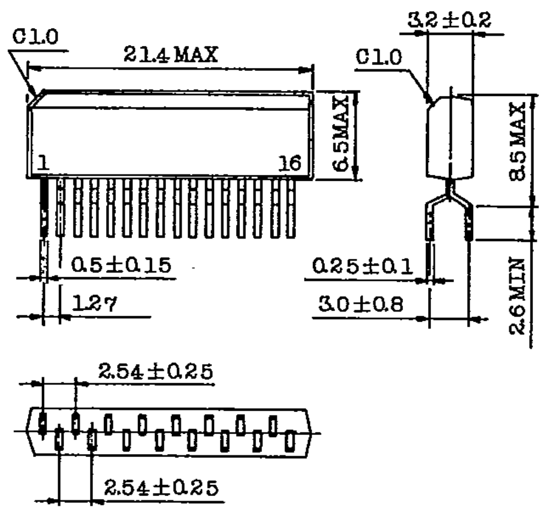
PLL FM STEREO MULTIPLEX

TA7413AP, IC for PLL FM stereo multiplex, is provided with the anti-noise and the pilot cancel functions and with the non-adjusting VCO.

- Separation control (SPC)
- High cut control (HCC)
- High blend control (HBC)
- Pilot cancel
- VCO stop
- Forced monaural
- Non-adjusting type VCO
- Since separation control (SPC) and high cut control (HCC) are independent to each other, high blend control (HBC) can be realized.
- Through using this IC and noise-canceller IC TA7409P in pair, multi-path noise can be reduced.
- Through this pair usage, bad influence caused by pilot signal can be reduced. (beat distortion etc.)
- Low distortion ratio. THD=0.02% monaural at $V_i$=400m$V_{rms}$ (Typ.)
- Wide operating power supply voltage range : $V_{opr}$=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

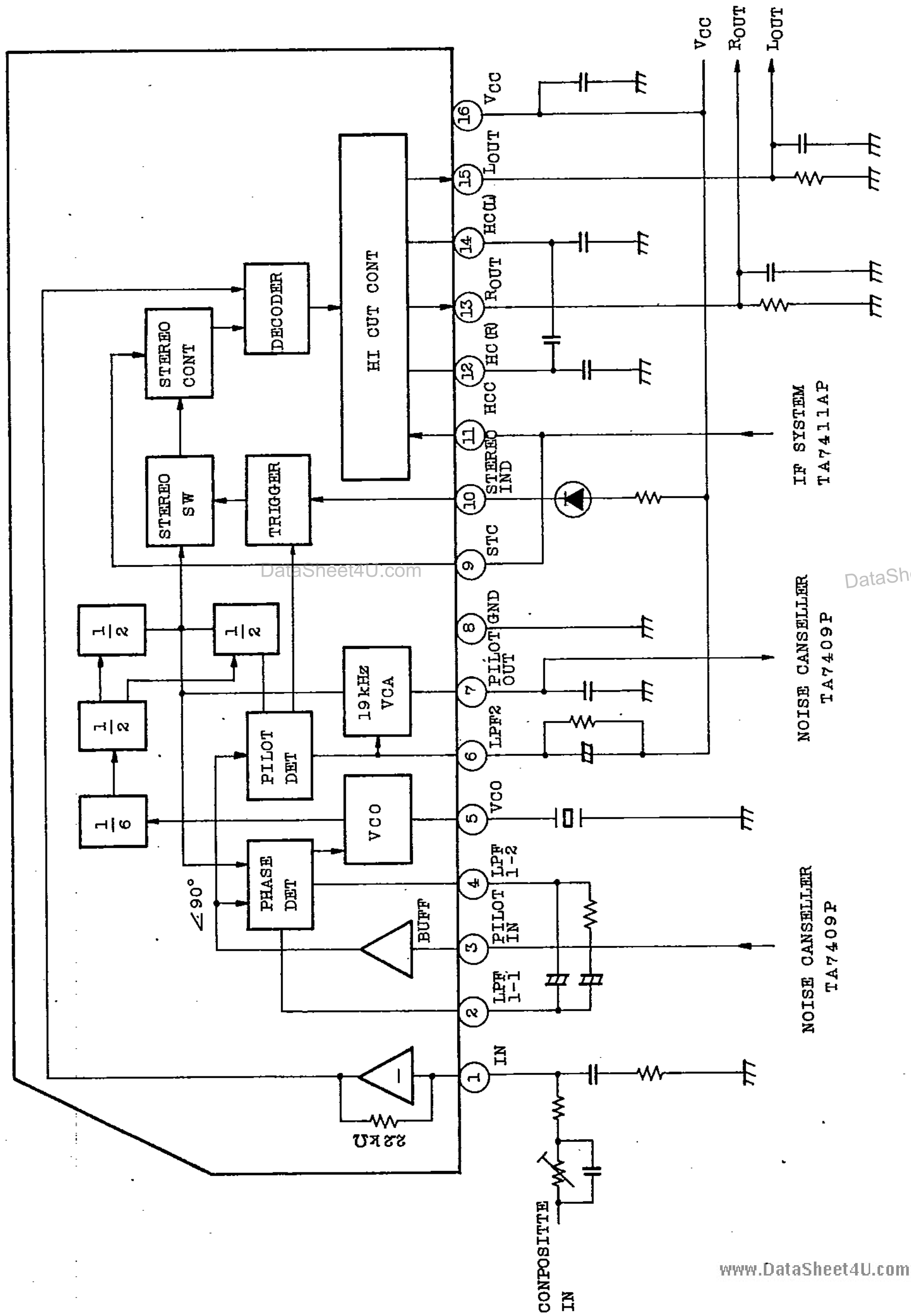


MAXIMUM RATINGS (Ta=25°C)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 16 | V |
| Power Dissipation (Note) | $P_D$ | 750 | mW |
| Operating Temperature | Topr | -30~85 | °C |
| Storage Temperature | Tstg | -55~150 | °C |
| Stereo Lamp Driving Current | $I_L$ max | 30 | mA |

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

BLOCK DIAGRAM



## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, $V_{CC}$=8V, $V_i$(mono)=400m$V_{rms}$, $f_m$=1kHz, $V_{SPC}$=2.4V, $V_{HCC}$=1.5V Lout monitor, SW1=off, SW2=a, SW3=a, Ta=25°C)

| CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|---|
| Quiescent Supply Current | $I_{CCQ}$ | | $V_i$=0 | | – | 13.5 | 21 | mA |
| ③ Pin Input Resistance | $R_{in}$ | | | | – | 33 | – | kΩ |
| Allowable Monaural Input | $V_i$(mono) max | | THD=1% | | – | 900 | – | m$V_{rms}$ |
| Allowable Composite Input | $V_i$(stereo) max | | $\frac{L+R}{P}$ = 9 | | 700 | 900 | – | m$V_{rms}$ |
| Separation | Sep1 | | Lonly mode. SW3=a→b Ronly mode. SW3=b→a | $f_m$=100Hz | – | 40 | – | dB |
| | Sep2 | | | $f_m$=1kHz | 25 | 50 | – | dB |
| | Sep3 | | | $f_m$=10kHz | – | 37 | – | dB |
| Stereo Distortion | THD1 | | L+R=360m$V_{rms}$ P=40m$V_{rms}$ | $f_m$=100Hz | – | 0.07 | – | % |
| | THD2 | | | $f_m$=1kHz | – | 0.06 | 0.2 | % |
| | THD3 | | | $f_m$=10kHz | – | 0.6 | – | % |
| Monaural Distortion | THD(mono) | | | | – | 0.02 | – | % |
| Voltage Gain | Gv | | | | -3 | -1.5 | 0 | dB |
| Channel Balance | C.B | | SW3=a→b | | -1.5 | 0 | 1.5 | dB |
| S/N at Stereo | S/N(stereo) | | L+R=360m$V_{rms}$, P=40m$V_{rms}$ | | – | 83 | – | dB |
| SPC Attenuation Amount | S·ATT1 | | L-R=360m$V_{rms}$ P=40m$V_{rms}$ | $V_{SPC}$=1.3V | -7 | -4.5 | -2 | dB |
| | S·ATT2 | | | $V_{SPC}$=0.3V | – | -55 | -30 | dB |
| HCC Attenuation Amount | H·ATT1 | | $f_m$=10kHz | $V_{HCC}$=0.7V | -6 | -3.5 | -1 | dB |
| | H·ATT2 | | | $V_{HCC}$=0.3V | -14 | -11 | -7.5 | dB |
| Pilot Cancel Amount | P·ATT | | | | – | 20 | – | dB |
| Lamp Sensitivity | $V_L$(on) | | Put-on | | – | 17.5 | 23 | m$V_{rms}$ |
| | $V_L$(off) | | Put-off | | 8 | 13 | – | m$V_{rms}$ |
| VCO Stop Voltage | $V_{STP}$ | | V6 voltage when ⑦ pin 19kHz output is annihilated | | – | 8.5 | – | V |
| SCA Rejection Ratio | $SCA_{rej}$ | | | | – | 75 | – | dB |
| Carrier Leak | CL | | L+R=360m$V_{rms}$ P=40m$V_{rms}$ SWb=1 | f=19kHz | – | 43 | – | dB |
| | | | | f=38kHz | – | 75 | – | dB |
| Stereo Lamp Current | $I_{Lamp}$ | | | | – | 1 | – | mA |

CLASSIFICATION OF PILOT OUTPUT $V_P$ (lamp sensitivity $V_L$(on), $V_L$(off)

| RANK | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $V_P$ (mVrms) | 32~44 | 40~52 | 48~60 | 56~68 |
| Color | Red | Yellow | Green | Orange |

Condition

P=40mVrms

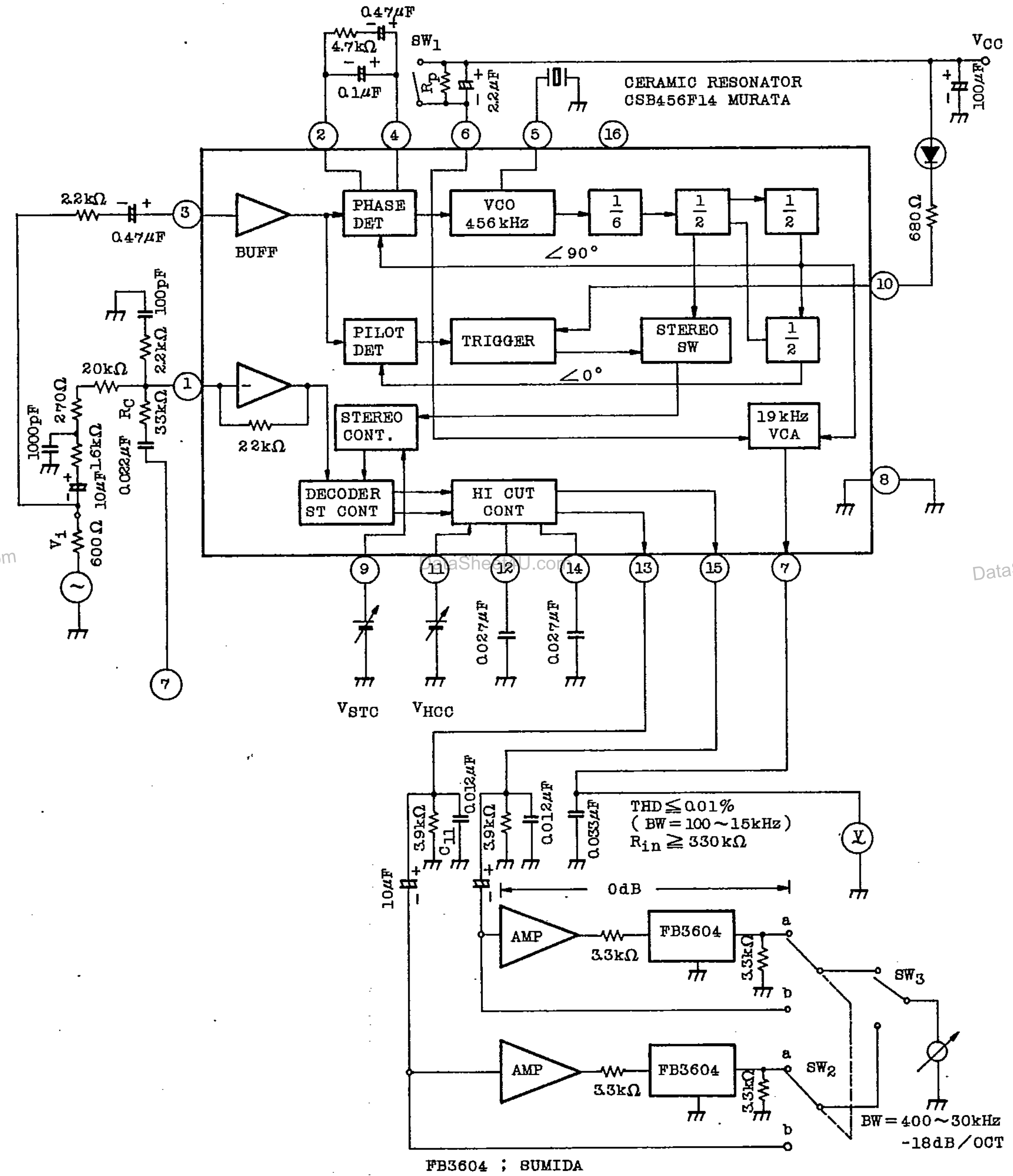
Rp=560kΩ

TERMINAL VOLTAGE AT NO SIGNAL

($V_{CC}$=8.5V, Ta=25°C, Typical value at the test circuit)

| PIN No. | TERMINAL | VOLTAGE (V) |
|---|---|---|
| 1 | In | 2.65 |
| 2 | LPF1-1 | 7.8 |
| 3 | Pilot in | 3.35 |
| 4 | LPF1-2 | 7.8 |
| 5 | VCO | 5.4 |
| 6 | LPF 2 | 8.2 |
| 7 | Pilot out | 3.4 |
| 8 | GND | 0 |
| 9 | STC | 7.0 |
| 10 | Stereo Ind | - |
| 11 | HCC | 7.0 |
| 12 | HC(R) | 3.4 |
| 13 | Rout | 4.3 |
| 14 | HC(L) | 3.4 |
| 15 | Lout | 4.3 |
| 16 | $V_{CC}$ | 8.5 |

## TEST CIRCUIT



BUILT-IN FUNCTION

1. Method for Forcible Monaural at Stereo Reception

In TA7413AP, in addition to the function of switching the stereo and the monaural receptions according to the existence of the pilot signal, the stereo reception can forcibly be switched to the monaural reception with the three kinds of methods shown in table 1.

Table 1.

| No. | METHODE FOR FORCIBLE MONAURAL | LAMP | PILOT CANCEL | VCO | REFERENCE |
|---|---|---|---|---|---|
| 1 | 6 Pin $V_{CC}$ | × | × | × | AM |
| 2 | 10 Pin OPEN | × | ○ | ○ | ST-MONO SW |
| 3 | 9 Pin GND | ○ | ○ | ○ | |

No.1 is effective for using the high cut control of TA7413AP at AM reception and the connection is made as shown in Fig. 1.
Since 1 pin is an input terminal of the operational amplifier, the impedance is low and AM characteristics is little influenced even if AM input is connected.
No.2 is applicable for changing over the stereo and the monaural receptions at FM reception through the panel switch.



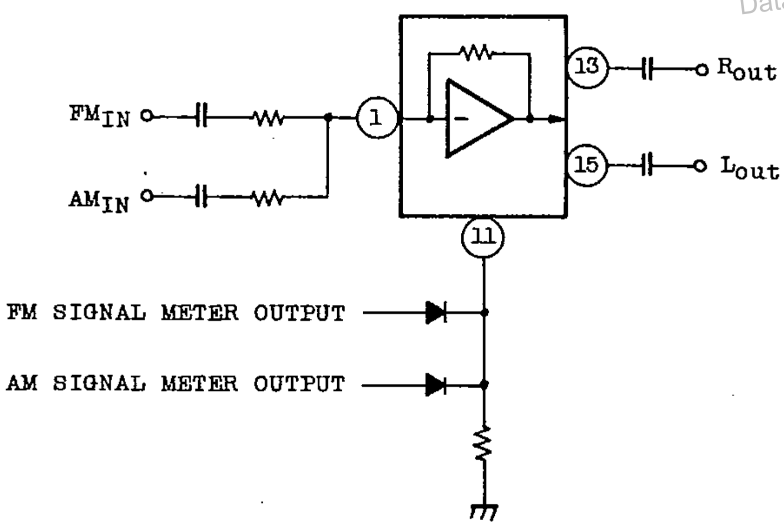



Fig. 1

2. SPC (Separation control)

For SPC, the circuit which gradually controls the 38kHz amplitude to be used in separation circuit is adopted.

The relation between the control voltage and the separation is different from the conventional one.

As shown in Fig. 2, in the range of 0~20dB of the separation which is effective for the noise reduction, the curve is slow and in the range of 20~50dB, the curve is made sharp and when the separation becomes about 20dB, SPC is made to rapidly grow effective. Therefore, the noise is effectively reduced without sacrificing the separation.

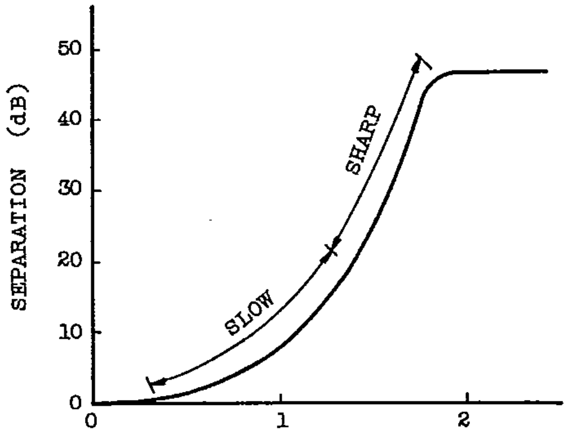



Fig. 2

3. HCC (High Cut Control)

In TA7413AP, composite signal is separated into L and R outputs and HCC is carried out independently on each outputs.

Therefore, this system has following advantages as compared with the conventional system.

(1) Since SPC and HCC can independently be controlled, flexible setting is possible regarding the separation depended on the destination and the frequency characteristics.

(2) Even when HCC is carried out with SPC released the effect of noise reduction can be obtained.

In the conventional system, HCC is applied only to (L+R), and the

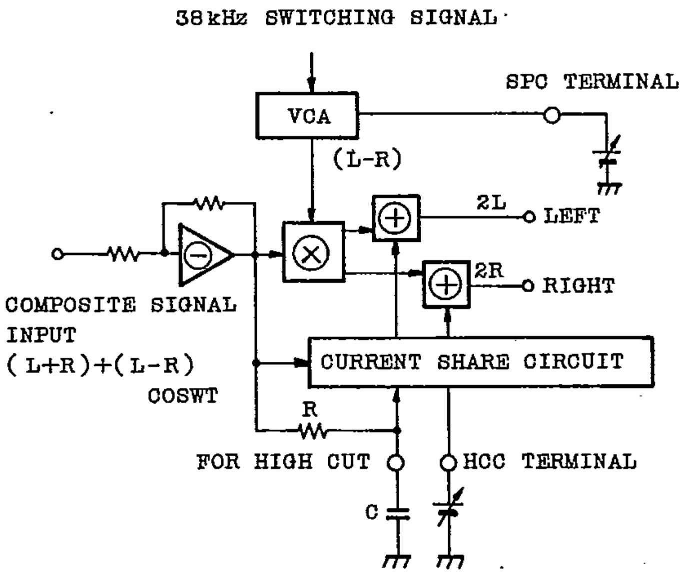



Fig. 5 BLOCK DIAGRAM OF CONVENTIONAL SYSTEM

output of (L-R) modulation circuit is output unchanged, therefore, when HCC is applied, although the treble is attenuated, the reduction effect of the noise produced by (L-R) demodulation can not be expected.

Since the phases in the mean and treble signals in (L+R) delay according to HCC, the separation of the mean and treble is inevitable deteriorated.

For the cut-off frequency of HCC, refer to the item of HBC described later.

4. HBC (High blend control)

By means of connecting the capacitor CHB between HC (High cut) terminals of 12 and 14 pins as shown in Fig.6 to control HCC terminal with DC voltage $V_{HCC}$ such as the signal meter output, HBC is made possible. The signal high-blended with CHB and the fundamental L and R signals are individually input to the current share circuit, and which signal is to be output is determined by $V_{HCC}$.

The cut-off frequency of HCC is obtained through the formula below.

$$f_C = \frac{1}{2\pi CR} \text{ (Hz)}$$

C: CHC
R: 2.2kΩ(Typ.)

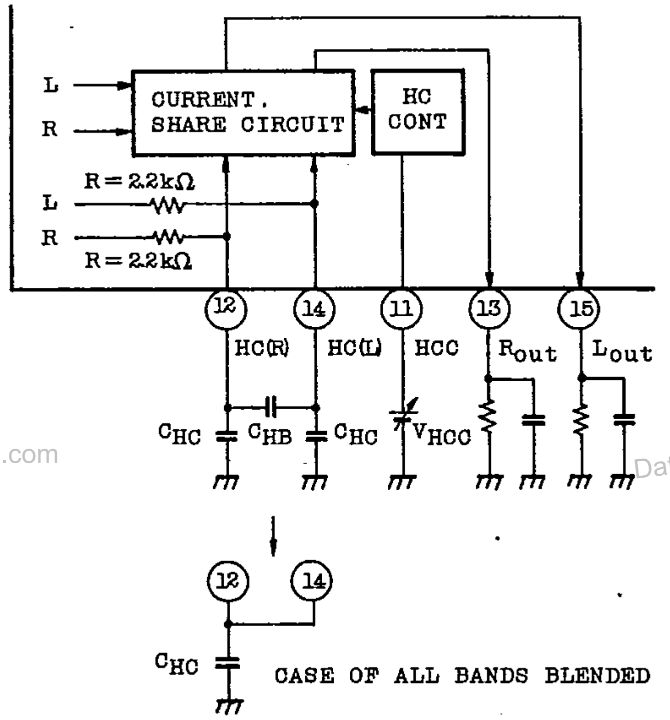



Fig. 6 PRINCIPLE DIAGRAM OF HBC

The cut-off frequency of HBC is determined by the following formula.

$$f_C = \frac{1}{4\pi CR} \text{ (Hz)}$$

C: CHB
R: 2.2kΩ(Typ.)

For blending all bands, short CHB as shown in Fig.6, and for additional high cut, CHC can be reduced to one piece.

In this case, the internal resistance becomes 1.1kΩ(Typ.) and $f_C$ is determined by the following formula. For making $f_C$ equal to that in case of HCC described above, CHC is necessary to be doubled.

$$f_C = \frac{1}{2\pi CR} \text{ (Hz)}$$

C: CHC
R: 1.1kΩ(Typ.)

## 5. Pilot Cancel

For pilot cancel, the triangular wave (pilot output $V_P$), which is made through integrating the current output of the square wave at 7 pin, is connected to input 1 pin with the resistance $R_C$.
This pilot output $V_P$ is obtained in proportion to the input pilot level, and the classification of rank 1~4 to the absolute values of amplitude is made as shown in table 2.

Table 2

| RANK CLASSIFICATION | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Rp | ∞ | 1MΩ | 560kΩ | 390kΩ |

When Rp in the table is connected between 6 and 16 pins according to each rank, the pilot output Vp of about 48~60mV$_{rms}$ is obtained for the pilot signal of 40mV$_{rms}$. The pilot cancel amount in the electric characteristics shows the value when the appropriate Rp is added.
Since this pilot output Vp is the input pilot level following type, when the cancel is once set with $R_C$, the enough pilot cancel amount is obtained even if the modulation degree is varied at the broadcasting station.
For using with FM noise canceller IC TA7409P, make connection as shown in Fig.7.

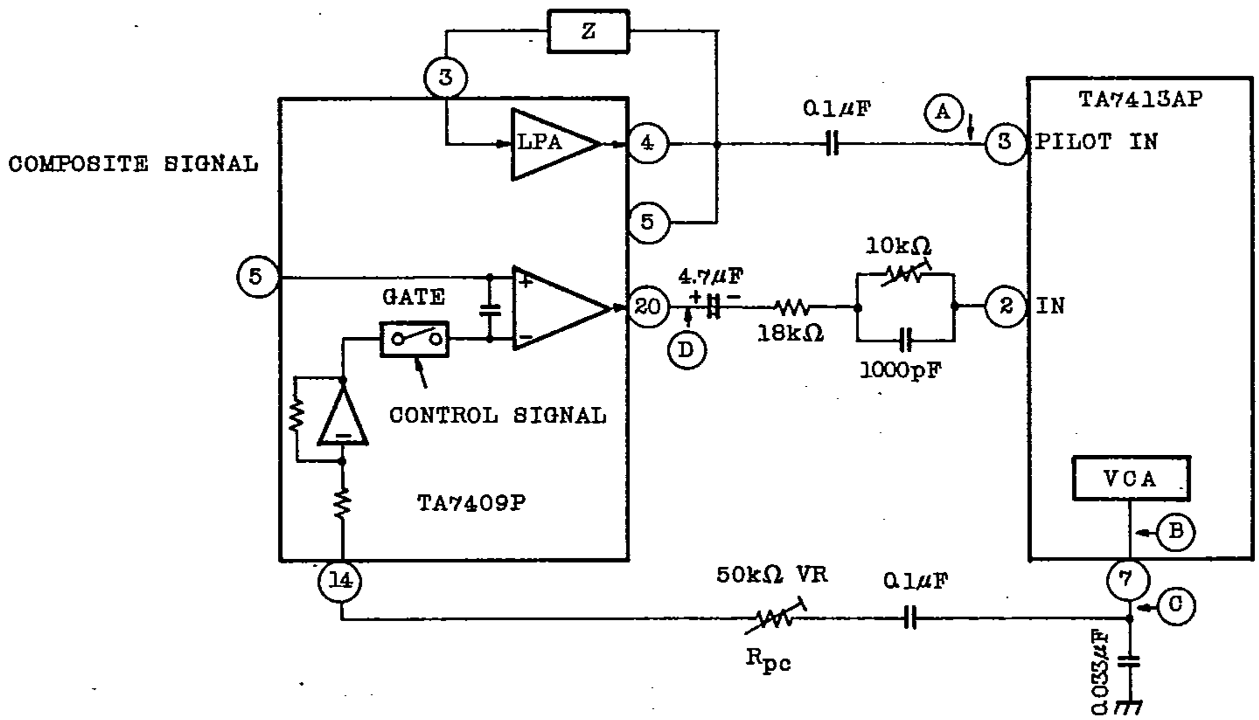



Fig. 7

WAVEFORM OF EACH PART (Pilot modulation only)

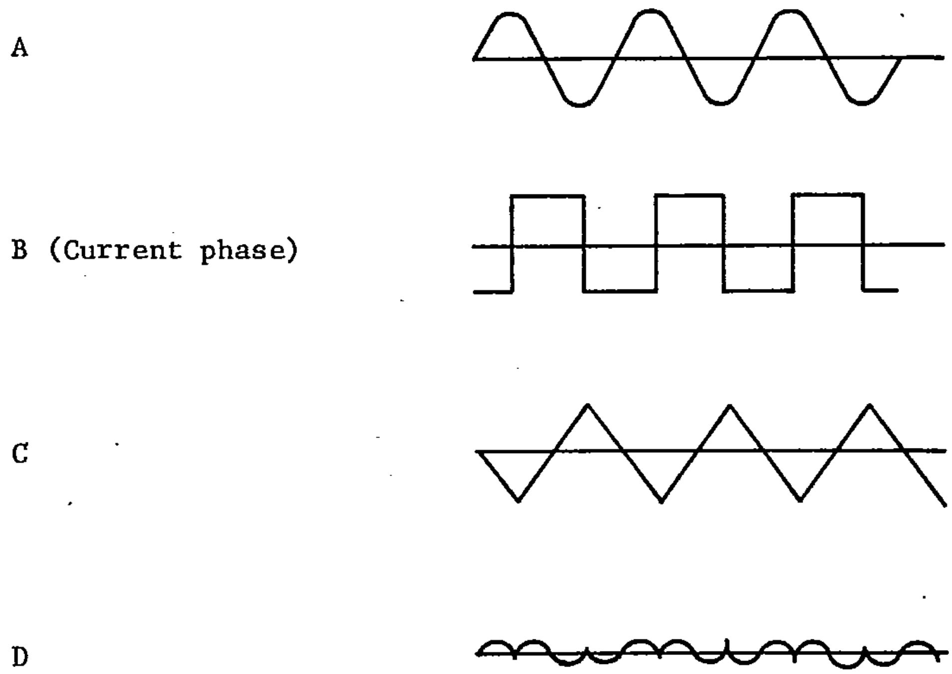





Fig. 8

OPERATION DESCRIPTION

When the pilot signal is input to 3 pin, the triangular wave (pilot output $V_P$), of which phase is delayed by about 180°, is output to 7 pin.
When this triangular wave is input to 14 pin of TA7409P, the pilot signal is cancelled by the internal differential amplifier and only the residual component is output from 20 pin.

ADJUSTING METHOD

Perform adjustment so that TA7409P 20 pin output is made minimum with $R_{PC}$ at the modulation only of the pilot signal. For the correct adjustment, carry out adjustment so as to make the residual components equal and minimum with $L_{OUT}$ and $R_{OUT}$ of TA7413AP.

6. Lamp Sensitivity

The lamp sensitivity is inversely proportional to the amplitude of the triangular wave. The lamp sensitivity in the electric characteristics shows the value when the external Rp is added according to Table 2. For increasing the lamp sensitivity, for example, set rank 2→Rp =∞, rank 3→Rp =1MΩ or rank 4→Rp=560kΩ, and the ON and OFF sensitivity of each lamp shows the value smaller than that of the standard by about 5mV. At this time, since triangular wave becomes about 56~68$mV_{rms}$, change the $R_C$ value to 36kΩ(Typ.)

7. Separation Adjustment

TA7413AP is designed for using with IC for noise canceller in pair.
To obtain the optimum separation, adjust with phase compensating circuit provided to the input.

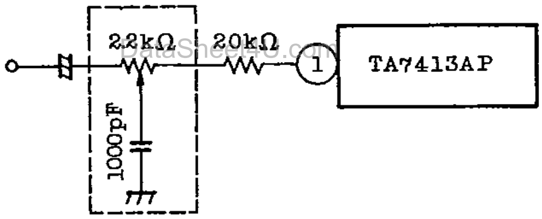
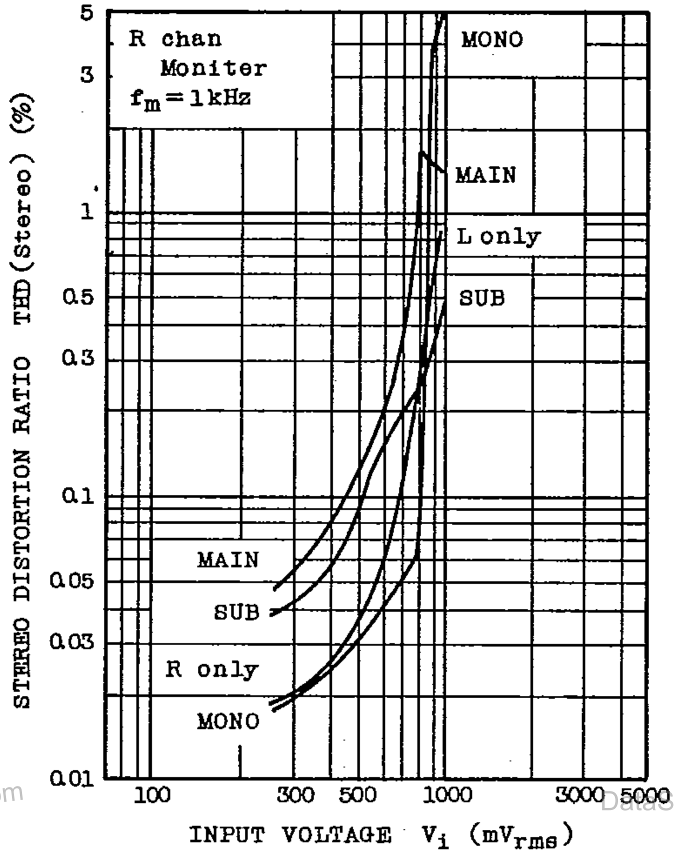
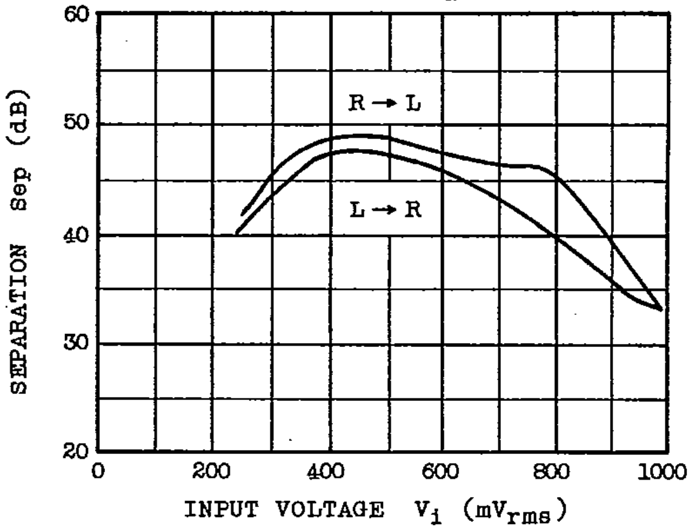



Fig. 9 PHASE COMPENSATING CIRCUIT

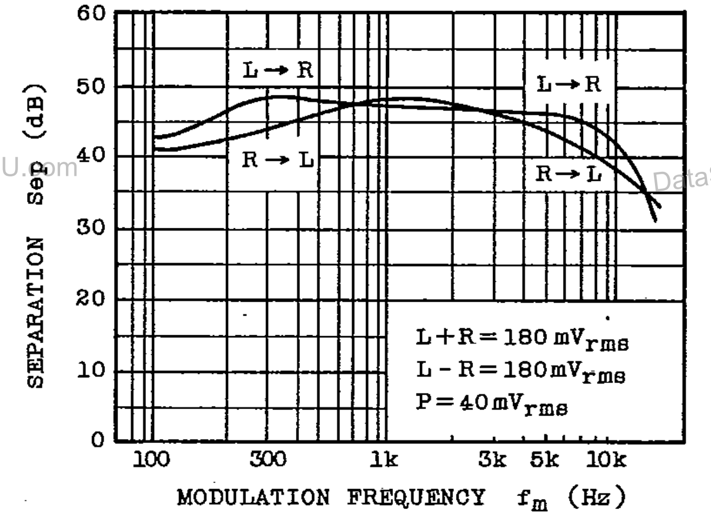
THD (Stereo) — $V_i$



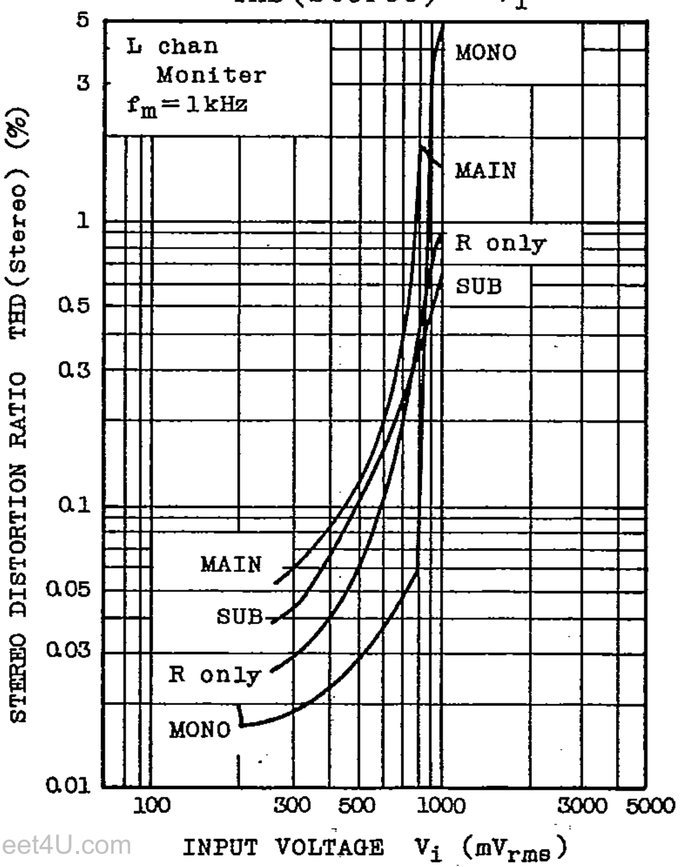

Sep — $V_i$



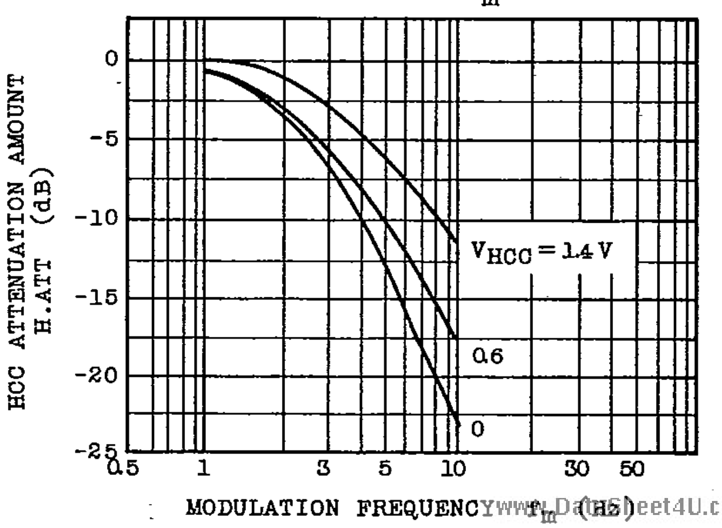

Sep — $f_m$

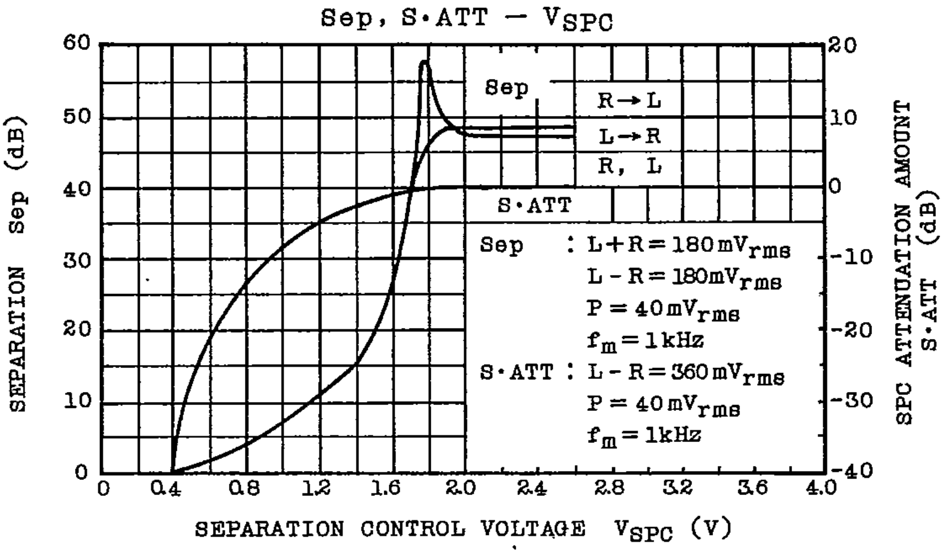


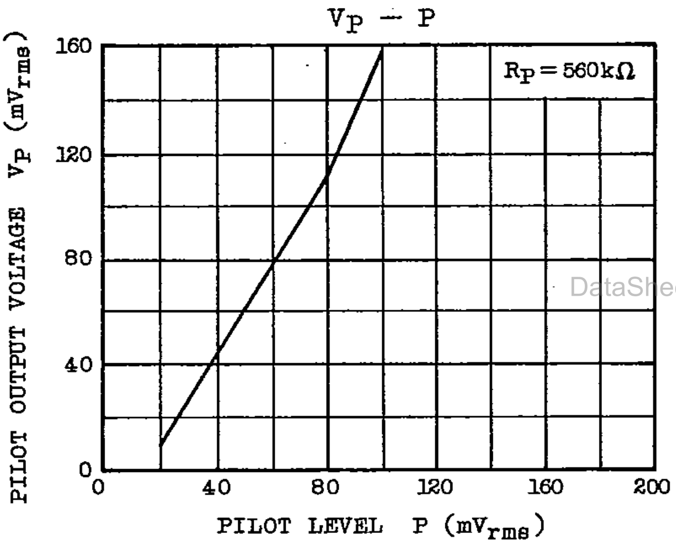

THD (Stereo) — $V_i$

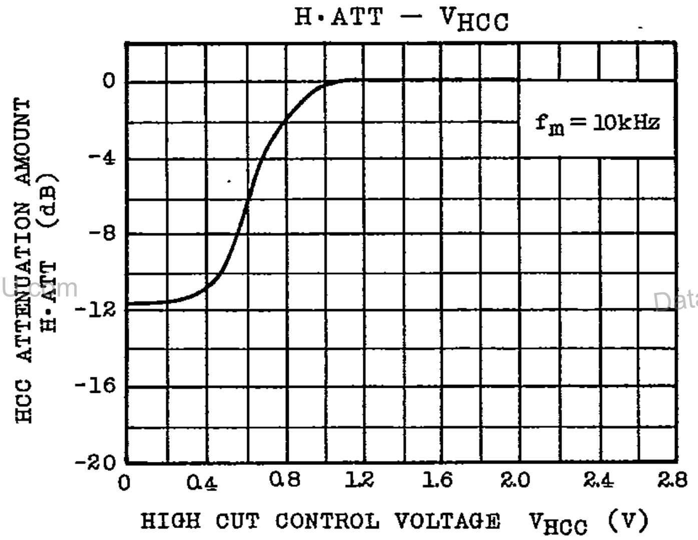


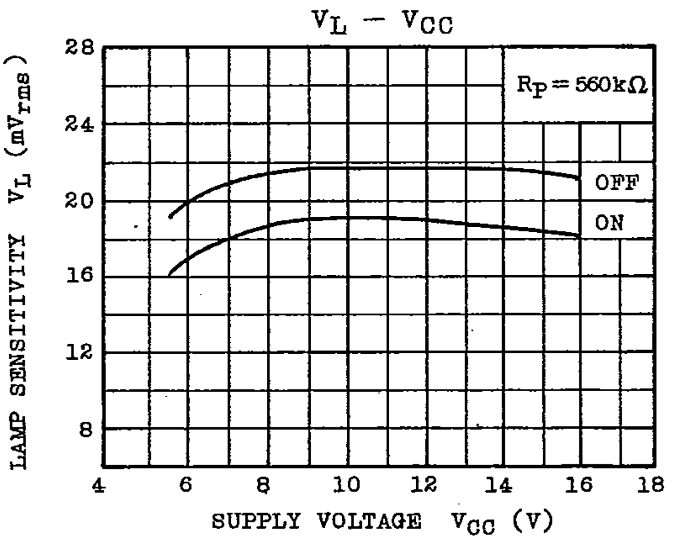

H·ATT — $f_m$

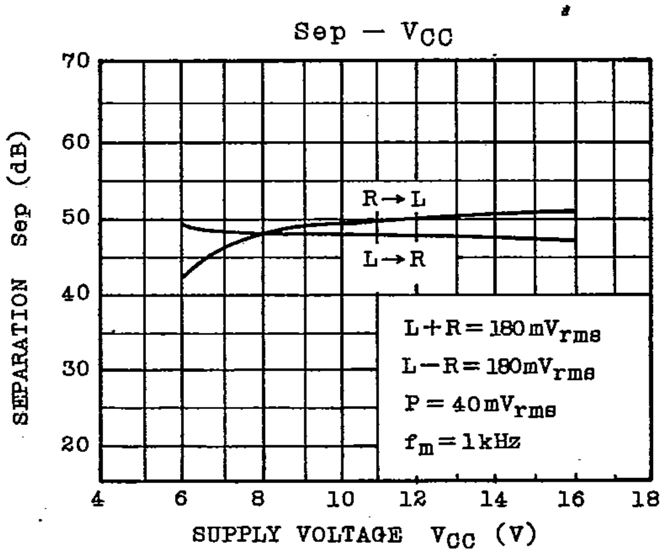



Sep, S·ATT — V_SPC
SEPARATION Sep (dB)
SPC ATTENUATION AMOUNT S·ATT (dB)
Sep
R→L
L→R
R, L
S·ATT
Sep : L+R = 180mVrms
L - R = 180mVrms
P = 40mVrms
fm = 1kHz
S·ATT : L - R = 360mVrms
P = 40mVrms
fm = 1kHz
SEPARATION CONTROL VOLTAGE V_SPC (V)

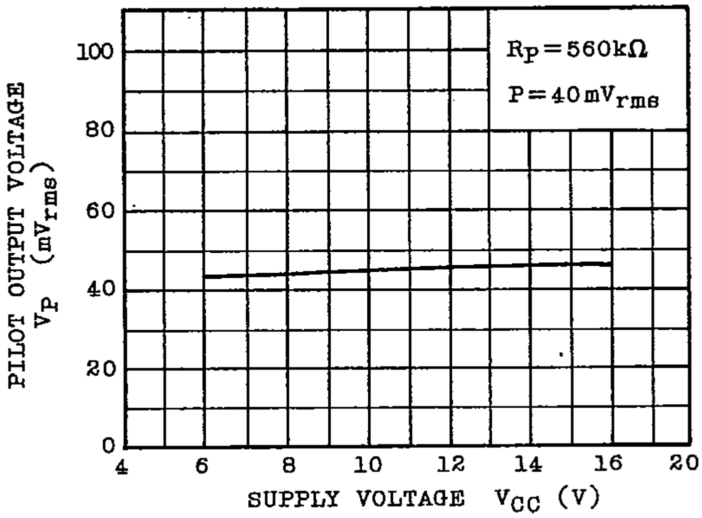

V_P — P
PILOT OUTPUT VOLTAGE V_P (mVrms)
Rp = 560kΩ
PILOT LEVEL P (mVrms)


H·ATT — V_HCC
HCC ATTENUATION AMOUNT H·ATT (dB)
fm = 10kHz
HIGH CUT CONTROL VOLTAGE V_HCC (V)

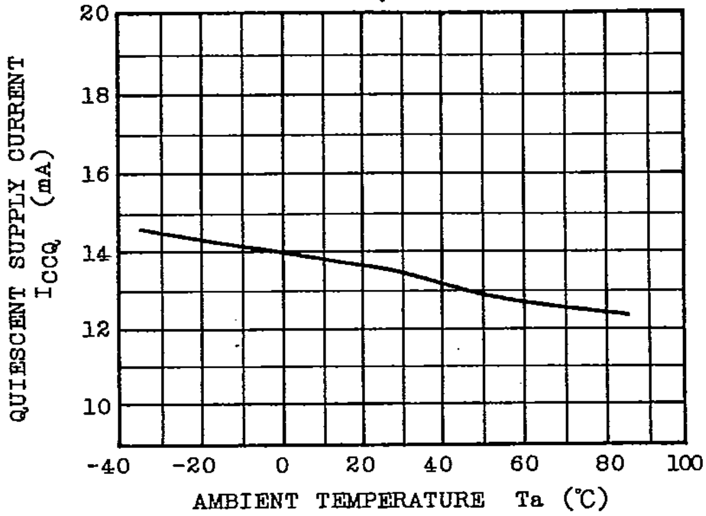

V_L — V_CC
LAMP SENSITIVITY V_L (mVrms)
Rp = 560kΩ
OFF
ON
SUPPLY VOLTAGE V_CC (V)


Sep — V_CC
SEPARATION Sep (dB)
R→L
L→R
L+R = 180mVrms
L−R = 180mVrms
P = 40mVrms
fm = 1kHz
SUPPLY VOLTAGE V_CC (V)

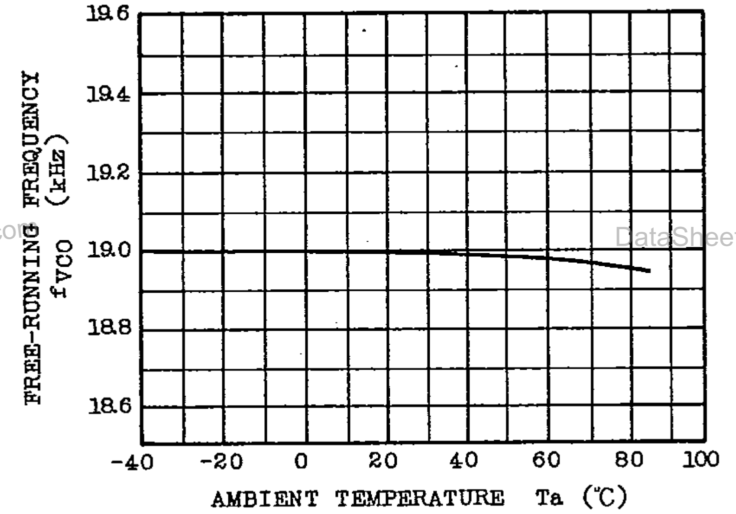
$V_P - V_{CC}$



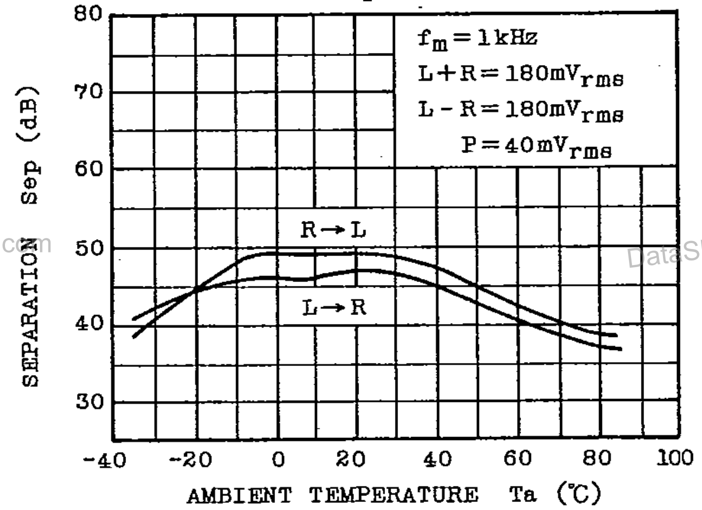

$I_{CCQ} - Ta$



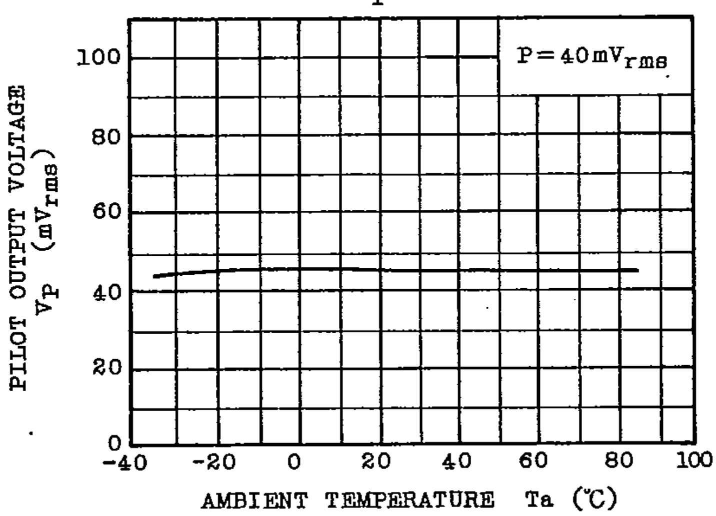

$f_{VCO} - Ta$



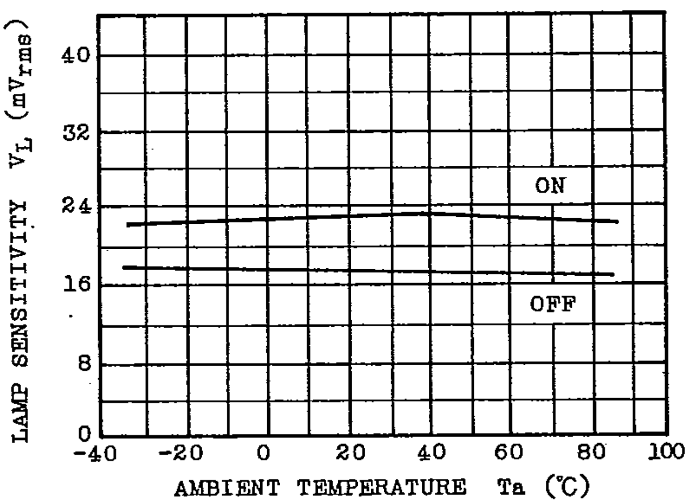

Sep — Ta




$V_P - Ta$



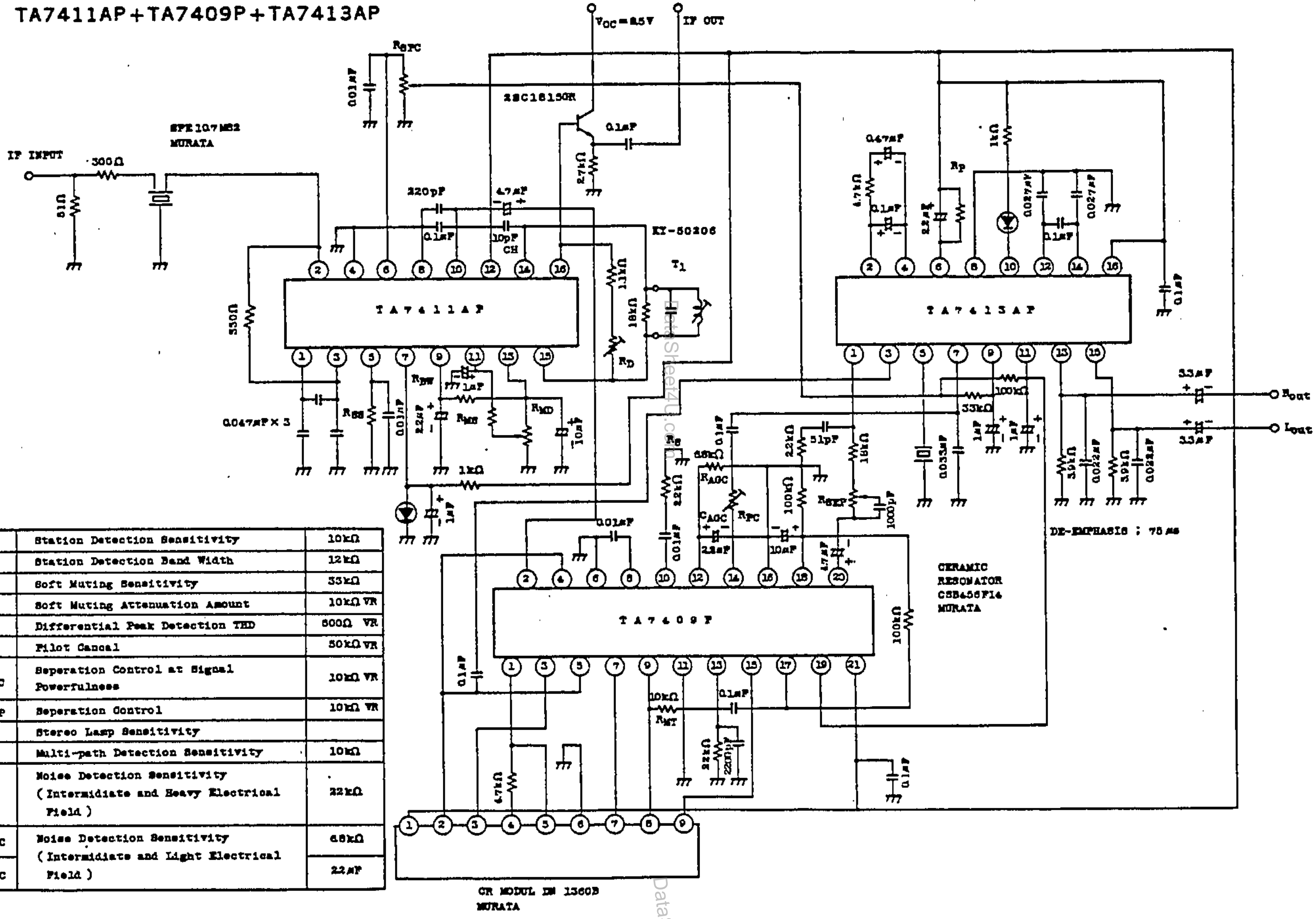

$V_L - Ta$



## APPLICATION CIRCUIT (EXAMPLE)

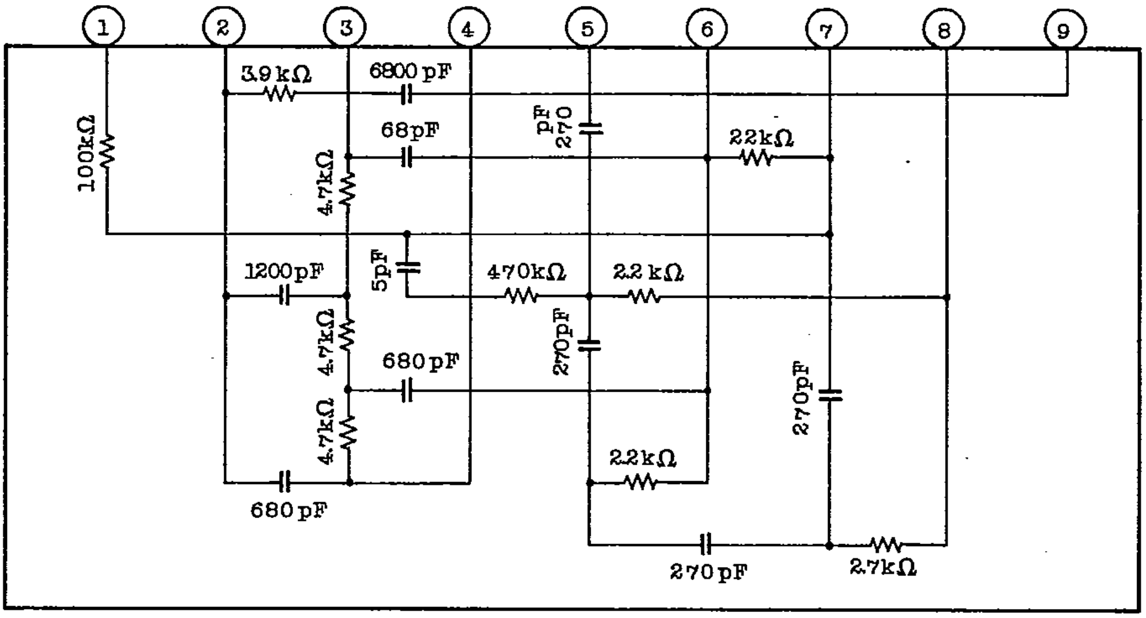
(High Cut and High Blend Action at the time of Multi-path)

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 FREQ. (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±60ppm MITSUMI |