NS9542A4
NS9543B4
NS9544B4

Data Sheet

(Version 1.7)

Contents ; 目次

1. Description; 解説

NS9542/43/44 are an integrated circuit designed for AM/FM/FM stereo decoder for i-Pod docking radio, Radio-CD, clock radio, etc. applications.
RDS/RBDS with block sync reception (NS9543 only) are also available.
DSP solution gives less external components.

2. Features; 機能

- Fully Radio blocks including PLL frequency synthesizer
- RDS / RBDS reception with Block Sync and Error correction. Synchronized data can be readout via serial interface (I^2C or 3-wire) with polling RDS interruption, RDSI. (NS9543 only)
- No alignment required
- Receiving Frequency FM; 65 to 108MHz continuously
  AM; 520 to 1710 KHz (10KHz step),
  522 to 1620 KHz (9KHz step)
- Low IF (200 KHz) for FM and zero IF for AM
- FM Stereo Noise Control (SNC). Starting point can be selectable by register setup.
- FM High Cut Control (HCC). Starting point can be selectable by register setup.
- FM pilot signal canceller
- Station detector for seek tuning. Seek stop sensitivity can be selectable by register setup.
- FM Soft-muting. Starting point can be selectable by register setup.
- Band Muting (BMUTE)
- AM antenna tuning for loop antenna and bar antenna handling
- 3-wire and I^2C serial interface
- 19.2 MHz Crystal Oscillator
- Package: 36pin SSOP
- Power supply: 3.3V +/-0.3V
- Operating Power drain: <95mA (FM), <80mA(AM)
- Full CMOS process

3. Block Diagram; ブロック図

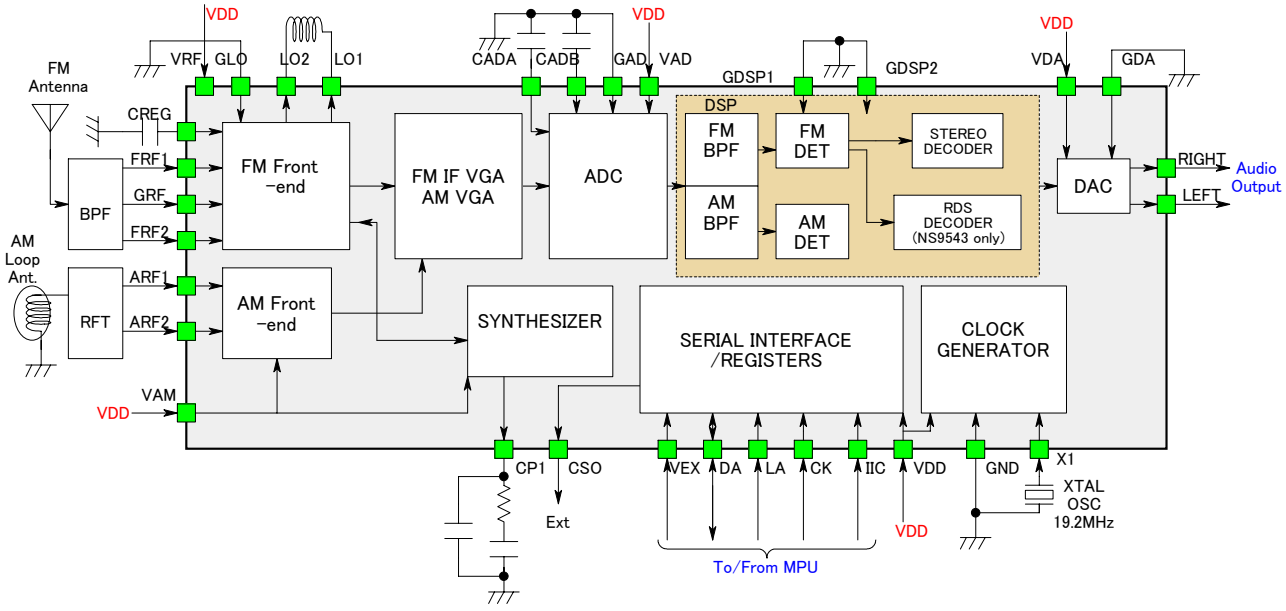


Figure 1

4. Electrical Specifications

4.1. Absolute Maximum Ratings; 絶対最大定格

Items 項目	Symbol 記号	Conditions 条件	Min 最小値	Max 最大値	Unit 単位
Maximum Power Supply Voltage	VDDmax		0	3.7	V
Maximum Input Voltage	Vi	All pins	-0.3	VDD+0.3	V
Storage Temperature	Tstg		-40	+125	degC

Table 1

4.2. Recommended Operating Conditions; 推奨動作条件

Items 項目	Symbol 記号	Conditions 条件	Min 最小値	Typ 標準値	Max 最大値	Unit 単位
Power Supply	VDD		3.0	3.3	3.6	V
I/O interface power supply	VEX		1.62	3.3	3.6	V
Operating Temperature	Ta		-20	25	+75	degC

Table 2

4.3. Electrical Performance; 電気的性能

4.3.1. Conditions; 条件

The following conditions will be used unless otherwise specified.

4.3.2. General; 一般

VDD=3.3 +/-0.05 , Ta=25+/-5C,
Load for audio output : RL=100Kohm,
Signal Generator Output Voltage shows terminated level (not emf)
Antenna Impedance =75 ohms
Filter: LPF=15KHz, HPF=100Hz

Items	Symbol	Conditions	Min	Typ	Max	Unit
standby Current	Istby	VDD=3.3V			500	uA
Status Readout		RSSI, Station Detector, stereo indicator				

Table 3

4.3.3. FM Receiver Characteristics; FM 受信特性

Carrier Frequency: f =98MHz, Vi=60dBu

Modulation: Deviation=+/-75KHz, frequency=1KHz, Pilot Tone=10% (NS9543 only: Pilot Tone=8%, RDS=2.6%)

Mo=Mono mode, ST=Stereo mode, unless otherwise specified

Items	Symbol	Conditions	Min	Typ	Max	Unit
Current Drain	IDD	No RF signal input		85	95	mA
Frequency Coverage	Fcov		65		108	MHz
Receiving Frequency step	FM_STEP		50 (except OIRT) 30 (for OIRT)			KHz
IF Frequency	FIF			200		KHz
Local Oscillator Freq.	fLO		260		432	MHz
Useable Sensitivity	US	SNR=30dB, Mono		5	14	dBu
Signal-to-Noise Ratio(ST)	SNR2		58	66		dB
Harmonic Distortion(Mo)	THD1			0.4	1.0	%
Harmonic Distortion(ST)	THD2			0.4	1.0	%
Harmonic Distortion(Mo)	THD3	Vin=114dBu		0.4	1.0	%
IF Rejection Ratio	IFR		100	120		dB
Image Rejection Ratio	IRR			60		dB
AM Rejection Ratio	AMRR		50	60		dB
Seek Sensitivity	SS	Address 6Ch:30d	17	25	33	dBu
Stereo Separation	SEP		25	40		dB
Stereo Noise Control *[1]	SNC	SEP=15dB HCC=6h,SNC=7h	30	42	54	dBu
High Cut Control *[1]	HCC	10KHz mod/60dBu→9dBu HCC=6h,SNC=7h	-15		-5	dB
Audio Output	VAF		500	600		mVrms
Audio Muting attenuation	AMUTE		60			dB
Band Muting attenuation	BMUTE	BMT_BW=1h(20KHz) @ +/- 30KHz	60			dB
De-emphasis*[1]	DEM	DMEP=1h		50		uS
		DMEP=0h		75		uS
Frequency Response (De-emphasis 50uS)	FR	30Hz De-emphasis 50uS, Ref.1KHz, LPF/HPF off	-2.0	+0.5	+3.0	dB
Frequency Response (De-emphasis 75uS)	FR	30Hz De-emphasis 75uS, Ref.1KHz, LPF/HPF off	-1.5	+1	+3.5	dB
RDS Sensitivity *[2]	RDSS	RDS receiving level	-	33	38	dBu

Notes:
*1: Selected by register setup
*2: NS9543 only

Table 4

4.3.4. AM Receiver Characteristics; AM 受信特性

Carrier Frequency: f=999KHz, Vi=68dBu
Modulation: Modulation=30% , frequency=1KHz,

Items	Symbol	Conditions	Min	Typ	Max	Unit
Current Drain	IDD	No RF signal input		75	80	mA
AM Frequency Coverage	AMFcov	10KHz step	520		1710	KHz
		9KHz step	522		1620	KHz
Receiving Frequency step	AM_STEP			1.0		KHz
IF Frequency	FIF			0		KHz
Antenna Tuning Inductance	L_AM			650		uH
Useable Sensitivity	US1	S/N=20dB,		9	24	dBu
Signal to noise Ratio	SNR1		45	55		dB
Harmonic Distortion1	THD1			0.5	1.3	%
Selectivity	SEL	Delta-f= +/-9KHz	55	60		dB
Seek Sensitivity	SS	RSSI_RD:40d	8	14	20	dBu
Ant. Input Impedance	Ziam	Without RFT		100		kohm
Frequency Response*[1]	FR	100Hz, Ref.1KHz, LPFS_SEL=1h(1.5KHz) HPFS_SEL=0h(50Hz)	-2	0	+2	dB
		4KHz, Ref.1KHz, LPFS_SEL=1h(1.5KHz) HPFS_SEL=0h(50Hz)	-10.5	-8.5	-6.5	dB
Audio Output	VAF		150	250		mVrms

Note:
*1: Set LPF and HPF of Audio Analyzer to “off”./ オーディオアナライザの LPF および HPF の設定は off にする。

Table 5

4.3.5. Xtal Osc. Element and Circuit Characteristics; 水晶振動子特性

Items	Symbol	Conditions	Min	Typ	Max	Unit
Xtal Oscillation Freq.	FX			19.2		MHz
Frequency Tolerance	Del-f	F=19.2MHz,	-30	0	+30	PPM
Series resistance	Rsx				50	ohm
Load capacitance	Cpx	F=19.2MHz		16		PF
Negative impedance	R_NEG			-6Rsx	-4*Rsx	ohm

Table 6

4.3.6. SYNTHESIZER Characteristics; シンセサイザー特性

Synthesizer is only used for FM mode.

Items	Symbol	Conditions	Min	Typ	Max	Unit
Reference Frequency	FREF		0.12, 0.2, 0.4 (NS9542) 0.04, 0.12, 0.2, 0.4 (NS9543 / 44)			MHz
Divided _N Ratio	P		P=(260 to 432) / FREF			-
LPF Resistor				4.7		Kohm
LPF Lag Capacitance				0.18		uF
LPF Lead Capacitance				0.012		uF
VCO cont. Voltage	V_CONT		0.2		1.6	V

Table 7

4.3.7. DC characteristics ; DC 特性

（VEX Pin Voltage / VEX 端子電圧 ：1.62V - 3.6V)

Items	Symbol	Conditions	Min	Typ	Max	Unit
Low level input voltage (VEX-related input levels)	ViL	IIC, LA, CK, DA	0	-	0.3 VEX	V
High level input voltage (VEX-related input levels)	ViH	CK, DA	0.7 VEX	-	5.0 *1	V
		IIC, LA	0.7 VEX	-	VEX	
Low level Output Voltage at 0.5mA sink current: (VEX-related input levels)	VoL	CSO	0		0.2VEX	V
High level Output Voltage at -0.5mA sink current: (VEX-related input levels)	VoH	CSO	0.8VEX		VEX	V
Low level output voltage (open drain) at 3 mA sink current: VEX > 2V VEX < 2V (VEX-related input levels)	 VoL1 VoL3	DA	 0 0	 - -	 0.4 0.2 VEX	 V V
Hysteresis of Schmitt trigger inputs: VEX > 2V VEX < 2V (VEX-related input levels)	Vhys	IIC, LA, CK, DA	 0.05 VEX 0.1VEX	 - -	 - -	 V V
Note: *1: Refer to Application Note"1.3". for details as the connecting method of VEX port and the pull-up resistors differs depending on the signal level of serial interface. シリアルインターフェースのシグナルレベルにより VEX 端子とプルアップ抵抗の接続方法が異なりますので、詳細については、Application Note "1.3."を参照してください。						

Table 8

4.3.8. AC characteristics ; AC 特性

（VEX Pin Voltage / VEX 端子電圧 ：1.62V - 3.6V)

Items	Symbol	Min	Typ	Max	Unit
Output fall time from VIH min to VIL max with a bus capacitance of 10 to 400 pF バス容量 10～400 pF での VIH min から VIL max の出力立下り時間	tof	20+0.1Cb	-	250	nS
Input current for each I/O pin with an input voltage of 0.1VEX and 0.9VEXmax 入力電圧 0.1～0.9VEX での 各 I/O ピンの入力電流	Ii	-10	-	10	μA
Capacitance for each I/O pin 各 I/O ピンの容量	Ci	-	-	10	pF

Table 9

4.3.9. 3-wire control interface characteristics ; 3-wire コントロールインターフェース特性

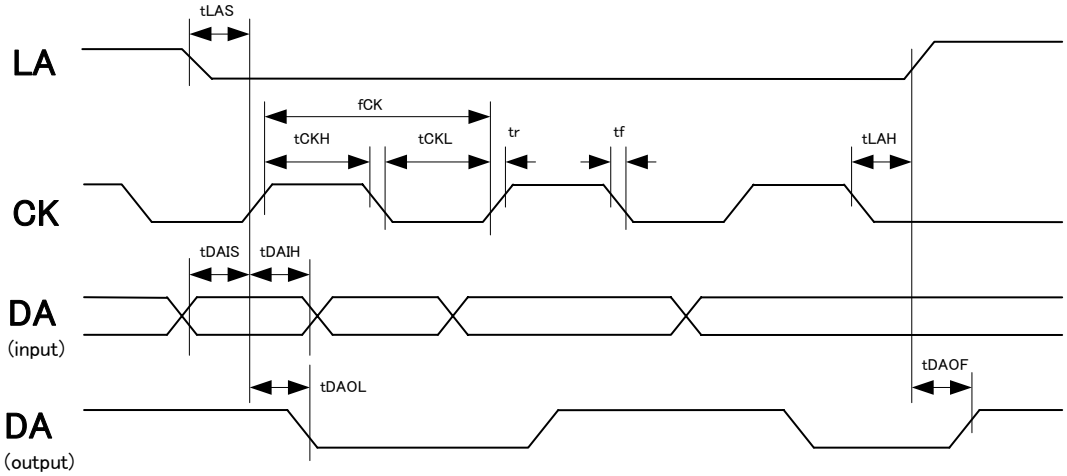


Figure 2

Items	Symbol	Min	Typ	Max	Unit
CK clock frequency ; CK クロック周波数	fCK			400	kHz
CK clock "H" period ; CK クロック"H"期間	tCKH	0.6		-	µS
CK clock "L" period ; CK クロック"L"期間	tCKL	1.3		-	µS
Data setup time ; データセットアップ時間	tDAIS	100			nS
Data hold time ; データホールド時間	tDAIH	100			nS
Data "L" output time ; データ"L"出力時間	tDAOL			1	µS
Data output floating time ; データ出力フローティング時間	tDAOF			1	µS
LA setup time ; LA セットアップ時間	tLAS	100			nS
LA hold time ; LA ホールド時間	tLAH	100			nS
Rise time of DA and CK ; DA および CK の立上り時間	tr	20+0.1Cb		300	nS
Fall time of DA and CK ; DA および CK の立下り時間	tf	20+0.1Cb		300	nS
Bus line capacitance ; バスライン容量	Cb			400	pF

Table 10

4.3.10. I²C control interface characteristics ; I²Cコントロールインターフェース特性

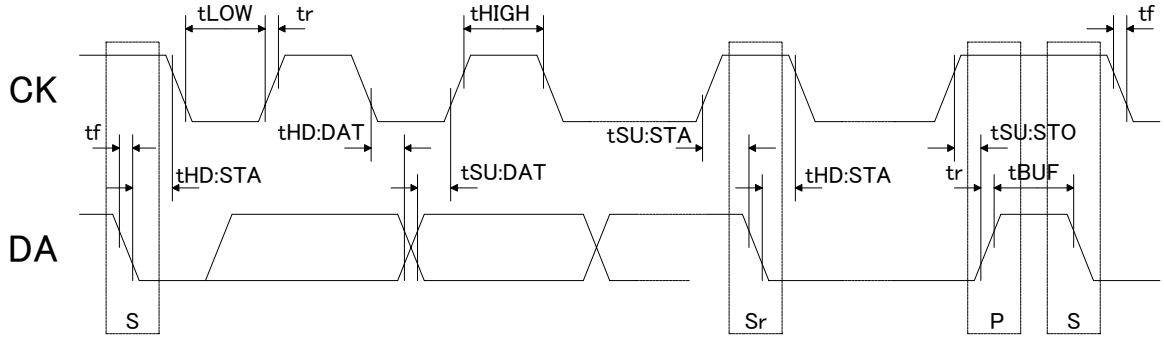


Figure 3

	Symbol	Min	Typ	Max	unit
Hold time (repetition START condition) ; ホールド時間（反復 START 条件）	tHD:STA	0.6		-	µS
Setup time (repetition START condition) ; セットアップ時間（反復 START 条件）	tSU:STA	0.6		-	µS
Data hold time ; データホールド時間	tHD:DAT	0		0.9	µS
Data setup time ; データセットアップ時間	tSU:DAT	100		-	nS
Setup time of STOP condition ; STOP 条件のセットアップ時間	tSU:STO	0.6		-	µS
Bus free time of STOP and START conditions ; STOP 条件と START 条件とのバスフリー時間		1.3		-	µS
CK clock "L" period ; CK クロック"L"期間	tLOW	1.3		-	µS
CK clock "H" period ; CK クロック"H"期間	tHIGH	0.6		-	µS
Rise time of DA and CK ; DA および CK の立上がり時間	tr	20+0.1Cb		300	nS
Fall time of DA and CK ; DA および CK の立下り時間	tf	20+0.1Cb		300	nS
Bus line capacity ; バスライン容量	Cb			400	pF
CK clock frequency ; CK クロック周波数	fck			400	kHz

Table 11

4.3.11. Electrical Characteristic curves

Standby Current

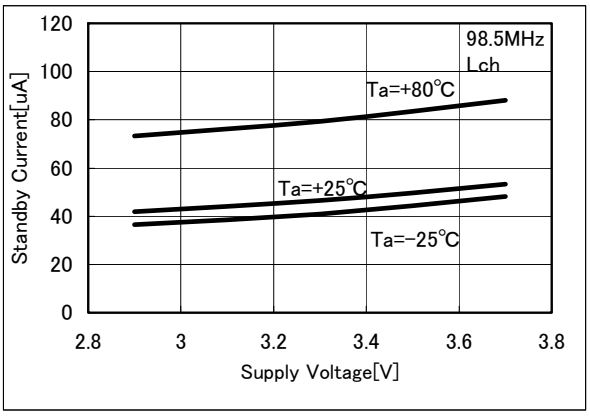


Figure 4

FM_Consumption Current

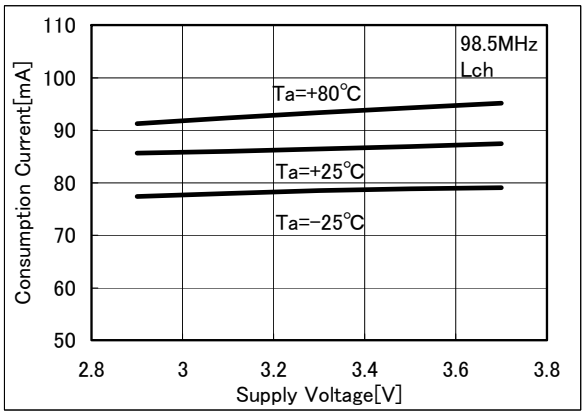


Figure 5

FM_Audio Output Level

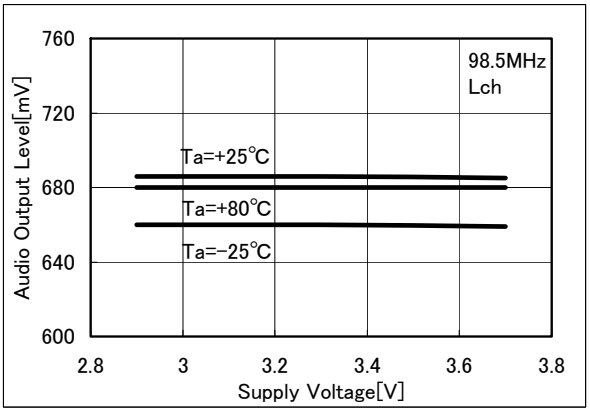


Figure 6

FM_Signal to Noise Ratio

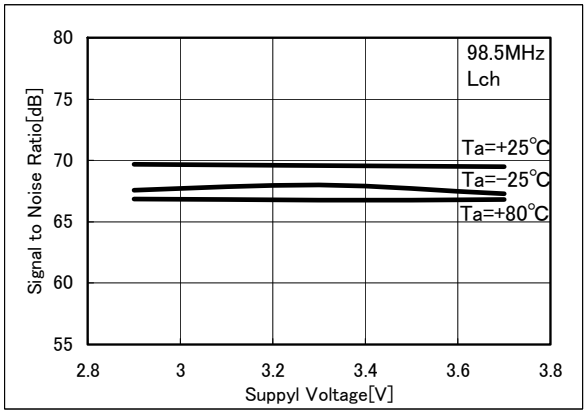


Figure 7

FM_Total Harmonic Distortion

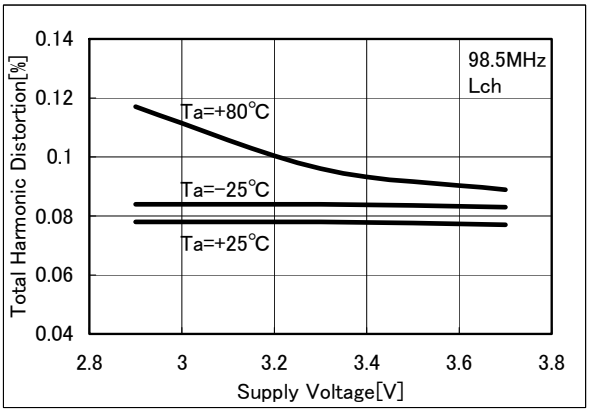


Figure 8

FM_Usable Sensitivity

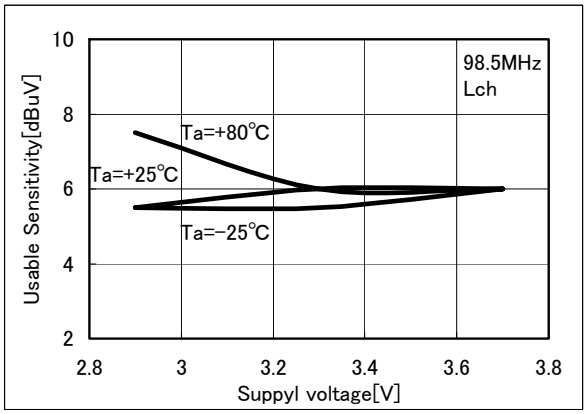


Figure 9

Stereo_Signal to Noise Ratio

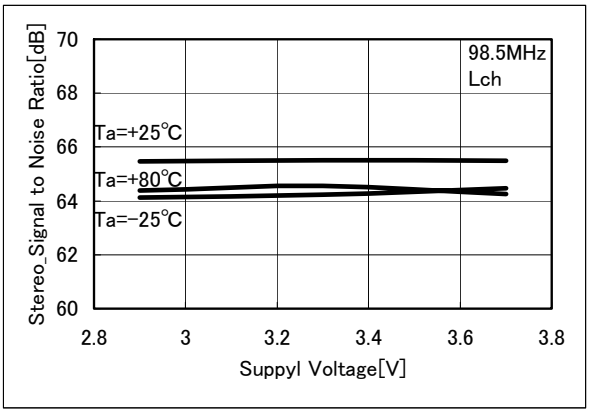


Figure 10

Stereo Separation

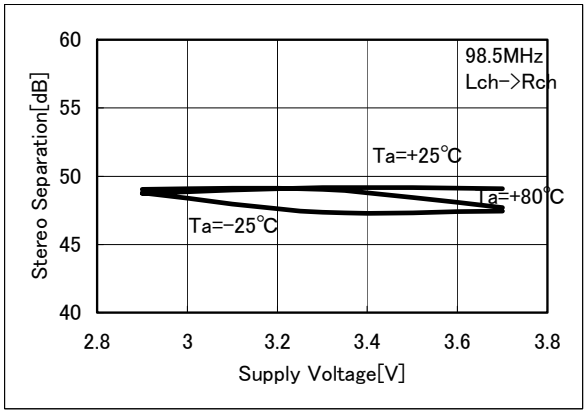


Figure 11

AM_Consumption Current

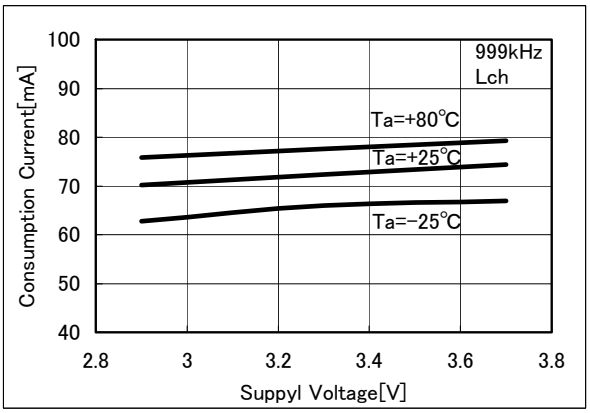


Figure 12

AM_Audio Output Level

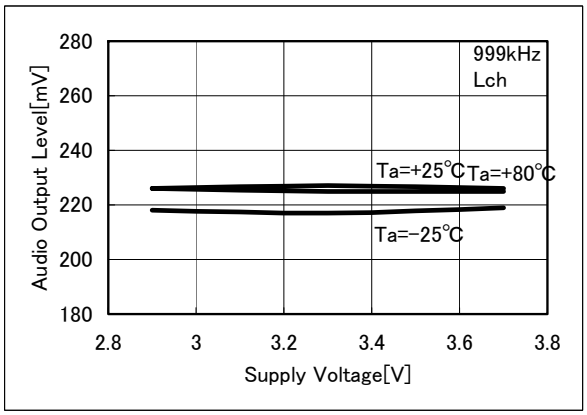


Figure 13

AM_Signal to Noise Ratio

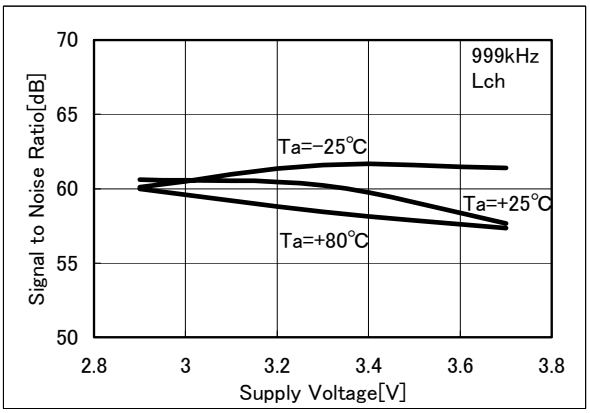


Figure 14

AM_Total Harmonic Distortion

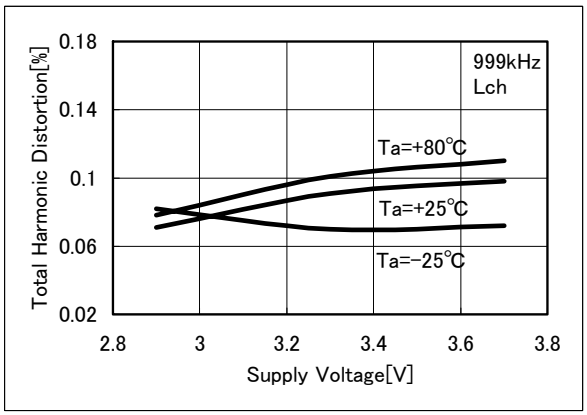


Figure 15

AM_Usable Sensitivity

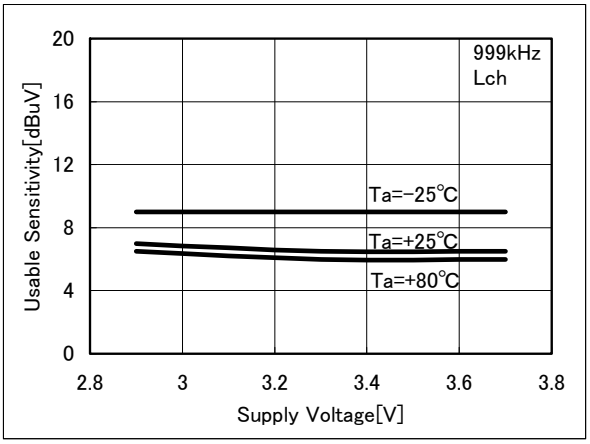


Figure 16

FM INPUT VS OUTPUT

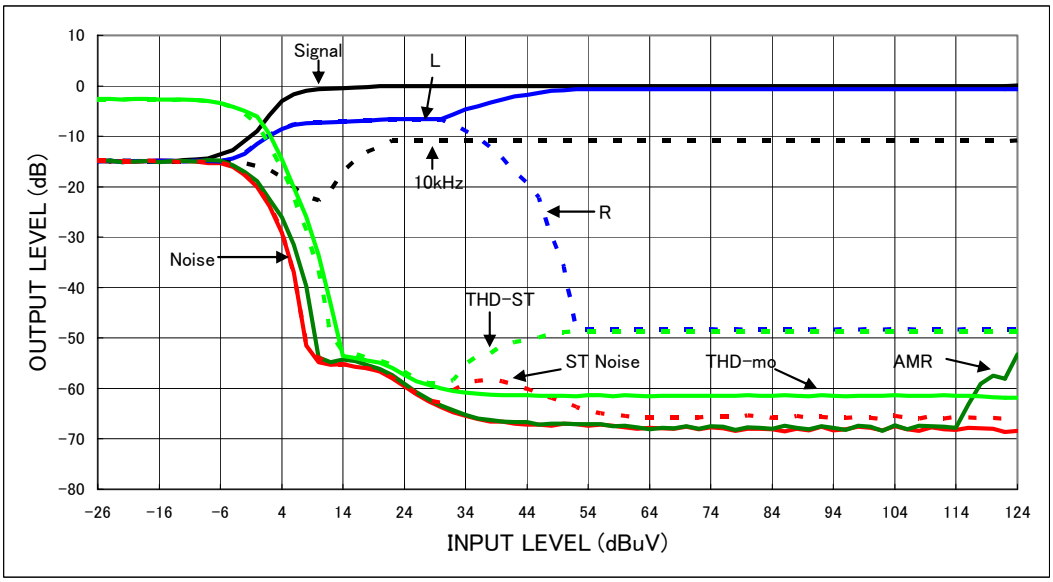


Figure 17

AM INPUT VS OUTPUT

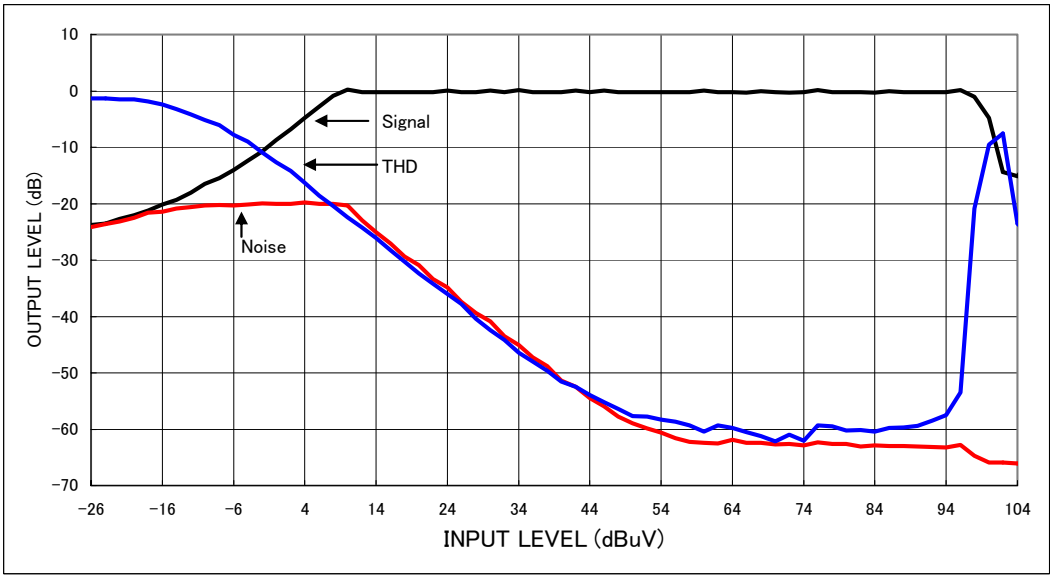


Figure 18

5. Connection Diagram for Measurement;測定用接続図

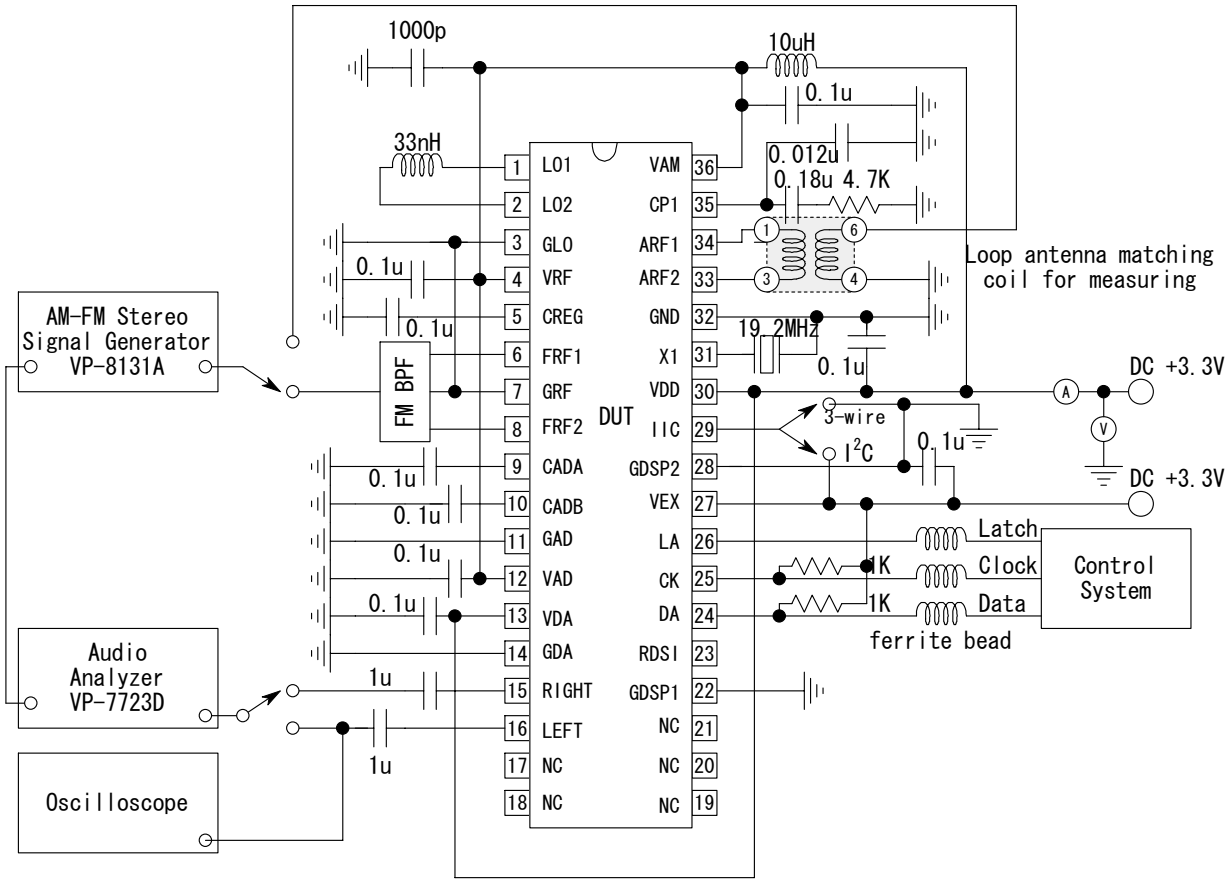


Figure 19

Electrical characteristics were measured by our original JIG.
電気的特性は、弊社作製の治具によって測定されたものです。

6. Pin Grid Assignment; ピン配置

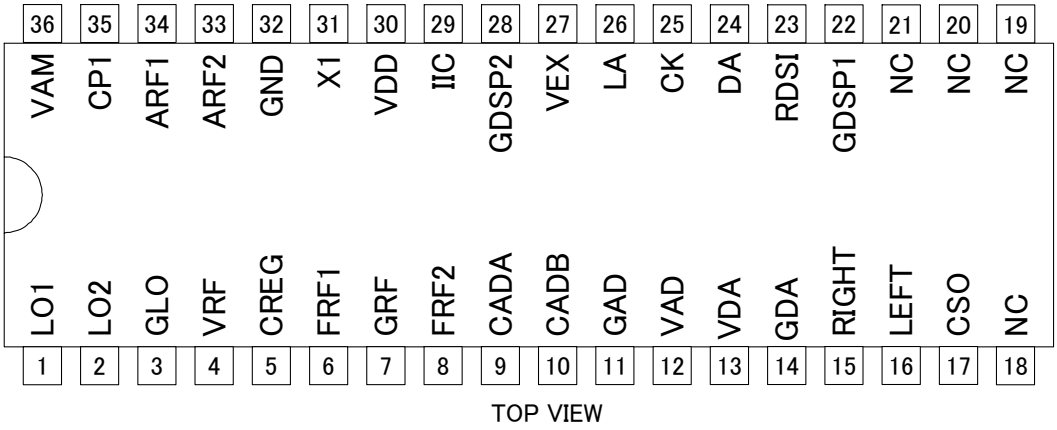


Figure 20

Pin #	SYMB	Description	Pin #	SYMB	Description
1	LO1	Adding a inductor for Local oscillator	36	VAM	AM & Synth. Power
2	LO2		35	CP1	Synthe. PLL LPF
3	GLO	Local Osc. Ground	34	ARF1	AM input Positive
4	VRF	RF power supply	33	ARF2	AM input Negative
5	CREG	Regulator Decoupling	32	GND	Xtal and Synthesizer Ground
6	FRF1	FM input positive	31	X1	Xtal element Connect.
7	GRF	RF Ground	30	VDD	Digital Power Supply
8	FRF2	FM input Negative	29	IIC	I^2C or 3-wire select
9	CADA	ADC decoupling-1	28	GDSP2	DSP Ground
10	CADB	ADC decoupling-2	27	VEX	I/O interface Power Supply
11	GAD	ADC Ground	26	LA	Latch or Address input
12	VAD	ADC Power Supply	25	CK	Serial Clock input
13	VDA	DAC Power Supply	24	DA	Serial Data I/O
14	GDA	DAC Ground	23	RDSI	RDS Interruption output (NS9543 only)
15	RIGHT	Audio Output – R	22	GDSP1	DSP Ground
16	LEFT	Audio Output – L	21	NC	No connection
17	CSO	Port Extension (NS9543 and NS9544)	20	NC	No connection
18	NC	No connection	19	NC	No connection

Table 12

7. Package Outline; 外形寸法

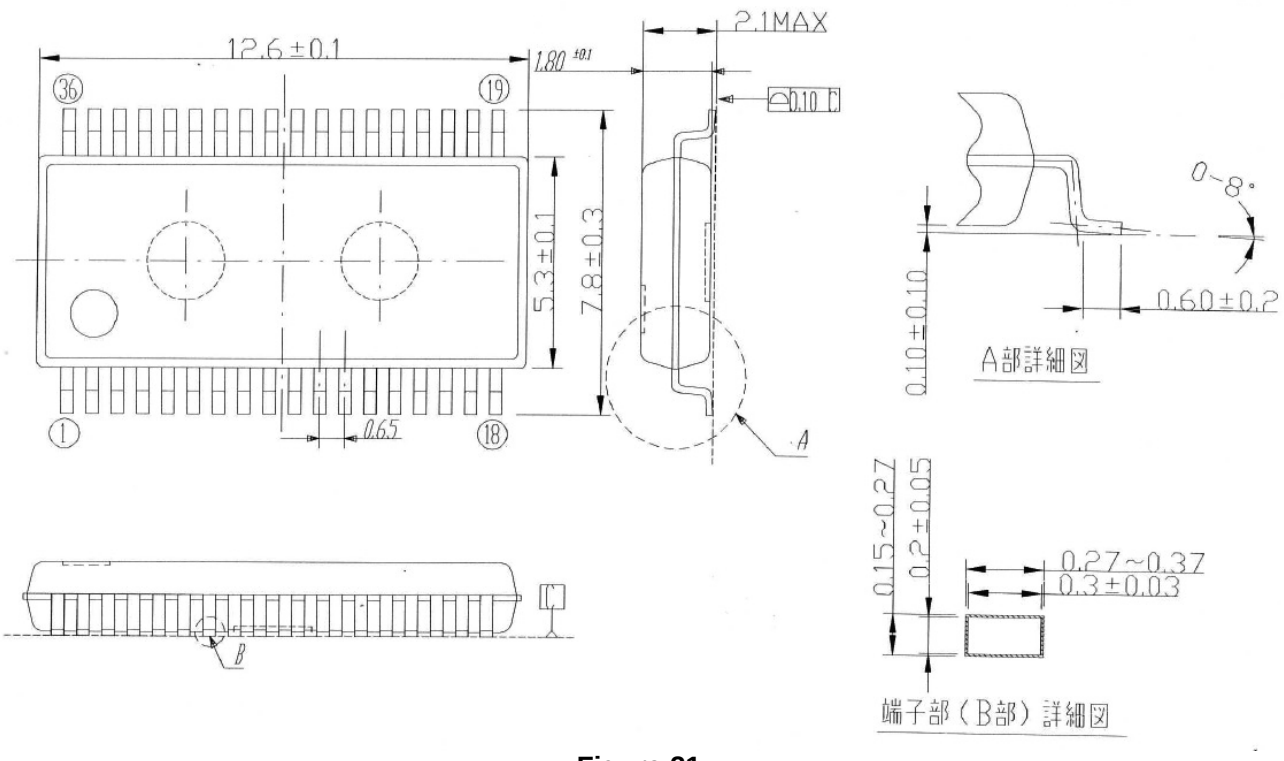
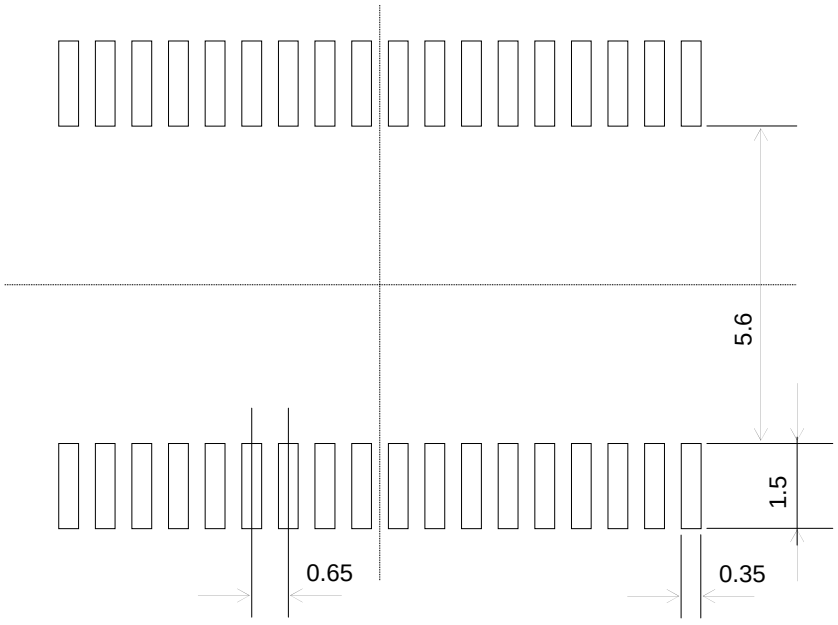


Figure 21

Unit : mm

8. Recommended foot pattern; 推奨フットパターン



Unit : mm

9. Directions; 注意事項

(1) Do not disclose this specification to any third party. The copyrights and know how specified in this document belong to our company.

本書は弊社の著作権、ノウハウに関する内容が含まれていますので、第3者には開示しないように願います。

(2) Apply the IC only for the purpose approved by our company.

本製品を弊社と合意した用途以外の目的に使用しないでください。

(3) Be sure to provide the appropriate protection function on your product to prevent secondary damage caused by the IC malfunction or failure. We assume no responsibility whatsoever for injury or death, fire accidents, and other serious accidents caused by unsuitable use.

本製品に万が一異常や不具合が生じた場合でも、2次災害防止のため、セット本体に適切な予防機能を必ず付加してください。不適当な使用による人身事故、火災事故、その他の重大事故につきましては、当社は一切その責任を負いません。

(4) We assume no responsibility whatsoever for the issue of industrial property rights occurred by using the IC described in this document.

本書に記載されている IC の使用に起因する工業所有権に関する諸問題につきまして当社は一切その責任を負いません。

(5) Any questions about this document or any other matters not specified in this document shall be solved by negotiation between two parties.

本書に記載無き事項及び記載事項に疑義が生じた場合は、両者の合議により解決することとします。

Revision / 更新履歴

Date	Version	Paragraph	Description	Revised by
08/09/09	1.7	4.Electrical Specifications	4.3.11. Electrical Characteristic curves ・ Figure17 and 18 Revised.	S.Hiraoka
08/05/28	1.6	8.Recommended foot pattern	Added “Recommended foot pattern”	S.Hiraoka
08/02/14	1.5	4.Electrical Specifications	4.3.3. FM Receiver Characteristics ・Revised the unit of High Cut Control to “dB”. ・Added to conditions of “High Cut Control”. ・Added to conditions of “Stereo Noise Control”. 4.3.11. Added “Electrical Characteristic curves”	S.Hiraoka
		5. Test and Application circuit	5. Deleted “Test and Application circuit” 5. Added “Connection Diagram for Measurement”	
07/12/13	1.4	1.Description	Revised	S.Hiraoka
		2.Features	Revised	
		3.Block Diagram	Revised	
		4.Electrical Specifications	4.3.3.FM Receiver Characteristics ・Changed to Conditions of “Band Muting attenuation” “@30KHz”. 4.3.7.I2S Characteristics ・Deleted “I2S Characteristics” 4.3.7.DC characteristics ・Changed to Conditions of “Low level Output Voltage at 0.5mA sink current” “CS0”. ・Changed to Conditions of “High level Output Voltage at -0.5mA sink current” “CS0”. ・Changed Note.	
		5. Test and Application circuit	5.1. Test and Application circuit Figure4. ・Changed #18, 19, 20 and 21 to non-connection ・Deleted L4, L5 and L6. ・Changed Note *3 and *4. ・Added Note *6. 5.2. Parts List ・Deleted L4, L5 and L6.	
		6. Pin Grid Assignment	Figure6 and Table14. ・Changed #18, 19, 20 and 21 to non-connection	
07/11/21	1.3	4.Electrical Specifications	4.3.2.General ・Added filter setting of Audio Analyzer. ・Changed to value of “standby Current”. ・Deleted “High level Input Voltage”. ・Deleted “Low level Input Voltage”. ・Deleted “High level output Voltage”. ・Deleted “Low level output Voltage”. 4.3.3.FM Receiver Characteristics ・Changed Carrier Frequency to 98MHz only. ・Deleted “Signal-to-Noise Ratio(Mo)”. ・Deleted “IF Band width” ・Deleted “ACA Selectivity” ・Added “IF Rejection Ratio ” ・Changed to value of “Image Rejection Ratio” ・Changed to value of “Seek Sensitivity” ・Deleted “L/R Balance” ・Deleted “Band Muting band width” ・Added “Band Muting attenuation”	S.Hiraoka

			・Changed to value of “De-emphasis” ・Changed to value of “Frequency Response” ・Changed to value of “RDS Sensitivity” 4.3.4.AM Receiver Characteristics ・Changed Carrier Frequency to 999KHz only. ・Separated AM Frequency Coverage into 9KHz and 10KHz. ・Deleted “IF Band width” ・Changed to value of “Frequency Response” ・Added filter setting of Audio Analyzer in the Note. 4.3.8.Deleted “Interface Characteristics”. 4.3.8.Added “DC characteristics”. 4.3.9.Added “AC characteristics”. 4.3.10.Added “3-wire control interface characteristics”. 4.3.11.Added “I2C control interface characteristics”.	
		5. Test and Application circuit	5.1. Test and Application circuit Figure4. ・ Changed to value of the part connected to Pins #15 and #16 “1uF” ・ Figure4. and 5. Revised 5.2. Parts List ・ Changed to values of L1 “LQW18AN33NG00D”. ・ Added L2, L3, X1 and AM LOOP ANTENNA.	
07/11/01	1.2	4.Electrical Specifications	4.3.4.AM Receiver Characteristics ・Changed to value of “Harmonic distortion”	S.Hiraoka
07/10/11	1.1	4.Electrical Specifications	4.3.3.FM Receiver Characteristics ・Changed to value of “Carrier Frequency” “F2=74MHz” ・Changed to value of “Useable sensitivity” ・Changed to value of “Signal to noise ratio(Mo)” ・Changed to value of “Signal to noise ratio(ST)” ・Changed to value of “Harmonic distortion(Mo),THD1” ・Changed to value of “Harmonic distortion(ST),THD2” ・Changed to value of “Harmonic distortion(Mo),THD3” ・Changed to value of “Image rejection ratio” ・Changed to value of “AM rejection ratio” ・Changed to value of “Seek Sensitivity” ・Changed to value of “Stereo separation” ・Changed to value of “Stereo noise control” ・Changed to conditions of “High Cut Control” ・Changed to value of “High Cut Control” ・Changed to value of “Audio output” ・Deleted “RDS Indicator Sens.” 4.3.4.AM Receiver Characteristics ・Changed to value of “AM Frequency coverage” ・Changed to value of “Useable sensitivity”	S.Hiraoka

			・Changed to value of “Signal to noise ratio” ・Changed to value of “Harmonic distortion” ・Changed to value of “Audio output” 4.3.7. I2S Characteristics ・Changed to value of “Master clock” ・Changed to value of “Sampling frequency”	
07/08/04	1.0		New Release	S.Hiraoka