

# The SkyAngel 911FD 4G personal alarm system

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Issue 1  
August 2, 2022

## ABSTRACT AND INTRODUCTION

The SkyAngel 911FD 4G personal alarm system is a small teardrop-shaped unit ordinarily worn around the user's neck on a lanyard. If the user presses a large button on the face of the unit, the unit places a cellular call to "911", and when the emergency call taker answers, the user can communicate over a two-way speakerphone. The unit will operate essentially anywhere there is cellular service (from any of several carriers).

The unit includes a fall detector, and if the user falls, the unit automatically initiates a call to 911. (The user has the option of aborting that call if this is a "false alarm".)

Elaborated variants of the unit provide further features, including the ability to place emergency calls (and send emergency text messages) to several correspondents.

This article describes the unit in some detail and discusses various of its features and their ramifications.

## 1 THE UNIT

### 1.1 Physical

Figure 1 shows the SkyAngel 911FD 4G unit. It is approximately 2.4 in. high, 1.6 in. wide, and 0.6 in. thick, and weighs approximately 1.4 oz.



Figure 1. SkyAngel 911FD 4G

## 1.2 Nomenclature

Of course the "911" in the name refers to the fact that the unit calls "911" in case of an emergency. The suffix "FD" refers to the fact that the unit includes fall detection functionality. The "4G" refers to the fact that the cellular transceiver in the unit is able to operate over "4G" cellular networks (in some cases, the only service that is provided is via the "4G" scheme).

## 1.3 Internals

The unit includes:

- A full-featured cellular transceiver (as found in a cell phone) capable of operating on all US cellular networks, including those using protocols up through "4G".
- An array of accelerometers and gyroscopes used to observe the unit's motion in order that it can detect when the user has fallen.
- A full-featured GPS receiver. (We will see, however, that this is not of any utility in the normal situation of the unit.)
- A speakerphone circuit.
- Rechargeable battery, charging control circuitry, state of charge monitoring circuitry, etc.

## 1.4 Resistance to dust and water

The unit is rated under the international intrusion protection standard at IP67, indicating that it is resistant to the intrusion of any dust, and is resistant to being submerged in water to a depth of one meter for up to 30 minutes.

The distributor says that it may be worn in the shower for a modest time, or while bathing, so long as it does not remain submerged for over 10 minutes.

## 2 MANUFACTURE AND DISTRIBUTION

The unit is manufactured by Shenzhen Eview GPS Technologies Ltd. of Shenzhen, China. It is their model number EV-07BX-A.

The principal US distributor is Assistive Technology Services, with main offices in Murfreesboro, Tennessee.

### 3 INFRASTRUCTURE

#### 3.1 Cellular service

No subscription to a cellular service is required on behalf of this unit. It places its calls over an available cellular network as a “non-subscribed” station.

US law requires that any cellular telephone (or functional equivalent), if technically capable, be allowed to place calls to “911” whether or not the phone has an active subscription to a cellular carrier service, and this unit draws upon that policy.

As a consequence of its situation, the unit does not have a telephone number, and cannot be called. The economic corollary of its situation is that there are no charges for cellular service.

#### 3.2 No response bureau

No “response bureau” (other than cognizant “911” centers) is involved in the basic *modus operandi* of this unit. Thus there is no monthly fee for such a service. (See section 9 for a further discussion of this.)

#### 3.3 The economic bottom line

The unit can be purchased directly from the US distributor, through Amazon, and through other channels. At this writing the cost (including shipping) is typically less than \$200.00. There are no ongoing fees or other costs for usage.

### 4 USER INTERFACE

Figure 2 shows the controls and other elements of the user interface.



**Figure 2. User interface**

The two oval gray buttons adjust the received sound volume, and only work when the unit is on a call. These buttons are recessed to the

point that one must often use a fingernail, rather than just the tip of the finger, to activate them.

Some of the icons on the buttons do not pertain to this version of the unit but to variants with other features.

The red indicator light shows the status of the battery and of charging. It is discussed in detail in section **Error! Reference source not found.**

The blue indicator light seemingly indicates, by patterns of 4, 2, or 1 flashes, or being off altogether, the status of the GPS receiver. I do not yet know exactly what the different indications mean, (It is difficult to get authentic information on this indicator.)

The green indicator light shows the status of the cellular "connection" (and in fact if the unit is ON). It is discussed in detail in section 6.

## 5 BATTERY AND CHARGING

The unit is powered by an internal rechargeable battery. The distributor says that typically the life of one charge is 4 days of continuous operation. The unit is recharged with a familiar "wall wart" charger with a USB-A connector. The unit end of the charging cord has an ingenious magnetically-retained breakaway connector, making it easy to take up the unit when on charge without any need to unplug the charging cord.

When the charging cord is connected, the red indicator light begins to flash slowly. In addition, after a few seconds, there is a voice prompt<sup>1</sup>, "**Your mobile alarm is charging**".

The magnetic charging connector is a bit "unsteady", and it is not too difficult to knock askew such that the connection is broken.

When charging is complete, the red light will light steadily. When the unit is taken off charge, the red light will go dark.

If the battery level falls below a certain threshold, the red light will begin to flash rapidly. In addition, at the onset of this state, there is a voice prompt, "**Battery is low. Please recharge your battery**".

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<sup>1</sup> In a dreadful female voice.

## 6 OPERATION

### 6.1 Idle mode

As mentioned above, with the unit idle and properly operating, the green indicator light on the unit flashes about once every three seconds.<sup>2</sup> There may be flashes from the blue indicator light; this seemingly indicates (so far as we have been able to determine) that the GPS receiver is in the process of “acquiring” the needed number of GPS satellites.

### 6.2 Power OFF and ON

Ordinarily the user would have no need to turn the unit OFF, and then later ON. But than easily be done when necessary.

To turn the unit OFF: press and hold both the Volume Up and SOS buttons until the unit vibrates (about 2 seconds); release the buttons. Then, after about one second, do that again. The green indicator light will go dark, an indication that the unit is OFF.

To turn the unit ON: press and hold Volume Up button until the unit vibrates (about 1 second). Various indicator lights will flash in celebration.

### 6.3 SOS button operation

#### 6.3.1 *The basics*

A call to 911 is manually initiated by pressing the large “SOS” button on the face of the unit for at least 3 seconds. After than time, the unit begins to vibrate intermittently, and shortly there is a voice prompt, “**Your Alarm has been activated. Click the SOS to stop.**” Indeed if the SOS button had been pressed accidentally, pressing it again will abort the call.

Otherwise, the voice prompt is given three times, then is followed by the voice prompt, “**Calling contact number 1**”. Thus odd-seeming phrase comes from the fact that, in a different variant, the unit might have a list of several numbers that are called in sequence (one of which is “911”). The unit then calls 911 over the cellular system.

At this point the green indicator light changes to flashing at an interval of about 1 second. That pattern persists when the call is answered

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<sup>2</sup> The manual says that this indication also shows that a cellular signal is being received (that is, there is cellular service). It does not say what the indication is if the unit is on and no cellular signal is received. But in any case, I think that description is in error.

and throughout the connection with the 911 call center (whose formal name is Public Safety Answering Point, or "PSAP").

If there is no workable cellular service the green indicator will continue to flash at an interval of 1 second. To abort the call attempt, press and hold the SOS button until the unit vibrates. The green indicator will return to flashing at an interval of 3 seconds.

When the PSAP call taker answers, the user is able to communicate via the speakerphone circuit in the unit. The receiving sound volume can be raised or lowered by pressing the appropriate one of two small gray buttons on the side of the unit.

It is not known to me whether the non-default sound volume level set this way will initially come into effect on a subsequent call.

### 6.3.2 *The calling number*

As the unit is non-subscribed and thus does not have a telephone number, no "Caller's telephone number" will be displayed on the PSAP console. Rather, typically, a pseudo-number is displayed, of the form:

911-zzz-zzzz

where zzz-zzzz is the last seven digits of the unit's International Mobile Equipment Identity (IMEI), a permanent "electronic serial number" for any cellular station as a piece of hardware (independent of its status as a subscribed cellular station or not).

### 6.3.3 *Callback?*

Since the unit does not have a cellular telephone number, the PSAP would be unable to call it back after the connection is ended (as could be done for a call from a landline telephone or a subscribed cellular station).

### 6.3.4 *Geographical location*

When a call to 911 appears at the PSAP, no information as to the geographical location of the calling station is transmitted over the connection. However, the PSAP equipment, if instructed to do so by the PSAP call taker, may send an inquiry through a separate network for this purpose to the cellular system (we assume a call from a cellular station).

The cellular system will first try and fulfill this request by analyzing the radio signals received from the unit, perhaps (if the system layout

allows) by time-of-arrival trilateration among three cell base stations<sup>3</sup> that can receive the current signal from the calling station. If that is not workable, other schemes of estimating the calling station's location from the received signal may be used. The last resort is to just provide the location of the cell base station itself.

If that result is not sufficiently precise for the PSAP's needs, the PSAP can request the position again ("rebid"). In this case, the cellular system may ask the calling station for its location as determined by its onboard GPS receiver (if it is so equipped). The station determines its location (if it has not already done so) and returns it to the cellular system, which then forwards it to the inquiring PSAP.

But it seems that, in actual practice, if the calling station is non-subscribed (even though it may be equipped with a functioning GPS receiver), the station is not requested to give its coordinates, or if it is, they are not forwarded to the PSAP.

We do not currently know the source of this limitation.

But the bottom line is, if we have a SkyAngel unit (in the configuration described here) and call 911, the PSAP will not be able to get a precise location determined by the GPS receiver in the unit.

## 6.4 Fall detection

### 6.4.1 *Operation*

The unit will detect if it believes the wearer has fallen. In such a case, after a short delay, the unit begins to vibrate intermittently, and shortly there is a voice prompt, "**Fall alert has been activated. Click the SOS to stop.**" Indeed if the button was pressed accidentally, pressing it again will abort the call.

Otherwise, the voice prompt is given three times, then is followed by the voice prompt, "**Calling contact number 1**". The unit then calls 911 over the cellular system.

The remainder of the story is that same as for an SOS button call.

### 6.4.2 *Testing*

The manual currently supplied with the unit suggest that the user test the overall function of the unit once a month, by using the SOS button mode to actually call 911. One should of course promptly announce

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<sup>3</sup> Cell base stations are often called "towers", but that term is not apt, as for many base station no tower is involved (the antennas being atop a department store, for example).

that “This is not an emergency”, and advise the PSAP call taker that you are making a test call.

The current manual does not suggest any testing to be done by the user to verify that the fall detection feature is working as intended.

But the manual for an earlier version of the unit suggests that it be tested periodically as follows: the unit is dropped onto the floor from a height of at least 2 feet and left undisturbed. In a few seconds, the fall alert voice prompt should be heard (after which the user should abort the action by pressing the SOS button).

It turns out that in some specimens of this model tested by the author the fall alert sequence only begins after a test drop if the test is done within 5 seconds of the unit being powered up, or within five seconds after a successful response to a prior fall test (behavior X).

In other specimens, the fall alert sequence begins after a test drop at any time (behavior Y).

My initial reaction was that behavior Y is a defect in the unit, suggesting that detection of an actual fall by the wearer would not be detected (except, of course, in the first five minutes after the unit is powered up).

A colleague, however, suggested as follows:

The “test drop” is not meant to emulate an actual human fall, but rather only to confirm that the unit’s sensors are functioning.

And, consistent with that, perhaps there is one algorithm by which an actual human fall is detected, and a separate one intended to detect a test drop.

Now perhaps initially in the design of this item both algorithms were in effect at all times. But maybe there were a number of complaints by users that when their unit fell off the nightstand or such it would trigger a fall alert sequence, a nuisance to the user.

Then, perhaps, the manufacturer, mindful that the drop test was meant to be “elective”, arranged the firmware so that the test drop detection algorithm was only valid for the first five minutes after power up. Then a knowing person seriously wishing to make the drop test (albeit no longer recommended to users) could power the unit down and then back up in order to provide a five minute window in which the drop test could be made.

As of this writing, I am pursuing this conundrum with both the manufacturer and the distributor.



Any conclusions of this will be reported in a later issue of this article.

## **6.5 Performance**

I have no information on studies of the performance of this unit as to detection of actual human falls.

## **7 The SkyAngel "Friends" edition**

### **7.1 Introduction**

Available from the US distributor of this unit is an alternate variant, which they bill as "SkyAngel/Friends". It is able to be "programmed" with a list of up to 10 telephone numbers (one of which would normally be "911").

When the SOS button is pressed, or if the fall detector detects a fall, these numbers are called in sequence until one answers. In addition, SMS (text) messages are sent to all the numbers on the list (except "911"), advising that so-and-so has had an emergency, and including the location of the unit (as determined by its internal GPS receiver), in terms of latitude and longitude coordinates, formatted as a link that, if clicked on, should bring up a map from Google maps with that location pinpointed.

Of course, for all this to be possible, the unit must be a subscribed cellular station, with its own telephone number. Else it could not place calls other than to 911. The distributor has arranged with a cellular carrier for "subscriptions" at some favorable price, and the distributor has a supply of SIMs for subscriptions under that plan.

### **7.2 The SIM**

SIM is an acronym for Subscriber Identity Module. In the early cell phones it was a plug in block, hence the name. Today the SIM is a small chip that is inserted in a cellular telephone or other cellular station, which confers upon it its telephone number as a subscribed station (and some related information).

It is sometimes spoken of as a "SIM card". This is in part because at one time it was in the form of a plastic card the size of a standard credit card. In fact today, SIMs are often supplied by the cellular carrier as a plastic card like that mentioned above, with the tiny chip itself on a breakaway portion of the card. The SIM itself is then broken out of the card to be put into a receptacle in the phone. This arrangement makes it less likely that the tiny SIM chips would be mishandled or lost.

The SIM is available in several form factors. The current smallest one, the *nano SIM* (the one of interest here) has dimensions 12.3 mm × 8.8 mm.

The basic SkyAngel 911FD 4G unit has a receptacle for a nano SIM on its main circuit board. But in its basic configuration, there is no SIM in it.

### **7.3 Back to the SkyAngel/Friends unit**

A technician at the distributor opens the back of the unit and inserts a SIM. (The distributor probably also notifies the cellular carrier that the “subscription” with that number should be activated in the cellular system.)

Now the unit is a *bona fide* subscribed cellular station. Then, using any cell phone, the technician sends SMS (text) messages to the unit that tell it (in a straightforward syntax) what telephone numbers to include in its call list.

In this scenario, the purchaser of the “SkyAngel Friends” unit then must pay the distributor a certain monthly fee which is, in effect, to pay for the cellular subscription for that unit.

### **7.4 The call list**

When the user has received the unit, he creates the list of telephone numbers by sending SMS (text) messages from any cell phone (the syntax is described in the manual for this type of unit).

He can of course add to or change that list at a later time in the same way.

### **7.5 Interaction with the PSAP**

If a call is made to 911 by this type of unit, its telephone number will be displayed on the PSAP console. If the call ends, but the PSAP call taker needs to communicate again with the caller, the unit can be called back with that number (as it is a *bona fide* subscribed cellular station). A voice prompt announces the incoming call, and it is answered automatically. The call taker and the user can then converse over the speakerphone feature of the unit.

In this case, since the calling device is a subscribed cellular station, it will be possible for the PSAP to request a refined location for the

caller's "phone", and this will ordinarily be provided, based on the coordinates of the unit as determined by its onboard GPS receiver.<sup>4</sup>

This variant of the unit has many other possible special features, but those are beyond the scope of this article.

## 7.6 Do it yourself

The user of a basic SkyAngel 911FD 4G unit may also himself arrange for it to become a subscribed cellular station. He arranges with his cellular carrier for a new "line" (essentially, an additional number) on a "bring your own phone" basis. The carrier gives the user a nano SIM for the new number.

The user then opens the back of his unit (three white plastic "feet" are pulled out, and under each is a tiny screw) and inserts the SIM in the receptacle. The unit is then closed up, and without further ado it has become a subscribed cellular station.

It is expected that if this is done early in the unit's life, and done carefully, the water seal between the halves of the housing will still do its job.

Then the user "programs" the list of telephone numbers to be called by sending SMS messages from any cell phone, as described above in section **Error! Reference source not found.**

Is this sanctioned by the distributor? Maybe not, and they remind users that to open up the unit is to invalidate the warranty. However, I have found hints that, in special circumstances, they will tolerate this scenario, if they can "talk the user through" the procedure.

In this scenario the user pays whatever increase in the monthly charges to the cellular carrier comes about due to the additional "line". There is no monthly fee due to the distributor.

## 8 CONTROL OF VOICE PROMPTS

To disable (almost) all voice prompts, with the unit idle, press the Volume down button twice. A voice prompt will advise that voice prompts have been disabled.

To re-enable all voice prompts, with the unit idle, press the Volume down button twice. A voice prompt will advise that voice prompts have been enabled.

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<sup>4</sup> Again, I do not yet understand why this is limited to calls from subscribed cellular stations.

## 9 NO RESPONSE BUREAU INVOLVED

Not that the *modus operandi* of the SkyAngel 911FD 4G does not involve a commercial “response bureau” to which emergency calls go (as is the case for many other personal emergency alarm systems). The call taker at such a bureau would try to communicate with the caller to ascertain the nature of the emergency, and if warranted, would contact the cognizant PSAP (there being special telephone numbers for that purpose, known to the operators of such bureaus) and ask them to dispatch the proper emergency responders.

There is monthly fee for such a service, but that does not apply to the basic *modus operandi* of the unit under discussion (which does not involve such a bureau).

For the user who would like the “response bureau” service model, the distributor can arrange for it through a commercial response bureau. Further details of this are beyond the scope of this article.

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