Calculating constant of the K type LPF

Z_O : Filter characteristic impedance $[\Omega]$

f_C: Cut-off frequency $[Hz]$

$$C = \frac{1}{2\pi f_C Z_0} \ (F)$$

$$L = \frac{Z_0}{2\pi f_C} \ (H)$$

Constant when $Z_0 = 75\Omega$

Cut-off frequency : fc	C	L
80MHz	26.5pF	298nH
90MHz	23.6pF	265nH
100MHz	21.2pF	239nH
110MHz	19.3pF	217nH
120MHz	17.7pF	200nH

Table 7 Constant of the K type LPF

The following figure shows an example when using the print filter type BPF manufactured by SOSHIN ELECTRIC.

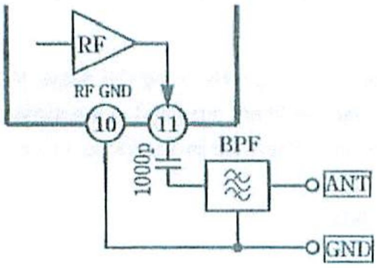

Fig. 17 RF Output BPF Circuit

Pass band (MHz)	Type
76 ～ 108	GFWB1 (Chip type)
88 ～ 108	GFMB1 (Chip type)
76 ～ 90	GFJB3 (Lead type)
88 ～ 108	GFMB3 (Lead type)
76 ～ 108	GFWB3 (Lead type)

Table 8 SOSHIN ELECTRIC BPF ($Z_0 = 75\Omega$)

To control the transmission output level, insert an attenuator between Pin 11 and LPF (or BPF). For the transmission output level standard, conform to the Radio Law of each country or region.

In Japan, in terms of the FM broadcasting frequency range, radio waves must be transmitted within the electric field strength of the faint radio station stipulated in the Radio Law Enforcement Regulations, Article 6, Section 1. The faint radio station must manufacture faint radio devices based on the regulation of "the electric field strength of 500μV/m (54dBμV/m) or less at a distance of 3m" stipulated in the electric field strength measurement law.

The following figure shows the relationship between the electric field strength (at a 3m distance) stipulated by the faint radio standard and frequency.

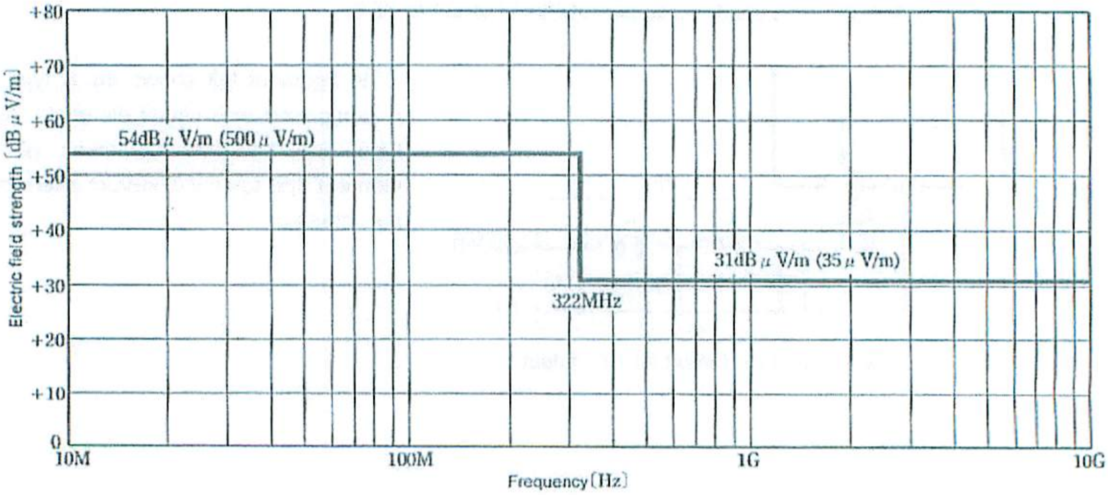

Fig. 18 Electric Field Strength (at a 3m Distance) Stipulated by the Faint Radio Standard in Japan

Because it is usually difficult for a faint transmitter to generate the oscillation section which provides faint output, insert an attenuator in the transmission output circuit or adjust the 3m distance electric field strength to 54dBμV/m(500μV/m) or less using a transmission antenna having poor radiation efficiency, as shown below. For example, you can use a single lead line for the antenna to adjust the distance.

The following figure shows the relationship between the electric field strength and the communication distance.

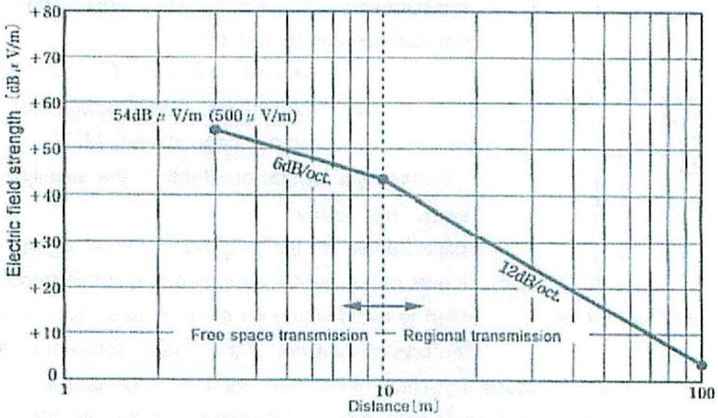

Fig. 19 Electric Field Strength and Communication Distance

Generally, the electric field strength at a distance of more than 10m is influenced by ground reflection, receiving large attenuation of 12dB/oct compared to the case of the free space transmission. Thus, only tens meters of transmission distance will be feasible.

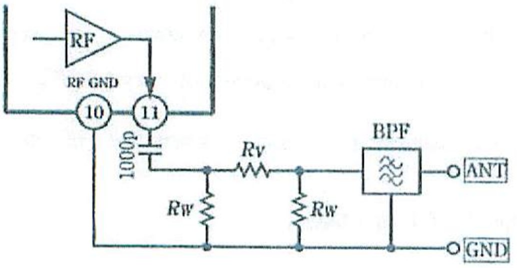

Fig. 20 RF Output π Type Attenuator Circuit

The figure at left shows the π type attenuator. For the sake of the attenuator structure, accuracy may deteriorate at high frequency because of the influence of L from the floating capacity or resistors. Therefore, the maximum attenuation per level is 20 dB. If the attenuation level of 40dB is required, split attenuation into the two levels, such as 20dB + 20dB.

Calculating π Type Attenuator

n= Attension level (dB)

Z= Input /output impedance (Ω)

$$k = 10^{\frac{n}{20}}$$

$$k^2 = 10^{\frac{n}{10}}$$

$$R_V = \frac{Z}{2}\left(\frac{k^2-1}{k}\right) \ (\Omega)$$

$$R_W = Z\left(\frac{k+1}{k-1}\right) \ (\Omega)$$

Constant when Zo = 75Ω

Attenuation level(dB)	Rv(Ω)	Rw(Ω)
1dB	8.65	1300
3dB	26.4	439
6dB	56.0	226
10dB	107	144
15dB	204	107
20dB	371	91.7

Table 9 Constants of π Type Attenuator

3.8 Crystal Oscillator (Pin 13, 14)

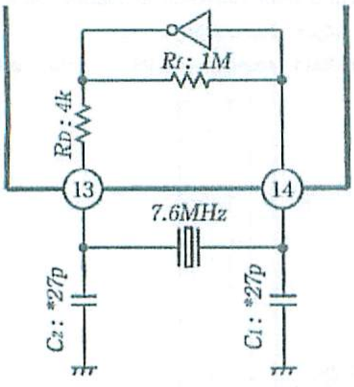

Fig. 21 Crystal oscillator circuit

Connect the crystal oscillator of 7.6MHz frequency.

Inquire the crystal manufacturer for the value of load capacitances C1, C2 . The approximate value of load capacitance can be found by:

$C=C_1=C_2=2(C_L-C_A)$ 〔F〕 where,

C_L : equivalent series capacitance 〔F〕

C_A : stray capacitance 〔F〕 .

Dispose the crystal oscillator in the vicinity of IC terminal and keep the stray capacitance to the minimum. Other signals may sneak into inputs of the oscillation circuit and cause trouble. Make every effort to avoid wiring on the bottom surface or in the vicinity of the crystal oscillator. If the crystal oscillator is laid on its side and used, take care to prevent the crystal oscillator case from coming in contact with other patterns. In addition, when it is used by being laid on its side, the crystal oscillator is susceptible to the wiring on the bottom surface. Use the bottom surface for GND as much as possible.

Make sure that a satisfactory value is obtained for the negative resistance. Set the margin (oscillation allowance) of the oscillator circuit in such a manner that the ratio of the negative resistance of the circuit $|-R|$ to effective resistance merit Re average of crystal oscillator becomes not less that 25 times.

$$25\sim50 < \frac{|-R|}{Re}$$

$$Re=R_1\left(1+\frac{C_0}{C_L}\right)^2 \,(\Omega)$$

R_1 : Equivalent series resistance of crystal 〔Ω〕

C_0 : Parallel capacitance of crystal 〔F〕

C_L : Equivalent series capacitance of crystal 〔F〕

The negative resistance of this IC oscillator $|-R|$ is 1.5kΩ.

3.9 Serial data entry (Pin 15, 16, 17) (BH1415F/FV, BH1418FV/KN)

Control voltage of this terminal is 0.8 x Vcc-Vcc for the "H" level and GND-0.2 x Vcc for the "L" level. When operation power supply voltage of present IC differs from that of microcontroller, take utmost care.

Right after IC power supply is turned on, logic circuit is "unstable," and PLL circuit and others are not making normal operation. Right after turning on the power supply, be sure to enter the serial data to stabilize operation.

In the event that the apparatus is used with IC power supply turned OFF and power supply of microcontroller connected to serial data input terminals (15, 16, 17 pins) turned ON, current flows into serial data input terminals (15, 16, 17 pins) from microcontroller. Insert a limiting resistor.

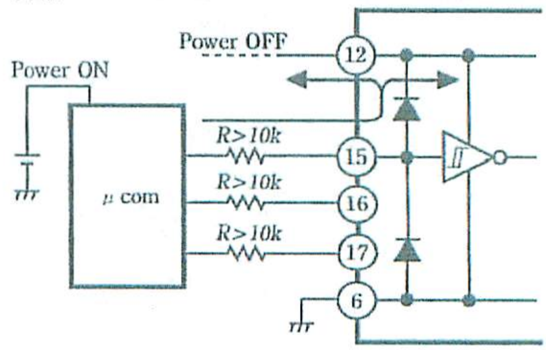

Fig. 22 Serial BUS I/F circuit

3.10 Separation Adjust (Pin 19)

Advance the SUB signal phase at RC time constant across the composite signal output and input to FM modulator portion (surrounded by dotted line) and adjust separation. In such event, keep pin 19 open.

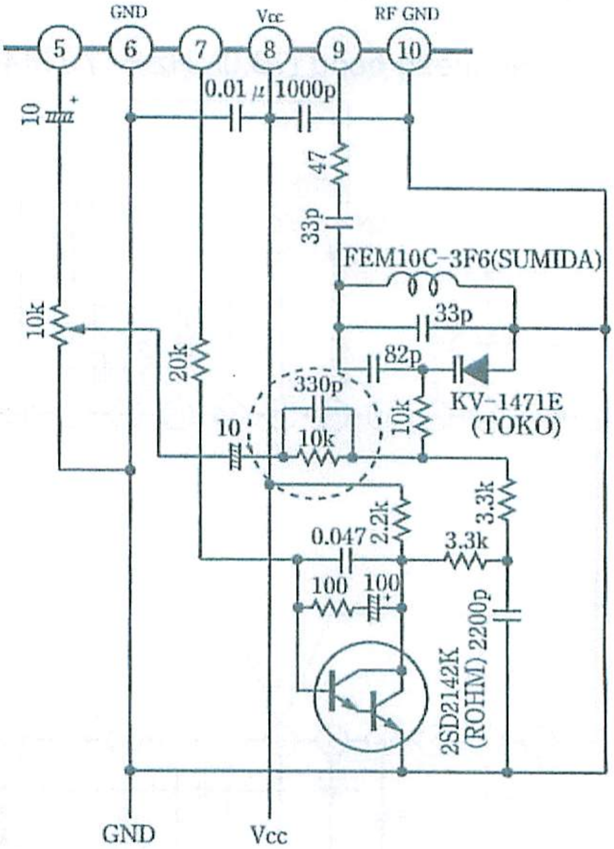

Fig. 23 Separation adjustment circuit 1

For another method, vary the phase of pilot signal by the constant across pin 19 and GND and adjust separation. Connect LC resonant circuit to advance the pilot signal phase.

This method is not realistic because the L value becomes excessively large.

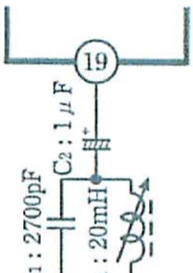

Fig. 24 Separation adjustment circuit 2

4. Applied Circuit Examples

Note: Terminal number put down in this material is for SOP20 package version BH1415F, BH1416F, and BH1417F.

For SSOP-B24 package version BH1415FV, BH1417FV, and BH1418FV as well as VQFN28 package version BH1418KN, read differently the terminal number and use.

4.1 BH1415F Japanese band (76.0MHz ~ 79.0MHz)

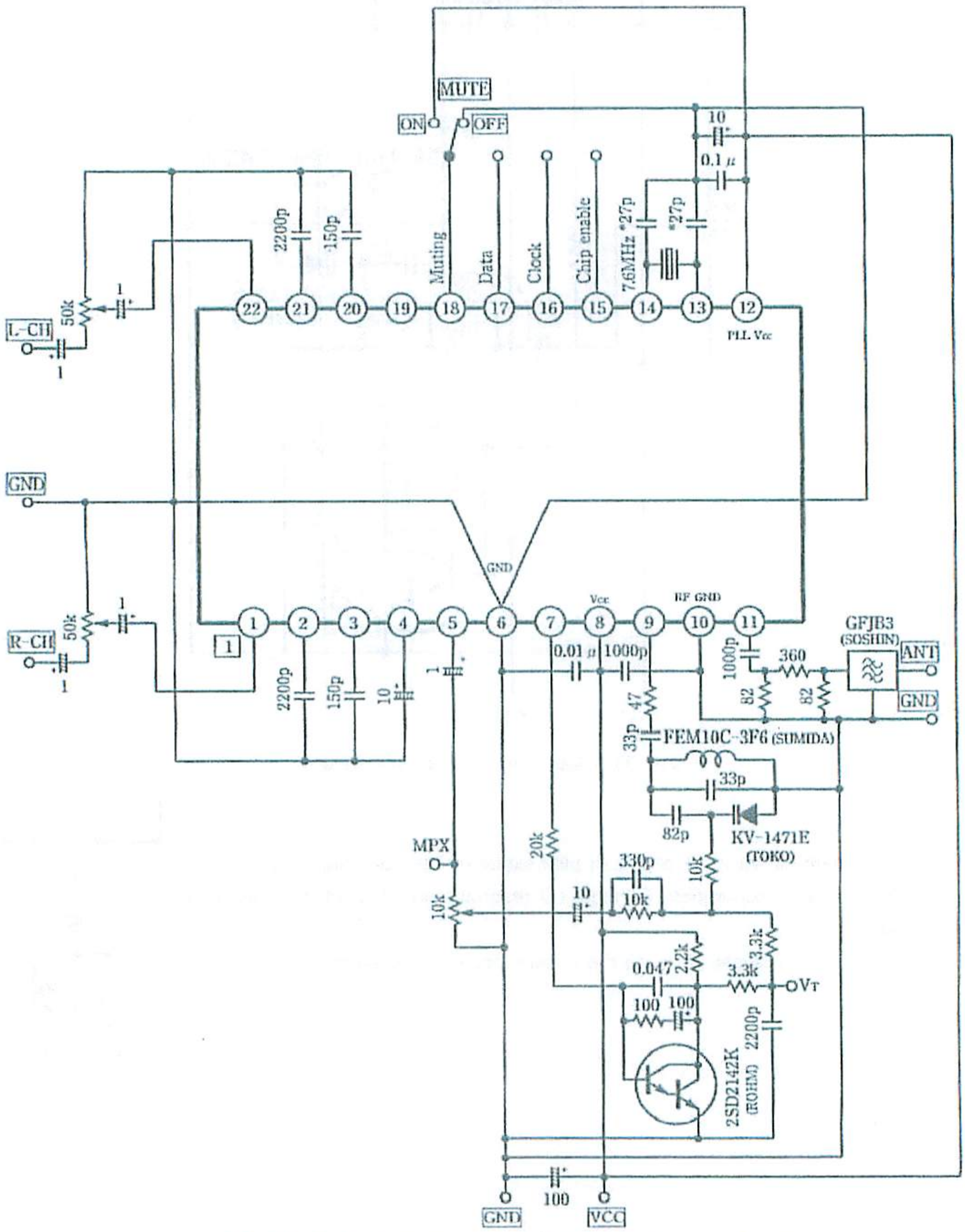

Fig. 25 Applied circuit example: BH1415F Japanese band

4.2 BH1415F US band (88.1MHz ~ 91.1MHz)

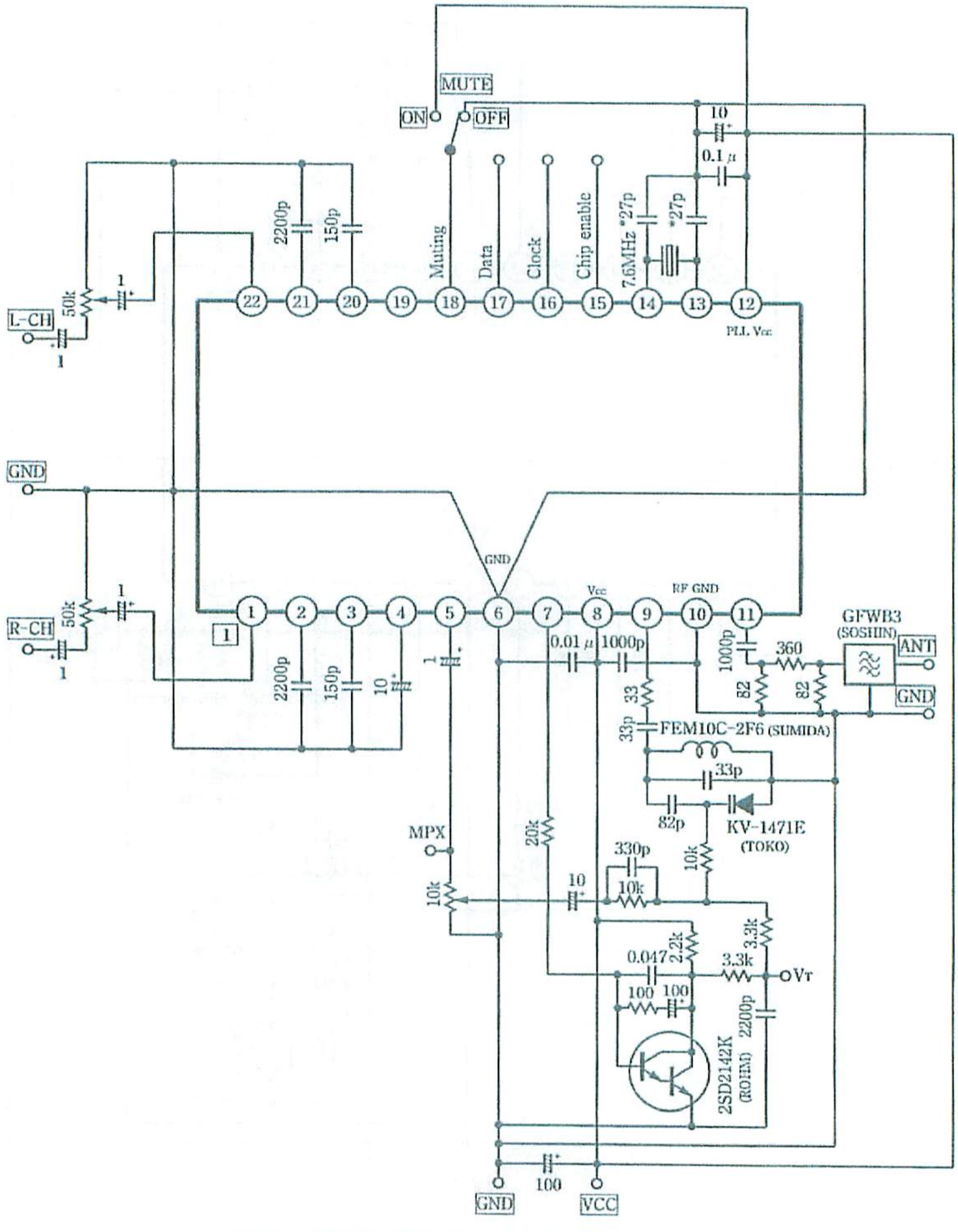

Fig. 26 Applied circuit example: BH1415F Japanese band

4.3 BH1416F Japanese band (76.8MHz ~ 78.0MHz)

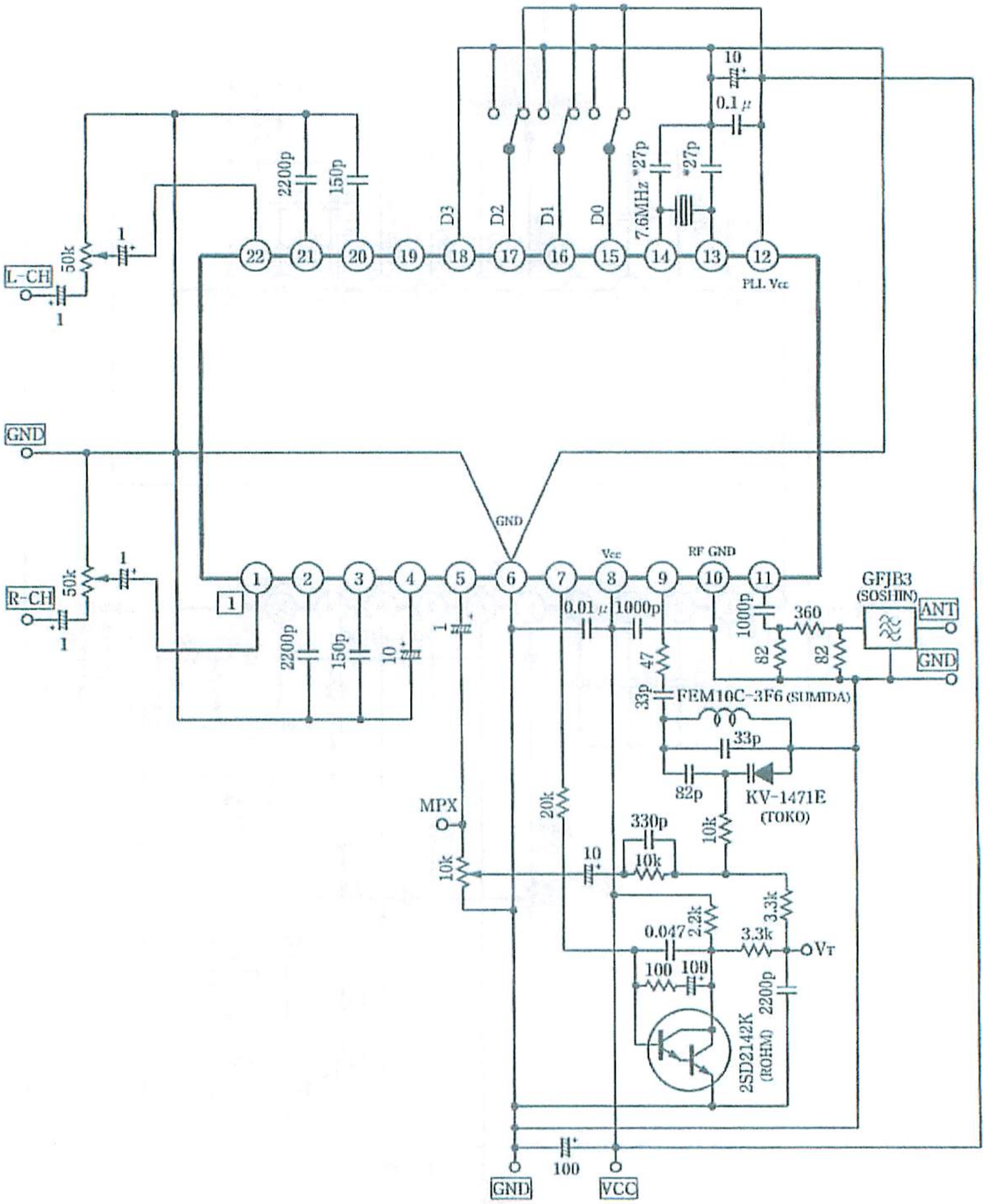

Fig. 27 Applied circuit example: BH1416F Japanese band

4.4 BH1416F Japanese band (88.0MHz ~ 89.2MHz)

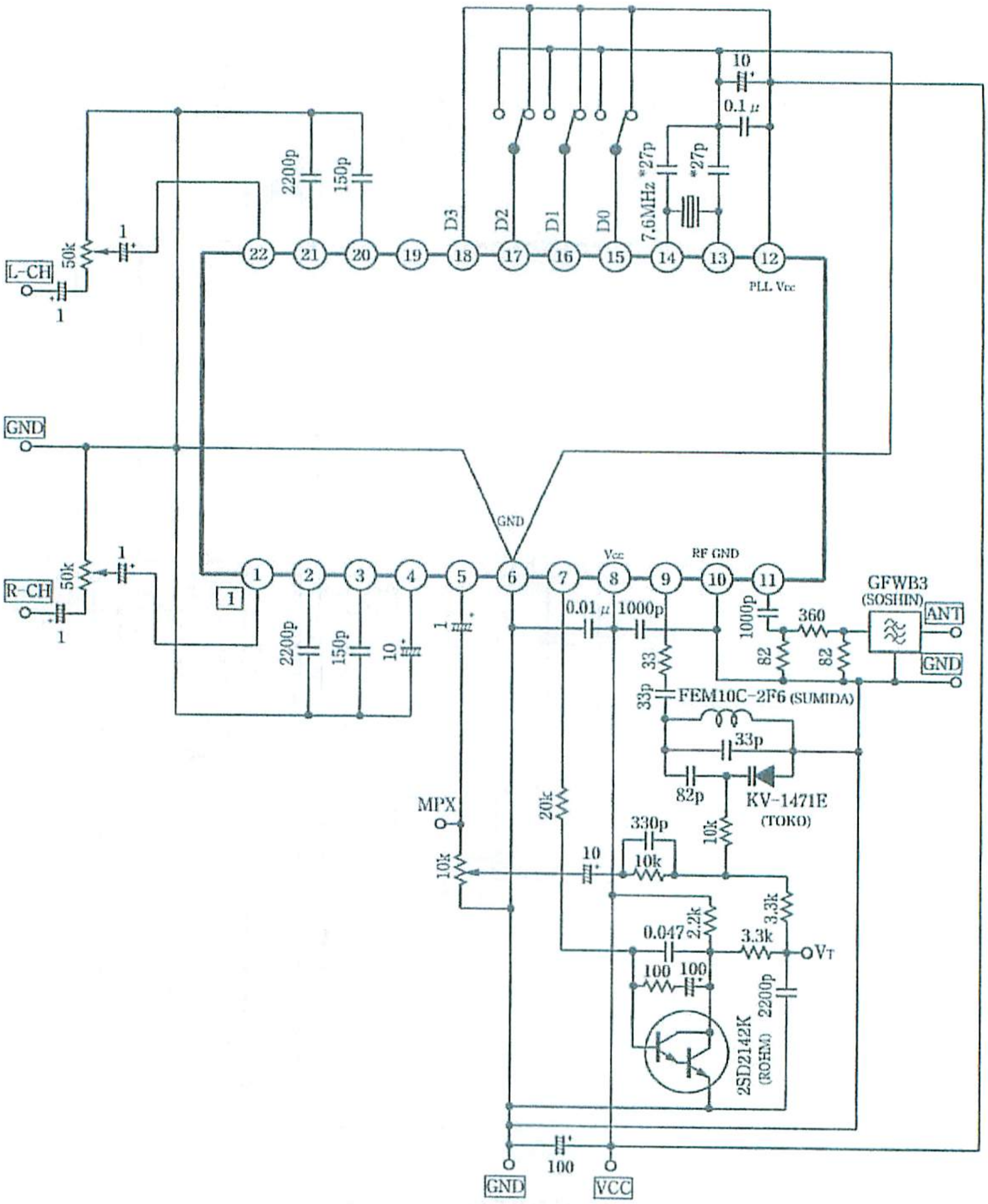

Fig. 28 Applied circuit example: BH1416F Japanese band

4.5 BH1417F US band (87.7MHz ~ 88.9MHz)

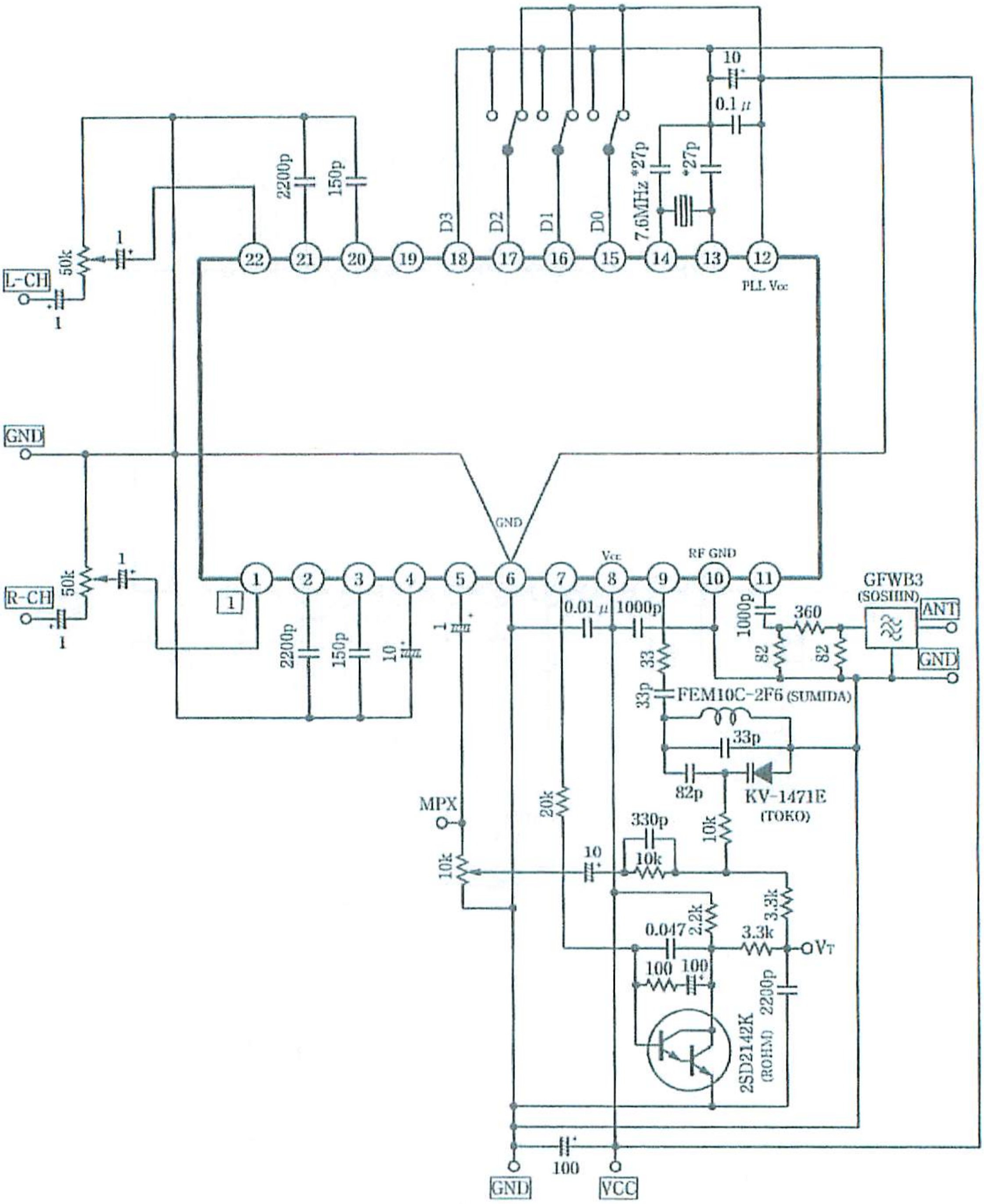

Fig. 29 Applied circuit example: BH1417F US band

4.6 BH1418FV US band (88.1MHz ~ 91.1MHz)

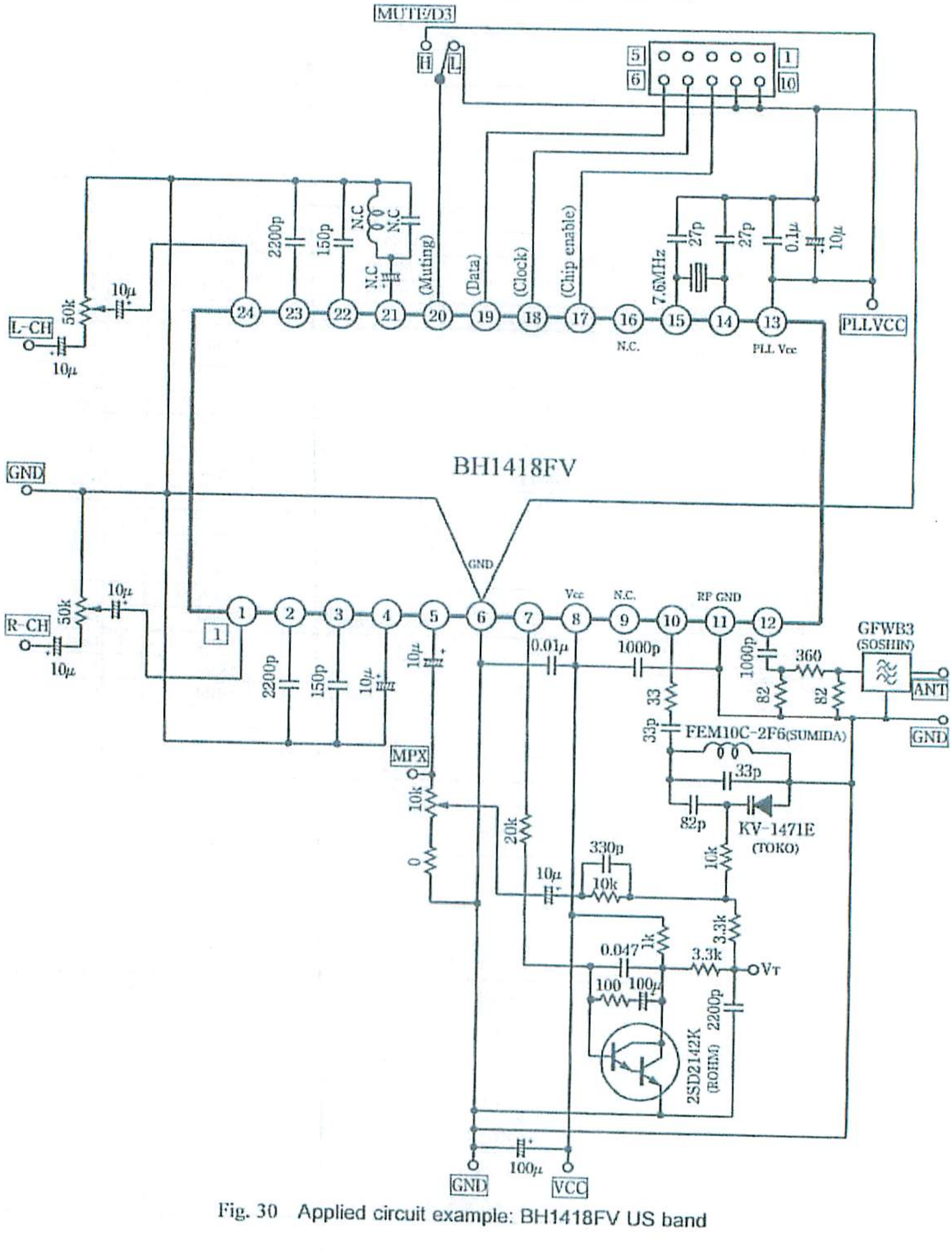

Fig. 30 Applied circuit example: BH1418FV US band