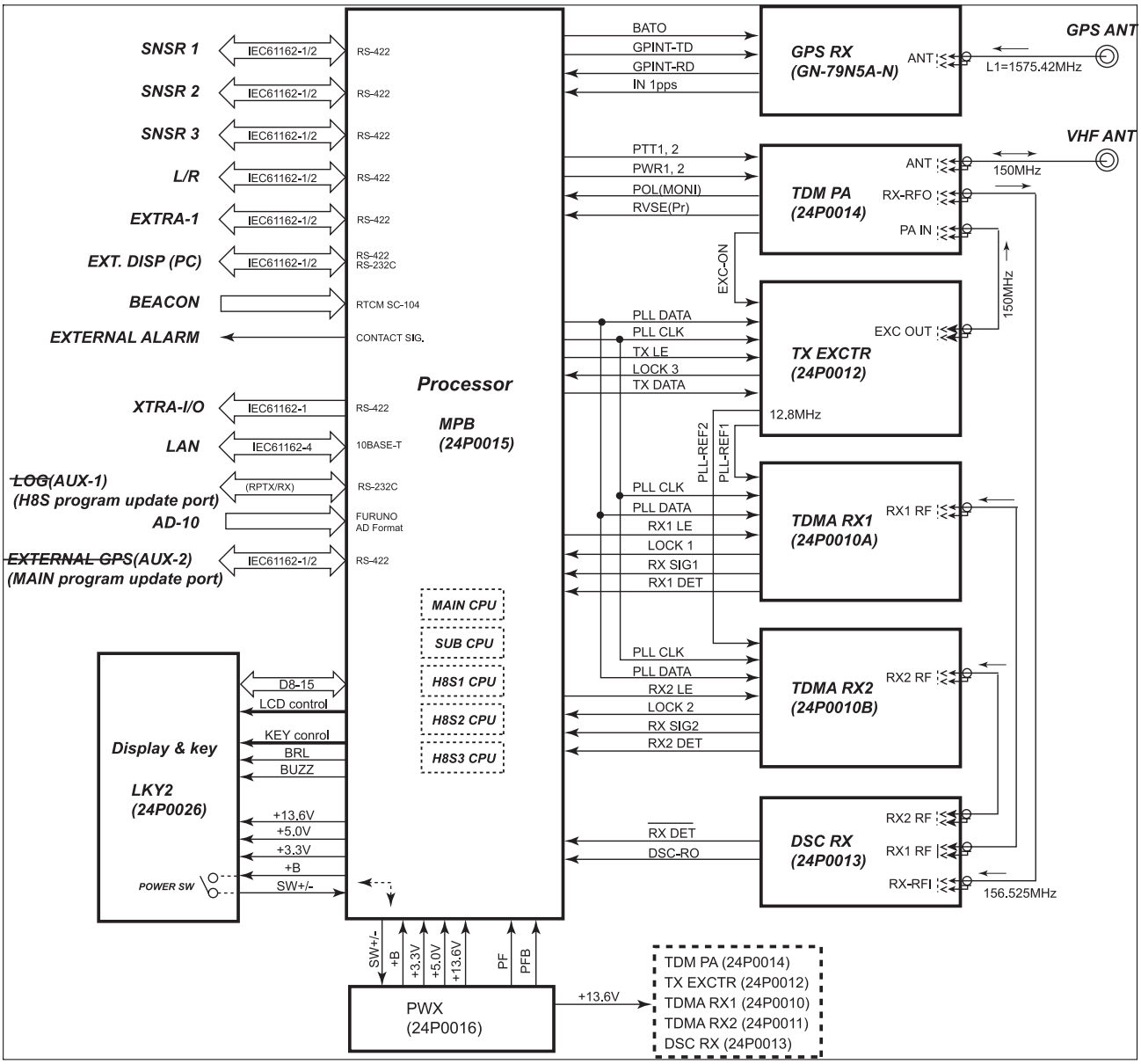


Figure 5.2.3.2 Major Signals

5.2.3.3 TX EXCTR (24P0012)

Fig. 5.2.3.3 shows the block diagram of the TX EXCITR board. The board receives AIS and DSC TX data, both BT product from the MPB board. The BT product parameter represents bandwidth multipled by time. This parameter is a nonnegative scalar. It is used to reduce the bandwidth at the expense of increased intersymbol interference. The relationship between B and T defines the bandwidth of the system.

The signal is amplified and then sent to the VCO, of which center frequency is 44.5375 MHz, for GMSK modulation. Potentiometers provided at the input stage are;

R6 (MOD): Adjusts modulation amplitude of a modulating signal.
($F_{deviation}$ = ±2.4 kHz with TX data of 1 kHz, 1Vpp)
Modulation index = maximum frequency deviation/modulating frequency

R8 (FRQ): Adjusts the center frequency of VCO, 44.5375 MHz ±50 Hz

R11 (1.65 V): Determines reference voltage to operation amplifier U3

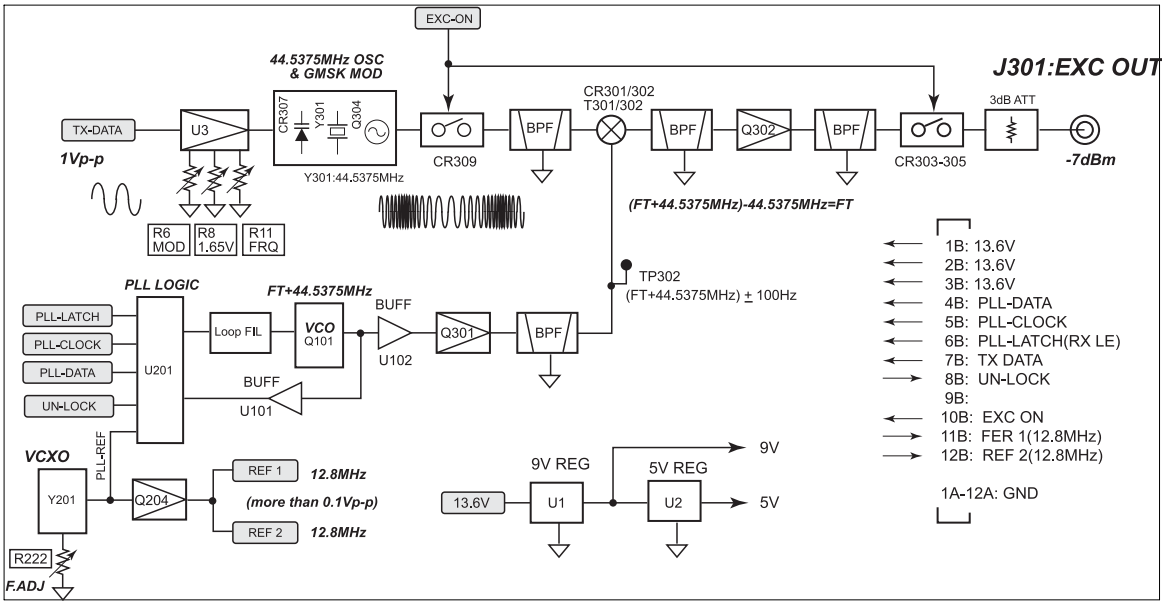


Figure 5.2.3.3 Block Diagram of EXCTR Board

PLL synthesizer consisting of U201 and associated parts oscillates at Ft + 44.5375 MHz. The 12.8 MHz reference signal is generated by VCXO Y201 and sent to the synthesizer. The PLL synthesizer on TDMA RX1 and TDMA RX2 boards also uses the 12.8 MHz signal. R222 is used to adjust the VCXO output signal to 12.8 MHz.

Double balanced mixer, consisting of CR301 and CR302, mixes 44.5375 MHz FM signal with Ft + 44.5375 MHz signal output of PLL synthesizer and outputs Ft signal to be transmitted
The “EXC ON” signal from the PA board switches on and off the TX exciter. Switched are the diodes placed at GMSK modulator and exciter output.

The board outputs –7 dBm signal to the TMD PA board.

5.2.3.4 TDM PA (24P0014)

The TDM PA board 24P0014 amplifies the signal from the TX EXCTR board. U1 (M57710) is a Power Amplifier module. Power control signals, PWR-LVL 1 and PWR-LVL2 select the supply voltage to Q2 and U5 (Automatic Power Controller). Potentiometer R44 adjusts the output power of the system.

CR8 and CR9 detect the PA output level. The level varies depending on antenna matching. The signal from CR8 and CR9 is send to the Automatic Power Control circuit U5 which decreases the gain of Q1 and Q2 to prevent the PA from being damaged when the VSWR increases.

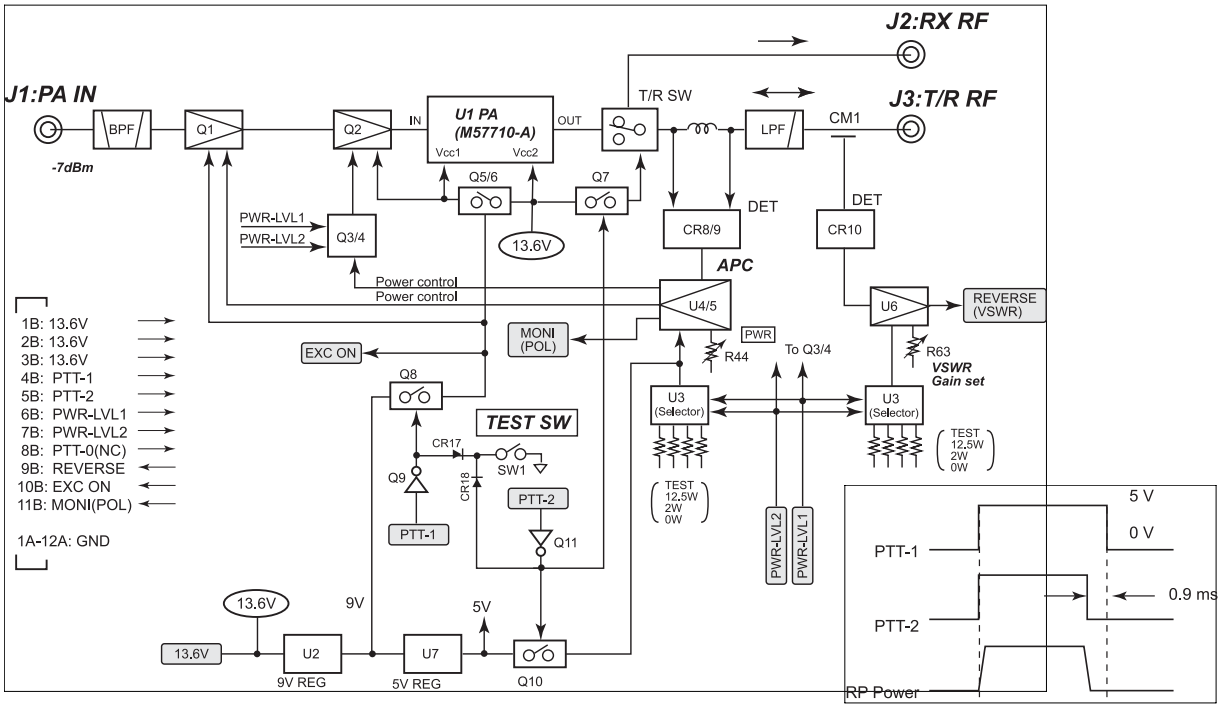


Figure 5.2.3.4 Block Diagram of TDM PA Board

The APC sends “MONI (POL) signal to the CPU when the TX time exceeds the specified time. The MONI signal is used to generate the error message “TX” and stop transmitting. CR10 and U6 measure VSWR and generate “REVERSE (VSWR)” signal to display the error message “ANT” when VSWR is 3 or above. The system does not stop transmitting with the error message “ANT.” R63 is adjusted so that the REVERSE signal is 1 V with VSWR of 3.

PTT1 and PTT2 signals ensure the transmission period within that required by the authority.

To gain access to the TEST SW, SW1, remove the front panel. The system transmits the signal continuously with test switch set to ON. The switch is used to measure frequency and power of the signal to be transmitted.

5.2.3.5 DSC RX (24P0013)

The signal pick-upped by the VHF antenna is delivered to the J201 on the DSC RX board via the TX PA board. After amplifying by Q201 and Q202, the RF signal is sent to DSC receiver circuit on the same board and TDMA (or AIS) receivers on TDMA RX 1 and TDMA RX 2 boards.

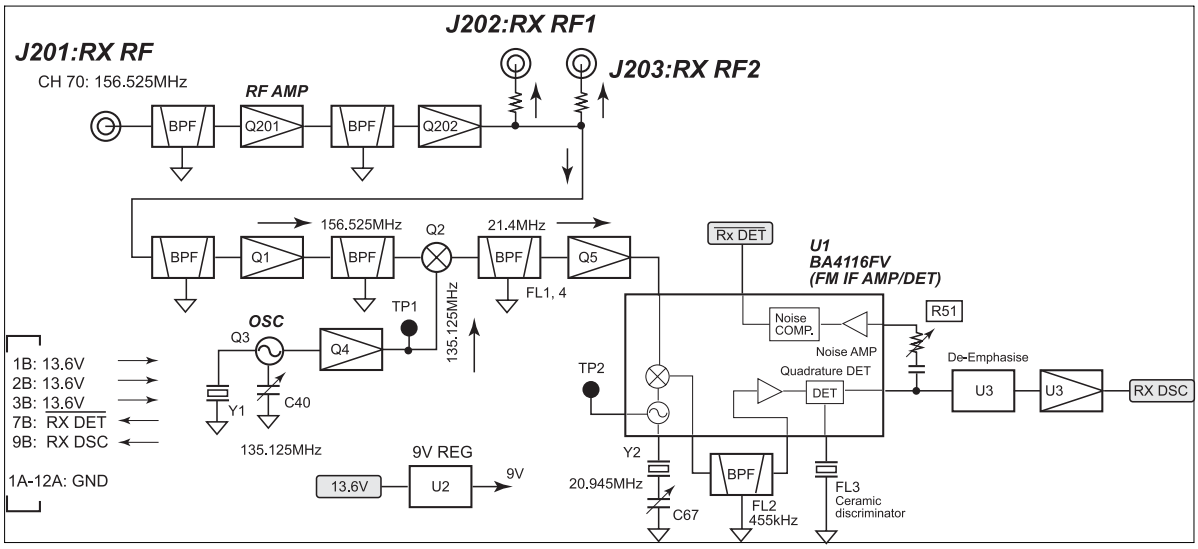


Figure 5.2.3.5 Block Diagram of TDMA RX Board

The DSC receiver consists of a bandpass filter, Q1 and the succeeding circuits. Q2 converts 156.525 MHz RF signal to 21.4 MHz 1st IF signal. The 1st local oscillator Y1 oscillates at 135.125 MHz.

U1 contains a frequency converter, an amplifier, a demodulator, and a detector. In U1, 21.4 MHz IF signal is frequency-converted to 455 kHz 2nd IF signal, using 20.945 MHz from 2nd local oscillator Y2. The detected DSC signal (RX DSC) or 1200 bps FSK (1700 ±400 Hz) signal is sent to the H8S3 CPU via the modem on the MBP board.

When receiving DSC signal, U1 outputs the RX DET signal to the H8S3 CPU for DSC signal processing.

Adjusters on the DSC RX board are;

Adjuster	Test Point	Ratings
C40	TP1	135.125 MHz ±100 Hz
C67	TP2	29.945 MHz ±50 Hz
R51	RX DET line	Active (Low) with RX input of 0 dBu

5.2.3.6 TDMA RX1 (24P0010A) and TDMA RX2 (24P0010B)

TDMA RX1 (24P0010A) and TDMA RX2 (24P0010B) boards are VHF TDMA (Time Division Multiple Access) receivers. RX1 receives channel A signal while RX2 receives channel B signal. These boards are in operation even when own transmitter is on.

The difference between RX1 and RX2 is;

	TDMA RX1	TDMA RX2
PLL frequency:	Fr + 45 MH **z**	Fr + 45.1 MH **z**
1st IF:	45 MHz	45.1 MHz
2nd Oscillator:	44.545 MHz	44.645 MHz
2nd IF:	455 kHz	455 kHz (same as RX1)

The signal from the DSC RX board, Fr is mixed by the Double Balanced Mixer with the output of the PLL

synthesizer Fr + 45 MHz (45.1 MHz on RX2) to produce the 1st 45 MHz (45.1 MHz on RX2) IF signal.

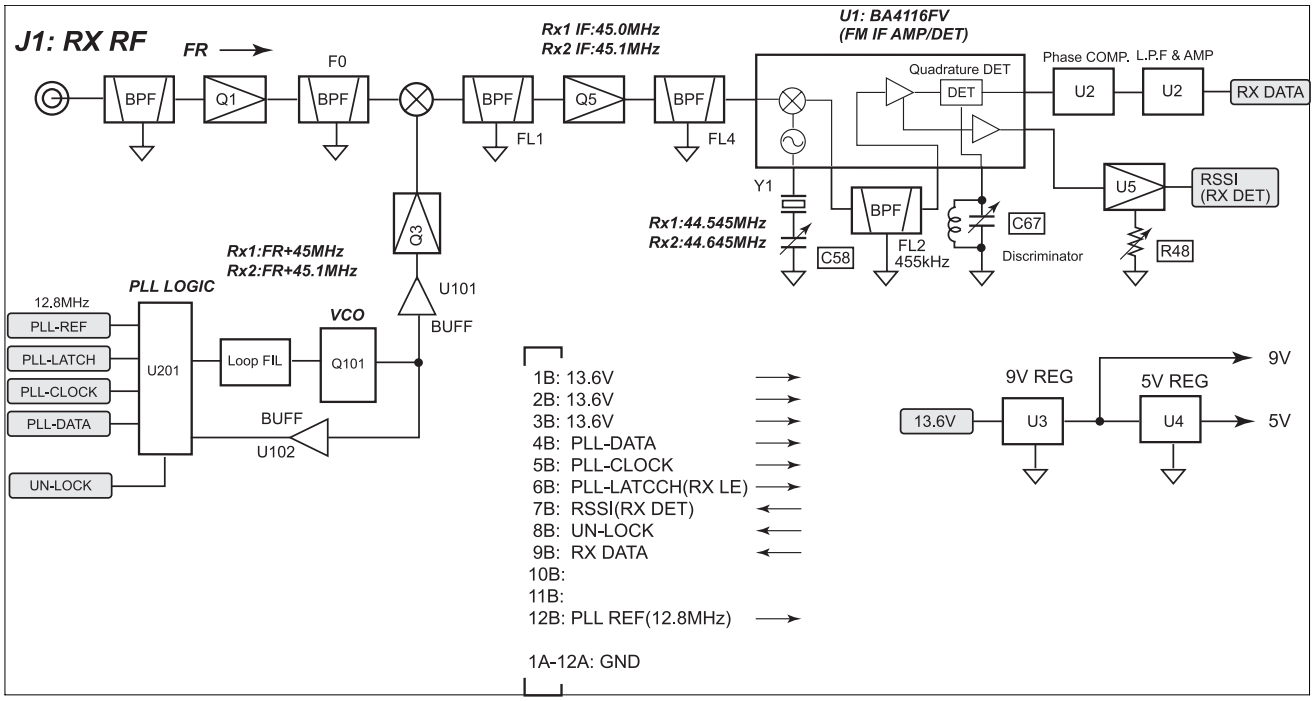


Figure 5.2.3.6 Block Diagram of TDMA RX Board

U1 is the same IC as U1 on the DSC RX board. The detected signal RX DATA is sent from the RX1 board to the MAIN CPU via GMSK modem on the MBP board and from the RX2 board to the SUB CPU.

U1 outputs RSSI (RX DET) signal to the MAIN (SUB) CPU when the TDMA signal is received.

Adjusters on the DSC RX board are;

Adjuster	Test Point	Ratings
C58	TP2	44.545 MHz ±100 Hz on RX1 44.645 MHz ±100 Hz on RX2
R51	RX DET line	0.5 V with RX input of 5 dBu

5.2.3.7 MPB (24P0015)

Fig. 5.2.3.7 shows the block diagram of the MPB board.

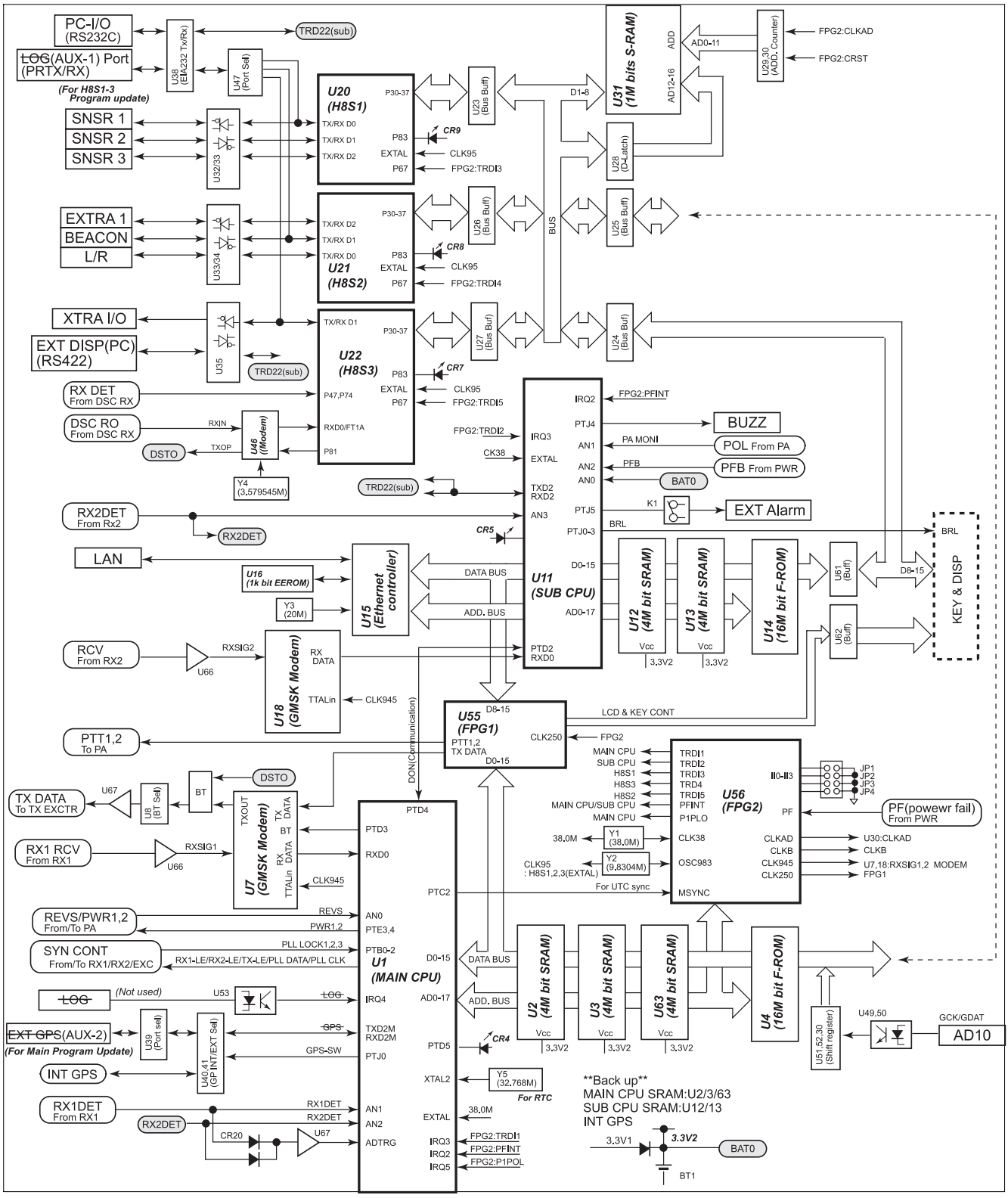


Figure 5.2.3.7 Block Diagram of MPB Board

CPU

Five central processor units (CPU) are:

(1) MAIN CPU (U1, SH7709A/HD6417709AF133)
Operating frequency: 76 MHz
Memories: 16 MB flash ROM (U4), battery back-upped 4 MB SRAM (U2, U3, and U63)

(2) SUB CPU (U11, SH7709A/HD6417709AF133)
Operating frequency: 76 MHz
Memories: 16 MB flash ROM (U14), battery-backupped 4 MB SRAM (U12, and U13)

(3) H8S1 CPU (U20, 2144F/DF2144FA20)
Operating frequency: 9.83 MHz
Memories: built-in 128k bit flash ROM and 4 MB SRAM

(4) H8S2 CPU (U21, 2144F/DF2144FA20)
Operating frequency: 9.83 MHz
Memories: built-in 128k bit flash ROM and 4 MB SRAM

(5) H8S3 CPU (U22, 2144F/DF2144FA20)
Operating frequency: 9.83 MHz
Memories: built-in 128k bit flash ROM and 4 MB SRAM

Clock signal
The MPB board generates following clock signals.

Oscillator	Frequency	Usage
Y1	38 MHz	CPU clock
Y2	9.8304 MHz	TDMA modem
Y3	20 MHz	LAN
Y4	3.579545 MHz	DSC modem
Y5	32.768 MHz	RTC clock

6 Operator's Manual Incl. Circuit Diagrams (FCC Rule § 2.1033)

(See separate covers)

Attachment A LIST OF MEASURING/TEST EQUIPMENT

No.	Instrument/Ancillary	Type	Serial No.	Manufacturer	Calibration Due date
1	Spectrum analyzer	R3273	101003561	ADVANTEST	02.2003
2	Vector signal generator	SMIQ03B	1125.5555.03	R&S	02.2003
3	Frequency counter	5385A	2730A05114	HP	08.2003
4	Digital multimeter	E2377A	3651J18660	HP	03.2003
5	Attenuator (30 dB)	8498A	1801A04084	HP	08.2003
6	Power supply	PAN55-20	AK003307	KIKUSUI	- - - - - -
7	Personal computer	Endeavor NT-1400	139000724	EPSON DIRECT	- - - - - -
8	Personal computer	Endeavor NT-1400	139000725	EPSON DIRECT	- - - - - -
9	AIS Transponder	AS-100	- - - - - -	Furuno	- - - - - -
10	EMI Test Receiver	ESCS30	826457/021	R&S	
11	Bi-conical antenna	VBA6106A	1296	Schaffner	04.2003
12	Log periodic antenna	UHALP9107	8411059	Schwarzbeck	09.2002
13	Reference dipole antenna	3121C	1339/1393	Electro-Metrics	08.2004