

PATENT SPECIFICATION

(11) 1 235 643

DRAWINGS ATTACHED



1 235 643

(21) Application No. 4633/70 (22) Filed 30 Jan. 1970

(45) Complete Specification published 16 June 1971

(51) International Classification H 03 f 1/00

(52) Index at acceptance

H3T 1A1 1A2 2L

(72) Inventor KENNETH WILLIAM MAULDING

(54) INPUT AND OUTPUT CIRCUIT WIRING ARRANGEMENT FOR TWO-PORT CIRCUIT ELEMENT

(71) We, MULLARD LIMITED of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to input and output circuit wiring arrangements for two-port electric circuit elements.

In the case, for example, of an amplifier working at high gain and/or high frequency capacitance and inductive effects between the output circuit wiring and the input circuit wiring for the amplifier can produce unwanted feedback between the amplifier's output and input circuits.

It is known that such unwanted feedback can be eliminated by using coaxial connections for the input and output circuit wiring. However, it may not always be possible to employ coaxial connections for this purpose; for instance, in the case where an amplifier (or other two-port circuit element) is to be plugged into printed circuit wiring in which is incorporated the input and output circuit wiring for the amplifier.

According to the present invention an input and output circuit wiring arrangement for a two-port circuit element comprises a signal conductor arranged symmetrically between twin earth conductors to form a symmetrical but unbalanced connection for one port of the element, and two signal conductors which form a symmetrical and balanced push-pull connection for the other port of the element.

In carrying out the invention the connection formed by the signal conductor arranged between the twin earth conductors can be for either the input port or the output port of the two-port circuit element with the push-pull connection formed by the two signal conductors for the other port.

As will be described by using an input and output circuit wiring arrangement according to the invention, a symmetrical

wiring layout can be realised which effects substantially complete cancellation of both inductive and capacitive feedback between the output circuit wiring and the input circuit wiring for a two-port circuit element.

The invention is particularly (but not exclusively) suited to realisation as printed circuit wiring because accuracy in the symmetry of the wiring layout can be readily achieved by known printed circuit wiring techniques.

In further considering the nature of the invention reference will now be made by way of example, to the accompanying drawings in which:—

Figure 1 shows diagrammatically known forms of input and output circuit wiring arrangements;

Figure 2 shows an input and output circuit wiring arrangement according to the invention; and

Figure 3 shows diagrammatically the realisation of an input and output circuit wiring arrangement according to the invention as printed circuit wiring.

Referring to the drawings, in Figure 1a a two-port circuit element 1 has an input port 2 to which a source 3 is connected and an output port 4 to which a load 5 is connected. Both the input circuit wiring and the output circuit wiring for the element 1 are asymmetric and unbalanced due to the connection to earth of the lower terminal of each port. As signified by the arrowed lines 6 and 7 such an input and output circuit wiring arrangement can suffer from both capacitive and inductive feedback between the input circuit wiring and the output circuit wiring. The inductive feedback is due to the mutual coupling (M) between the input circuit wiring and the output circuit wiring, and the capacitive feedback (C) is due to the capacitance between the live input wire and the live output wire.

In the arrangement shown in Figure 1b, in which parts corresponding to similar parts in Figure 1a have been given the same ref-

[Price 25p]

erence numerals, the earth connection at the lower terminal of each port has been removed so that both the input circuit wiring and the output circuit wiring is now balanced and symmetrical. Approximately equal capacitances are now present between the conductors of the input and output circuit wiring, the capacitive currents of which are mutually cancelling so that the capacitive feedback is approximately eliminated. However, inductive feedback can still be present due to the mutual coupling (M) between the input circuit wiring and the output circuit wiring.

In the arrangement shown in Figure 1c, in which also parts corresponding to similar parts in Figure 1a have been given the same reference numerals, the input circuit wiring and the output circuit wiring each comprises a signal conductor 8 (or 9) arranged symmetrically between twin earth conductors 10 and 11 (or 12 and 13) to form a symmetrical but unbalanced connection to each port of the two-port circuit element 1. In this arrangement, inductive feedback is approximately eliminated because approximately equal but opposite mutual inductance exists between each input loop and each output loop. However, capacitive feedback can still be present because capacitances between the live input wire and the live output wire are not all mutually cancelling.

Turning now to Figure 2, the input and output circuit wiring arrangement there shown is in accordance with the present invention and comprises input circuit wiring of the form shown in Figure 1c and output circuit wiring of the form shown in Figure 1b. It has been found that by using such a hybrid arrangement a substantially complete cancellation of both inductive and capacitive feedback is possible. More specifically, the use at one port of the two-port circuit element 1 of circuit wiring comprising a signal conductor arranged symmetrically between twin earth conductors provides for the elimination of inductive feedback by the production of mutually cancelling fluxes, and the use at the other port of circuit wiring comprising symmetrical and balanced push-pull conductors provides for the elimination of capacitive feedback by the production of mutually cancelling capacitances between the conductors of the input and output circuit wiring.

The same effect is achieved with the input and output circuit wiring reversed, that is, with the wiring of the form shown in Figure 1b connected at the input port of the two-port element 1 and the wiring of the form shown in Figure 1c connected at the output port.

Figure 3 shows a printed circuit wiring layout corresponding to the input and output circuit wiring arrangement of Figure 2.

This printed circuit wiring layout comprises a main earth region 14 which bounds a long narrow slot 15 and a second broader, slot 16. A signal conductor 17 is provided centrally in the slot 15, and two signal conductors 18 and 19 are provided symmetrically in the slot 16 in spaced relationship. Terminal holes 20, 20a allow connection of a source (or load) between the earth region 14 and the signal conductor 17, terminal holes 21, 21a and 21b allow connection of the input port, (or output port) of a two-port circuit element (e.g. an amplifier) to the earth region 14 and the signal conductor 17 (the connection to the earth region being thus a twin earth connection), terminal holes 22, 22a allow connection of the output port (or input port) of the two-port circuit element to the signal conductors 18 and 19, and terminal holes 23, 23a allow connection of a load (or source) to the signal conductors 18 and 19. The connection comprising the earth region 14 and the signal conductor 17 will be a symmetrical but unbalanced connection, and the connection comprising the two signal conductors 18 and 19 will be a balanced push-pull connection.

It is mentioned that whereas there is only approximate elimination of capacitive feedback in the arrangement of Figure 1b and only approximate elimination of inductive feedback in the arrangement of Figure 1c, the hybrid use of such arrangements in accordance with the invention results in substantially complete elimination of both capacitive and inductive feedback due to the complete symmetry which can be obtained between the input and output conductors with such a hybrid arrangement.

WHAT WE CLAIM IS:—

1. An input and output circuit wiring arrangement for a two-port circuit element, said arrangement comprising a signal conductor arranged symmetrically between twin earth conductors to form a symmetrical but unbalanced connection for one port of the element, and two signal conductors which form a symmetrical and balanced push-pull connection for the other port of the element.

2. A circuit wiring arrangement as claimed in Claim 1, in combination with a two-port circuit element having the connection formed by the signal conductor arranged between the twin earth conductors connected to either its input port or its output port and the push-pull connection formed by the two signal conductors connected to its other port.

3. A circuit wiring arrangement as claimed in Claim 1, or the circuit wiring arrangement of the combination claimed in Claim 2, realised as printed circuit wiring.

4. A circuit wiring arrangement as claimed in Claim 3, wherein said printed circuit wiring is a printed circuit layout com-

erence numerals, the earth connection at the lower terminal of each port has been removed so that both the input circuit wiring and the output circuit wiring is now balanced and symmetrical. Approximately equal capacitances are now present between the conductors of the input and output circuit wiring, the capacitive currents of which are mutually cancelling so that the capacitive feedback is approximately eliminated. However, inductive feedback can still be present due to the mutual coupling (M) between the input circuit wiring and the output circuit wiring.

In the arrangement shown in Figure 1c, in which also parts corresponding to similar parts in Figure 1a have been given the same reference numerals, the input circuit wiring and the output circuit wiring each comprises a signal conductor 8 (or 9) arranged symmetrically between twin earth conductors 10 and 11 (or 12 and 13) to form a symmetrical but unbalanced connection to each port of the two-port circuit element 1. In this arrangement, inductive feedback is approximately eliminated because approximately equal but opposite mutual inductance exists between each input loop and each output loop. However, capacitive feedback can still be present because capacitances between the live input wire and the live output wire are not all mutually cancelling.

Turning now to Figure 2, the input and output circuit wiring arrangement there shown is in accordance with the present invention and comprises input circuit wiring of the form shown in Figure 1c and output circuit wiring of the form shown in Figure 1b. It has been found that by using such a hybrid arrangement a substantially complete cancellation of both inductive and capacitive feedback is possible. More specifically, the use at one port of the two-port circuit element 1 of circuit wiring comprising a signal conductor arranged symmetrically between twin earth conductors provides for the elimination of inductive feedback by the production of mutually cancelling fluxes, and the use at the other port of circuit wiring comprising symmetrical and balanced push-pull conductors provides for the elimination of capacitive feedback by the production of mutually cancelling capacitances between the conductors of the input and output circuit wiring.

The same effect is achieved with the input and output circuit wiring reversed, that is, with the wiring of the form shown in Figure 1b connected at the input port of the two-port element 1 and the wiring of the form shown in Figure 1c connected at the output port.

Figure 3 shows a printed circuit wiring layout corresponding to the input and output circuit wiring arrangement of Figure 2.

This printed circuit wiring layout comprises a main earth region 14 which bounds a long narrow slot 15 and a second broader, slot 16. A signal conductor 17 is provided centrally in the slot 15, and two signal conductors 18 and 19 are provided symmetrically in the slot 16 in spaced relationship. Terminal holes 20, 20a allow connection of a source (or load) between the earth region 14 and the signal conductor 17, terminal holes 21, 21a and 21b allow connection of the input port, (or output port) of a two-port circuit element (e.g. an amplifier) to the earth region 14 and the signal conductor 17 (the connection to the earth region being thus a twin earth connection), terminal holes 22, 22a allow connection of the output port (or input port) of the two-port circuit element to the signal conductors 18 and 19, and terminal holes 23, 23a allow connection of a load (or source) to the signal conductors 18 and 19. The connection comprising the earth region 14 and the signal conductor 17 will be a symmetrical but unbalanced connection, and the connection comprising the two signal conductors 18 and 19 will be a balanced push-pull connection.

It is mentioned that whereas there is only approximate elimination of capacitive feedback in the arrangement of Figure 1b and only approximate elimination of inductive feedback in the arrangement of Figure 1c, the hybrid use of such arrangements in accordance with the invention results in substantially complete elimination of both capacitive and inductive feedback due to the complete symmetry which can be obtained between the input and output conductors with such a hybrid arrangement.

WHAT WE CLAIM IS:—

1. An input and output circuit wiring arrangement for a two-port circuit element, said arrangement comprising a signal conductor arranged symmetrically between twin earth conductors to form a symmetrical but unbalanced connection for one port of the element, and two signal conductors which form a symmetrical and balanced push-pull connection for the other port of the element.

2. A circuit wiring arrangement as claimed in Claim 1, in combination with a two-port circuit element having the connection formed by the signal conductor arranged between the twin earth conductors connected to either its input port or its output port and the push-pull connection formed by the two signal conductors connected to its other port.

3. A circuit wiring arrangement as claimed in Claim 1, or the circuit wiring arrangement of the combination claimed in Claim 2, realised as printed circuit wiring.

4. A circuit wiring arrangement as claimed in Claim 3, wherein said printed circuit wiring is a printed circuit layout com-



prising a main earth region which bounds first and second narrow slots aligned with each other, a first signal conductor provided centrally in said first slot and extending
5 along it longitudinally, second and third signal conductors provided symmetrically in said second slot and extending longitudinally along it in spaced relationship, and terminal
10 holes or other means for the connection of one port of the two-port circuit element to said first signal conductor and said earth region at each side of that conductor, for the connection of the other port of the two-port
15 circuit element to said second and third signal conductors, and for the connection of a source and load to the two-port circuit element, the one between the earth region and said first signal conductor and the other
20 across said second and third signal conductors.

5. A circuit wiring arrangement substantially as hereinbefore described with reference to Figure 2 of the accompanying drawing.

6. A printed circuit wiring layout substantially as hereinbefore described with reference to Figure 3 of the accompanying drawing. 25

7. An arrangement as claimed in Claim 5 or a layout as claimed in Claim 6, in combination with a two-port circuit element having its input and output ports connected thereto. 30

G. V. CARCASSON,
Chartered Patent Agent,
Mullard House,
Torrington Place,
London, W.C.1.
Agent for the Applicants

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1971.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

