

# Precautions in the Operation

Thank you for considering adoption of our POLYVARICONS. At this juncture we advise the users to look over the precautions we have cited below since these are points that will serve as reference in considering the design and manufacturing process. Perusal of these precautions is doubly advised since our POLYVARICONS are built much higher in accuracy and precision than other radio parts and the knowledge obtained will be useful in preventing disruption of accuracy.

## 1. Rotation Stopper Strength

Torsional moment beyond imagination is applied to the stopper unit inside the variable capacitor during the process of mounting the pulley on the shaft or of tracking alignment. The stopper of our POLYVARICON has been designed stout, but there is some danger of its being broken when the torsional moment is greater than the product standard. For this reason, adequate design consideration and manufacture control are requested. If it is broken, two-point tuning and tracking alignment will become impossible.

## 2. Work of Mounting Pulley on the Shaft (load withstanding in axial direction)

Design consideration is requested by all means so that the load in the axial direction will be the maximum (1kg or less). If overload should be applied in the axial direction or if the pulley is mounted using an air screw driver, the capacitance characteristics of the variable capacitor will be exposed to the danger of deterioration.

## 3. Terminal Heat Resistance and Wax Treatment

As the POLYVARICON is built mainly of plastic material, terminal soldering should be done as quickly as possible and soldering should be applied to the terminal tip as far as possible. If the wax should ever penetrate into the interior of the variable capacitor or through the trimmer adjusting hole in large quantity, it will dissolve the dielectric between the electrodes and give rise to short-circuiting fault.

## 4. Receiving Frequency Scale

While the scales are determined by the capacitance curve of the variable capacitor, designing on the basis of approximately identical scale would be possible regardless of the level of maximum variable capacitance, provided the variable coefficient curves are identical. The user is advised to confirm the item on the variable coefficient curves in the 6 and 7 page and the bottom part of the various types pages.

Variable Coefficient Code curve	Applications	Remarks
A	Used for AM band the curve is close to wavelength linearity at receiving frequencies of 520~1650kHz; it is also the standard curve of POLYVARICON.	EIAJ Standard 1a
B	Regularly spaced in the receiving range of 88~108MHz in the FM band; it is the standard curve for the FM band.	EIAJ Standard 4c
C	It is the standard curve of the OSC side when curve A (EIAJ 1a) is used for the ANT side. Use it in the receiving range of 520~1650kHz.	EIAJ Standard 1b

### 5.Consideration of the stray capacitance is necessary for the tuning and oscillating circuits composed of variable capacitors and coils

The stray capacitance of the circuits increases beyond anticipation under the influence of the printed patterns, component parts arrangement, terminal and lead wires and change-over switches.

The minimum tuning capacitance Cc at the maximum variable capacitance of 140pF of the variable capacitor would be obtainable from

$$\left(\frac{f \text{ max.}}{f \text{ min.}}\right)^2 = \frac{Cv \text{ max.}+Cc}{Cc} = \frac{140+Cc}{Cc}$$

$$\left(\frac{1650}{520}\right)^2 = \frac{140+Cc}{Cc} \quad , \quad Cc=15.4$$

Minimum tuning capacitance : Cc=C<sub>T</sub> +C<sub>v</sub> min.+C<sub>s</sub>+C<sub>d</sub>.

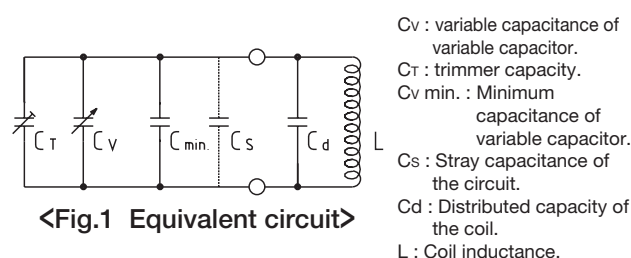
Therefore, it would be necessary to design so as to obtain C<sub>v</sub> min.+C<sub>s</sub>+C<sub>d</sub><15.4.

Next, the minimum tuning capacity of the oscillating circuit will be calculated. As in the case of the ANT circuit,

$$\left(\frac{f \text{ max.}}{f \text{ min.}}\right)^2 = \frac{Cv \text{ max.}+Cc}{Cc}$$

$$\left(\frac{2105}{975}\right)^2 = \frac{82+Cc}{Cc} \quad , \quad Cc=22.40$$

As shown above, since the minimum tuning capacitance of 22.4pF in the case of the oscillating circuit is higher than that of the ANT circuit, there is some margin in designing. However, as the distributed capacity of the oscillator coil is comparatively high and comes in two types, including 4pF or less and 7pF or less, adequate consideration should be given to the distributed capacity of the coil.



<Fig.1 Equivalent circuit>

## 6. Tracking Error

Tracking error is determined largely by the capacitance error of the variable capacitor and the  $Q_L$  of the antenna circuit, but lately a trend towards higher antenna  $Q_L$  is seen. For instance, even when the capacitance error of the variable capacitor is within  $\pm (1\text{pF}+1\%)$ , the tracking error will become big if the  $Q_L$  is high. The user is advised to give careful attention to the parts cited below as they are associated with  $Q_L$  of the antenna circuit.

### 6-1 One $Q_o$ of Antenna Coil

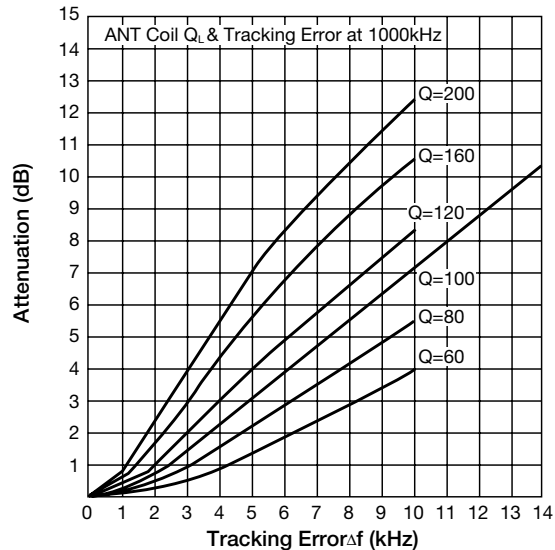
Set the least upper bound of standard without fail.

### 6-2 Input Impedance of Transistor and IC Used

A graph showing the antenna coil  $Q_L$  at 1000kHz and the tracking error is given below.

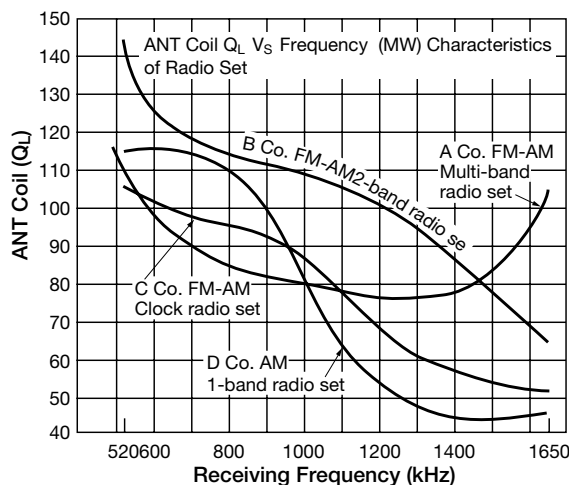
Attenuation (dB) is calculated from the following equation :

$$\text{Attenuation} = 10 \log \left\{ 1 + 4Q_L^2 \left( \frac{\Delta}{f} \right)^2 \right\} \text{ (dB)}$$



<Fig. 2>Antenna coil  $Q_L$  and tracking error at 1000kHz Attenuation (dB)

For reference,  $Q_L$  of the various frequencies of radio sets now sold on the market is shown in the figure below, but antenna coil  $Q_L$  of 100 or less is recommended in order to do away with trouble arising from tracking errors.



<Fig. 3> QL of marketed radio sets.

An example of calculating the relationship between antenna coil QL and capacitance tolerance ± (1pF+1%) is given.

1. Receiving frequency covering range : 520~1650kHz
2. ANT side maximum variable capacitance : 140pF
3. Variable capacitor capacitance at 1000kHz : 26.6pF

(Variable factor  $Y = \frac{26.6}{140} = 0.19$ )

4. At 1000kHz the capacitance tolerance is ± (1pF+1%) = 1.27pF. However, as actual quality unevenness of manufactured products is about 1/2, ±0.64pF would be about reasonable.
5. The tracking error (kHz) at a drift of ΔC=0.64pF from the standard value of 26.6pF is calculated as below.

$$\text{Tuning frequency } f = \sqrt{\frac{1650^2}{\left(\frac{1650^2}{520^2} - 1\right) Y + 1}}$$

$$f_1 = \frac{\text{tuning frequency}}{1000 \text{ (kHz)}} = \sqrt{\frac{1650^2}{\left(\frac{1650^2}{520^2} - 1\right) 0.19 + 1}}$$

The tuning frequency f<sub>2</sub> when there is a drift of ΔC= 0.64 from the standard value of 26.6pF would be :

$$\text{Variable factor} = \frac{26.6 + 0.64}{140} = 0.1946$$

$$f_2 = \sqrt{\frac{1650^2}{\left(\frac{1650^2}{520^2} - 1\right) 0.1946 + 1}} = 992.6 \text{ kHz}$$

$$f_1 - f_2 = 1000 - 992.6 = 7.4 \text{ kHz}$$

From the foregoing, the tracking error Δf=7.4kHz, and from the figure shown in the preceding section, the attenuation becomes 5dB when QL=100.

## 7. Receiving Coverage Range

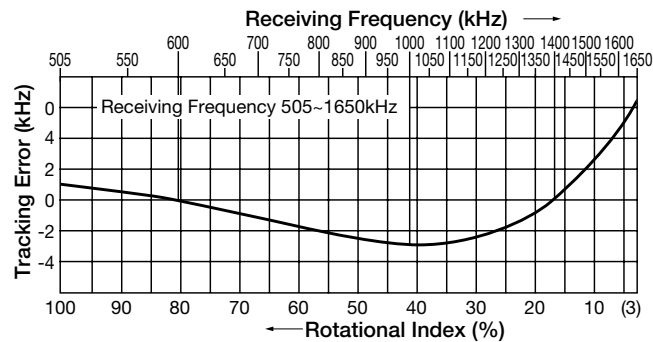
The trackingless variable capacitor of our company has been designed and manufactured free of tracking error over the entire MW band receiving frequency range of 520~1650kHz with 455kHz used as the intermediate frequency. If, for this reason, the coverage range drifts from the specified range, such, for instance, as 505 to 1650kHz, tracking error will arise as shown in the figure. In the circumstances, the trackingless variable capacitors should be used within the coverage range specified.

### Tracking Error at 1000kHz in Case of Use Outside Specified Range

In case of use in the coverage of 505~1650kHz, tracking error frequency of 3kHz arises. Therefore, tracking error of 1.3dB arises from

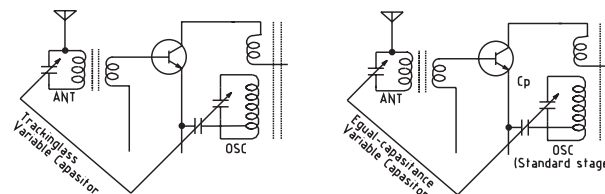
$$\begin{aligned} \text{attenuation} &= 10 \log \left\{ 1 + 4Q_L^2 \left( \frac{\Delta f}{f} \right)^2 \right\} \text{ dB} \\ &= 10 \log \left\{ 1 + 4 \times 100^2 \left( \frac{3}{1000} \right)^2 \right\} = 1.3. \end{aligned}$$

Request : In case designing is to be executed for the frequency range other than that of our designation, our advise is to contact our competent technical division without fail. Special adjustments for reducing the tracking error possible.

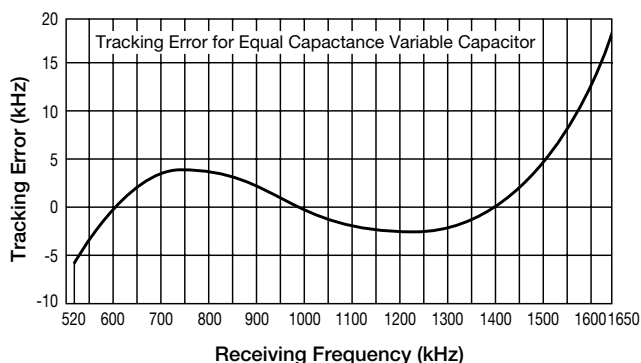


<Fig. 4> Tracking error when the trackingless variable capacitor is used outside the specified frequency range.

In case any variable capacitor of equivalent capacitance is used, padding capacitor is added to the OSC circuit as shown in the figure. This allow tracking only at 3 points, to be exact.



<Fig. 5> Circuits of trackingless variable capacitor and equivalent capacitor.



<Fig. 6> Tracking error when equivalent capacitor is used.

## 8. Howling

Speaker vibration is transmitted to the electric parts to cause vibration of the interior of the parts and the terminals and lead wires. This gives rise to oscillation in the extraneous band, thus ending in howling. Our POLYVARICONS enjoy high reputation for howling-free performance, but as variable capacitors are generally made of thin metal plates, consideration against howling is necessary.

- (1) The speaker and the POLYVARICON should be mounted as far apart as possible.
- (2) The printed board on which the variable capacitor is mounted should be firmly screwed on to the set cabinet so as to unitize it with the cabinet.
- (3) Soldering on to the variable capacitor terminals should be the shortest and the soldering should be firm and strong against vibration.
- (4) The rotary driving drum and the pulley directly connected with the variable capacitor shaft may vibrate and give rise to howling.
- (5) When the lug and the lead wires extending from the variable capacitor are touching other parts, howling is likely to develop.
- (6) Provision of vibration preventing cushion on the printed board of the set is desirable.

## 9. Storage and Transportation

- (1) As variable capacitors are high-precision devices, application of shocking load may damage their precision.
- (2) As all the terminals are of silver-or tin-plated finish, they may become discolored and the solder-fastness may deteriorate if they are exposed to high humidity or to sulfurous acid gas.