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Liou et al.

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(54) **WEARABLE WIRELESS ELECTRONIC DEVICE**

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H01Q 1/12 (2006.01)
G04R 60/02 (2013.01)
G04R 60/14 (2013.01)

(52) **U.S. Cl.**
CPC ***G04R 60/02*** (2013.01); ***G04R 60/14*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/273; H01Q 7/00; H01Q 9/26; G04G 21/04
USPC ..... 343/718, 700 MS, 908, 878; 368/10, 47
See application file for complete search history.

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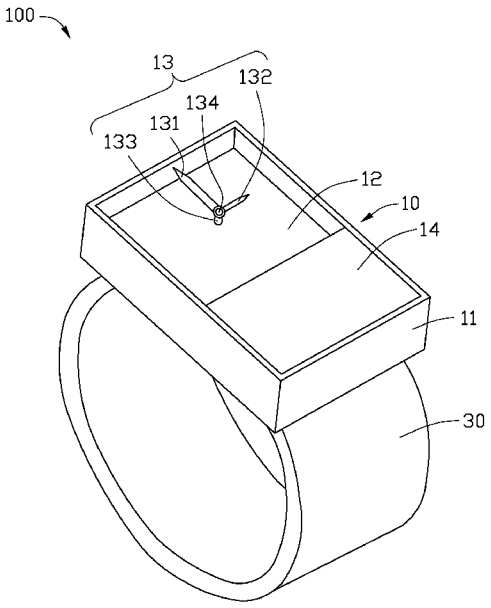
(57) **ABSTRACT**

A wearable wireless electronic device includes a watch dial and a hand module. The hand module includes a first hand and a second hand that are rotatably coupled to the watch dial. The first and second hands are configured to indicate current time and send/receive wireless signals. When the first and second hands rotate relative to the watch dial, the first and second hands are configured to display current time. When the first hand is positioned at a predetermined position substantially perpendicular to the second hand, the first and second hands are configured to send/receive wireless signals.

14 Claims, 4 Drawing Sheets



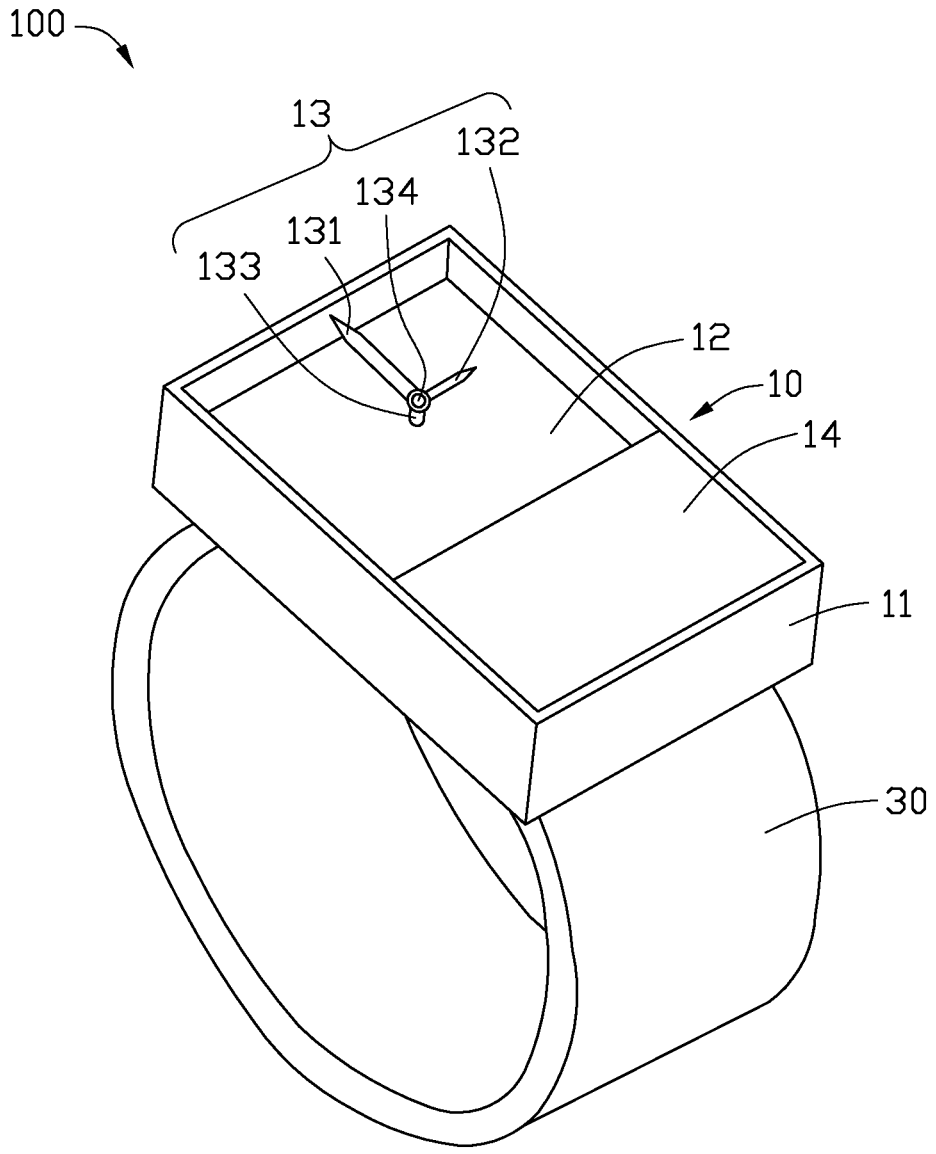


FIG. 1

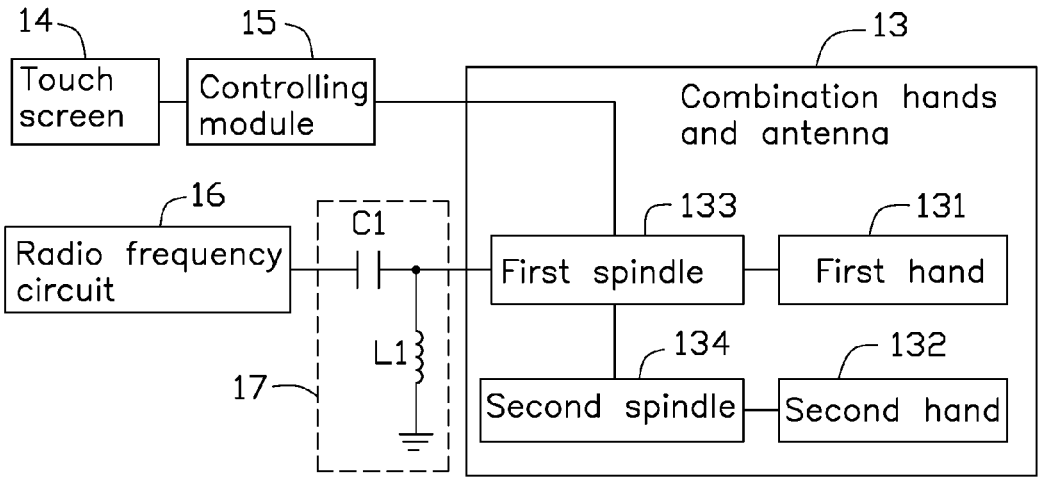

14
Touch screen
15
Controlling module
13
Combination hands and antenna
16
Radio frequency circuit
C1
L1
17
133
First spindle
131
First hand
134
Second spindle
132
Second hand

FIG. 2

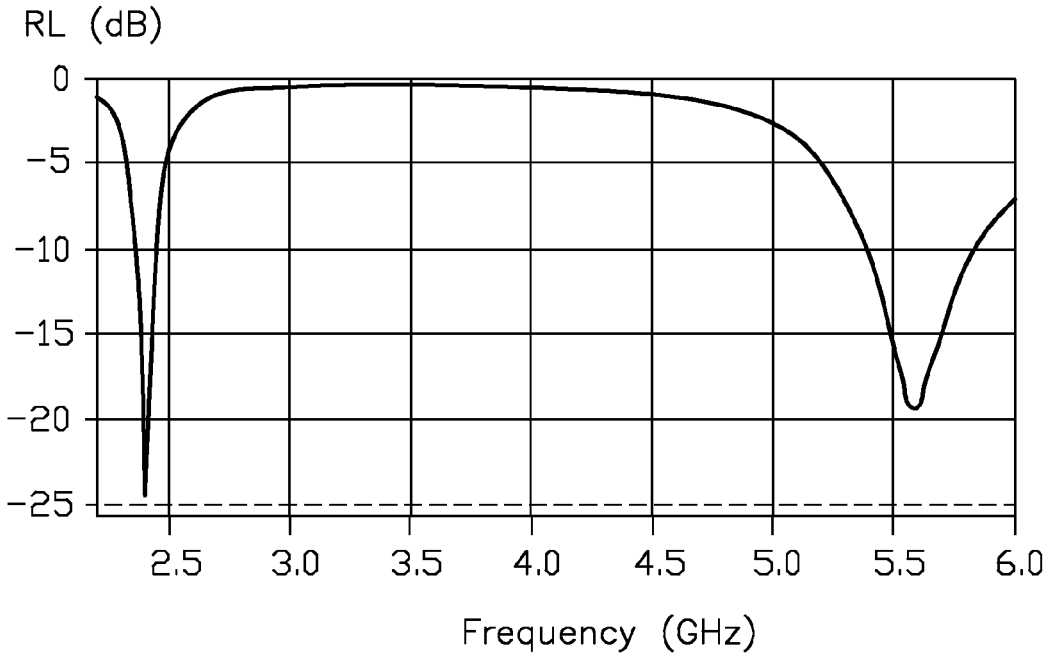


FIG. 3

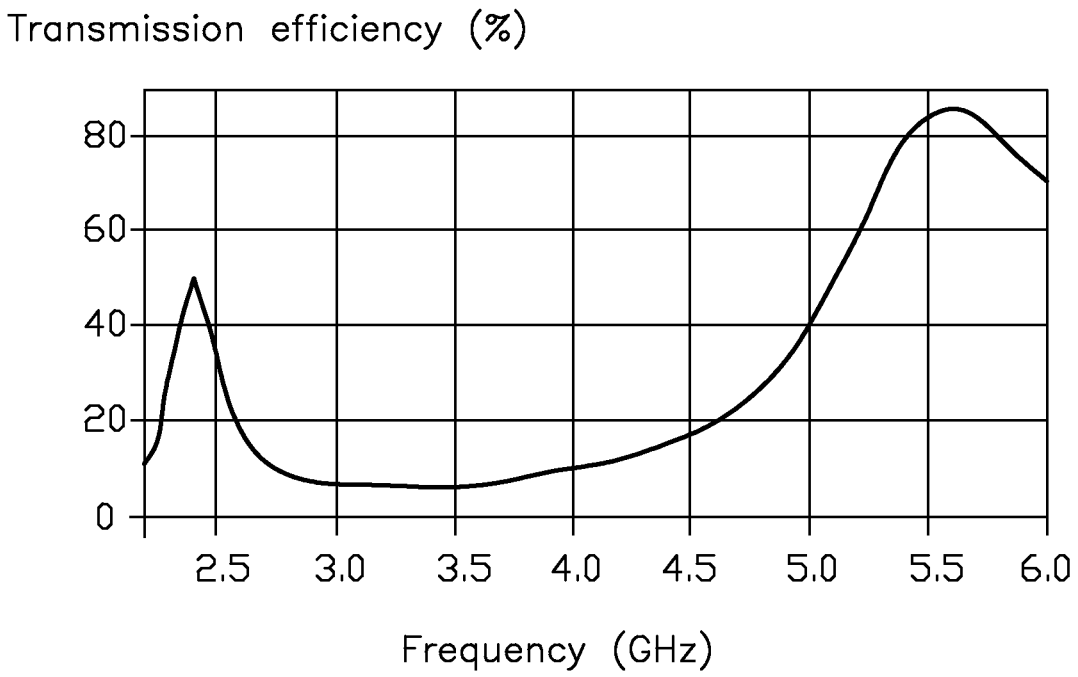

Transmission efficiency (%)
80
60
40
20
0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Frequency (GHz)

FIG. 4

WEARABLE WIRELESS ELECTRONIC DEVICE

FIELD

The subject matter herein generally relates to wearable devices, and particularly to a wearable wireless electronic device having an antenna.

BACKGROUND

As wireless communication technology develops, most portable electronic devices have wireless communication function. The wireless communication needs a physical antenna to be the medium for transmitting or receiving signals. The antenna will cause an increase in volume, when the volume of the electronic device such as an electronic device worn on a wrist is small, it is difficult to keep the device with small and exquisite appearance.

BRIEF DESCRIPTION OF THE DRAWINGS

Implementations of the present technology will now be described, by way of example only, with reference to the attached figures.

FIG. **1** is an isometric view of one embodiment of a wearable wireless electronic device.

FIG. **2** is a block diagram of the wearable wireless electronic device as shown in FIG. **1**.

FIG. **3** is a diagram showing return loss ("RL") measurements of a hand module of the wearable wireless electronic device as shown in FIG. **1**.

FIG. **4** is a diagram showing transmission efficiency measurements of a hand module of the wearable wireless electronic device as shown in FIG. **1**.

DETAILED DESCRIPTION

It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein can be practiced without these specific details. In other instances, methods, procedures and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

Several definitions that apply throughout this disclosure will now be presented.

The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently connected or releasably connected. The term "comprising" when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the like.

FIG. **1** illustrates an isometric view of one embodiment of a wearable wireless electronic device **100** having time indication and wireless communication functions. The wireless electronic device **100** includes a main body **10** and a strap **30** coupled to two ends of the main body **10**. The strap **30** is configured to be worn on a wrist of a user. The main body **10** includes a casing **11**, a watch dial **12**, a touch screen **14** and a hand module **13**. The watch dial **12** and the touch screen **14** are received in the casing **11** side by side.

The hand module **13** is configured to either indicate current time or serve as an antenna. The hand module **13** includes a first hand **131**, a second hand **132**, a first spindle **133** and a second spindle **134**. The first and second hands **131**, **132** are hour hand and minute hand, respectively. The first spindle **133** is coupled to the first hand **131**. The second spindle **134** is coupled to the second hand **132**. The first and second spindles **133**, **134** are configured to drive the first and second hands **131**, **132** to rotate, respectively, thereby displaying current time, and further configured to feed current signals to the first and second hands **131**, **132** respectively. When the first and second hands **131**, **132** rotate relative to the watch dial **12**, the first and second hands **131**, **132** display current time. When the first and second hands **131**, **132** are motionless at a predetermined position, the first and second hands **131**, **132** serve as an antenna to send/receive wireless signals. In at least one embodiment, when the first and second hands **131**, **132** serve as the antenna, the first hand **131** is substantially perpendicular to the second hand **132**. For example, when the first and second hands **131** and **132** serve as the antenna, the first and second hands **131** and **132** can be positioned at the three o'clock position as shown in FIG. **1**.

The touch screen **14** is configured to indicate current time when the hand module **13** serve as the antenna, and further configured to select the function of the hand module **13** in response to a touch of a user.

FIG. **2** illustrates a block diagram of the wearable wireless electronic device **100** as shown in FIG. **1**. The wearable wireless electronic device **100** is further provided with a controlling module **15**, a radio frequency circuit **16**, and an impedance matching circuit **17**. The controlling module **15** is electronically coupled to the touch screen **14**, and is configured to control operations of the first and second hands **131**, **132** in response to commands input from the touch screen **14** by a user. In particular, when the controlling module **15** receives a first command from the touch screen **14**, the controlling module **15** controls the first and second spindles **133** and **134** to drive the first and second hands **131**, **132** to the predetermined position, and controls the first and second hands **131**, **132** to remain motionless for a period of time to serve as an antenna to send/receive wireless signal. Alternatively, when the controlling module **15** receives a second command from the touch screen **14** during the first and second hands **131**, **132** serve as the antenna, the controlling module **15** controls the first and second hands **131**, **132** to move to a position in which the first and second hands **131**, **132** indicate the current time, and further controls the first and second hands **131**, **132** to rotate to keep indicating the current time.

The radio frequency circuit **16** is electronically coupled to the first and second hands **131**, **132** through the impedance matching circuit **17**. In particular, the impedance matching circuit **17** includes a capacitor C**1** and an inductor L**1**. The radio frequency circuit **16** is grounded via the capacitor C**1** and the inductor L**1**, a node between the capacitor C**1** and the inductor L**1** is electronically coupled to the first and second spindles **133**, **134**. Accordingly, the radio frequency circuit **16** can feed current signals to the first and second hands **131**, **132** through the impedance matching circuit **17** and the first

and second spindles **133**, **134**, to drive the first and second hands **131**, **132** to send/receive wireless signals. The capacitor C**1** with appropriate capacitance and the inductor L**1** with appropriate inductance can ensure the hand module **13** resonates at a desired frequency band. In at least one embodiment, the capacitance value of the capacitor C**1** is about 700 pF; the inductance value of the inductor L**1** is about 1.5 nH. The first hand **131** is configured to receive/send wireless signal at a first frequency band from about 5200 MHz to about 5800 MHz (WiFi); the second hand **132** is configured to send/receive wireless signal at a second frequency band from about 2400 MHz to about 2484 MHz (Bluetooth).

FIG. **3** illustrates a diagram showing return loss ("RL") measurements of the hand module **13** as shown in FIG. **1**. It can be derived from FIG. **3** that RL is lower than −5 dB when the hand module **13** operates at the first frequency band from about 5200 MHz to about 5800 MHz, and the second frequency band from about 2400 MHz to about 2484 MHz.

FIG. **4** illustrates a diagram showing transmission efficiency measurements of the hand module **13** as shown in FIG. **1**. A transmission efficiency of the hand module **13** at the first frequency band from about 5200 MHz to about 5800 MHz is in a range from about 60% to about 82%, and the transmission efficiency of the hand module **13** at the second frequency band from about 2400 MHz to about 2484 MHz is in a range from about 40% to about 50%. Thus, the hand module **13** can be utilized in WiFi and Bluetooth communication system with an exceptional communication quality

In summary, the wearable wireless electronic device **100** utilizes the first and second hands **131**, **132** to serve as antenna to send/receive wireless signals, thus there is no need to distribute additional volume to the antenna, and a small and exquisite appearance of the wearable wireless electronic device **100** can be achieved.

The embodiments shown and described above are only examples. Many details are often found in the art. Therefore, many such details are neither shown nor described. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, including in matters of shape, size and arrangement of the parts within the principles of the present disclosure up to, and including the full extent established by the broad general meaning of the terms used in the claims. It will therefore be appreciated that the embodiments described above may be modified within the scope of the claims.

What is claimed is:

1. A wearable wireless electronic device comprising:

a watch dial;

a hand module comprising a first spindle, a second spindle, a first hand and a second hand, the first spindle rotatably coupled to the watch dial, the second spindle rotatably coupled to the first spindle, the first spindle coupled to the first hand, the second spindle coupled to the second hand;

a radio frequency circuit; and

an impedance matching circuit electronically coupled between the radio frequency circuit and the first spindle, the radio frequency circuit electrically coupled to the first and second hand through the impedance matching circuit and the first and second spindle;

wherein the first and second hands configured to indicate current time and further configured to send/receive wireless signals; when the first and second hands rotate relative to the watch dial, the first and second hands are configured to display current time; when the first hand and second hand are motionless at a predetermined position, the first hand and the second hand serve as an antenna to send/receive wireless signals, the radio frequency circuit feeds current signals to the first and second hand through the impedance matching circuit and the first spindle and second spindle, the first hand operates at a first frequency band, the second hand operates at a second frequency band, the impedance matching circuit enables the first hand and the second hand to resonate at a desired frequency band.

2. The wearable wireless electronic device of claim **1**, further comprising a touch screen and a controlling module electronically coupled to the touch screen, wherein the touch screen is configured to control the operation of the hand module.

3. The wearable wireless electronic device of claim **2**, wherein when the controlling module receives a first command from the touch screen, the controlling module is configured to control the first and second hands to move to the predetermined position, and control the first and second hands to remain motionless for a period of time to send/receive wireless signal; when the controlling module receives a second command from the touch screen during the first second hands serve as the antenna, the controlling module is configured to control the first and second hands to move to a position in which the first and second hands indicate the current time.

4. The wearable wireless electronic device of claim **2**, wherein the touch screen is further configured to indicate current time when the hand module serve as an antenna.

5. The wearable wireless electronic device of claim **1**, wherein the impedance matching circuit comprises a capacitor and an inductor, the radio frequency circuit is grounded via the capacitor and the inductor, a node between the capacitor and the inductor is electronically coupled to the first spindle.

6. The wearable wireless communication device of claim **5**, wherein the first spindle is configured to rotate the first hand, the second spindle is configured to rotate the second hand; the node between the capacitor and the inductor is electronically coupled to the first hand through the first spindle, and electronically coupled to the second hand through the second spindle.

7. The wearable wireless electronic device of claim **1**, wherein the first hand is an hour hand, the second hand is a minute hand.

8. A wearable wireless electronic device comprising:

a watch dial; and

a hand module configured to selectively indicate current time or serve as an antenna, and comprising a first spindle, a second spindle, a first hand, a second hand, the second spindle coaxial with the first spindle, the first spindle rotatably coupled to the watch dial, the second spindle rotatably coupled to the first spindle, the first spindle coupled to the first hand, the second spindle coupled to the second hand:

a radio frequency circuit; and

an impedance matching circuit electronically coupled between the radio frequency circuit and the first spindle, the radio frequency circuit electrically coupled to the first and second hand through the impedance matching circuit and the first and second spindle;

wherein the first spindle and second spindle are configured to rotate the first and second hands relative to the

watch dial to indicate current time, and further configured to feed current signals to the first and second hands, respectively, to send/receive wireless signals; when the first and second hands rotate relative to the watch dial, the first and second hands are configured to display current time; when the first and second hands are motionless at a predetermined position, the first and second hands serve as an antenna to send/receive wireless signals, the radio frequency circuit feeds current signals to the first and second hand through the impedance matching circuit and the first spindle and second spindle, the first hand operates at a first frequency band, the second hand operates at a second frequency band, the impedance matching circuit enables the first hand and the second hand to resonate at a desired frequency band.

9. The wearable wireless electronic device of claim **8**, wherein when the first and second hands are configured to send/receive wireless signals, the first hand is positioned substantially perpendicularly to the second hand.

10. The wearable wireless electronic device of claim **8**, further comprising a touch screen and a controlling module electronically coupled to the touch screen, wherein the touch screen is configured to control the operation of the hand module through the controlling module in response to a touch of a user.

11. The wearable wireless electronic device of claim **10**, wherein when the controlling module receives a first command from the touch screen, the controlling module is configured to control the first and second hands to move to the predetermined position, and control the first and second hands to remain motionless for a period of time to send/receive wireless signal; when the controlling module receives a second command from the touch screen during the first second hands serve as the antenna, the controlling module is configured to control the first and second hands to move to a position in which the first and second hands indicate the current time.

12. The wearable wireless electronic device of claim **10**, wherein the touch screen is further configured to indicate current time when the hand module serve as an antenna.

13. The wearable wireless electronic device of claim **8**, wherein the impedance matching circuit comprises a capacitor and an inductor, the radio frequency circuit is grounded via the capacitor and the inductor, a node between the capacitor and the inductor is electronically coupled to the first spindle.

14. The wearable wireless electronic device of claim **8**, wherein the first hand is an hour hand, the second hand is a minute hand.

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