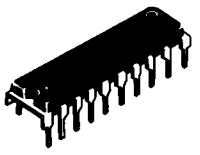
HA11211

FM/AM TUNER SYSTEM

HA11211 is an IC system specially developed for stereos. It is high performance 18 pin IC, integrating all the functions necessary for FM IF and detection by AM IF amplifiers. The following are the functions and features:



(DP-16-2)

FUNCTIONS

FM

- IF Amp.
- Detector Circuit
- Low Noise Audio Amp.
- Signal Meter Circuit
- Center Meter Circuit
- Muting Circuit
- AFC Circuit

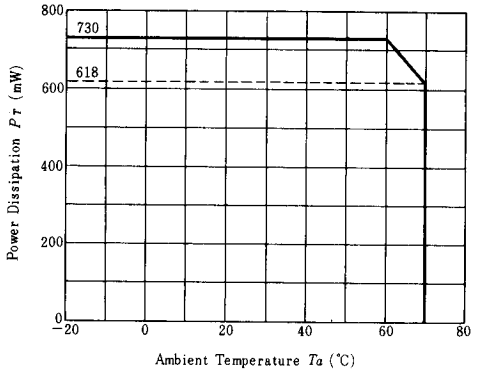
AM

- IF Amp.
- AGC Circuit

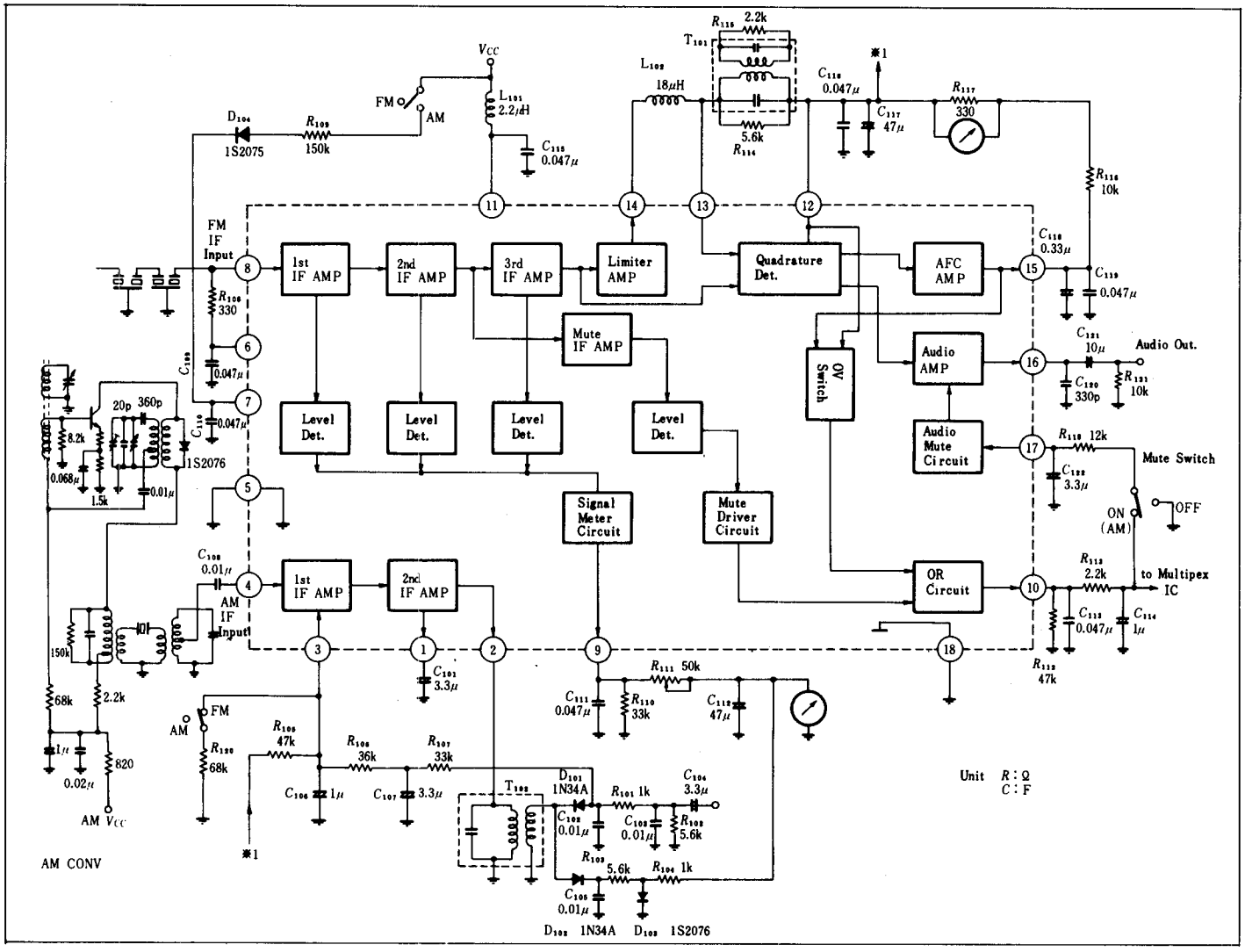
FEATURES

- Labor saving and miniaturization are possible, since the FM IF amplifier detection and AM IF amplifiers are enclosed in the same package.
- FM IF amplifiers have high stability due to the adoption of the full balance three stage direct coupled differential amplifier.
- Utilizes the quadrature detection circuit.
- High sensitivity (Input limiting sensitivity: 15V typ.)
- Large detection output (450 mVrms typ. at 100% modulation)
- Low distortion factor (0.04% typ, when the double tuning detection coil is used.)
- High S/N (79dB typ.)
- Muting circuit which does not produce the unbalance at right or left when detuning. (It is possible to change the band width by the set band width ±65 kHz typ. and resistance value R_{116}.)
- Muting attenuation is large. (80dB typ.)
- AM rejection ratio is good. (55dB at 100dBμ input)
- S/N of AM IF is good. (50dB at 64dBμ input)
- AGC FOM of AM IF is good (48dB)
- Electrodynamic range for the input of the signal meter is large. (43dBμ to 115dBμ typ.)

■ DERATING CURVE



■ BLOCK DIAGRAM AND TYPICAL APPLICATION CIRCUIT



■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Ratings	Unit
Supply Voltage	V_{CC}	13	V
Power Dissipation	P_T*	730	mW
Operating Temperature	T_{opr}	−20 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C

* Value at Ta=60°C

■ ELECTRICAL CHARACTERISTICS (Ta=25°C)

DC CHARACTERISTICS (V_{CC}=12V, Non-signal)

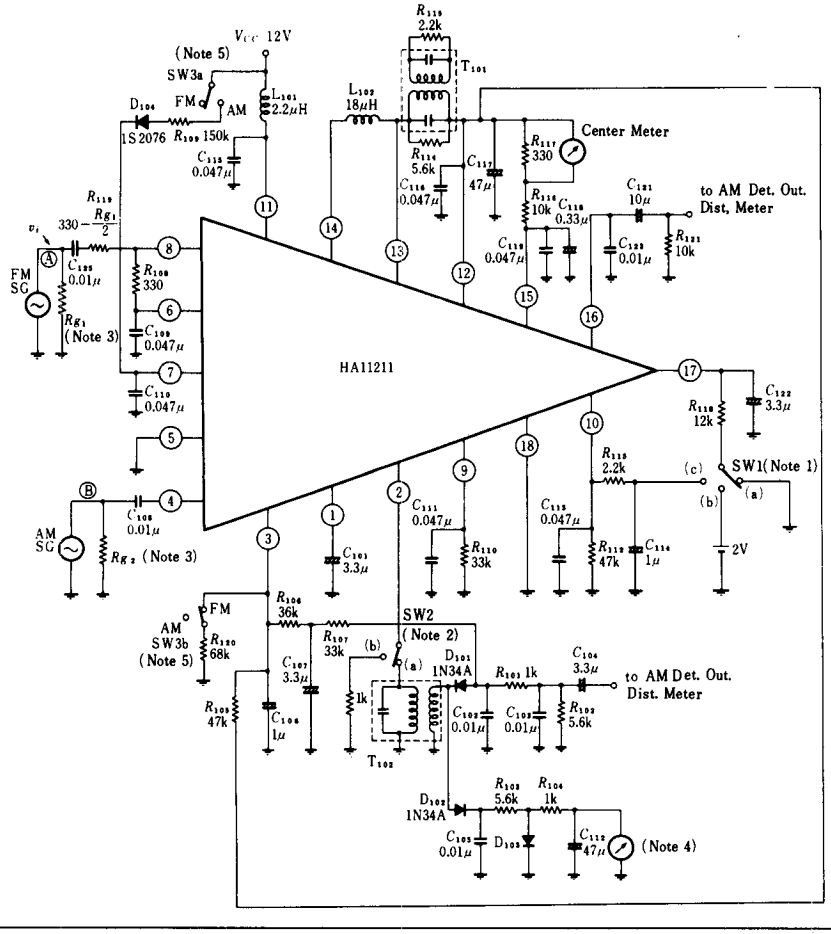
Item	Symbol	Typical Value	Unit
Pin 1 (AM IF Bypass)	V_1	2.7	V
Pin 4 (AM IF Input)	V_4	0.7	V
Pin 6 (FM IF Input DC Feedback)	V_6	1.9	V
Pin 7 (FM IF Input DC Feedback)	V_7	1.9	V
Pin 8 (FM IF Input)	V_8	1.9	V
Pin 10 (Muting Control Voltage)	V_{10}	5.4	V
Pin 12 (Refference)	V_{12}	5.6	V
Pin 15 (AFC)	V_{15}	5.6	V
Pin 16 (Audio Out.)	V_{16}	5.6	V

AC CHARACTERISTICS (Notes 1)

Item		Symbol	Test Condition	min	typ	max	Unit
Total Current Drain		I_{11}	V_{in}=100dBμ, M_{ute} ; ON	—	38.5	56.2	mA
FM	Limiting Sensitivity	$V_{in(lim)}$	V_{in}=-3dB point from output voltage when 100dBμ input	—	31	37	dBμ
	Recovered AF Voltage	$V_{O1(AF)}$		270	450	700	mVrms
	Total Harmonic Distortion	$T.H.D_1$		—	0.04	0.1	%
	Signal-to-noise Ratio	$(S+N/N)_1$		73	79	—	dB
	AM Rej ection Ratio	AMR	V_{in}=100dBμ, FM ; 400Hz, △f=75kHz, AM ; 1kHz m=0.3	—	55	—	dB
	Muting Sensitivity	$V_{in}(M_{ute})$	V_{10}=1.4V	43	48	53	dBμ
	Muting Attenuation	$M_{ute(ATT)}$	V_{17}=2V	73	80	—	dB
	Muting Bandwidth	$BW(M_{ute})$	V_{10}=1.4V (Note 3)	78	130	220	kHz
	Meter Swing	V_{9-70}	V_{in}=70dBμ	0.5	1.8	—	V
		V_{9-100}	V_{in}=100dBμ	3.0	4.4	—	V
AM	Recovered AF Voltage	$V_{O2(AF)}$		55	82	125	mVrms
	Total Harmonic Distortion	$T.H.D_2$		—	0.5	2.0	%
	Signal -to-noise Ratio	$(S+N/N)_2$		44	50	—	dB
	IF AGC Figure of Merit	AGC (FOM)	V_{in}=Voltage difference from 84dBμ input, when 10dB output down	—	48	—	dB
	Input Impedance	R_{in}		—	0.9	—	kΩ

Note : 1. Unless otherwise specified, test conditions are : V_{CC}=12V
FM·····$f_{(IF)}$=10.7MHz, $f_{(mod)}$=400Hz, △f=75kHz and V_{in}=100dBμ
AM·····$f_{(IF)}$=455kHz, $f_{(mod)}$=400Hz, m=0.3 and V_{in}=64dBμ
Test circuit is shown below.
2. Test point of Vin is :
FM·····point A in test circuit, so that the voltage between pin 8 and ground is a half of Vin at point A.
AM·····point B
3. $BW_{(Mute)}$ is tested under sampling of AQL=1.0%

■ TEST CIRCUIT



Notes:
1. SW1 is connected to (b) when measuring MUTE (ATT) and it is connected to (c) when measuring AM characteristics.
2. SW2 is connected to (a) except the case, it is connected to (b) when measuring G of AM.
3. Rg1 and Rg2 are the same resistance value as the output impedance of SG.
4. Meter of 200μA or 1.2kΩ.
5. SW3 is the change-over switch for FM and AM.

GENERAL EXPLANATION OF CIRCUIT CONSTRUCTION AND OPERATIONS

FM section consists of a 3 stage IF amplifier, a limiter, a quadrature detector, audio amplifier, a level detector for signal meter, and IF amplifier for muting, a level detector, a 0V switch and an audio muting ciruit. AM IF section consists of a 2 stage IF amplifier. The operations of each circuit are as explained below.

1. EM OPERATIONS

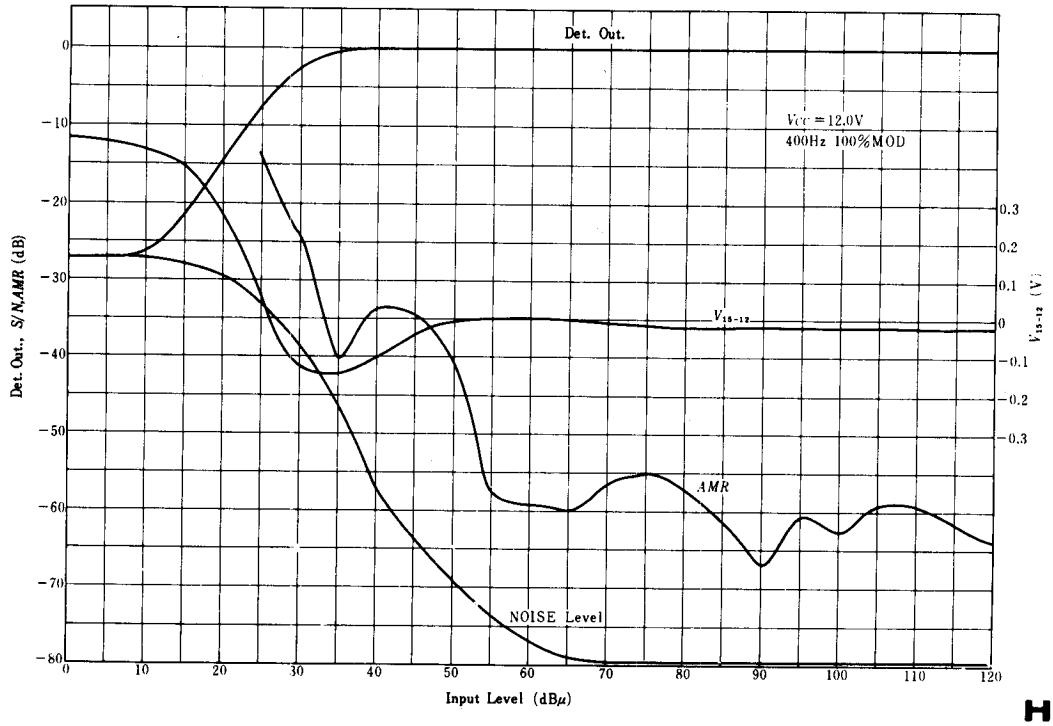
The signal (Intermediate frequency) that has been frequency converted at the front-end is added to pin 8 through the intermediate frequency filter. The signal is amplified by the 1st IF amp, 2nd IF amp and 3rd IF amp that is designed by a full balanced 3 stage direct coupled differential amplifier, and then, it is added to the limeter amp and to the one input of the double balanced type quadrature FM detector circuit. For the other input of quadrature detector circuit, signal is added after shifting the phase of the limiter amp output by the external phase shift circuit (L_{102}, T_{101}). Pin 6 and pin 7 are DC negative feedback terminals from the 3rd IF amp output to the first IF amp output. The quadrature detector circuit output is connected to the audio amp and the AFC amp. Pin 16 is the audio output. The AFC output, namely, S-curve is obtained at the external resistance R between pin 15 and the reference voltage terminal pin 12. Muting is operated by two signals. The one is signed strength which is detected from the output of IF amp and another is band-width signal which is generated by using "S-curve". To obtain the just-tuned point, "Zero voltage" point of the center of the S-curve is detected by "Zero voltage swtich" circuit. And by setting plus and minus threshold voltage on the S-curve, the band-width signed is generated. These two signals are logic-gated by "OR". Consequently, only when signal strength is enough and just tuned, Mute gate passed the recovered audio output. The MUTE IF amp is connected to the second IF amp output to determine the input level for the operations o muting. The MUTE amp output is inputed to the OR circuit through the level detector and mute driving circuit. From there, it is inputed to the "0V switch" circuit. Accordingly, the muting control signal appears on the OR circuit output pin 10, when the input signal is small, and even if the input signal is large, it still appears at detuning time. Pin 10 voltage is added to pin 17 by means of the external attached L.P.F. (R_{113}, C_{114}, R_{118} and C_{122}) and the mute switching circuit. When the DC voltage over $2V_{BE}$ is added to pin 17, the audio mute circuit operates, and pin 16 detection output attenuates to a considerable extent.

The voltage for the signal meter is obtained rectified at the peak detector connected to each of the first IF amp, the second IF amp, and the third IF amp, and is output to pin 9, after being added to the signal meter circuit.

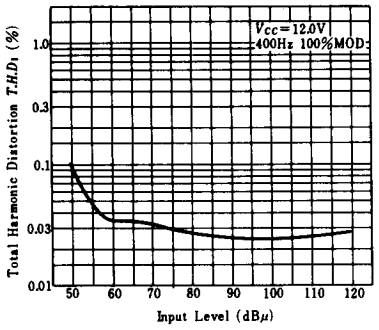
2. AM OPERATIONS

As in the case of AM. the frequency converted intermediate frequency signal is inputed to pin 4. The input signal is amplified by the first and second IF AMP and then outputed to pin 2. The detection transformer (T_{102}) is connected to pin 2, and the detection is made by the external attached detection circuit (D_{101}, C_{102}, R_{101}, C_{103}, and R_{102}). The pin 12 voltage is splited by resistance (R_{105}, R_{106}, R_{107} and D_{101}) for pin 3, and the bias voltage is added to pin 3. This generates detection direct current voltage at pin 1, then, it operates as the AGC terminal. Pin 1 is the by-pass terminal of the intermediate frequency signal. The meter is driven by the rectifier circuit (D_{102} and C_{105}). The general gain of the first and second IF amp is set at 65dB when the load impedance is 1 kΩ.

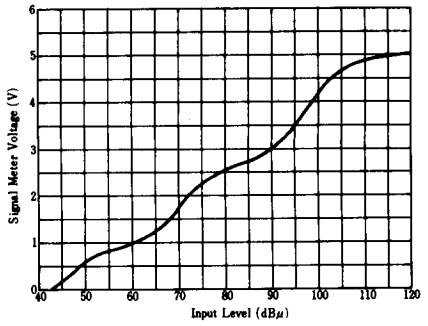
FM CHARACTERISTICS VS. INPUT LEVEL



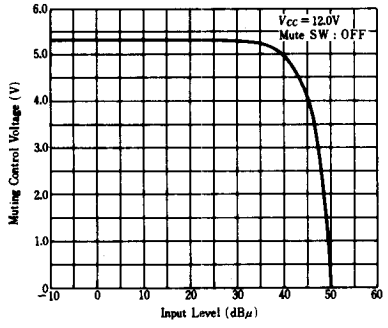
TOTAL HARMONIC DISTORTION VS. INPUT LEVEL (FM)



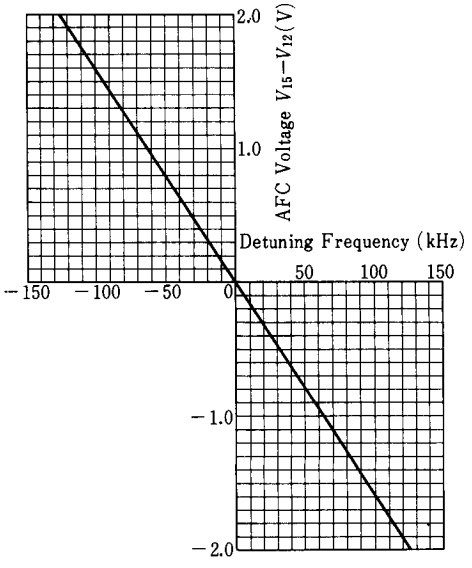
SIGNAL METER VOLTAGE VS. INPUT LEVEL (FM)



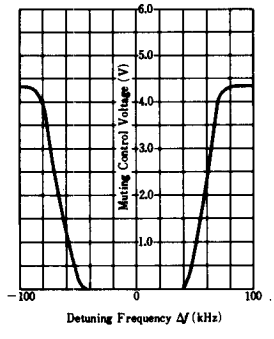
MUTING CONTROL VOLTAGE VS. INPUT LEVEL (FM)



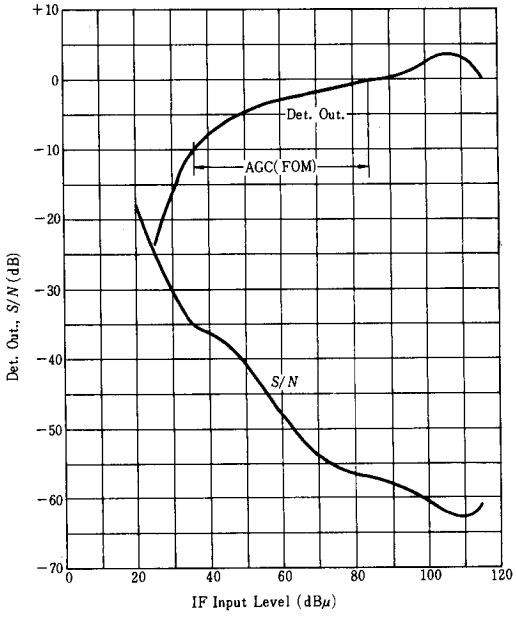
DETUNING FREQUENCY VS. AFC VOLTAGE (FM)



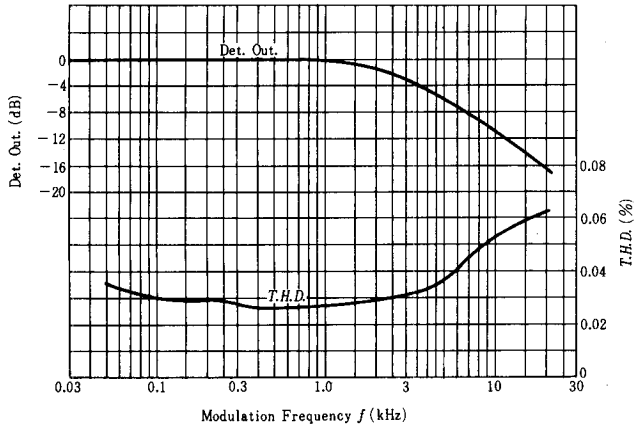
MUTING CONTROL VOLTAGE VS. DETUNING FREQUENCY (FM)



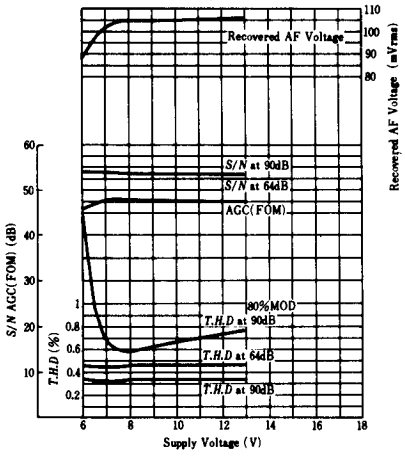
AM CHARACTERISTICS VS. IF INPUT LEVEL



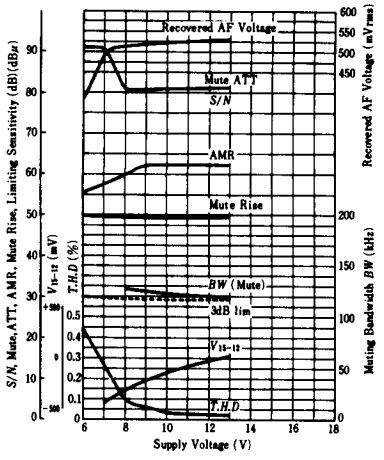
FM CHARACTERISTICS VS. MODULATION FREQUENCY



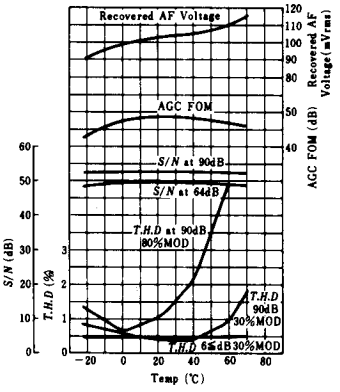
AM CHARACTERISTICS VS. SUPPLY VOLTAGE



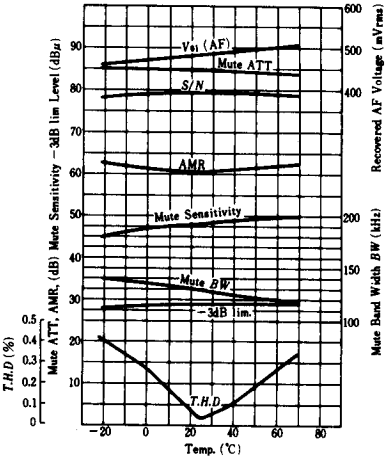
FM CHARACTERISTICS VS. SUPPLY VOLTAGE



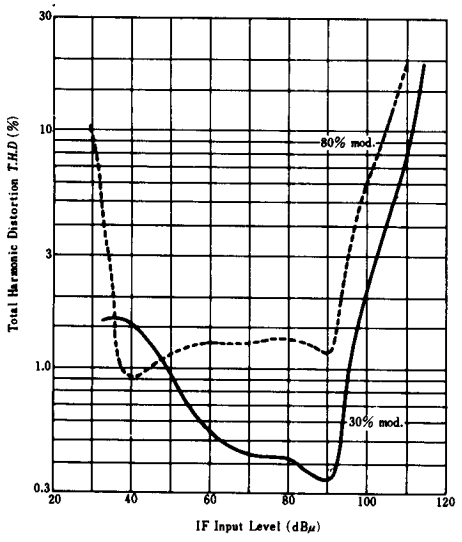
AM CHARACTERISTICS VS. AMBIENT TEMPERATURE



FM CHARACTERISTICS VS. AMBIENT TEMPERATURE



TOTAL HARMONIC DISTORTION VS. IF INPUT LEVEL



■ EXTERNAL COMPONENTS

1. RESISTANCE

Parts No.	Recommended Value (Ω)	Purpose	Influence		Remarks
			Smaller than Recommended Value	Larger than Recommended Value	
R_{101}	1k	Smoothing voltage with C_{103}	Increase in leakage of carrier	Decrease in detection output	
R_{102}	5.6k	Determination of D_{101} bias current	Decrease in output	Deterioration of distortion	
R_{103}	5.6k	Determination of meter current	Deterioration of distortion	——	Necessary to make optimum constant depending upon meter used
R_{104}	1k	Determination of meter current	Deterioration of distortion	——	Same as above
R_{105}	47k	AGC voltage supply to pin 3 bias by R_{106}, R_{107} & D_{101}	Deterioration of AGC response	Quick AGC response	There may be distortion deterioration, high detection output, and low AGC FOM, if the pin voltage is caused to decrease. Moreover, there may be poor distortion, low detection output, and high A C FOM, if pin 3 voltage is caused to rise.
R_{106}	36k	Smoothing AGC voltage with AGC bias voltage supply & C_{106}	Quick AGC response	Deterioration of AGC response	
R_{107}	33k	Smoothing AGC voltage with AGC bias voltage supply & C_{107}	Quick AGC response	Deterioration of AGC response	
R_{108}	330	Intermediate freq filter matching with impedance	——	——	
R_{109}	150k	At the time of AM, operation points of FM IF AMP slip to lower gain	——	S/N deterioration of AM	
R_{110}	33k	Pin 9 load resistance	Large consumption of current	——	
R_{111}	50k	Determination of meter current	——	——	Semi-fixed resistor is utilized for meter current adjustment.
R_{112}	47k	Stabilization of pin 10 voltage			These are used for preventing chattering of pin 12 as with C_{113} and C_{114} voltage. Please use recommended value
R_{113}	2.2k	Smoothing of muting control voltage with C_{114}	Small time constant	Large time constant	
R_{114}	5.6k	Determination of detection output by load impedance of detection coil	Decrease in detection output	Detection output increase, but distortion factor band width is poor	
R_{115}	2.2k	Determination of distortion factor	Deterioration of distortion factor	Deterioration of distortion factor	
R_{116}	10k	Determination of AFC voltage size and muting band range	Smaller AFC voltage, broader muting band width	Larger AFC voltage, narrower muting band width	Since R_{116} and C_{118} constitute the low pass filter, in case of a change in R_{116}, C_{118} must change to ensure $C_{116} \times C_{118}$= constant.
R_{117}	330	Bypass resistance to regulate sensitivity of center meter	Slower center meter sensitivity	Better center meter sensitivity	
R_{118}	12k	Smoothing of muting control voltage with C_{121}	Smaller time constant	Larger time constant	Influence by popping noise at time of muting ON/OFF.
R_{119}	$330-\frac{Rg_1}{2}$	Matching of impedance	——	——	Rg_1 has the same value as output impedance of FM SG
R_{120}	68k	Decrease in gain of AM IF AMP at time of FM	——	Poor AMR at time FM strong input	
R_{121}	10k	Determination of detection output size	Smaller detection output	Larger detection output	For impedance, when looking to next stage from pin 16, it is better to produce over 30kΩ to reduce the detection output dispersion.

2. CONDENSERS, COILS AND DIODES

Parts No.	Recommended Value (μF)	Purpose	Influence		Remarks
			Smaller than Recommended Value	Larger than Recommended Value	
C_{101}	3.3	Bypass condenser	Decrease in AM IF voltage gain	——	Pin 1 IC resistance is 220Ω Typ Chemical (Breakdown>6.3V)
C_{102}	0.01	Smooth condenser (of detector)	Deterioration of distortion	——	MYL Condenser

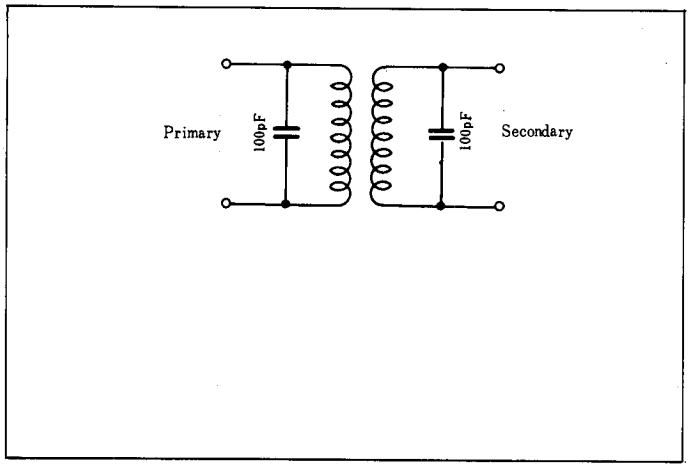
(to be continued)

2. CONDENSER, COIL AND DIODES

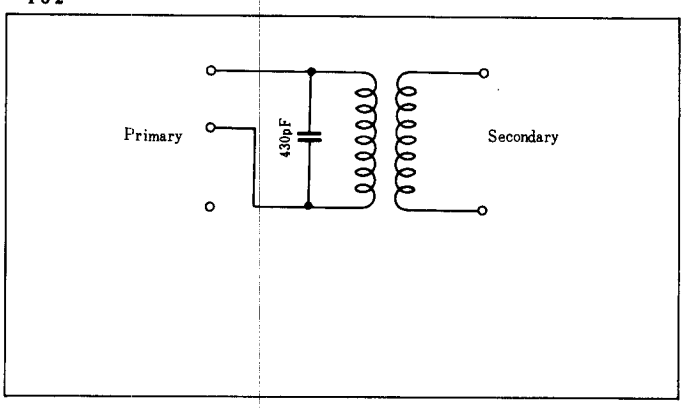
Parts No.	Recommended Value (μF)	Purpose	Influence		Remarks
			Smaller than Recommended Value	Larger than Recommended Value	
C_{103}	0.01	Determination of cutoff frequency of low pass filter with R_{101}	Deterioration of S/N, Distortion	——	MYL Condenser
C_{104}	3.3	Detection output coupling condenser	——	——	Chemical Condenser
C_{105}	0.01	Charge condenser of meter voltage	——	——	
C_{106}	1	Smoothing of AGC voltage with R_{106}	Poorer distortion in lower limit	Deterioration of AGC response	Chemical Condenser (Breakdown > 6.3V)
C_{107}	3.3	Smoothing of AGC voltage with R_{107}	Poorer distortion in lower limit	Deterioration of AGC response	Chemical Condenser (Breakdown > 6.3V)
C_{108}	0.01	Coupling of AM input signal	Smaller pin 4 input	——	Pin 4 input resistance is 900Ω TYP. MYL Condenser
C_{109}	0.047	Bypass condenser	Deterioration of FM IF oscillation stability	——	Please use good quality condensers with high freq. characteristcs.
C_{110}	0.047	By-pass condenser	Same as above	——	Same as above
C_{111}	0.047	By-pass condenser	Poor distortion at and around meter rise	——	Since a bad influence is exerted on the weak electric field S/N dip. AMR, etc., be careful of pattern position.
C_{112}	47	Smoothing of meter voltage with R_{111}	Quicker meter response	Slower muting response	Chemical Condenser (Breakdown > 6.3V)
C_{113}	0.047	By-pass condenser	——	——	Refer to position on pattern chart.
C_{114}	1	Smoothing of muting control voltage with R_{113}	Mis-operations of muting for prevention of a decrease of the alternating current that is included in muting control voltage	Slower muting response	
C_{115}	0.047	Decoupling, decoupling condenser with R_{101}, (application of high freq. characteristics)	Smaller decoupling effect	——	Please lower the position of GND like the pattern to around GND power source
C_{116}	0.047	By-pass condenser (High frequency)	——	——	Use both C_{116} and C_{117}.
C_{117}	47	By-pass condenser (Low frequency)	Deterioration of AM S/N	——	Use both C_{118} and C_{119} Chemical Condenser (Breakdown > 12V)
C_{118}	0.33	Smoothing of AFC voltage	Includes alternating current in AFC voltage (mis-operations of muting)	Slower response of AFC voltage	
C_{119}	0.047	By-pass condenser (High frequency)	——	——	Same as above
C_{120}	330p	By-pass condenser	Since high freq·pass of output pin 16 canges, it is necessary to pay attention to oscillation, etc.	——	Same as C_{123}. For development of f characteristics without removing deemphasis characteristic.
C_{121}	10	Detection output coupling condenser	Low limit is cut	——	
C_{122}	3.3	Smoothing of muting control voltage with R_{118}	Alternating current that is included in muting control voltage does not drop	Slower response of muting	
C_{123}	0.01	By-pass condenser	Slip from deemphasis characteristics	Slip from deemphasis characteristics	Provide deemphasis characteristics with pin 16 output impedance. Same as C_{120}
C_{125}	0.01	Input coupling condenser	——	——	
L_{101}	2.2μH	Decoupling of power source with C_{115}	——	——	Use a good one with high freq. characteristics. Necessary to pay attention to oscillation stability characteristics.
L_{102}	18μH	Detection phase shift coil	Normal detection characteristics are not obtained.		
D_{101}	IN34A	AM detection	——	——	
D_{102}	IN34A	Meter detection	——	——	
D_{103}	IS2076	Meter voltage control	——	——	
D_{104}	IS2076	AM changeover	——	——	

3. TRANS

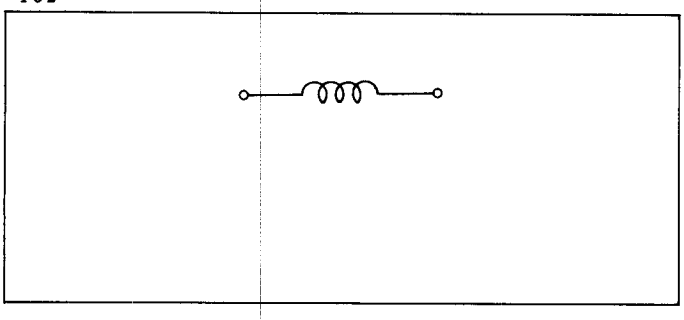
T_{101}



T_{102}



L_{102}



■ **PC-BOARD LAYOUT PATTERN (Bottom View)**