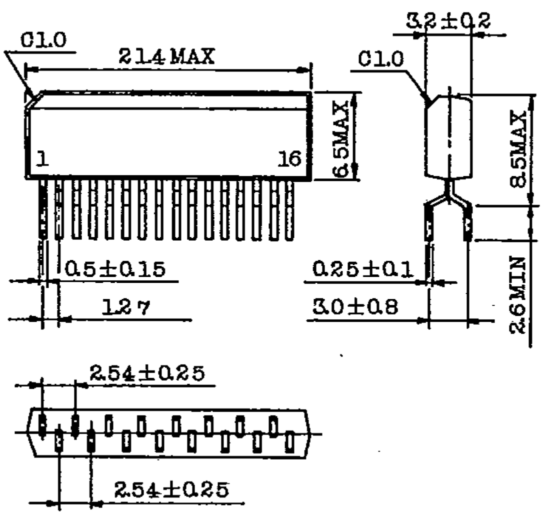
FM IF SYSTEM (DIFFERENTIAL PEAK DETECTION)

TA7411AP is an IC designed for car tuner, and is provided with the flexible muting function and station detection function which allow the features realized conforming to the specification of the tuner.

- Differential 6-stage IF limiter amplifier
- Signal meter output
- Differential peak detector
- Station detection
- Bands muting
- Signal strength muting
- Effective against multi-path distortion with adoption of differential peak detector.
- Low distortion ratio can be realized with single tuning coil. (Typically 0.05% at 1kHz ±75kHz dev.)
- Sensitivity and attenuation of signal strength muting, and sensitivity and band of stop signal can freely be set with the external resistance.
- Signal meter output proportional to input signal strength can be obtained.
- Excellent S/N
- Operating power supply voltage : V_{opr}=7~16V (Ta=25°C)

Unit in mm



Lead pitch is 2.54 and tolerance is ±0.25 against theoretical center of each lead that is obtained on the basis of No.1 and No.2 leads.

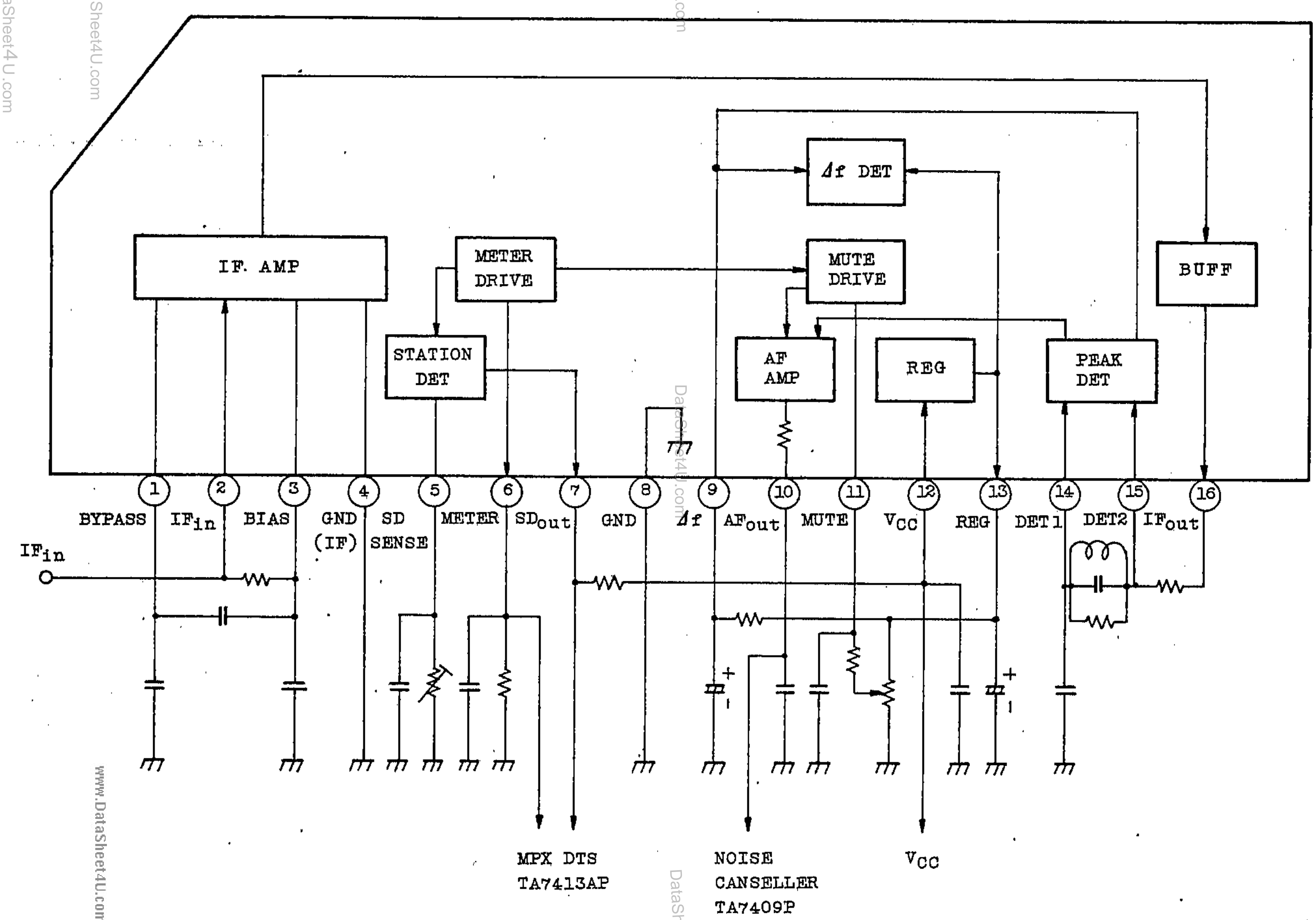
JEDEC	—
TOSHIBA	Z16A-P

Weight : 0.99g

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	16	V
Power Dissipation	PD	750	mW
Operating Temperature	Topr	-30~85	°C
Storage Temperature	Tstg	-55~150	°C
Tuning Indication Current	I7 max	20	mA
External Overflow Current	I13 max	5	mA

Note: Derated above Ta=25°C in the proportion of 6mW/°C.


IF. AMP
METER DRIVE
STATION DET
Δf DET
MUTE DRIVE
AF AMP
REG
PEAK DET
BUFF
1 BYPASS
2 IFin
3 BIAS
4 GND (IF)
5 SD SENSE
6 METER
7 SDout
8 GND
9 Δf
10 AFout
11 MUTE
12 VCC
13 REG
14 DET1
15 DET2
16 IFout
IFin
MPX DTS TA7413AP
NOISE CANSELLER TA7409P
VCC

ELECTRICAL CHARACTERISTICS

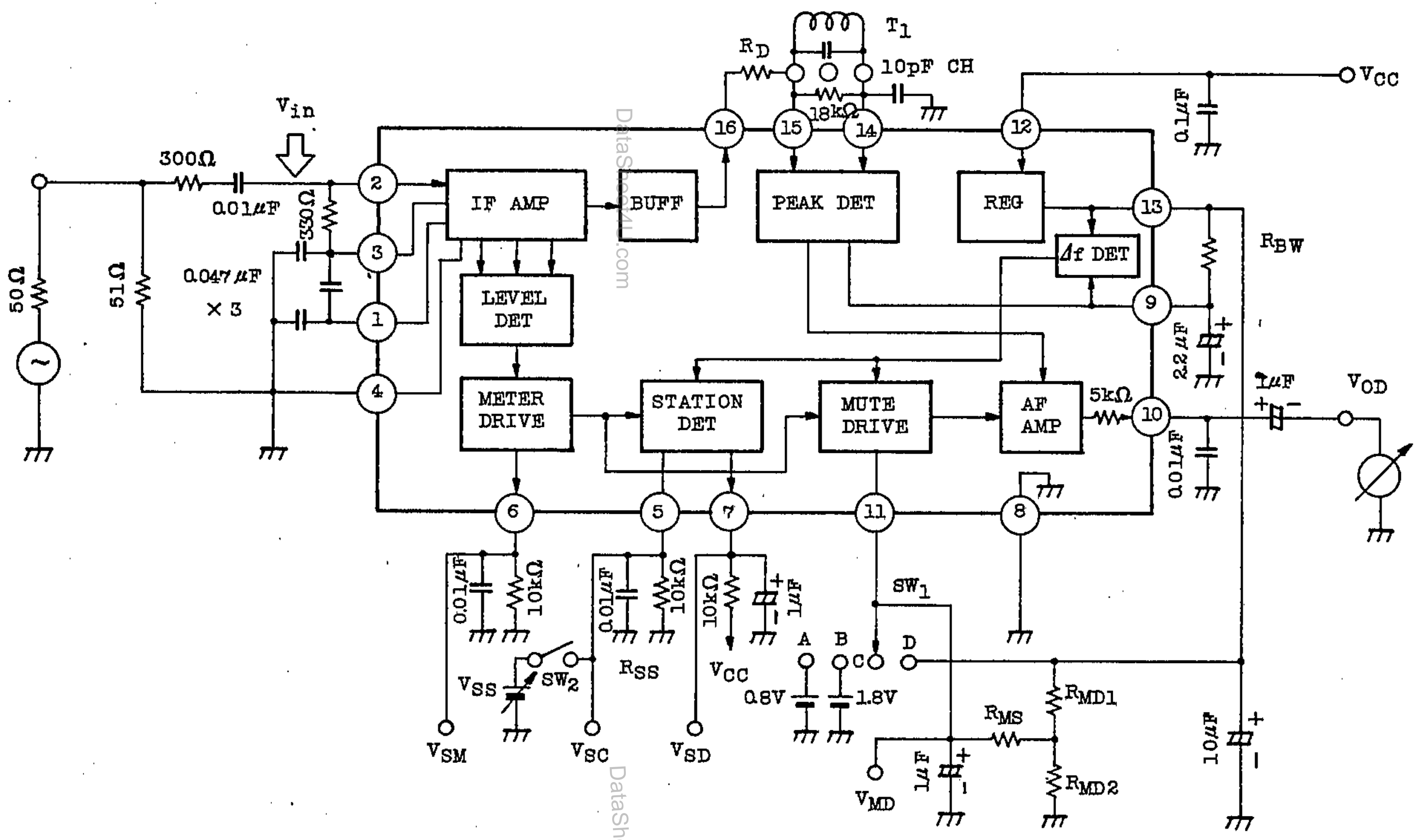
(Unless otherwise specified, V_{CC}=8.5V, f_i=10.7MHz, Dev=±75kHz, f_m=400Hz, V_i=80dBμ SW1=D (Mute off), SW2=off)

CHARACTERISTIC	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Quiescent Supply Current	I_{CCQ}		V_i=0, SW1=C	10	13.5	19	mA
Limiting Sensitivity	V_i(lim)			–	33	35	dBμ
Detection Ouptut	V_{OD}			350	430	550	mV_{rms}
Total Harmonic Distortion Ratio 1	THD1		Dev=±22.5kHz, R_D=1.3kΩ	–	0.04	0.5	%
Total Harmonic Distortion Ratio 2	THD2		Adjust R_D to optimum value. (R_D=1.3kΩ+500ΩVR)	–	0.05	–	%
Signal to Noise Ratio	S/N			71	78	–	dB
AM Rejection Ratio	AMR		AM=30%	–	55	–	dB
Signal Meter Output	VSM1		V_i=0dBμ	–	0	0.3	V
	VSM2		V_i=50dBμ	0.5	1.5	2.5	
	VSM3		V_i=70dBμ	2.6	3.8	5.1	
	VSM4		V_i=100dBμ	5.4	6.5	6.8	
Soft Muting Attenuation	ATT1		SW1=A	35	40	45	dB
	ATT2		SW1=B	4	7	11	
Soft Muting Driving Voltage	VMD1		V_i=50dBμ; RMD1=7.5kΩ, RMD2=2.7kΩ, RMS=33kΩ, SW1=C	–	3.5	–	V
	VMD2		V_i=80dBμ	–	7.0	–	
Detuning Attenuation	ATT3		Δf=±200kHz	18	24	30	dB
Muting Band	BW(M)		R_{BW}=12kΩ, V_{OD}=−3dB	–	±70	–	kHz
Station Detection Sensitivity	V_{SS}		POINT: SW2=ON, V_{SD}=L→H	0.8	1	1.2	V
Station Detection Control Voltage	V_{SC1}		V_i=50dBμ; R_{SS}=10kΩ	–	1.5	–	V
	V_{SC2}		V_i=80dBμ	–	4.3	–	
Station Detection Band	BW(S)		R_{BW}=12kΩ	–	±45	–	kHz
AF Output Resistance	R_O			–	5	–	kΩ

DC CHARACTERISTICS (V_{CC}=8.5V, Ta=25°C, Terminal Voltage at No Signal)

TERMINAL No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Characteristic	Bypass	IF in	Bias	GND (IF)	SD Sense	Meter	SD out	GND	Δf	AF out	Mute	V_{CC}	Reg	Det 1	Det 2	IF out
DC Voltage (V)	3.0	3.0	3.0	0	0	0	0.1	0	4.6	4.8	1.3	8.5	4.8	2.4	2.4	2.4

TEST CIRCUIT



BUILT-IN FUNCTION

DIFFERENTIAL PEAK DETECTION

Differential peak detection method is for detecting each peak of the voltage variation of e_1 and e_2 when the input frequency varies and for obtaining the detection output by means of subtracting and amplifying the DC voltage with the differential amplifier. The levels of e_1 and e_2 for the input frequency are shown in Fig. 2. The point at which e_1 becomes minimum is the point at which Z_1 becomes minimum, here Z_1 is the input impedance of the following stage.

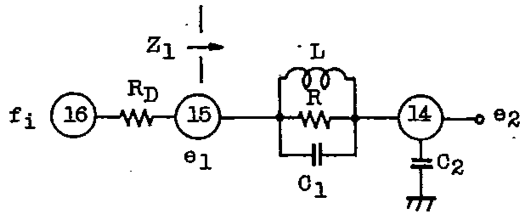


Fig. 1

The impedance Z_1 is obtained as follows:

$$Z_1 = \frac{1+S^2\ L(C_1+C_2)}{SC^2(1+S^2LC_1)} \quad \ldots\ldots (1)$$

(Provided S=jw.)

f_L is obtained by the expression (2) as follows.

$$f_L = \frac{1}{2\pi\sqrt{L(C_1+C_2)}} \quad \ldots\ldots (2)$$

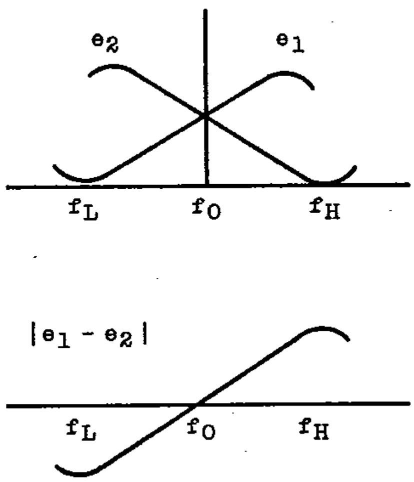


Fig. 2

Since the point at which e_2 becomes minimum is the point at which L and C_1 resonate parallel, f_H is obtained by the expression (3) as follows.

$$f_H = \frac{1}{2\pi\sqrt{LC_1}} \quad \ldots\ldots (3)$$

When the inductive susceptance of L and C_1 becomes the half of capacitive susceptance, the frequency f_0 is expressed by the following formula (4).

$$f_0 = \frac{1}{2\pi\sqrt{L\ (C_1+C_2/2)}} \quad \ldots\ldots (4)$$

The detection output is determined by the width of $f_H - f_L$. That is, the detection output is proportional to the ratio of C1 to C2 ... (C1/C2). Fig. 3 shows the variation of the detection output against C2 as C1=15pF. Take care for the fact when C1/C2 is reduced to reduce the detection output, the detection band is widended and S/N ratio is reduced to a certain degree. Therefore, for reducing the detection output with S/N kept high, supplement R to adjust the output.

In the conventional quadrature detection, for obtaining the low distortion ratio, multiple tuned coil is necessitated and resulting in the high cost and the complicated adjustment (to coincide f_0 with the minimum distortion value is rather difficult.)

In TA7411AP, since f_0 adjustment is performed with the coil and the distortion with R_D, not only the cost but also the adjusting time is reduced.

When R_D is made into the fixed resistance, R_D=1.3kΩ becomes the reference for the minimum distortion (in the condition of the test circuit).

As described above, the linearity of the S curve (distortion) is determined by R_D value. On the other hand, R_D value is necessary to be varied also with the value of C1 and C2 in order to make the distortion minimum and especially the influence on C2 is the greatest.

Set R2 against C1 and C2 referring to the graph in Fig. 3.

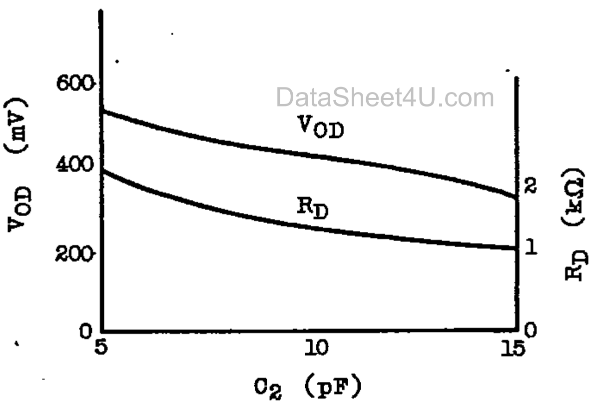


Fig. 3

Note: THD is adjusted to minimum with R_D.

SIGNAL STRENGTH MUTING CHARACTERISTICS

The muting of TA7411AP is composed of AF amplifier of which gain varies with the control voltage and the control voltage generating circuit (Mute Drive), of which voltage is proportional to the signal meter output.

Fig. 4 shows the outline of the muting circuit. The signal meter output is converted into the current I by 10kΩ externally attached to 8 pin, and 1/3 I current is output to 11 pin through 1:1/3 current mirror circuit. This current is converted into the control voltage by the externally connected V_M and R_{MS}.

Since the output current at 11 pin is about 0, the attenuation at quiescent state is determined almost by the value of V_M. By means of connecting the volume R_{MD} of about 10kΩ to the constant voltage output of 4.8V (13 pin), V_M is set by the volume output. The variation ratio (gradient) of attenuation of the detection output is determined by input signal level, that is by the ratio of the variation of 11 pin voltage V_{MD} to the variation of the signal meter voltage. Therefore, the larger R_{MS} grows, the sharper the gradient becomes. Usually, the value of R_{MS} is considered satisfactory with 33kΩ.

The muting amount against 11 pin voltage V_{MD} is shown in Fig. 4.

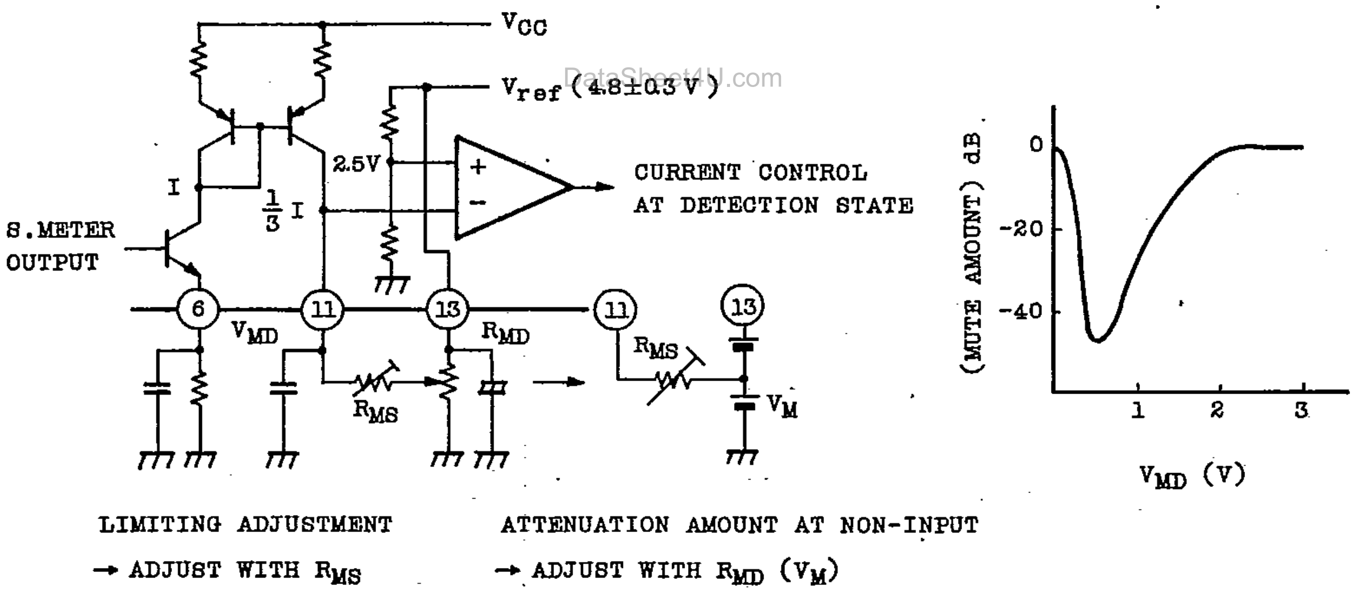


Fig. 4

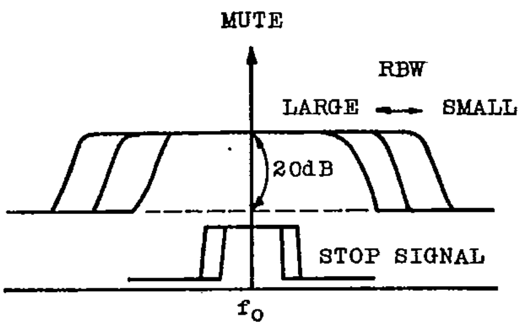
DETUNED MUTING CHARACTERISTICS

The positive and negative currents proportional to S curve are generated at AFC terminal 9 pin.

The alternating current portion is smoothed by the external capacitor and the DC voltage is generated at 9 pin through R_{BW} connected to 13 pin. When the variation of DC voltage generated at R_{BW} exceeds about ±0.7V, Δf detection circuit (Δf Det) is operated, 11 pin voltage is made to about 1.5V and AF amplifier is attenuated by about 20dB.

The width of the detuning muting is determined by the resistance value of RBW, however, since the width is varied by the detection output described above, set the value of R_{BW} after setting the detection output.

The muting characteristics when R_{BW} is changed in the test circuit condition is shown in Fig. 5.



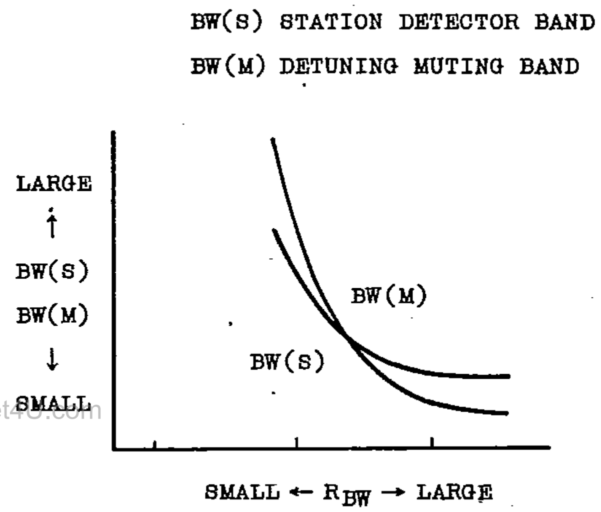


Fig. 5

STATION DETECTOR

The station detector (stop signal generator of DTS) detects the detuning frequency with the input signal strength and Δf detection circuit (Δf Det), and output it through the AND circuit.

As shown in Fig. 6, the signal meter output is converted into the current I by the 10kΩ resistance connected to 6 pin, and the current I is output at 5 pin through the current mirror circuit.

This current is convered into voltage through R_{SS}. On the other hand, 5 pin is internally connected to the minus input of the comparator in which 1V is added to the plus input. Therefore, by means of changing R_{SS} value connected to 5 pin, the stop signal sensitivity can be adjusted.

The variable width of the stop signal sensitivity is about 40dB in IF input voltage (at R_{SS}=2kΩ ~ 10kΩ). The band width is varied by R_{BW} as shown in Fig. 5.

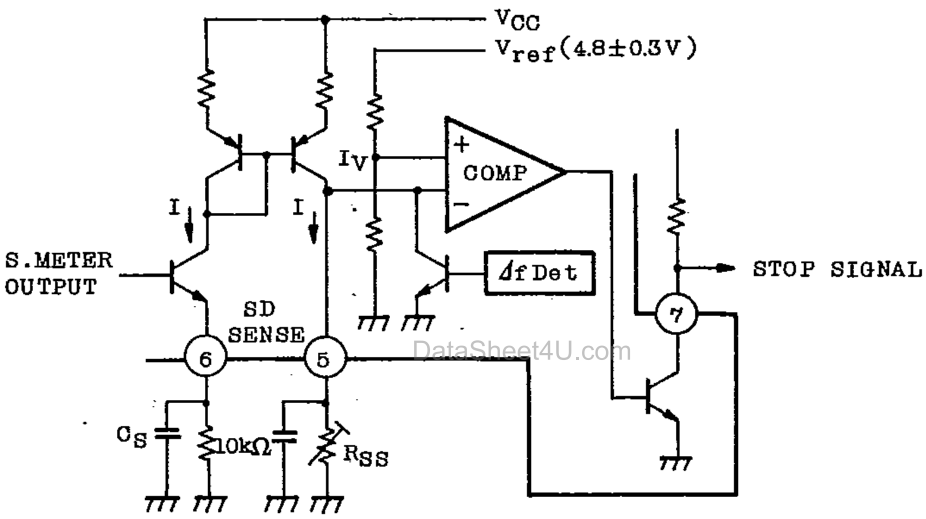


Fig. 6

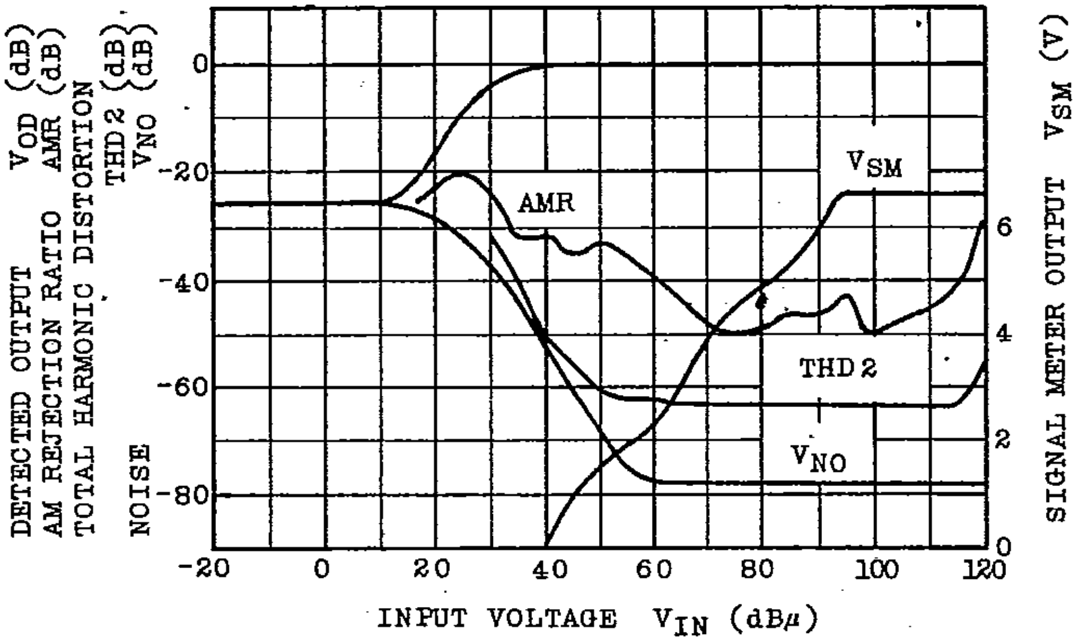
ADJUSTING METHOD OF TA7411AP

- Provide 10.7MHz, 80dBμ signal input.
- Connect voltmeter between 9 pin and 13 pin.
- Adjust T1 to set the voltmeter indication at about 0V.
- Adjust R_D so as to make the detection distortion minimum.

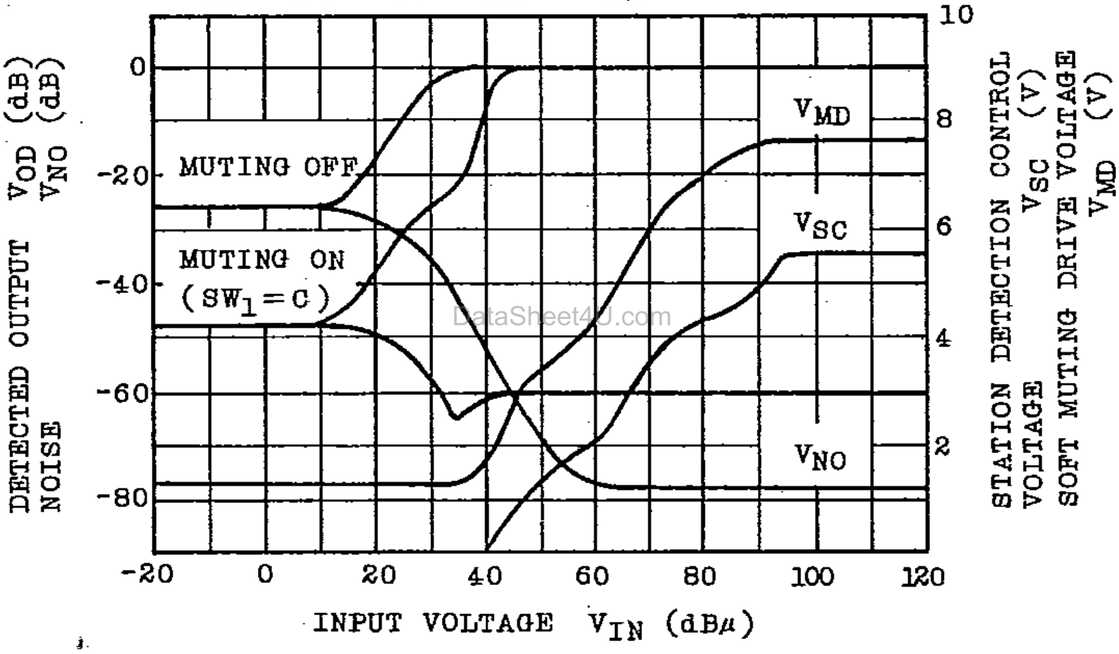
CAUTION ON APPLICATION

- When the capacity of the bypass capacitor C_S to be connected to S meter output 8 pin is considerably large, the audio signal depended on AM wave flows to make AMR characteristics deteriorated.
  Application with 0.01μF or below is recommended.

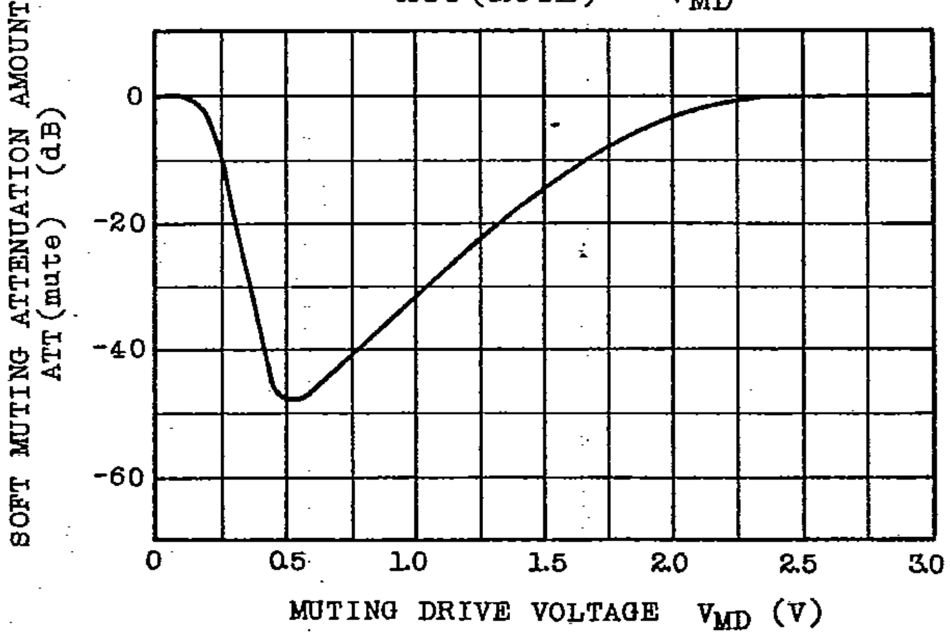
V_{OD}, AMR, THD 2, V_{NO}, V_{SM} — V_{IN}

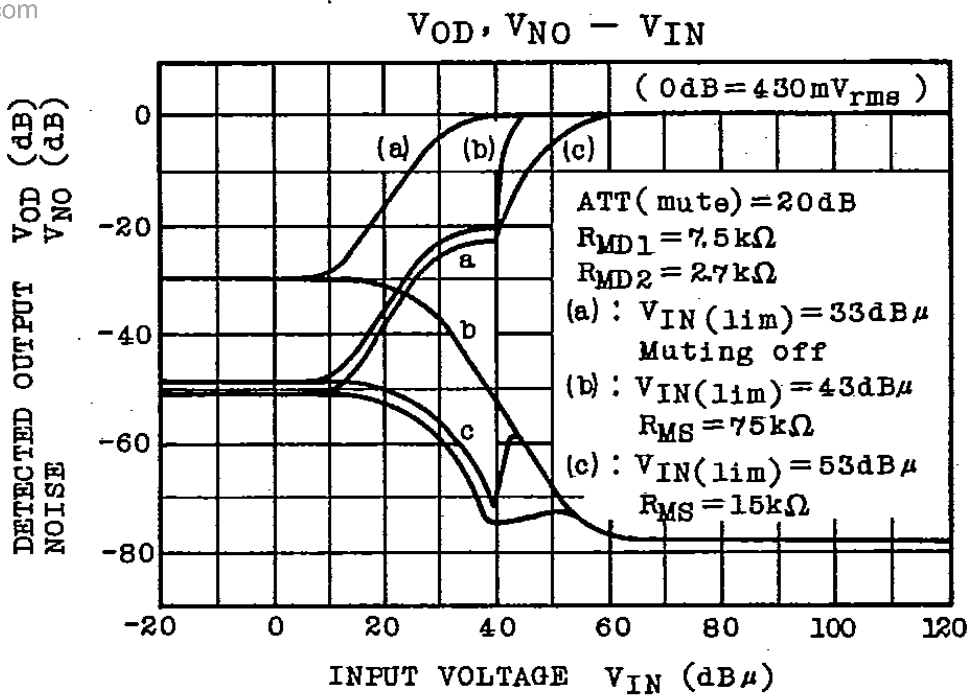


V_{OD}, V_{NO}, V_{SC}, V_{MD} — V_{IN} (MUTING ON)

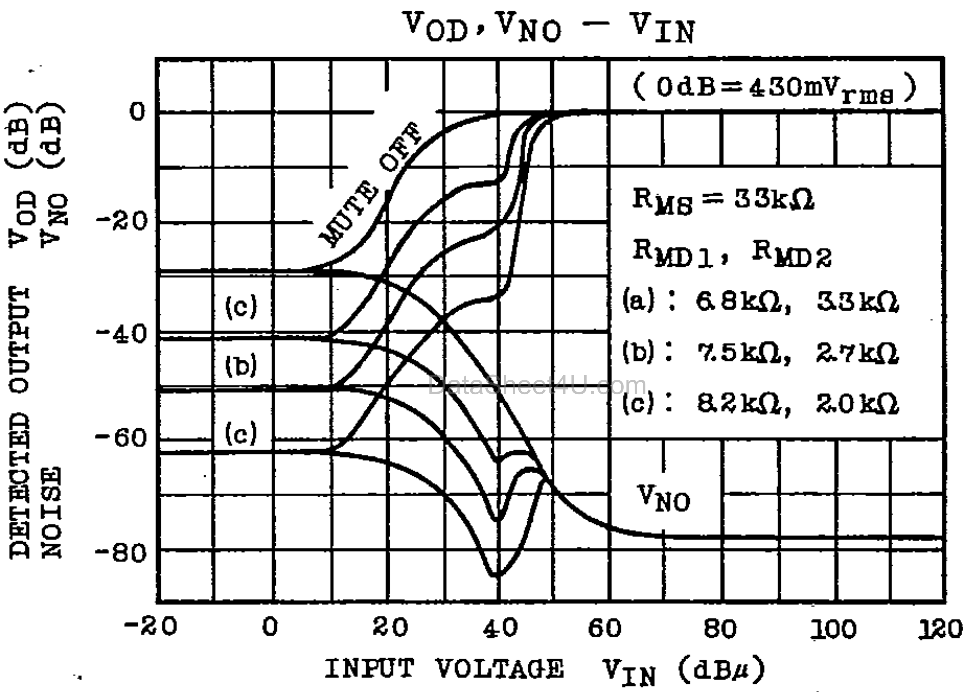


ATT (MUTE) — V_{MD}

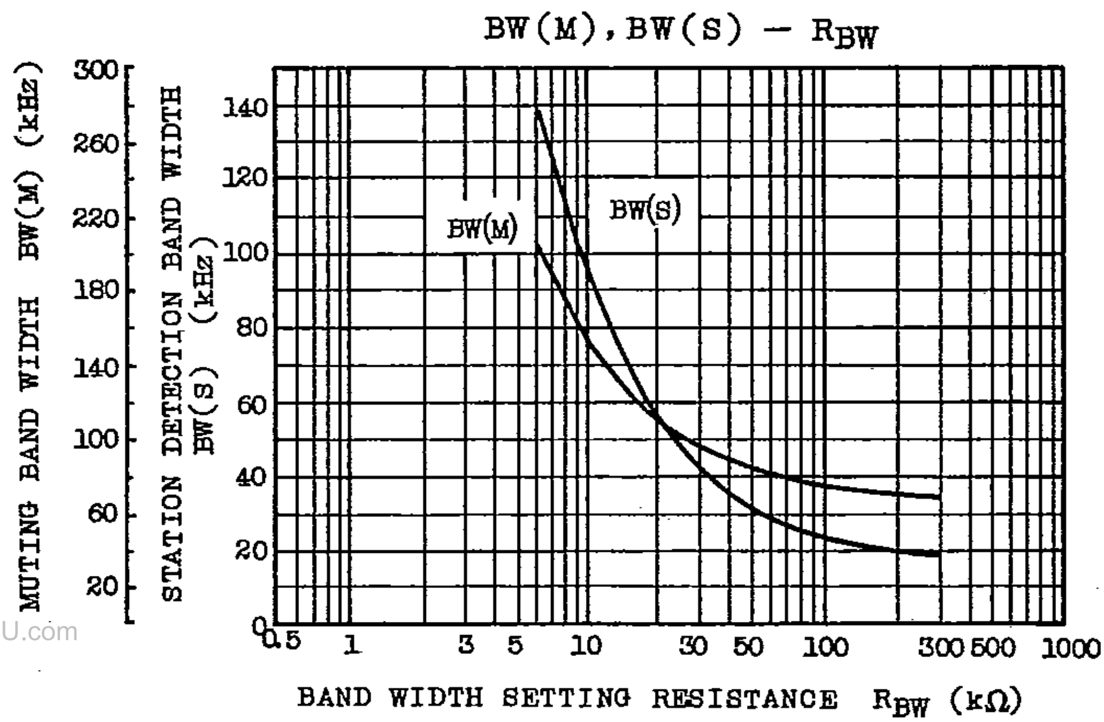




VOD, VNO — VIN
(0dB=430mVrms)
DETECTED OUTPUT VOD (dB)
NOISE VNO (dB)
0
-20
-40
-60
-80
(a)
(b)
(c)
a
b
c
ATT(mute)=20dB
RMD1=7.5kΩ
RMD2=2.7kΩ
(a) : VIN(lim)=33dBμ
Muting off
(b) : VIN(lim)=43dBμ
RMS=75kΩ
(c) : VIN(lim)=53dBμ
RMS=15kΩ
-20
0
20
40
60
80
100
120
INPUT VOLTAGE VIN (dBμ)

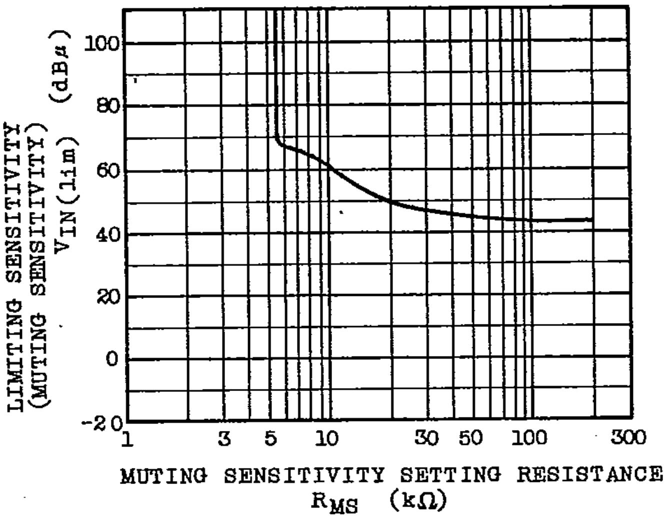


VOD, VNO — VIN
(0dB=430mVrms)
DETECTED OUTPUT VOD (dB)
NOISE VNO (dB)
0
-20
-40
-60
-80
MUTE OFF
(c)
(b)
(c)
RMS=33kΩ
RMD1, RMD2
(a) : 6.8kΩ, 3.3kΩ
(b) : 7.5kΩ, 2.7kΩ
(c) : 8.2kΩ, 2.0kΩ
VNO
-20
0
20
40
60
80
100
120
INPUT VOLTAGE VIN (dBμ)

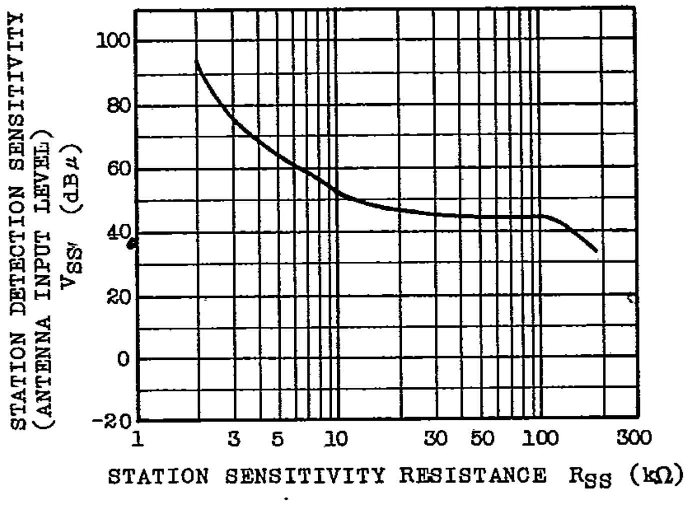


BW(M), BW(S) — RBW
MUTING BAND WIDTH BW(M) (kHz)
300
260
220
180
140
100
60
20
STATION DETECTION BAND WIDTH BW(S) (kHz)
140
120
100
80
60
40
20
0
BW(M)
BW(S)
0.5
1
3
5
10
30
50
100
300
500
1000
BAND WIDTH SETTING RESISTANCE RBW (kΩ)

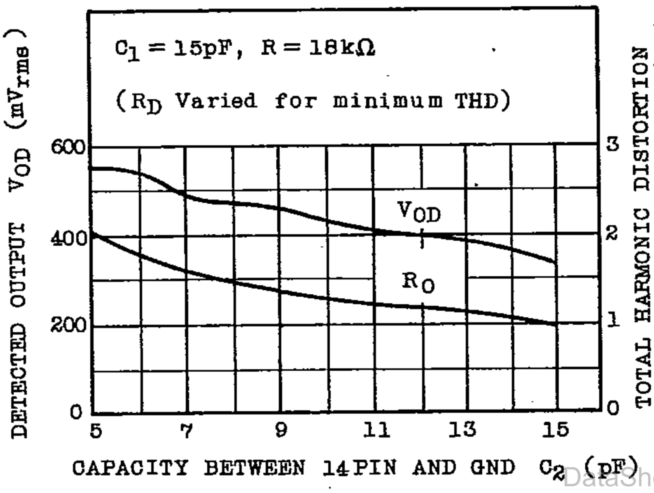
$V_{IN}(lim) - R_{MS}$



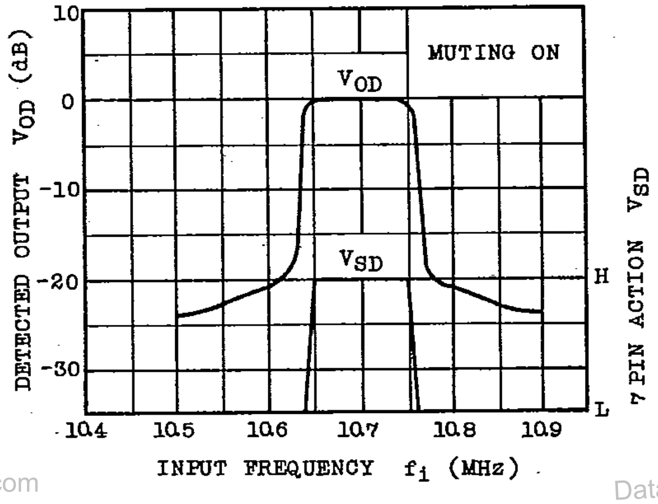
$V_{SS} - R_{SS}$



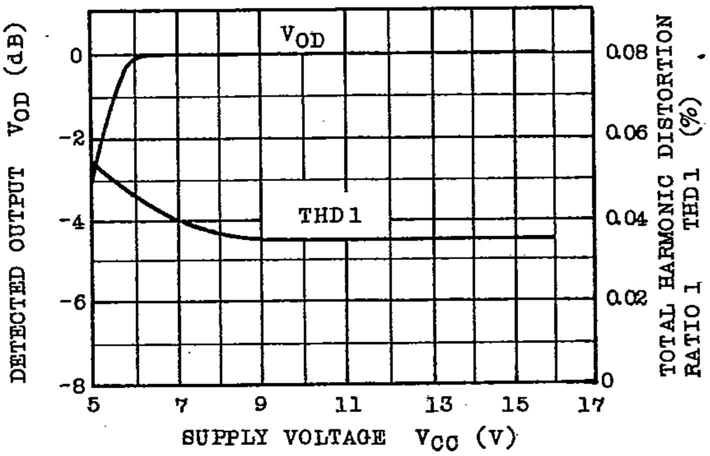
$V_{OD}, R_D - C_2$



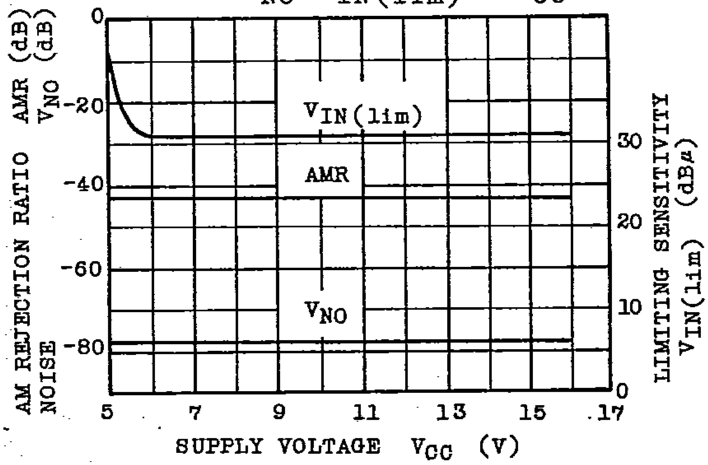
$V_{OD}, V_{SD} - f_i$

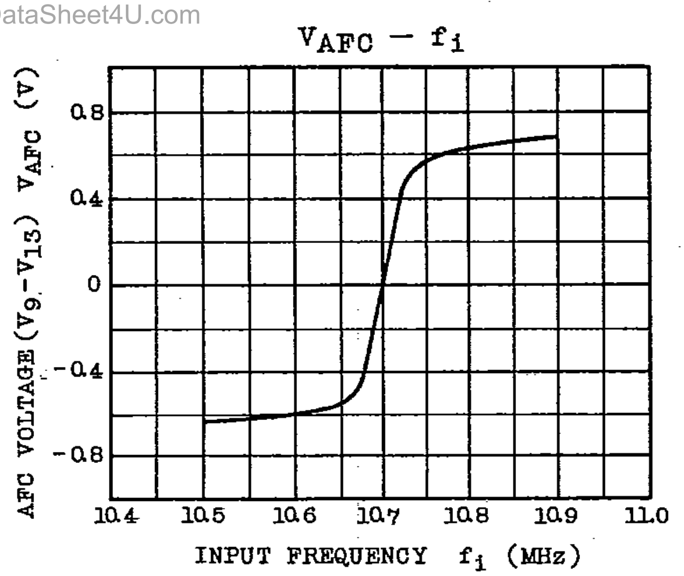


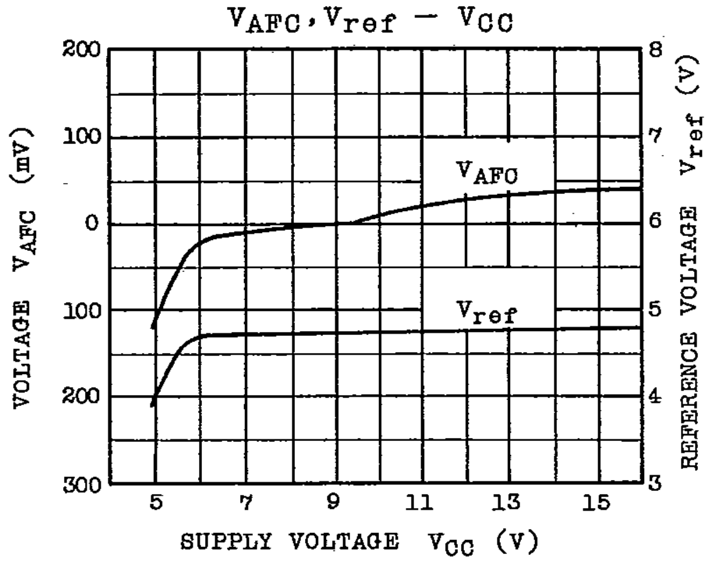
$V_{OD}, THD - V_{CC}$

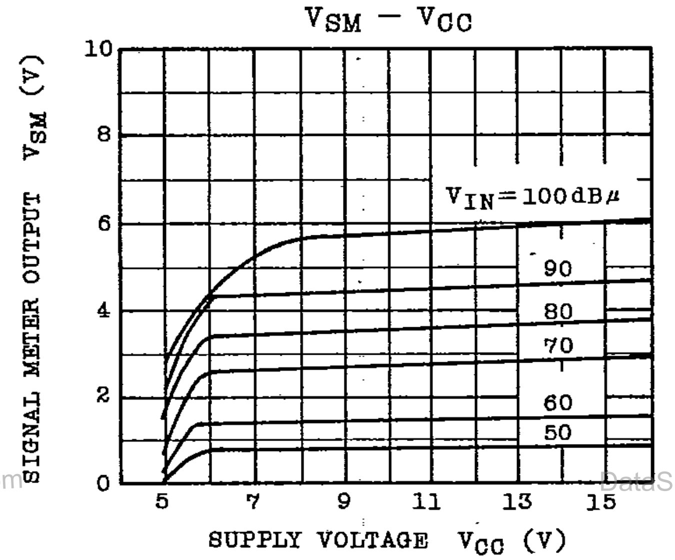


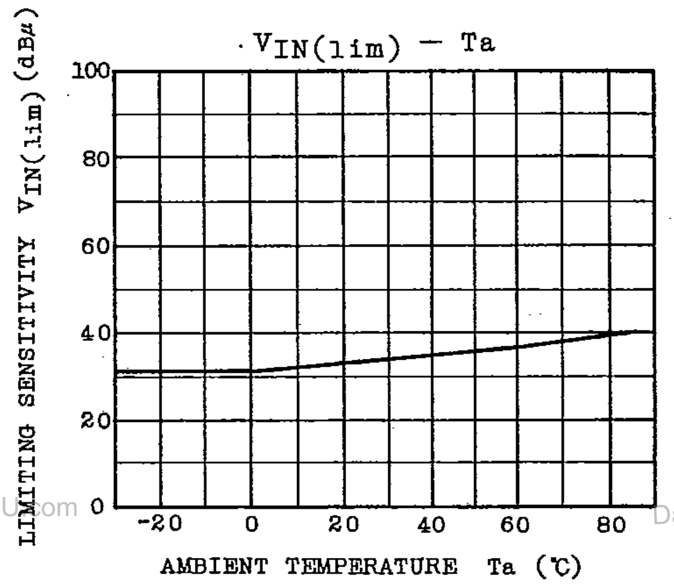
$AMR, V_{NO}, V_{IN}(lim) - V_{CC}$

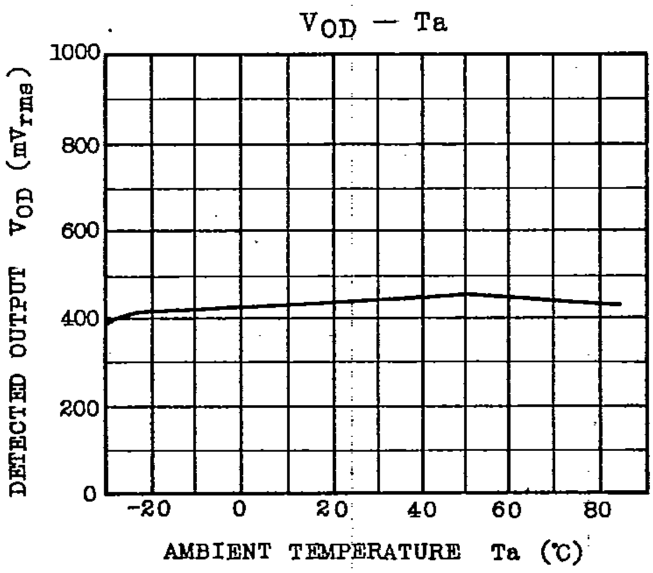


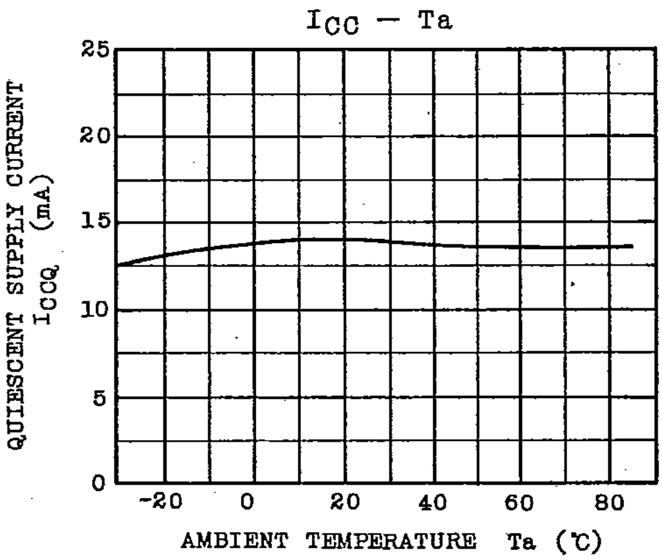

VAFC — fi
AFC VOLTAGE (V9-V13) VAFC (V)
0.8
0.4
0
-0.4
-0.8
10.4
10.5
10.6
10.7
10.8
10.9
11.0
INPUT FREQUENCY fi (MHz)

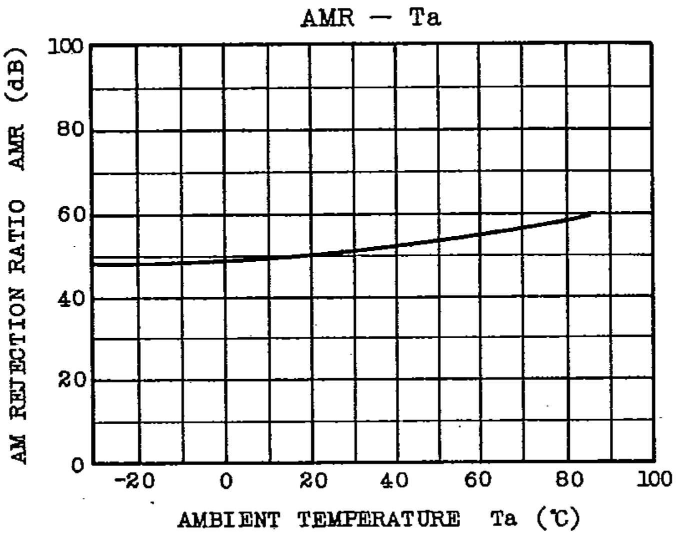

VAFC, Vref — VCC
VOLTAGE VAFC (mV)
REFERENCE VOLTAGE Vref (V)
VAFC
Vref
SUPPLY VOLTAGE VCC (V)

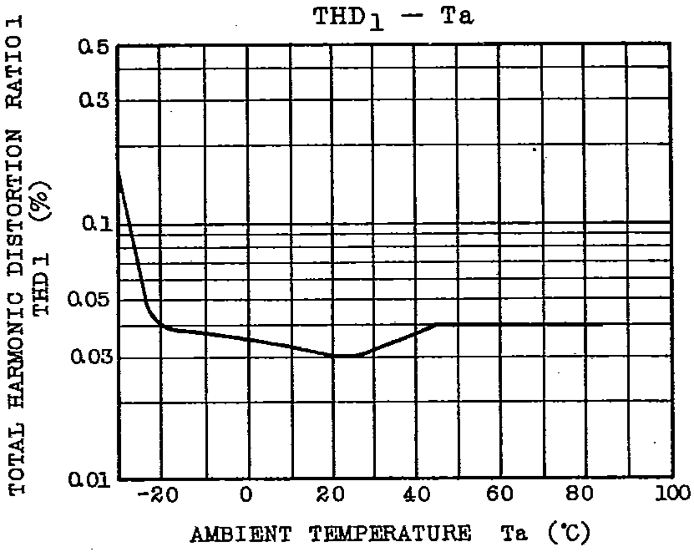

VSM — VCC
SIGNAL METER OUTPUT VSM (V)
VIN=100dBμ
90
80
70
60
50
SUPPLY VOLTAGE VCC (V)

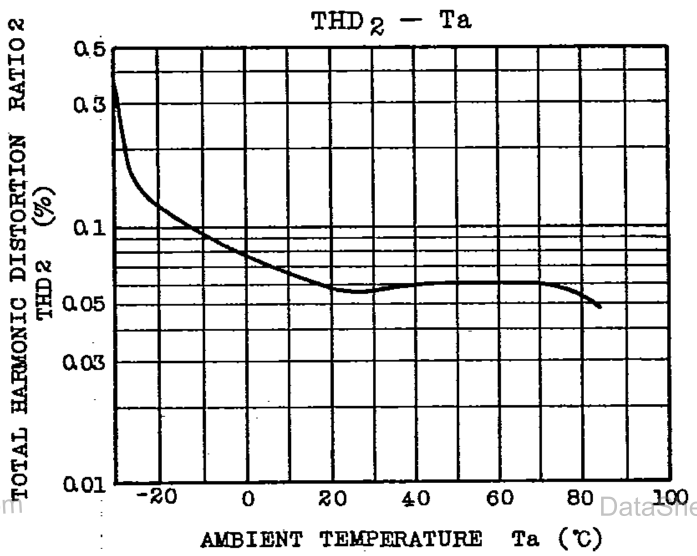

VIN(lim) — Ta
LIMITING SENSITIVITY VIN(lim) (dBμ)
AMBIENT TEMPERATURE Ta (℃)

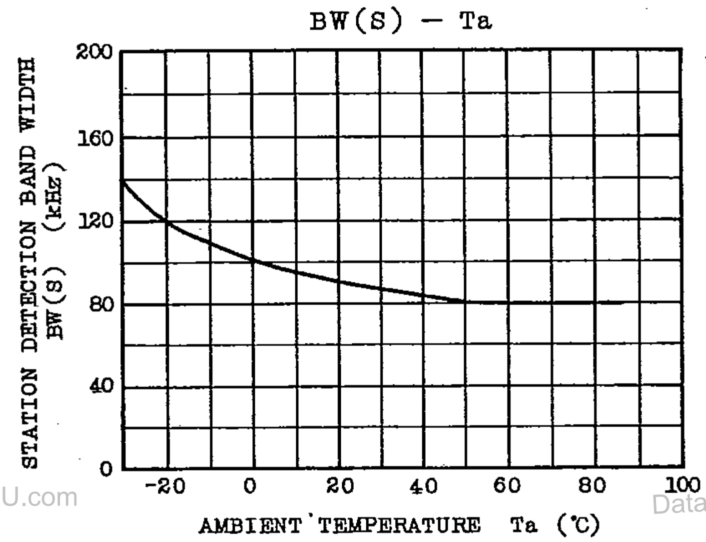

VOD — Ta
DETECTED OUTPUT VOD (mVrms)
AMBIENT TEMPERATURE Ta (℃)

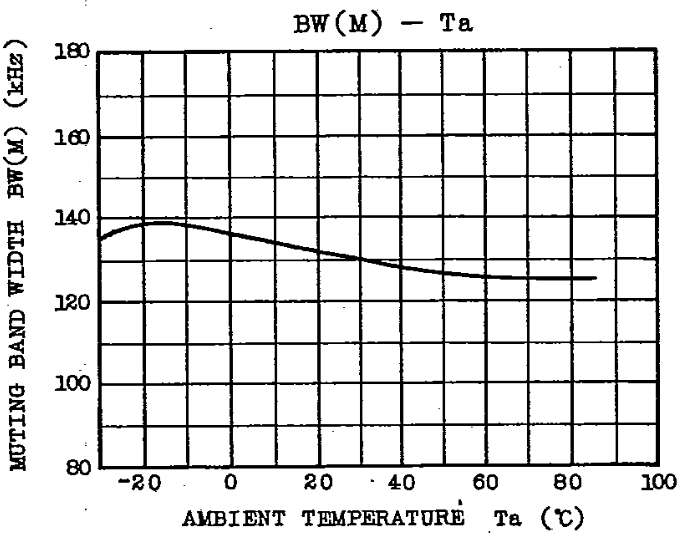

ICC — Ta
QUIESCENT SUPPLY CURRENT ICCQ (mA)
AMBIENT TEMPERATURE Ta (℃)

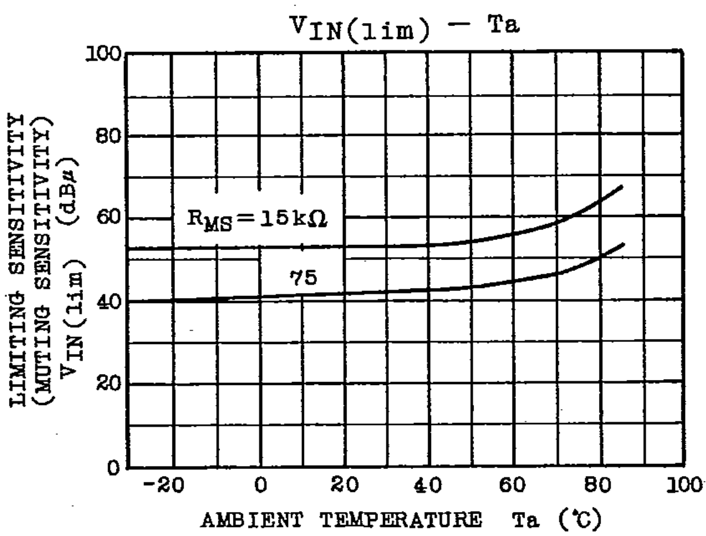

AMR — Ta
AM REJECTION RATIO AMR (dB)
100
80
60
40
20
0
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

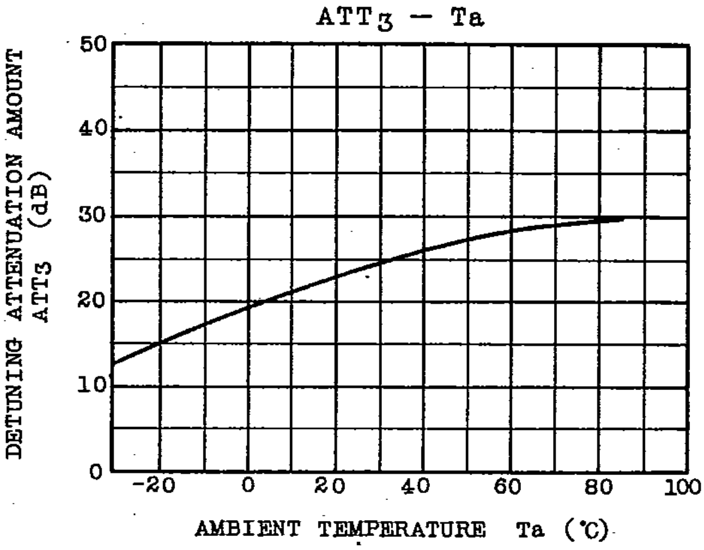

THD1 — Ta
TOTAL HARMONIC DISTORTION RATIO 1
THD 1 (%)
0.5
0.3
0.1
0.05
0.03
0.01
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

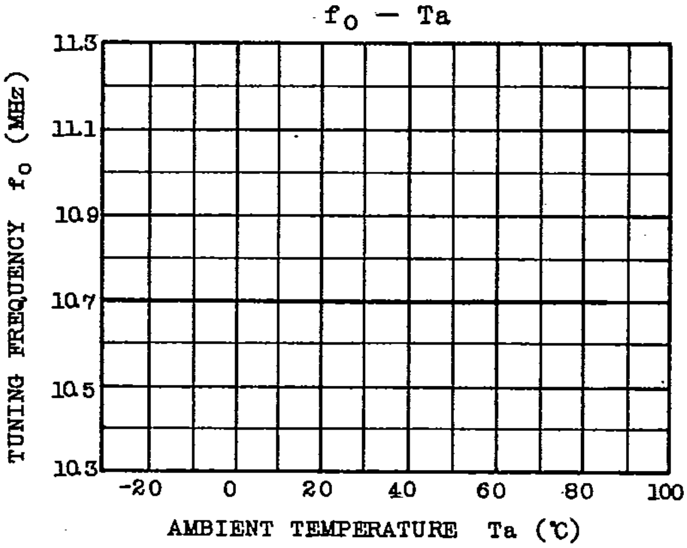

THD2 — Ta
TOTAL HARMONIC DISTORTION RATIO 2
THD 2 (%)
0.5
0.3
0.1
0.05
0.03
0.01
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

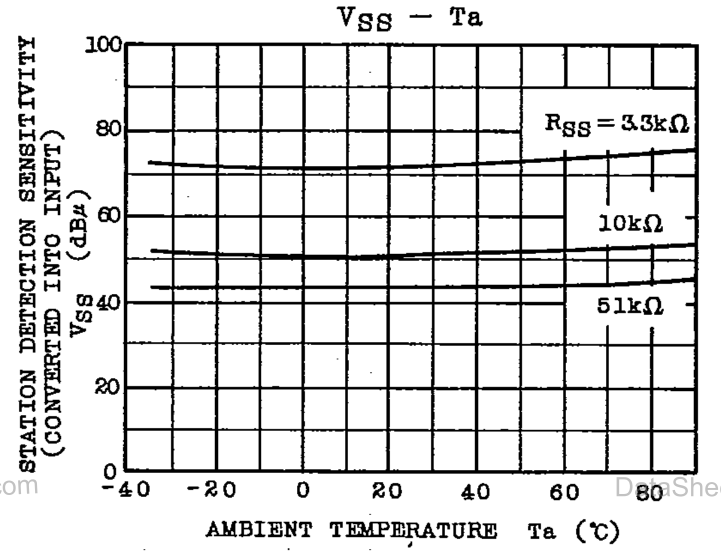

BW(S) — Ta
STATION DETECTION BAND WIDTH
BW(S) (kHz)
200
160
120
80
40
0
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)


BW(M) — Ta
MUTING BAND WIDTH BW(M) (kHz)
180
160
140
120
100
80
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

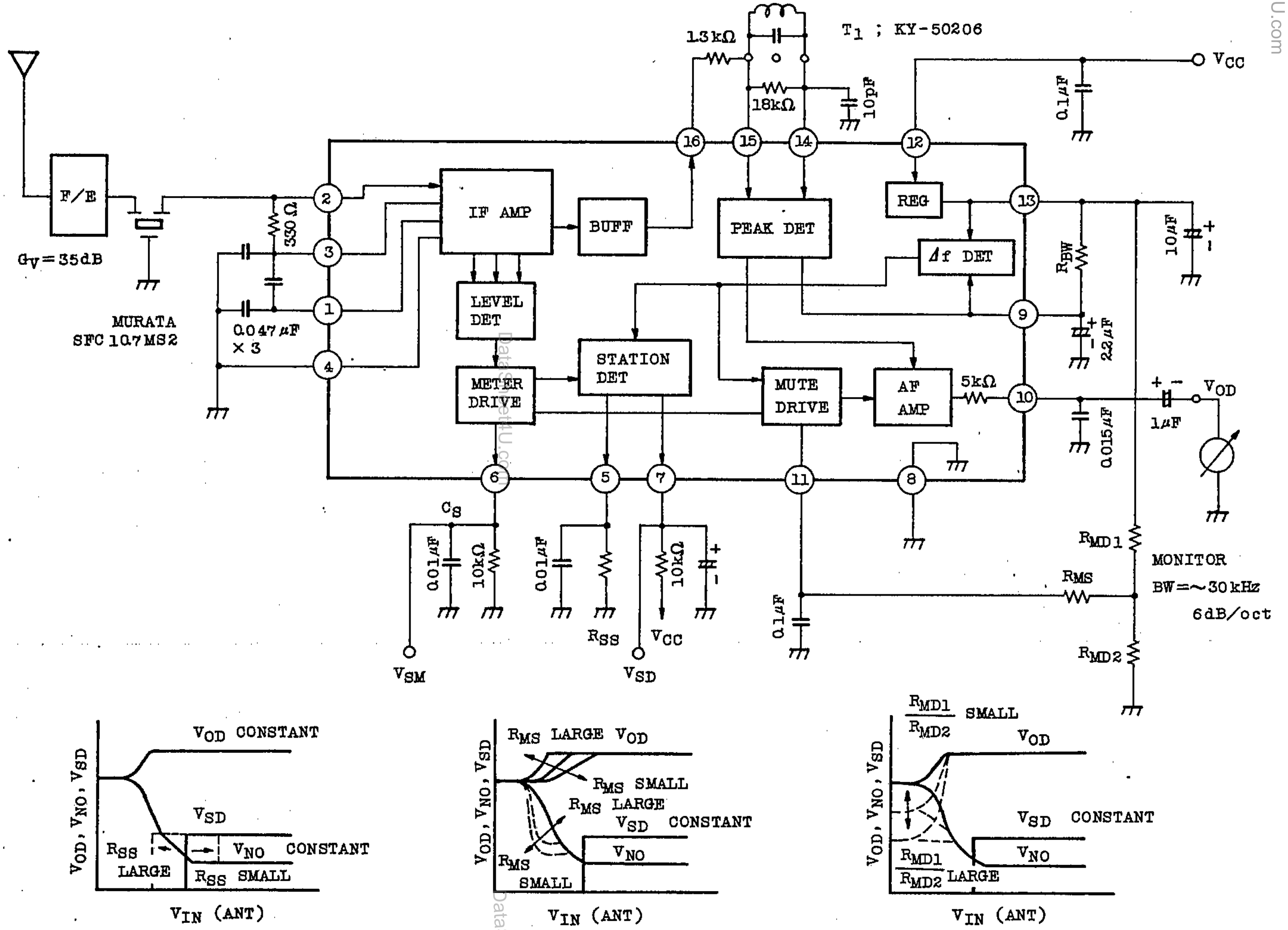

VIN(lim) — Ta
LIMITING SENSITIVITY
(MUTING SENSITIVITY)
VIN(lim) (dBμ)
RMS=15kΩ
75
100
80
60
40
20
0
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

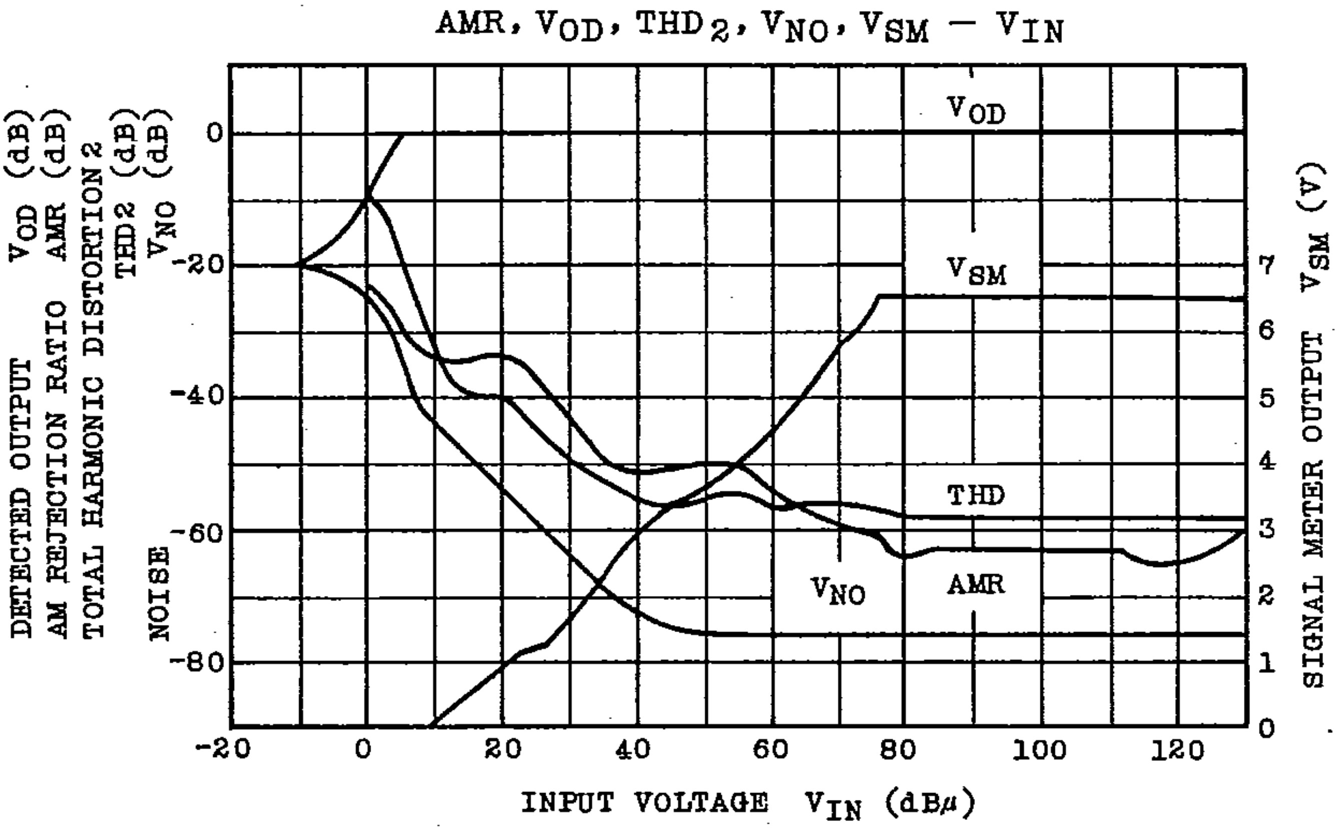

ATT3 — Ta
DETUNING ATTENUATION AMOUNT ATT3 (dB)
50
40
30
20
10
0
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)


fo — Ta
TUNING FREQUENCY fo (MHz)
11.3
11.1
10.9
10.7
10.5
10.3
-20
0
20
40
60
80
100
AMBIENT TEMPERATURE Ta (℃)

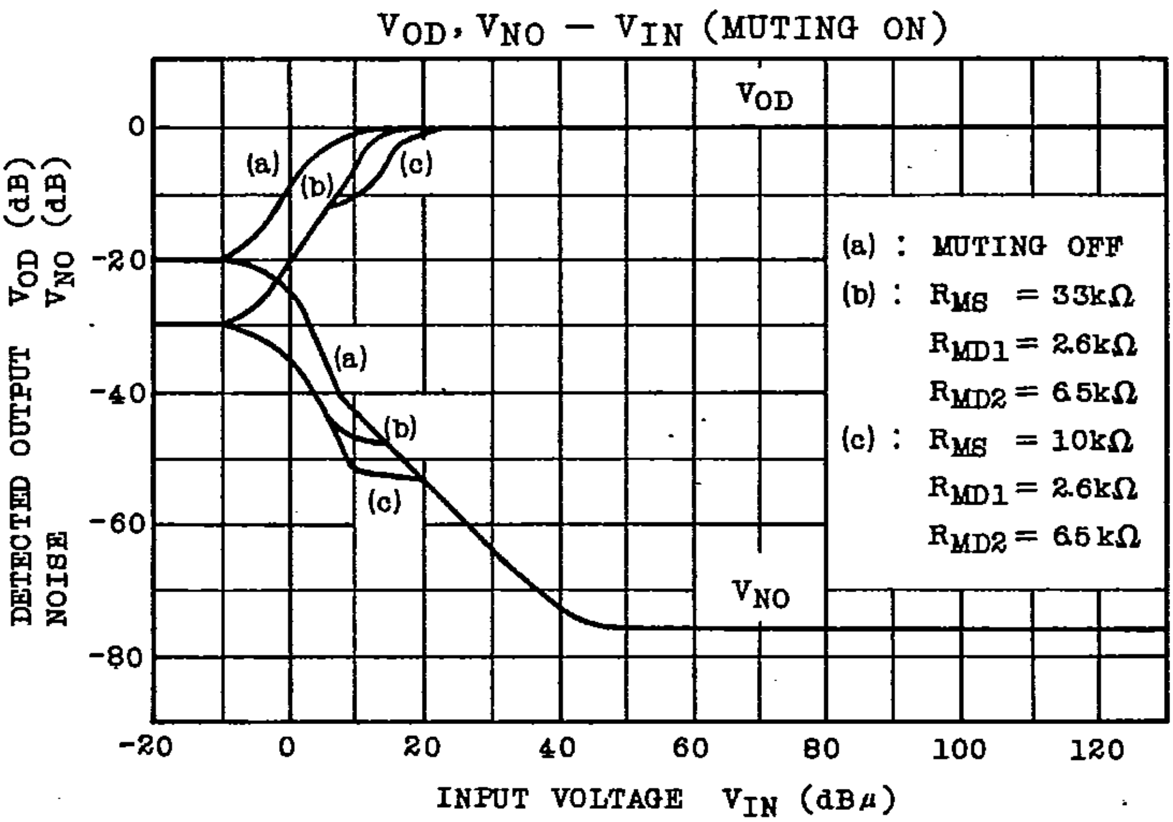

VSS — Ta
STATION DETECTION SENSITIVITY (CONVERTED INTO INPUT) VSS (dBμ)
100
80
60
40
20
0
RSS = 3.3kΩ
10kΩ
51kΩ
-40
-20
0
20
40
60
80
AMBIENT TEMPERATURE Ta (℃)

APPLICATION CIRCUIT 1



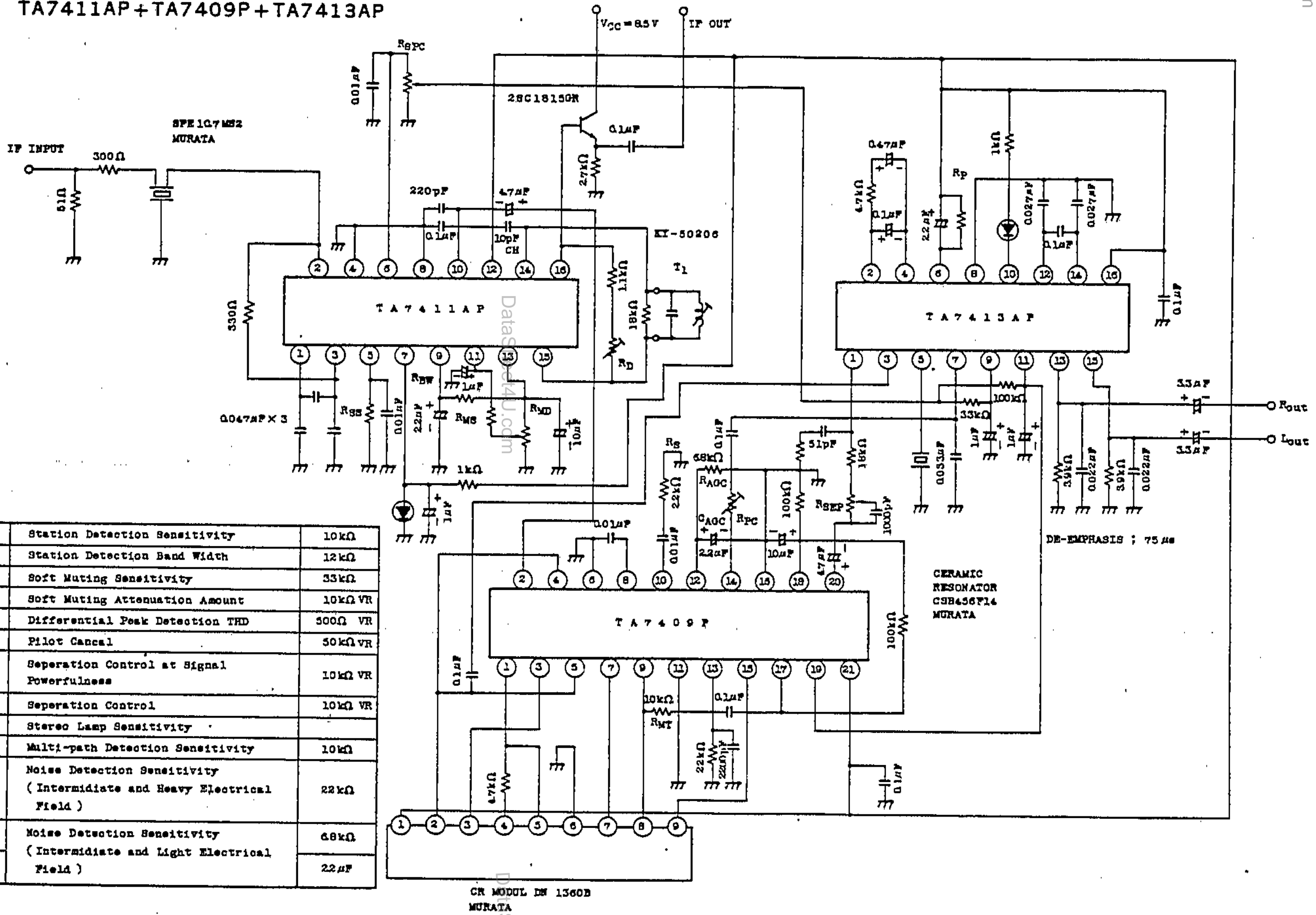


AMR, VOD, THD2, VNO, VSM — VIN
VOD
VSM
THD
AMR
VNO
DETECTED OUTPUT VOD (dB)
AM REJECTION RATIO AMR (dB)
TOTAL HARMONIC DISTORTION 2 THD2 (dB)
NOISE VNO (dB)
SIGNAL METER OUTPUT VSM (V)
INPUT VOLTAGE VIN (dBμ)



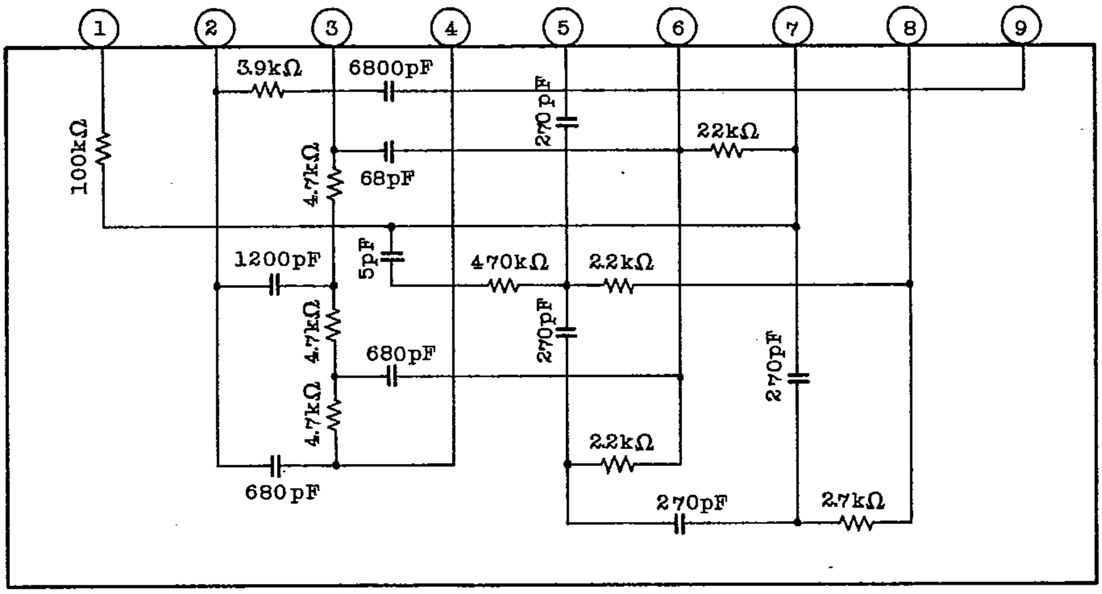
VOD, VNO — VIN (MUTING ON)
VOD
VNO
(a)
(b)
(c)
(a) : MUTING OFF
(b) : RMS = 33kΩ
RMD1 = 2.6kΩ
RMD2 = 6.5kΩ
(c) : RMS = 10kΩ
RMD1 = 2.6kΩ
RMD2 = 6.5kΩ
DETECTED OUTPUT VOD (dB)
NOISE VNO (dB)
INPUT VOLTAGE VIN (dBμ)

APPLICATION CIRCUIT (EXAMPLE)
(High Cut and High Blend Action at the time of Multi-path)
TA7411AP + TA7409P + TA7413AP



R_{SS}	Station Detection Sensitivity	10kΩ
R_{BW}	Station Detection Band Width	12kΩ
R_{MS}	Soft Muting Sensitivity	33kΩ
R_{MD}	Soft Muting Attenuation Amount	10kΩ VR
R_D	Differential Peak Detection THD	500Ω VR
R_{PC}	Pilot Cancel	50kΩ VR
R_{SPC}	Seperation Control at Signal Powerfulness	10kΩ VR
R_{SEP}	Seperation Control	10kΩ VR
R_P	Stereo Lamp Sensitivity	
R_{MT}	Multi-path Detection Sensitivity	10kΩ
R_S	Noise Detection Sensitivity (Intermidiate and Heavy Electrical Field)	22kΩ
R_{AGC}	Noise Detection Sensitivity (Intermidiate and Light Electrical Field)	68kΩ
C_{AGC}		22μF

CR MODULE DN 1360B (MURATA)



DATA OF COILS (TYP.)

COIL No.	STAGE	TEST FREQUENCY (MHz)	L (μH)	C_0 (pF)	Q_0	TURN 1-2	TURN 2-3	TURN 1-3	TURN 4-6	WIRE (mm)	NOTE
T1	DET	10.7		15	85				17	0.08 UEW	KY-50206 Temperature Coefficient of Tuning Frequency $f_{TC}=0\pm60ppm$ MITSUMI