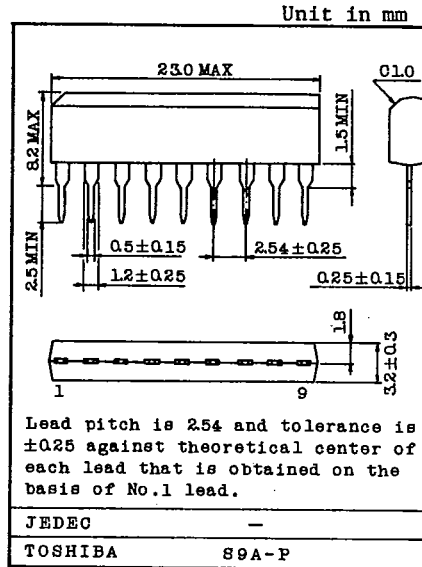


TA7324P

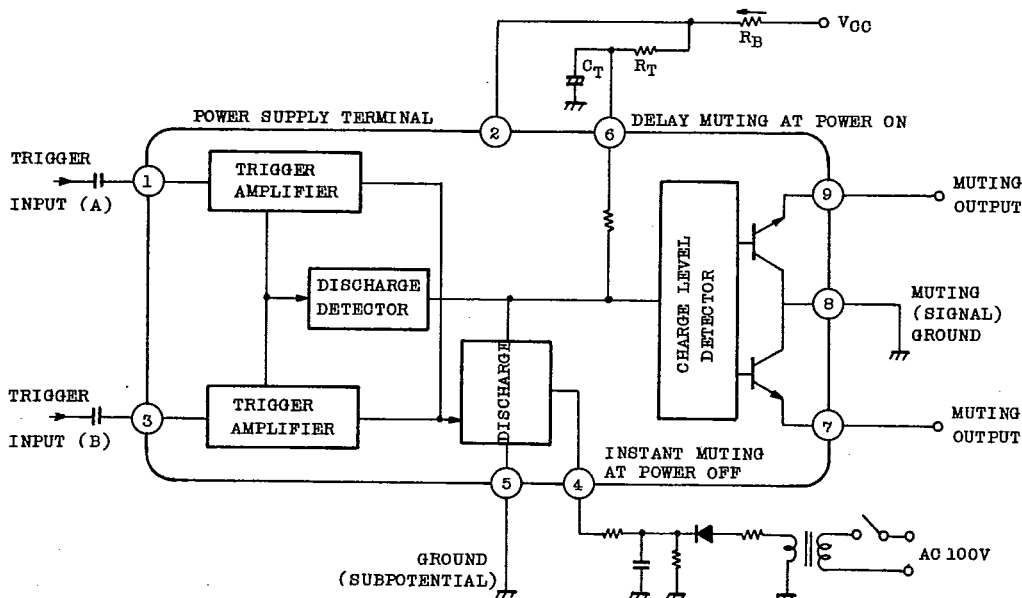
MUTING IC

TA7324P is developed for muting the popping sound made at power of one-off receivers, pre-amplifiers, main amplifiers, and other electric audio equipment as well as the noise made at changeover of switches.

- To mute the popping noise made in the case of receiving frequency or changeover of signal source of tuners.
- Delay muting at power ON.
- Instant muting at power OFF.
- Only a single timing capacitor and a very few external parts are provided.
- Either positive or negative pulse is applicable to the input trigger. The terminals consist of the high sensitive input terminal (sensitive level of 120mV) and the low sensitive input terminal (sensitive level of ±700mV)
- The operating power supply current is 5mA (Min.) available for portable sets.



BLOCK DIAGRAM



TOSHIBA

TA7324P

MAXIMUM RATINGS (Ta=25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage (V ₂₋₅) (Note1)	V ₂₋₅	3.4	V
Supply Current (I ₂) (Note2)	I ₂	20	mA
Power Dissipation (Note 3)	P _D	500	mW
Operating Temperature	T _{opr}	-20 ~ 75	°C
Storage Temperature	T _{stg}	-55 ~ 150	°C

Note 1. In case of constant voltage source.

Note 2. In case of constant current source.

Note 3. Derated above Ta=25°C in the proportion of 4mW/°C

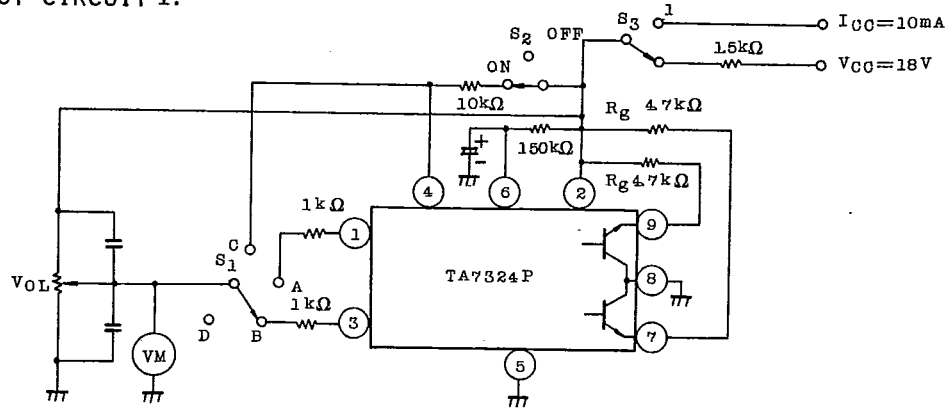
The input voltage at the trigger terminal is GND-V_{BE} (≅0.7V) < input voltage < V₂₋₅+V_{BE}.
When trigger terminals A and B are applied, must be set the operating supply current value from 5mA to 15mA.

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=18V, R_B=1.5kΩ)

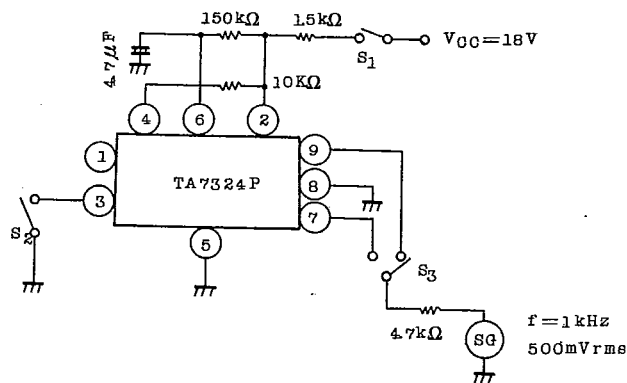
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Terminal Voltage	V ₂₋₅	1	Note 4 I _{CC} =20mA (CONST)	3.4	3.6	3.8	V
Trigger Sensitivity(A) V ₁	±TRIGA	1	Note 6	±0.5	±0.7	±0.9	V
Trigger Sencitivity(B) V ₃	±TRIGB	1	Note 7	±0.09	±0.12	±0.15	V
Trigger Sensitivity(A) I ₁	±(I TRIG-A)	1	Note 6	-	±20	±60	uA
Trigger Sensitivity(B) I ₃	±(I TRIG-B)	1	Note 7	-	±10	±30	uA
Detecting sensitivity at power OFF V ₄	V ₄ OFF	1	Note 8	-	0.75	1.0	V
Detecting current at power OFF	I ₄ OFF	1	Note 8	-	6	-	uA
Output Saturation Voltage at muting ON V ₇ , V ₉	V _{CE} (sat)	-	Note 9	-	18	40	mV
Max. Sink Current I ₇ , I ₉	I _{max}	-		1.4	1.6	-	mA
Terminal Voltage (Pin 1)	V ₁	1	Note 5	-	1.5	-	V
Terminal Voltage (Pin 2)	V ₂			3.2	3.5	3.6	V
Terminal Voltage (Pin 3)	V ₃				1.4	-	V
Terminal Voltage (Pin 6)				Muting OFF	2.6	2.7	2.8
Muting Attenuation	ATT	2	Note 10	45	50		dB
Muting Time at Power ON	M.T			-	1.8	-	sec

TA7324P

TEST CIRCUIT 1.



TEST CIRCUIT 2.



Note 4) Supply terminal Voltage (V₂₋₅)

$S_1 \rightarrow D, S_2 \rightarrow ON, S_3 \rightarrow 1$ (SW positions)

Read the voltage of pin 2 at ICC=20mA.

Note 5) Terminal voltage (V₁, V₂, V₃, V₆)

$S_1 \rightarrow D, S_2 \rightarrow ON, S_3 \rightarrow V$ (SW positions)

TA7324P

Read each terminal voltage at the above SW position.

Note 6) Trigger sensitivity (A), Trigger current (A) $\langle +\text{TRIG-A}, \pm(\text{I-TRIG-A}) \rangle$

$S_1 \rightarrow A, S_2 \rightarrow \text{ON}, S_3 \rightarrow V$ (SW position)

Turn VOL gradually to increase the indication of VM from 0V.
In this case, pin 9 and pin 7 of the muting output terminal are at L level (about 0V when output transistor is ON.).
As the value of VM is increased, pin 9 and pin 7 are turned from "L" level to "H" level at a certain point (about 3.5mA when output transistor is OFF. In this case, if the value of VM is $V_{ML(A)}$ the negative trigger sensitivity (A) is given by the following equation:

$$\text{Negative trigger sensitivity (A), } -\text{TRIG-A} = V_1 - V_{MH(A)}$$

If, after obtaining of the negative trigger sensitivity, the value of VM is further increased, pin 9 and pin 7 are re-turned from "H" level to "L" level.

In this case, if the indicating value of VM is $V_{MH(A)}$, the positive trigger sensitivity (A) is given as follows:

$$+\text{TRIG-A} = V_{MH(A)} - V_1$$

To measure the trigger current $\pm(\text{I-TRIG-A})$, read the current of pin 1 at the measuring time of the $V_{ML(A)}$ and $V_{MH(A)}$ described above.

Note 7) Trigger sensitivity (B), trigger current (B) $\langle +\text{TRIG-B}, \pm(\text{I-TRIG-B}) \rangle$

$S_1 \rightarrow B, S_2 \rightarrow \text{ON}, S_3 \rightarrow V$ (SW position)

Measuring method is the same as mentioned in Note 5.

Negative trigger sensitivity, $-\text{TRIG-B} = V_3 - V_{ML(B)}$

Positive trigger sensitivity, $-\text{TRIG-B} = V_{MH(B)} - V_3$

TA7324P

Note 8) Detection sensitivity and current at power OFF (V_4 OFF, I_4 OFF)

$S_1 \rightarrow C$, $S_2 \rightarrow$ OFF, $S_3 \rightarrow V$ (SW position)

Turn VOL gradually to increase the indicating value of VM from 0V. When pin 9 and pin 7 of the muting output are turned from "L" level to "H" level, the value of VM comes to V_4 . In this case, the current of pin 4 is I_4 OFF.

Note 9) Saturation voltage and maximum sink current at muting ON ($V_{CE(sat)}$, I_{Cmax})

$S_1 \rightarrow A$ or B , $S_2 \rightarrow$ ON, $S_3 \rightarrow V$ (SW position)

Measure the voltage and current of pin 9 and pin 7 when indicating value of VM is set to 0V. (Set $R_g = 0$ at measuring the current.)

Note 10) Muting attenuation and muting time at power ON (ATT, MT)

In the measuring circuit 2, the time from the instant when S_1 is ON (while S_2 remains OFF) and V_{CC} is applied to the circuit, to the moment when pin 9 and pin 7 are turned from "L" level to "H" level is taken as the muting time MT.

Measure the AC voltage at pin 9 or pin 7 with S_1 remains ON. In addition, turn S_2 ON, and measure the AC voltage at pin 9 or pin 7.

Muting attenuation ATT=20 log

$\frac{\text{AC voltage at pin 7 (9) at } S_2 \text{ OFF}}{\text{AC voltage at pin 7 (9) at } S_2 \text{ ON}}$

TA7324P

CHARGE AND DISCHARGE
LEVEL DETECTION

A built-in trigger amplifier is included in TA7324P for responding either to positive or negative pulse. In the trigger amplifier, two amplifiers are mounted in parallel; one is responding at a small level, while the other is responding at a large level. Both amplifiers are coupled to the discharge level detector circuit as shown Fig. 1 respectively.

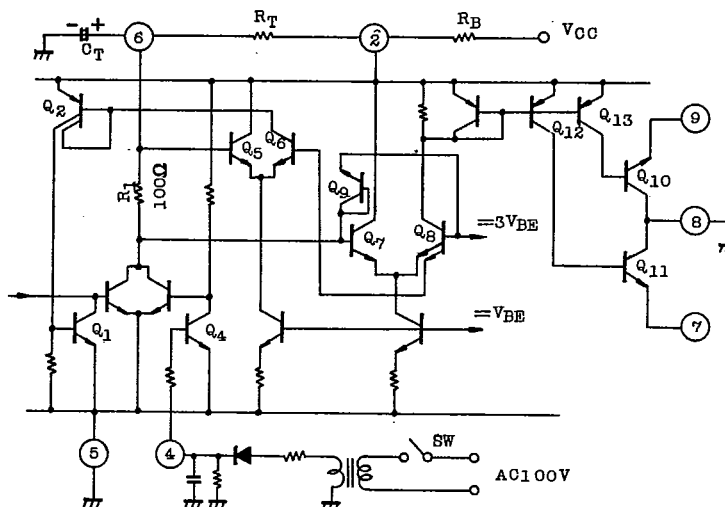


Fig.1 Charge and Discharge Level
Equivalent Circuit

The discharge level detector circuit forms a flip-flop discharge circuit. The circuit is designed so that the trigger pulse width to discharge circuit may be maintained beyond constant width to discharge fully the charge of C_T (Capacitor for muting and charging operation) even when the smaller width pulse is given to the trigger amplifier.

Charge operation and muting operation are described as follows:

1. OPERATION AT POWER (V_{CC}) ON (REFER TO FIG.2)

As soon as the power supply (V_{CC}) is ON, C_T starts to be charged through R_T and the potential V_6 on pin 6 rises gradually, in this case, Q_8 remains conductive till the base potential of Q_7 becomes equal to or more than the base potential ($3 V_{BE} \approx 2.1V$) of Q_8 and the muting operation is carried on by putting the muting output T_R Q_{10} and Q_{11} to ON position.

TA7324P

When C_T is more charged, the base potential of Q_7 rises higher than that of Q_8 , and the Q_8 , Q_{10} , and Q_{11} are turned OFF to release the muting.

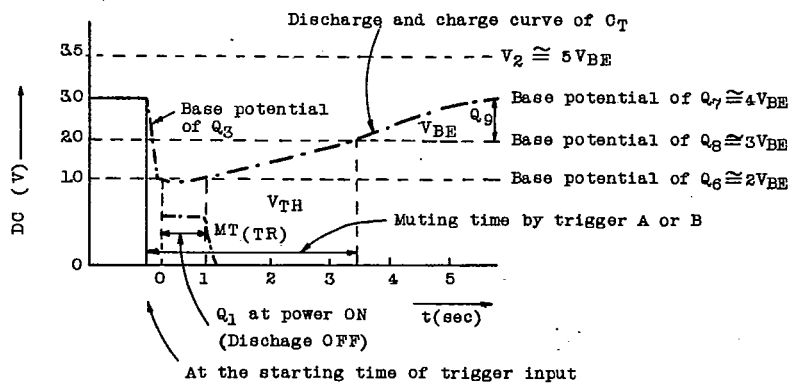


Fig. 3 Respective Operating Potentials at Muting by Trigger (A) or (B)

3. MUTING AT POWER OFF

When the power supply is ON, rectification from AC makes Q_4 ON and Q_3 OFF.

When AC is OFF, Q_4 is OFF and Q_3 is ON to discharge C_T for stating muting operation.

TA7324P

APPLICATION

1 SUPPLY VOLTAGE (V_{2-5}) AND SUPPLY CURRENT (I_2)

TA7324P contains a regulated power supply.

Therefore, as shown in Fig. 4, the voltage is applied to pin 2 through the resistor R_B . The supply current I_2 is, in this case, adjusted to about 10mA by defining the value of R_B .

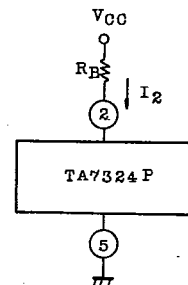


Fig. 4 Adding bias to Pin 2

According to V_{2-5} to I_2 characteristics shown in Fig. 1, when $I_2 = 10\text{mA}$, $V_{2-5} \approx 3.5\text{V}$ is given.

$$\text{Thus, } R_B \approx \frac{V_{CC} - V_{2-5}}{10} \text{ (k}\Omega\text{)}$$

For muting operation $V_{2-5} \gtrsim 2.8\text{V}$ is required. As shown in Fig. 1 if the current of $I_2 \gtrsim 3\text{mA}$ is flown, the muting function starts operating.

2. TRIGGER SENSITIVITY

Trigger sensitivity means the absolute value in the difference between the trigger terminal voltage at the start and the open voltage of trigger terminal. (Refer to Fig. 5.)

Trigger current is the value of current flowing into or from the trigger terminal at start of triggering.

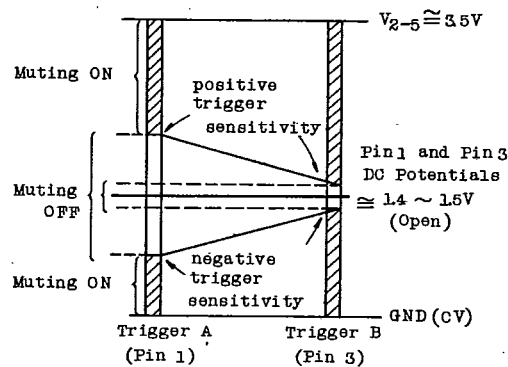


Fig. 5 Trigger Level

In TA7324P, the circuit is designed for discharging securely the timing capacitor even if a trigger of extremely narrow width is applied to the trigger input terminal. Consequently, the trigger is applied to even the input of pulse width less than μs , so that an erroneous operation may be caused when by a hair-like pulse is applied

TA7324P

to the trigger input terminal from the power supply or other sources. To prevent such erroneous operation, an integrated circuit of CR may be required to be provided to the input. In addition, trigger sensitivity varies according to temperature and voltage of V_{2-5} ; therefore, such variation should be considered before designing. Trigger terminal impedance is $15k\Omega \sim 25k\Omega$ at start of triggering. $I_2 = 5 \sim 15mA$ is recommended for pin 1 or pin 3 because muting may not be restored after triggering to mute if $I_2 = 15mA$ or more is applied.

3. MUTING AT POWER ON/OFF

(Refer to Fig. 6)

3.1 MUTING AT POWER ON

Muting at power ON continues

till V_{2-5} is over about $2.8V (4V_{BE})$, Q_{12} and Q_{13} are turned ON, the timing capacitor C_T is charged, and the base potential of Q_7 rises to about $2.1V (3V_{BE})$. Therefore, early rise is recommended for V_{2-5} potential.

3.2 MUTING AT POWER OFF

Muting at power OFF starts operating by decreasing the detecting terminal (pin 4) at OFF to about $0.7V$ or less (making Q_4 OFF.) Therefore, such a signal as is more than $0.7V$ in normal operation but turned to less than $0.7V$ instantly at power OFF, is required to be made.

Muting at power OFF starts operating at the time when pin 4 potential becomes less than $0.7V$ and continues till V_{2-5} becomes $2.8V$ or less. Therefore, the slow falling of V_{2-5} is more effective.

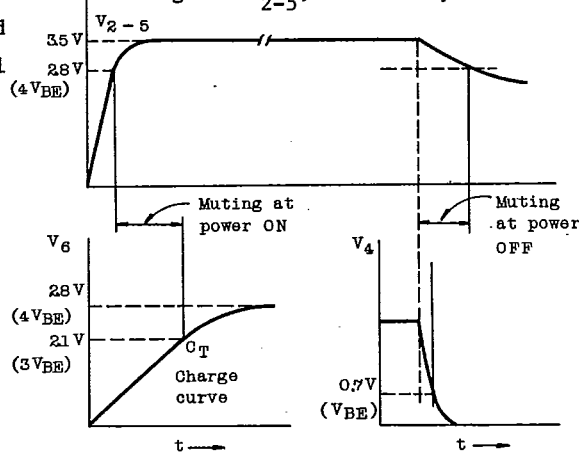


Fig. 6 Muting Operation at Power ON - OFF

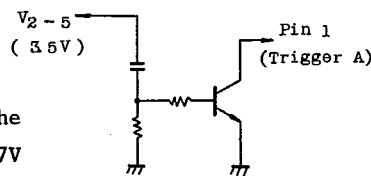


Fig. 7 Lengthening Way of Muting Time

TA7324P

The detecting terminal at power OFF (pin 4) is available for trigger input; however, it is recommended that this terminal be linearly triggered as much as possible, because a narrower width pulse may miss ample discharge from the timing capacitor.

4. MUTING TIME

Muting time at power ON and caused by trigger is decided by the timing C_T and R_T . With the consideration for Q_5 and Q_7 base currents, the following are roughly given:

$$\text{Muting time at power ON} : MT_{(ON)} \approx 1.3R_T C_T$$

$$\text{Muting time by trigger} : MT_{(TR)} \approx 0.45R_T C_T$$

Here, if muting time is lengthened by setting $R_T C_T$ time constant larger, distorted waves asymmetrical with respect to top and bottom may be originated by the slow speed of wave rise at muting OFF. Experiment tells that $MT_{(ON)} \approx 1.4\text{sec}$ ($R_T = 220\text{k}\Omega$ and $C_T = 4.7\mu\text{F}$) or less has brought a good result.

When $MT_{(ON)}$ is required especially to be made longer, a method of applying the trigger terminal as shown in Fig. 7 and another method of giving a signal of slow rise to the detecting terminal at power OFF (pin 4) are considered. To activate a continuous muting, the DC voltage to make muting ON should be applied to trigger A or B, or the voltage of the detecting terminal at power OFF (pin 4) should be decreased to make Q_4 OFF.

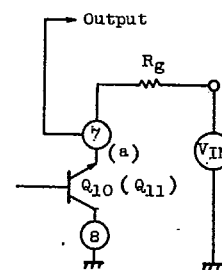


Fig. 8 Muting Output

TA7324P

5. SIGNAL LEVEL FOR MUTING AND ATTENUATION

Since peak value (half wave) and attenuation of signal for muting are decided according to the following conditions, the value of R_g is properly required for operation.

- o At muting ON, $V_{IN(peak)} = R_g \cdot I_{max}$

I_{max} is minimum value of maximum sink current.

- o At muting OFF, peak value and attenuation are decided by emitter-base reverse voltage of $Q_{10}(Q_{11})$, and the equation, $V_{IN(peak)} \leq 5V$, is given.

- o Let $Q_{10}(Q_{11})$ saturating resistance be R_s , muting attenuation is given by

$$\text{Muting attenuation: } ATT = -20 \log R_s / R_g \quad R_s = (V_{CE(sat)} / I_{max})$$

6. EXAMPLE OF APPLICATION (APPLIED TO A PRESET TUNER)

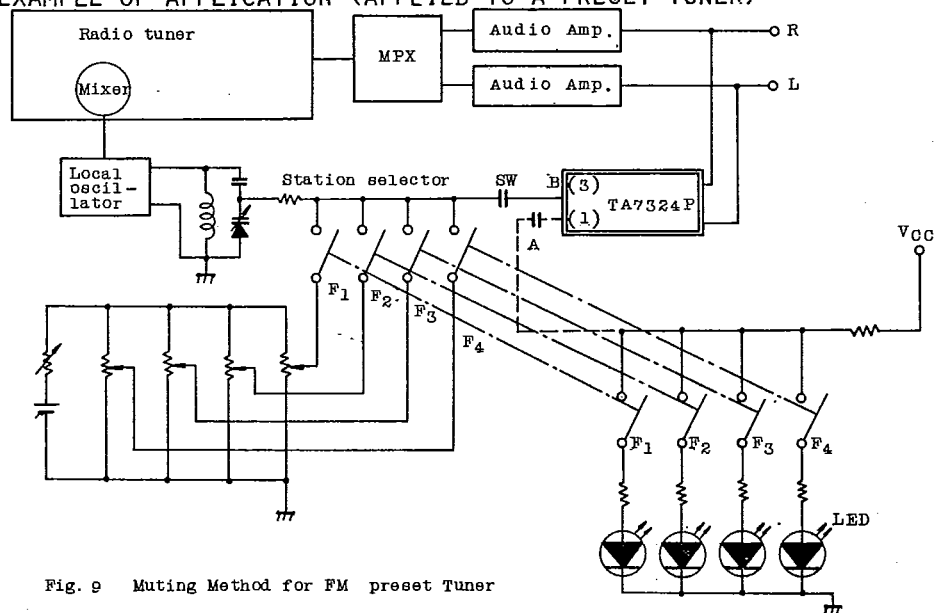
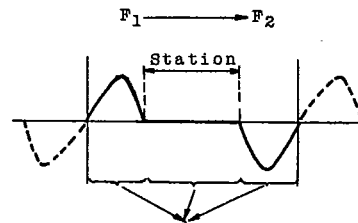


Fig. 9 Muting Method for FM preset Tuner

- (1) Utilization of voltage variation added to the variable capacitance diode
- (2) Utilization of voltage variation caused by station indicator LED

TA7324P

In case of an FM preset tuner as shown in Fig. 9, station selection from F_1 to F_2 by the preset station selector switch provides a drastic variation to the voltage applied to variable capacitance diode.



All are turned to 'buzz' sound

Accordingly, all of the detector DC voltage variation traced in and out the FM "S" curve and noise between stations as shown in Fig. 10 come out as "buzz" sound.

Fig. 10 "Buzz" Sound in Present Type

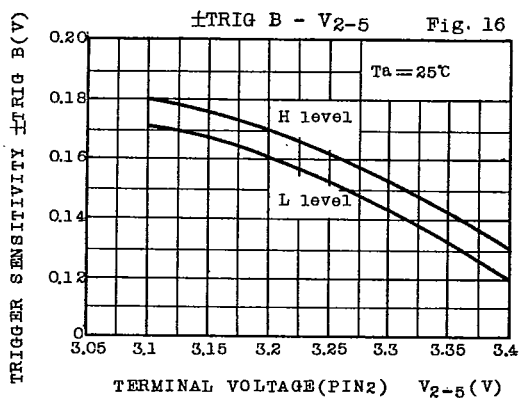
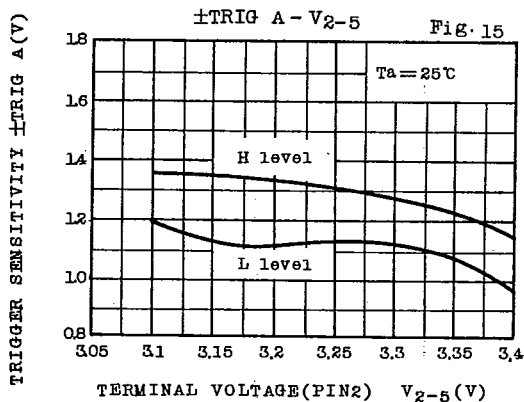
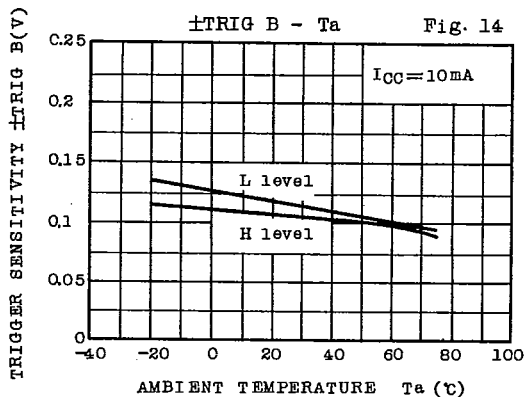
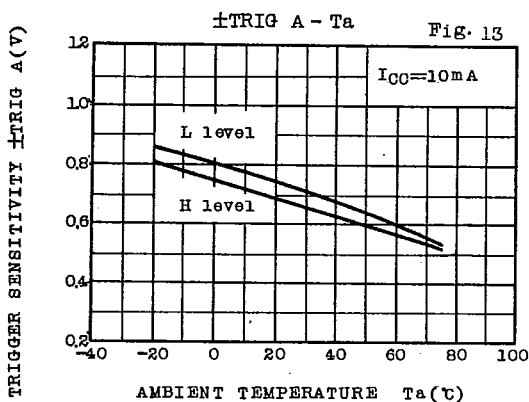
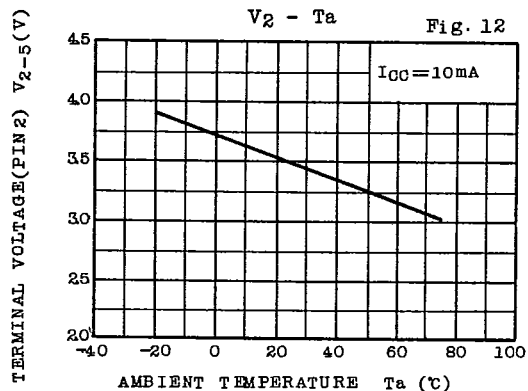
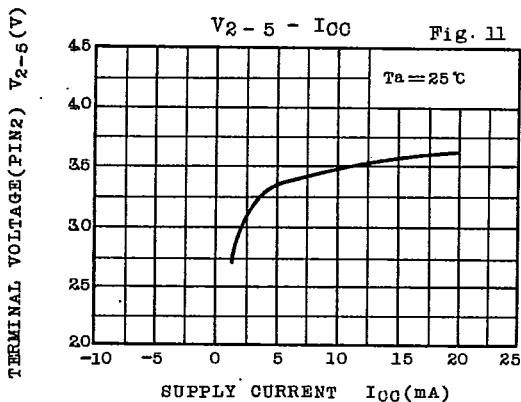
- o In case of the above FM preset tuner equipped with a non-shorting type switch for station selection and the station indicator LED (or an indicator lamp), only LED voltage detection can operate muting securely by using the terminal 1 of TA7324P, that is, the trigger A, as shown by the dotted line in Fig. 9.

For example, in case of presetting from F_1 to F_2 , after SW of F_1 turned OFF, SW of F_2 becomes ON; therefore, detection of switch OFF of F_1 permits the muting operation to be performed.

- o Even in case of using a shorting type switch, if the contact of indicator SW linked with the preset SW is securely ON several milli second ahead, the muting operation can be performed by voltage variation originated at LED ON. If the shorting type switch cannot securely make the other switch ON, the muting starts operating by detecting the voltage variation of variable capacitance by applying the terminal 3 of TA7324P, the trigger B, as shown by the solid line in Fig. 9.

However, in case where F_1 and F_2 are the same station or close stations at reception each other, no muting can be operated.
(Variation is within several mV of variable capacitance diode voltage.)

TA7324P



AUDIO LINEAR IC

TA7324P

