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(54) SEMI-CONDUCTOR DEVICE

(71) We, KABUSHIKI KAISHA DAINI SEIKOSHA, a Japanese company, of 31-1, 6-chome, Kameido, Koto-ku, Tokyo, Japan,

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 semi-conductor devices and to methods of making the same.

One know semiconductor device includes an oscillator circuit and is formed as an IC chip which is encapsulated or sealed in a resin casing with external electrical connections extending outside the casing. A plurality of condensers are provided within the casing as part of the oscillator circuit and the output frequency to an external circuitry is determined by the connection of that external circuitry to the external electrical connections, the condensers being electrically connected or short-circuited as necessary. However, this semi-conductor device has the disadvantage of a relatively large size due to the relatively large number of external electrical connections required and it is troublesome to provide the external circuitry with a signal of exactly the required frequency because the external circuitry must be soldered to the external electrical connections and any excess solder must be removed.

According to one aspect of the present invention, there is provided a semiconductor device comprising an electronic circuit consisting of a plurality of circuit components, an electrical connection electrically connected to the electronic circuit, a resin casing in which the electronic circuit and the electrical connection are encapsulated or sealed with a portion of the electrical connection extending outwardly of the casing for connection to an external circuitry, and one or more holes formed in the casing and the electrical connection electrically disconnecting one or more of the circuit components from the electrical connection.

The electronic circuit is preferably formed as an IC chip.

The electronic circuit may be electrically connected to the electrical lead frame by means of one or more gold or aluminium wires.

In the preferred embodiment the electronic circuit comprises or includes an oscillator circuit connected to a quartz crystal vibrator and including a plurality of condensers electrically connected in parallel with one another, said one or more holes being formed in the casing and the electrical connection electrically disconnecting one or more of said condensers from the electrical connection.

Said hole or holes may be circular in cross-section.

According to a further aspect of the present invention there is provided a method of making a semi-conductor device comprising an electronic circuit consisting of a plurality of circuit components an electrical connection electrically connected to the electronic circuit and a resin casing in which the electronic circuit and the electrical connection are encapsulated or sealed with a portion of the electrical connection extending outwardly of the casing for connection to an external circuitry, the method comprising forming one or more holes in the casing and the electrical connection electrically disconnecting one or more of the circuit components from the electrical connection.

Preferably said one or more holes are each formed by drilling.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 is a plan view of one embodi-

ment of a semi-conductor device according to the present invention;

Figure 2 is a section taken on the line A-A' of Figure 1;

Figure 3 illustrates the semi-conductor device of Figure 1 in greater detail; and

Figure 4 illustrates a modification of the semi-conductor device of Figure 1.

Referring first to figures 1 and 2 there is shown an embodiment of a semi-conductor device according to the present invention including an IC chip 1 comprising a main circuit and a selecting circuit portion, e.g. an oscillator circuit. The IC chip 1 is connected to electrical connections 2,5. The IC chip 1 and the electrical connections are encapsulated or otherwise sealed in a moulded resin casing 3. The IC chip 1 has input and output electrodes 1*a* each of which is electrically connected to a respective one of the electrical connections 2,5 by thin wires 4 made of, for example, aluminium or gold. One of the electrical connections indicated by the reference numeral 5, is connected to the selecting circuit portion of the IC chip. The electrical connection 5 has a plurality (six shown) of terminals 5*a* each of which is electrically connected to a respective one of the electrodes 1*a* of the IC chip by way of the wires 4.

Printed marks or cavities 6 (figure 2) are provided on the exterior surface of the casing 3 in positions corresponding to the locations where the terminals 5*a* are fixed to the electrical connection 5. The electrical circuit between a selected electrode or selected electrodes 1*a* of the selecting circuit portion of the IC chip 1 and the electrical connection 5 can be broken so that the semi-conductor device functions in a prescribed manner, by using a drill and drilling through the casing 3 at the location of the corresponding terminal or terminals 5*a*. In the embodiment shown in Figures 1 and 2 a circular hole is made in the casing 3 and in the electrical connection 5 at the location of one of the terminals 5*a* to disconnect it electrically from the corresponding electrode 1*a*. However, as shown in Figure 4, the same effect may be achieved by producing a rectangular hole or slot in the casing 3 and in the electrical connection 5.

Referring now to figure 3, the construction of the IC chip 1 is shown in greater detail. A quartz crystal vibrator 7 is mounted on the exterior of the casing 3. An inverter 8 forming part of the oscillator circuit of the IC chip is connected in parallel with the vibrator 7 *via* the wires 4. An output electrical terminal from the oscillator circuit is indicated by the reference numeral 9. The oscillator circuit includes a quartz crystal vibrator (not shown) and a fixed value condenser 11 for temperature compensation. A fixed value main condenser 12 is provided for frequency adjustment, and a plurality (four shown) of adjustment condenser 13*a*, 13*b*, 13*c*, 13*d* are connected in parallel therewith by way of the wires 4. An electrical lead wire 14 is also connected in parallel with the condensers 12, 13*a*, 13*b*, 13*c*, 13*d* which are thereby short-circuited. When the frequency of oscillation of the output signal at the terminal 9 is to be adjusted a hole 15 is formed to disconnect the wire 14 from the electrical connection 5 which is connected to earth thereby. The condenser 12 and the condensers 13*a*, 13*b*, 13*c*, 13*d* are then no longer short-circuited and the oscillator circuit operates. Subsequently, to adjust the frequency of oscillation of the output signal one or more of holes 16,17,18,19 are selectively drilled in the casing 3 in order to disconnect respective ones of the condensers 13*a*, 13*b*, 13*c*, 13*d*, from the earth 10. Thus the effective capacitance of the circuit changes to achieve the desired frequency of oscillation of the output signal.

It will be appreciated that the present invention is not limited to adjusting the value of a quantity by means of condensers, but also is applicable to other circuit elements or components.

The semi-conductor devices described above have the advantage that the electronic circuitry thereof can be adjusted even though the semi-conductor devices are encapsulated or sealed in the casing 3 and also the advantage that they are relatively small in size.

WHAT WE CLAIM IS:

1. A semi-conductor device comprising an electronic circuit consisting of a plurality of circuit components, an electrical connection electrically connected to the electronic circuit, a resin casing in which the electronic circuit and the electrical connection are encapsulated or sealed with a portion of the electrical connection extending outwardly of the casing for connection to an external circuitry, and one or more holes formed in the casing and the electrical connection electrically disconnecting one or more of the circuit components from the electrical connection.

2. A device as claimed in claim 1 in which the electronic circuit is formed as an IC chip.

3. A device as claimed in claim 1 or 2 in which the electronic circuit is electrically connected to the electrical connection by means of one or more gold or aluminium wires.

4. A device as claimed in any preceding claim in which the electronic circuit includes an oscillator circuit, connected to a

ment of a semi-conductor device according to the present invention;

Figure 2 is a section taken on the line A-A' of Figure 1;

Figure 3 illustrates the semi-conductor device of Figure 1 in greater detail; and

Figure 4 illustrates a modification of the semi-conductor device of Figure 1.

Referring first to figures 1 and 2 there is shown an embodiment of a semi-conductor device according to the present invention including an IC chip 1 comprising a main circuit and a selecting circuit portion, e.g. an oscillator circuit. The IC chip 1 is connected to electrical connections 2,5. The IC chip 1 and the electrical connections are encapsulated or otherwise sealed in a moulded resin casing 3. The IC chip 1 has input and output electrodes 1*a* each of which is electrically connected to a respective one of the electrical connections 2,5 by thin wires 4 made of, for example, aluminium or gold. One of the electrical connections indicated by the reference numeral 5, is connected to the selecting circuit portion of the IC chip. The electrical connection 5 has a plurality (six shown) of terminals 5*a* each of which is electrically connected to a respective one of the electrodes 1*a* of the IC chip by way of the wires 4.

Printed marks or cavities 6 (figure 2) are provided on the exterior surface of the casing 3 in positions corresponding to the locations where the terminals 5*a* are fixed to the electrical connection 5. The electrical circuit between a selected electrode or selected electrodes 1*a* of the selecting circuit portion of the IC chip 1 and the electrical connection 5 can be broken so that the semi-conductor device functions in a prescribed manner, by using a drill and drilling through the casing 3 at the location of the corresponding terminal or terminals 5*a*. In the embodiment shown in Figures 1 and 2 a circular hole is made in the casing 3 and in the electrical connection 5 at the location of one of the terminals 5*a* to disconnect it electrically from the corresponding electrode 1*a*. However, as shown in Figure 4, the same effect may be achieved by producing a rectangular hole or slot in the casing 3 and in the electrical connection 5.

Referring now to figure 3, the construction of the IC chip 1 is shown in greater detail. A quartz crystal vibrator 7 is mounted on the exterior of the casing 3. An inverter 8 forming part of the oscillator circuit of the IC chip is connected in parallel with the vibrator 7 *via* the wires 4. An output electrical terminal from the oscillator circuit is indicated by the reference numeral 9. The oscillator circuit includes a quartz crystal vibrator (not shown) and a fixed value condenser 11 for temperature compensation. A fixed value main condenser 12 is provided for frequency adjustment, and a plurality (four shown) of adjustment condenser 13*a*, 13*b*, 13*c*, 13*d* are connected in parallel therewith by way of the wires 4. An electrical lead wire 14 is also connected in parallel with the condensers 12, 13*a*, 13*b*, 13*c*, 13*d* which are thereby short-circuited. When the frequency of oscillation of the output signal at the terminal 9 is to be adjusted a hole 15 is formed to disconnect the wire 14 from the electrical connection 5 which is connected to earth thereby. The condenser 12 and the condensers 13*a*, 13*b*, 13*c*, 13*d* are then no longer short-circuited and the oscillator circuit operates. Subsequently, to adjust the frequency of oscillation of the output signal one or more of holes 16,17,18,19 are selectively drilled in the casing 3 in order to disconnect respective ones of the condensers 13*a*, 13*b*, 13*c*, 13*d*, from the earth 10. Thus the effective capacitance of the circuit changes to achieve the desired frequency of oscillation of the output signal.

It will be appreciated that the present invention is not limited to adjusting the value of a quantity by means of condensers, but also is applicable to other circuit elements or components.

The semi-conductor devices described above have the advantage that the electronic circuitry thereof can be adjusted even though the semi-conductor devices are encapsulated or sealed in the casing 3 and also the advantage that they are relatively small in size.

WHAT WE CLAIM IS:

1. A semi-conductor device comprising an electronic circuit consisting of a plurality of circuit components, an electrical connection electrically connected to the electronic circuit, a resin casing in which the electronic circuit and the electrical connection are encapsulated or sealed with a portion of the electrical connection extending outwardly of the casing for connection to an external circuitry, and one or more holes formed in the casing and the electrical connection electrically disconnecting one or more of the circuit components from the electrical connection.

2. A device as claimed in claim 1 in which the electronic circuit is formed as an IC chip.

3. A device as claimed in claim 1 or 2 in which the electronic circuit is electrically connected to the electrical connection by means of one or more gold or aluminium wires.

4. A device as claimed in any preceding claim in which the electronic circuit includes an oscillator circuit, connected to a

quartz crystal vibrator and including a plurality of condensers electrically connected in parallel with one another, said one or more holes being formed in the casing and the electrical connection electrically disconnecting one or more of said condensers from the electrical connection.

5. A device as claimed in any preceding claim in which said hole or holes are circular in cross-section.

6. A semi-conductor device substantially as herein described with reference to and as shown in the accompanying drawings.

7. A method of making a semi-conductor device comprising an electronic circuit consisting of a plurality of circuit components, an electrical connection electrically connected to the electronic circuit and a resin casing in which the electronic circuit and the electrical connection are encapsulated or sealed with a portion of the electrical connection extending outwardly of the casing for connection to an external circuitry, the method comprising forming one or more holes in the casing and the electrical connection electrically disconnecting one or more of the circuit components from the electrical connection.

8. A method as claimed in claim 7 in which said one or more holes are each formed by drilling.

9. A method of making a semi-conductor device substantially as herein described with reference to and as shown in the accompanying drawings.

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