

**BALANCED-TO-UNBALANCED TRANSFORMER****BACKGROUND OF THE INVENTION**

This invention relates to a  
balanced-to-unbalanced transformer employed in information  
5 wiring system for interconnecting balanced signals and  
unbalanced signals.

**DESCRIPTION OF RELATED ART**

For communication between computers or their  
terminal equipments, a wiring by means of coaxial cables  
10 and the like has been employed. In some occasion, it is  
desired to replace such wiring with unshielded twisted  
pair cables (UTP), in which event the  
balanced-to-unbalanced transformer (also known as "balun")  
has been employed for mutual signal interconnection  
15 between the unbalanced signal on the coaxial cable  
(unbalanced cable) and the balanced signal on the twisted  
pair lines (balanced cable). This balanced-to-unbalanced  
transformer is effective to restrain a common mode signal  
voltage which causes any unnecessary electromagnetic  
20 radiation of electromagnetic waves. Here, a transmission  
band has been expanded accompanying an accelerated speed  
of digital signal transmission because of development in  
the computer communication in recent years, and it has  
been demanded to ensure a balanced state over a wide band,  
25 whereby a manufacture of the balanced-to-unbalanced  
transformer has been made complicated and more effective  
measure for noise has been demanded. Further, when pulse  
signals containing a DC component are transmitted through



the balanced cable, in general, there has been employed a balanced-to-unbalanced transformer using a choke type transformer showing an excellent characteristic in common mode signal rejection ratio.

5           According to any known system, however, a common mode ground impedance characteristic is apt to be caused to vary by an installing state or an influence of the foregoing transformer on the balanced line after the installation of the transmission equipment, depending on  
10 the conditions under which the system is used. Due to this, there has been a problem that the unnecessary electromagnetic radiation inductive interference or the like is caused to occur due to a change in such situation as the ground impedance, ground conditions or the like,  
15 which change occurring upon connection of the balanced-to-unbalanced transformer to practical equipments.

#### SUMMARY OF THE INVENTION

          Accordingly, it is a primary object of the  
20 present invention to provide a balanced-to-unbalanced transformer reduced in the amount of the unnecessary electromagnetic radiation.

          In accordance with the present invention, the above object can be realized by means of a  
25 balanced-to-unbalanced transformer for transforming a balanced signal transmitted on a balanced cable and an unbalanced signal transmitted on an unbalanced cable, characterized in that an impedance element is inserted



across signal lines on the side of the balanced cable, and an electrical center point of the impedance elements is connected to at least one of a signal circuit ground and a frame ground on the side of the unbalanced cable.

5           In the present invention, it is possible to reduce the common mode impedance by grounding the center point of the impedance element between the signal lines on the balanced side to the circuit ground or frame ground.

10           In the present invention, further, it is possible to prevent a DC component signal from leaking to the ground by grounding the center point of the impedance element through such capacitive element as a capacitor so that capacitive element cut the DC component to the ground when the DC component signal is transmitted.

15           In the present invention, further, the impedance element is made to show a high impedance with respect to a characteristic impedance of the balanced cable side signal lines, so that any influence on the change in the characteristic impedance of the balanced side signal lines  
20           can be minimized by the addition of the impedance element.

25           Still in the present invention, it is made possible, by an addition of an impedance matching circuit to the signal lines on the unbalanced cable side, to attain a matching of the impedance of the balanced-to-unbalanced transformer as seen from the balanced cable side with the characteristic impedance of the balanced cable side, as well as a matching of the impedance of an unbalanced side input of the transformer



with the impedance of the equipment connected, and to have a role as an attenuation circuit of the transformer filled for reducing a return loss due to the equipments connected.

5 Other objects and advantages of the present invention shall be made clear as the description of the invention advances in the followings as detailed with reference to preferred embodiments shown in accompanying drawings.

10 BRIEF EXPLANATION OF THE DRAWINGS

FIGURE 1 is a schematic circuit diagram of the balanced-to-unbalanced transformer in an embodiment according to the present invention;

15 FIG. 2 is a schematic circuit diagram of the transformer in another embodiment according to the present invention;

FIG. 3 is an explanatory view for the operation of the respective embodiments shown in FIGS. 1 and 2;

20 FIGS. 4a and 4b are explanatory views for the feature in the embodiments of FIGS. 1 and 2;

FIGS. 5 to 8 are schematic circuit diagrams of the transformer in further embodiments according to the present invention; and

25 FIG. 9 is an explanatory view for the operation of the respective embodiments shown in FIGS. 5 to 8.

While the invention shall now be described with reference to the embodiments shown in the accompanying drawings, it should be appreciated that the invention is



not to limit the invention only to these embodiments shown but to include all alterations, modification and equivalent arrangements possible within the scope of appended claims.

5            DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in the followings to an embodiment on the basis of FIG. 1, the drawing is a schematic circuit diagram showing the balanced-to-unbalanced transformer in the embodiment, in which a choke type transformer T1 is  
10 connected at one terminal of a primary side winding and one terminal of a secondary side winding, through a connector CN1, to such unbalanced cable CA1 as a coaxial cable, and at the other terminals of both windings, through a connector CN2, to such balanced cable CA2 as  
15 twisted pair lines or the like. Here, two resistors R1 are connected across the terminals of the transformer T1 on the balanced cable side, while a center point of these two resistors R1 is connected through a capacitor C1 to a frame ground (grounding) FG. While in the present  
20 embodiment the center point is connected through the capacitor C1 to the frame ground (grounding) FG, it may be alternately connected to a ground SG of a signal circuit (a ground of unbalanced circuit). Further, while in the present embodiment the grounding is made through the  
25 capacitor C1, it is also possible to ground the center point of the two resistors R1 directly or through any other impedance element.

Since in the present embodiment the center point



of the two resistors  $R_1$  connected to the balanced cable side of the balanced-to-unbalanced transformer is grounded, it is made possible to provide to the transformer a common mode ground impedance stabilized to be low without relying on any external conditions, as shown in FIG. 3, any noise is made to readily flow to the ground, and the noise on the balanced cable side is reduced. In the event where the grounding is made through the capacitor  $C_1$ , further, a transmission of DC component signals is made possible because of no leakage current to ground.

Here, the ground impedance of common mode is determined by a parallel resistance ( $R_1/2$ ) of the two resistors  $R_1$  connected to the balanced cable side and an impedance of the capacitor  $C_1$  connected to the center point of the resistors. Now, provided that unshielded twisted pair lines of a characteristic impedance  $Z_0=100\Omega$  are used as the balanced cable CA2 and the resistance value of the resistors  $R_1$  is set to be an impedance higher than the characteristic impedance  $Z_0$  to be, for example,  $470\Omega$  to be three to five times as high as the characteristic impedance  $Z_0$ , with the center point of the resistors  $R_1$  grounded directly, a balanced series impedance will be about  $90.38\Omega$  as shown in FIG. 4a, and the common mode impedance will be about  $235\Omega$  as shown in FIG. 4b. In this manner, the impedance with respect to the common mode can be reduced without giving no remarkable influence on the balanced series impedance.



Even in the case where the center point of the resistors R1 is grounded through the capacitor C1, the impedance of the capacitor C1 at a frequency of noise can be kept sufficiently small, there is no substantial increase in the impedance of the common mode with respect to the frequency of noise by the capacitor C1.

FIG. 5 is a schematic circuit diagram showing the balanced-to-unbalanced transformer in another embodiment of the present invention, in which a resistor circuit comprising resistors R2 to R4 is connected to the unbalanced cable side terminals of the transformer T1 in the circuit shown in FIG. 1. These resistors R2 to R4 take a match of the impedance of the balanced-to-unbalanced transformer as seen from the balanced cable side with the characteristic impedance of the balanced cable as well as a match of the impedance of the unbalanced cable side input of the balanced-to-unbalanced transformer with the impedance of the equipments connected, and play a role of an attenuation circuit for reducing any return loss due to the equipments connected. While in the present embodiment the resistors R1 are connected through the capacitor C1 to the frame ground (grounding) FG, it is of course possible to connect them to the ground of the signal circuit (the ground of unbalanced circuit) SG.

FIGS. 6 to 8 are schematic circuit diagrams showing the balanced-to-unbalanced transformer in further embodiments of the present invention, in which multi-pair



cables are used as the balanced cable CA2 and idle lines are grounded. That is, in these embodiments, four pairs of cable lines are employed as the balanced cable CA2, one pair of cable lines connected to terminals 1 and 2 of the connector CN2 are used as the signal lines, while two pairs of cable lines connected to terminals 3 to 6 are connected to the frame ground (grounding) FG or to the ground of the signal circuit (the ground of unbalanced circuit) SG. Further, while in these embodiments the two pairs of the cable lines connected to the terminals 3 to 6 are shown to be grounded, they may be either one pair or three pairs of the cable lines.

In these embodiments, it is possible to further lower the common mode impedance than in the case of the foregoing embodiments, as shown in FIG. 9, and there can be shown an effect of increasing the noise reduction effect.

Since, in the foregoing arrangements, in particular, in the balanced-to-unbalanced transformer for transforming the balanced signal transmitted on the balanced cable and the unbalanced signal transmitted on the unbalanced cable, the impedance element connected across the signal lines on the balanced cable side and the center point of the impedance element are grounded to the circuit ground and frame ground, it has been found that the amount of unnecessary radiation of electromagnetic waves can be effectively reduced.

In the present invention, further, a variety of

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THIS SHEET HAS BEEN  
REPLACED

design modification are possible within a technical scope  
of the appended claims.

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What is claimed is:

1. A balanced-to-unbalanced transformer for transforming a balanced signal transmitted on a balanced cable and an unbalanced signal transmitted on an unbalanced cable, characterized in that an impedance element is inserted across signal lines on the side of the balanced cable, and an electrical center point of said impedance element is connected to at least one of a frame ground and a signal circuit ground on the side of the unbalanced cable.

2. The transformer according to claim 1, wherein the electrical center point of the impedance element is connected through a capacitive element to the signal circuit ground on the side of the unbalanced cable.

3. The transformer according to claim 1, wherein the electrical center point of the impedance element is connected through a capacitive element to the frame ground on the side of the unbalanced cable.

4. The transformer according to claim 2, wherein the impedance element is set to have a high impedance with respect to a characteristic impedance of the signal lines on the side of the balanced cable.

5. The transformer according to claim 3, wherein the impedance element is set to have a high impedance with respect to a characteristic impedance of the signal lines on the side of the balanced cable.

6. The transformer according to claim 2, wherein an impedance correction circuit for an impedance matching is



additionally connected to signal lines on the side of the unbalanced cable.

7. The transformer according to claim 3, wherein an impedance correction circuit for an impedance matching is additionally connected to signal lines on the side of the unbalanced cable.

8. The transformer according to claim 2, wherein multi-pair cable lines are employed as the balanced cable, and idle ones of the cable lines are connected to at least one of the frame ground and signal circuit ground on the unbalanced cable side.

9. The transformer according to claim 3, wherein multi-pair cable lines are employed as the balanced cable, and idle ones of the cable lines are connected to at least one of the frame ground and signal circuit ground on the unbalanced cable side.