Shield case structure for an oscillator.

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Description

The present invention relates to an oscillator and, more particularly, to the structure of a shield case for an oscillator which reduces the variation in the oscillation characteristics of the oscillator ascribable to the changes in environmental conditions.

It is a common practice with an oscillator to cover a body thereof with a shield case made of brass, phosphor bronze or similar metal, so that the body may be protected against external electromagnetic fields. Therefore, stray capacitance unavoidably exists between the shield case and various parts constituting the circuitry of the oscillator. When vibration is applied from the outside to the oscillator, it causes the shield case to vibrate since the latter is not implemented with a vibration absorbing material. The vibration of the shield case changes the physical distance between the inner periphery thereof and the component parts of the circuitry and, therefore, the stray capacitance. As a result, the externally derived vibration adversely affects the oscillation characteristics of the oscillator such as oscillation frequency, preventing the oscillator from oscillating in a stable manner.

In a specification of the UK patent application No. 8628933, which was published under No. 2198591 on June 15, 1988, there was proposed a microphonic-free voltage controlled oscillator in which components were soldered on to tracks which were printed directly on to a ceramic resonator.

A tray assembly for a directional radio, which was proposed in the specification of German Federal Republic patent application No. 36 29 142.0 published on March 10, 1988, included barrel shaped dampers suspending an oscillator unit freely in order to reduce the effect of vibrations.

A vibration noise filtering system for use in airborne radar master oscillator systems was proposed in the specification of United States patent No. 4,096,445, which was published on June 20, 1978. In this system, a master oscillator was coupled directly structurally to a source of aircraft vibration, whilst a slave oscillator, which was phased locked to the master oscillator, was isolated from the vibration source by a mechanical passive isolator.

A feature of a shield case structure to be described below is that it allows an oscillator associated therewith to undergo a minimum of variation in the oscillating state thereof against external vibrations and, therefore, to oscillate stably at all times.

The shield case to be described covers the circuitry of an oscillator and includes a conductive member which absorbs vibrations which may be applied to the shield case from the outside.

The following description and drawings disclose, by means of examples, the invention which is characterised in the appended claims, whose terms determine the extent of the protection conferred hereby.

In the drawings:

Fig. 1 is a section showing a specific construction of an oscillator to which the present invention is applicable;

Fig. 2 is a perspective view of a shield case embodying the present invention;

Fig. 3 is a perspective view showing a modified form of the shield case shown in Fig. 2;

Fig. 4 is a circuit diagram representative of an oscillator to which any of the shield cases shown in Figs. 2 and 3 is applicable;

Fig. 5 is a block diagram schematically showing an arrangement usable to measure the S/N (Signal-to-Noise) ratios attainable with a conventional shield case and a shield case of the present invention against externally derived vibrations;

Figs. 6 and 7 are graphs showing S/N ratios particular to conventional shield cases each having a particular thickness; and

Fig. 8 is a graph showing S/N ratios obtained with an oscillator having a shield case in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the shield case structure in accordance with the present invention will be described in detail with reference to the accompanying drawings.

Fig. 1 shows specific circuitry 12 provided on the body of a voltage controlled oscillator (VCO), for example, to which the illustrative embodiment of the present invention is applied. Specifically, provided on a hybrid substrate 14, the circuitry 12 has a strip line 16, various active elements 18, various passive elements 20, etc. The back (not visible) of the hybrid substrate 14 is connected to ground. Fig. 2 shows a shield case 22 embodying the present invention. The shield case 22 covers the circuitry 12 of the substrate 14 to isolate it from the outside, as shown in Fig. 1. As Fig. 2 indicates, the shield case 22 has a box-like configuration having an opening 24 at the bottom thereof.

A part 26 of the edges of the shield case 22 which define the opening 24 is soldered or otherwise connected to the back or grounding surface of the substrate 14. Assume that the face of the substrate 14, as distinguished from the back, is configured as a grounding surface. Then, use may be made of a modified shield case 22A shown in Fig. 3. Specifically, the modified shield case 22A has tongues 26a formed by bending a part of the edges of the opening 24 at right angle and soldered or otherwise connected to the edge portions of the face or grounding surface of the substrate 14.

The shield cases 22 and 22A shown in Figs. 2 and 3 each is implemented as a conductive material, par-
ticularly a sheet of alloy which absorbs vibrations. Typical of vibration absorbing alloy sheets is Gentalloy F series available from Toyo Aluminum (Japan). The shield cases 22 and 22A which are vibration-absorptive as mentioned above absorb vibrations which may be applied from the outside to the VCO 10, i.e., they do not vibrate. This prevents the physical distance between the shield case 22 or 22A and the various elements or parts of the circuitry 12 and, therefore, the stray capacitance existing between them from varying in spite of the vibrations. As a result, the oscillation characteristics of the VCO 10 such as oscillation frequency changes little.

Fig. 4 shows a specific construction of the circuitry 12 provided on the body of the VCO 10 and which is implemented as a Colpitts oscillator by way of example. The oscillation frequency of the VCO 10 shown in Fig. 4 is determined by the capacitances of capacitors C5 and C6 and the composite inductance of various elements which are located closer to the input terminal than a capacitor C3. A varactor diode X1 changes its capacitance in response to a DC input voltage, while a capacitor C1 cuts DC components. An inductor L1 is implemented as a coil for oscillation and adjusts the oscillation frequency. The capacitor C3 cuts DC components applied to the collector of a transistor Tr. Assuming that the input is open, and that the impedance of the elements preceding the capacitor C3 is Z, then the impedance Z is expressed as:

\[ Z = \frac{S L_1 (X_1 + C_1)}{S^2 L_1 [X_1 C_1 + C_2 (X_1 + C_1)] + X_1 + C_1} + \frac{1}{s C_3} \]

where s is the Laplace operator.

Further, the impedance Z may be produced by:

\[ Z = j \omega Z(o) \]

where \( Z(o) \) is representative of a real function.

Therefore, it may be regarded that a coil having an inductance \( Z(o) \) exists between the input terminal and the capacitor C3. Resistors R1 and R2 free the transistor Tr from unusual oscillations, while an inductor L2 is a choke coil for preventing high frequency from leaking into the power source. Capacitors C4 and C7 release noise particular to the power source to ground. A capacitor C8 cuts DC components. Further, resistors R3 and R4 are bleeder resistors for determining the operating point of the transistor Tr while a transistor R5 is an emitter resistor for determining the same.

Assuming that the oscillation frequency of the VCO 10 which is dependent on the capacitors C5 and C6 and inductor \( Z(o) \) is \( f_o \), it is expressed as:

\[ f_o = \frac{1}{2\pi} \sqrt{\frac{C_5}{2} + \frac{C_6}{Z(o)}} \quad \text{\((o) = 2\pi f_o\)} \]

However, since the circuitry 12 of the VCO 10 arranged as shown in Fig. 4 is covered with the shield case 22 (Fig. 2) or 22A (Fig. 3), stray capacitance is developed between the shield case 22 or 22A and the circuit parts and elements. Specifically, the oscillation frequency \( f_o \) is affected by the stray capacitance developed from the collector of the transistor Tr to ground in parallel with the capacitors C2 and C6 and varactor diode X1. When the previously mentioned constants C2, X1, C6 and \( Z(o) \) are considered as variables, the degree to which the stray capacitance affects the oscillation frequency \( f_o \) may be expressed by partial differentiation. However, which of such constants has the greatest influence is difficult to determine. In any case, it is obvious that the shield case caused to vibrate by the externally derived vibration changes the stray capacitance and, as a result, the oscillation frequency is changed as if it were frequency modulated with the vibrations. The shield case 22 or 22A in accordance with the present invention absorbs external vibrations and, therefore, does not vibrate since it is made of a conductive vibration-absorptive material. This is successful in preventing the oscillation frequency from being changed by the change in stray capacitance.

An oscillator with a conventional shield case which is made of phosphor bronze or similar metal and an oscillator with a shield case of the present invention which is implemented with a conductive vibration-absorptive material were compared with respect to the S/N ratio, as follows.

As shown in Fig. 5, an arrangement used for measurement, generally 30, has a vibrating unit 32 which is loaded with an object 34 with the intermediary of a 30 millimeters thick baked plate 36. The vibrating unit 32 vibrates the object 34, i.e., the conventional oscillator or the oscillator implemented with the present invention by way of the baked plate 36. The object 34 is affixed to the baked plate 36 at three points, while the baked plate 36 is affixed to the vibrating unit 32 at six points. For measurement, the vibrating unit 32 caused the object 34 to vibrate by 0.24 millimeter (peak-to-peak) at 10 to 50 hertz and by the gravitational acceleration of 1.53 over 50 hertz. The arrangement 50 further has a linear detector 38 to which the outputs of the object 34 and a reference signal generator 40 are applied, and an audio level meter 42 to which the output of the linear detector 38 is applied. The reference signal generator 40 generates an FM signal of 3 kilohertz with 1 kilohertz deviation. The linear detector 38 has no frequency band limitation and the audio level meter 42 includes a psphotometric filter therein.

Assume that the audio level determined by the linear detector 38 by demodulating the output of the object 34 under vibration is N, and that the audio level determined by the detector 38 by demodulating the output of the reference signal generator 40 is S. First, the S/N ratio was determined with the conventional shield case by the arrangement 30. Specifically, a 0.
3 millimeter thick and a 1.0 millimeter thick conventional shield case both of which were made of phosphor bronze were used. Figs. 6 and 7 indicate respectively the S/N ratio (dB) to vibration frequency (Hz) characteristics particular to the oscillator with the 0.3 millimeter thick shield case and the 1.0 millimeter thick shield case, as determined by the measurement. By contrast, Fig. 8 shows a S/N ratio (dB) to vibration frequency (Hz) characteristic obtained with the oscillator with the shield case of the present invention. The shield case of the present invention was implemented with a 0.3 millimeter thick vibration-absorptive alloy (Gentalloy F series available from Toyo Aluminum).

The minimum S/N ratio of the conventional shield case shown in Fig. 6 is smaller than zero decibel, and that of the conventional shield case shown in Fig. 7 is about 21 decibels. On the other hand, the minimum S/N ratio particular to the present invention is 38 decibels as shown in Fig. 8, which is a remarkable improvement over the prior art.

In summary, it will be seen that the present invention provides a shield case structure which is made of a conductive vibration-absorptive material and, therefore, not susceptible to external vibrations. This prevents the physical distance between the shield case and circuitry provided on the body of an oscillator from changing. As a result, the oscillator with such a shield case is capable of oscillating stably in spite of vibrations which may be applied from the outside.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope of the protection sought by the appended claims.

**Claims**

1. A oscillator (10) including oscillator circuitry (12) and a shield case (22) for covering the circuitry (12), characterised in that the shield case (22) is made of a conductive member including a sheet of a vibration absorbing alloy, such as Gentalloy F series or the equivalent, which absorbs vibrations which may be applied to the shield case (22) from the outside.

2. An oscillator (10) as claimed in claim 1, wherein the sheet of vibration absorbing alloy is 0.2 millimetre thick.

3. An oscillator (10) as claimed in claim 1, wherein the shield case (22) has a box-like configuration having an opening (24) at the bottom.

4. An oscillator (10) as claimed in any one of the preceding claims wherein the circuitry (12) is arranged on a face of a hybrid substrate (14) whose back constitutes a grounding surface, a part (26) of the edge portions of the shield case (22) which define the opening (24) being connected to the grounding surface of the hybrid substrate (14).

5. A method of making an oscillator (10), including the step of mounting oscillator circuitry (12) on a substrate (14), characterised in that the method further includes the step of covering the circuitry (12) with a shield case (22) made of a conductive member including a sheet of vibration absorbing alloy, such as Gentalloy F series or the equivalent, which absorbs vibrations which may be applied to the shield case (22) from the outside and which may affect the oscillation frequency of the oscillation circuitry (12).

**Patentansprüche**

1. Ozsillator (10) mit einer Ozsillatorschaltung (12) und einem Abschirmgehäuse (22) zum Abdecken der Schaltung (12), dadurch gekennzeichnet, daß das Abschirmgehäuse (22) aus einem leitfähigen Bauteil hergestellt ist, das eine Schicht aus einer vibrationsdämpfenden Legierung aufweist, wie z. B. aus der Gentalloy F-Serie oder dergleichen, welche Vibrationen absorbiert, die von außen auf das Abschirmgehäuse (22) einwirken können.

2. Ozsillator (10) nach Anspruch 1, wobei die vibrationsdämpfende Legierungsschicht 0,2 Millimeter dick ist.

3. Ozsillator (10) nach Anspruch 1, wobei das Abschirmgehäuse (22) kastenähnlich gestaltet ist und am Boden eine Öffnung (24) aufweist.


5. Verfahren zur Herstellung eines Ozsillators (10) mit dem Schritt der Montage einer Ozsillatorschaltung (12) auf einem Substrat (14), dadurch gekennzeichnet, daß das Verfahren ferner den Schritt der Abdeckung der Schaltung (12) mit einem Abschirmgehäuse (22) aufweist, das aus einem leitfähigen Bauteil hergestellt ist, das eine Schicht aus einer vibrationsdämpfenden Legierung aufweist, wie z. B. aus der Gentalloy F-Serie
oder dergleichen, welche Vibrationen absorbiert, die von außen auf das Abschirmgehäuse (22) einwirken und die Oscillationsfrequenz der Oszillatorschaltung (12) beeinflussen können.

Rervendications

1. Oscillateur (10) comprenant des circuits d’oscillateur (12) et un boîtier de blindage (22) pour recouvrir les circuits (12), caractérisé en ce que le boîtier de blindage (22) est fait d’un élément conducteur comprenant une feuille d’alliage absorbant les vibrations, telle que de la série Gentalloy F ou équivalent, qui absorbe les vibrations qui peuvent être appliquées au boîtier de blindage (22) venant de l’extérieur.

2. Oscillateur (10) selon la revendication 1, dans lequel la feuille d’alliage absorbant les vibrations est de 0,2 millimètre d’épaisseur.

3. Oscillateur (10) selon la revendication 1, dans lequel le boîtier de blindage (22) présente une configuration similaire à une boîte comportant une ouverture (24) dans sa partie inférieure.

4. Oscillateur (10) selon l’une quelconque des revendications précédentes, dans lequel les circuits (12) sont disposés sur une face d’un substrat hybride (14) dont le dos constitue une surface de mise à la masse, une partie (26) des parties de bord du boîtier de blindage (22) qui définissent l’ouverture (24) étant reliées à la surface de mise à la masse du substrat hybride (14).

5. Procédé de fabrication d’un oscillateur (10), comprenant l’étape du montage des circuits d’oscillateur (12) sur un substrat (14) caractérisé en ce que le procédé comprend de plus l’étape consistant à recouvrir les circuits (12) d’un boîtier de blindage (22) fait d’un élément conducteur qui comprend une feuille d’alliage absorbant les vibrations, telle que de la série Gentalloy F ou équivalent, qui absorbe les vibrations qui peuvent être appliquées au boîtier de blindage (22) venant de l’extérieur et qui peuvent affecter la fréquence d’oscillation des circuits oscillateurs (12).