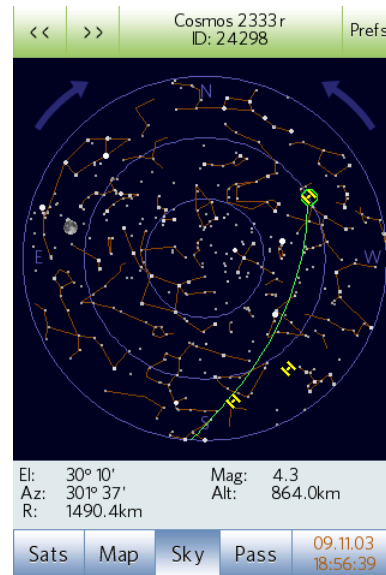


PocketSat3

Satellite Tracking for iOS and Android devices

Version 3.5 (12 September, 2011)



Introduction

Overview

PocketSat3 is a full-featured satellite tracking application for devices running Android or iOS, and is designed to be usable by both experienced satellite trackers as well as novices who are just interested in knowing when they can look up in the sky and see satellites. It is the 3rd major revision in the PocketSat series, which has set the standard for portable satellite tracking since 1999.

The iOS version runs on all models of iPhone, iPod Touch and iPad, and the Android version runs on almost any device based on Android 2.1 or newer.

PocketSat3 can display real-time plots of multiple satellites on both Earth maps and Sky charts. It also includes tools to predict when satellites will pass overhead and potentially be visible.

Features of PocketSat3 include:

- Configurable to compute satellite visibility from any location on Earth. Can query the device for your current location.
- Orbital data can be downloaded directly from the Internet, even if it is in a zip file.
- Track and plot real-time positions of up to 1000 satellites simultaneously.

- Map view shows satellite position and orbit track on an Earth map.
- Sky view shows satellite position and path in the sky, as well as current brightness.
- Sky view can also show the positions of the Sun, Moon, stars and constellations.
- “Red” display mode to preserve night vision.
- Flexible application clock can be set to any date and time as well as clock rate, allowing “what happens when...” experiments. You can make time stand still or even go backwards if you wish. A single button press restores the clock to current system time.
- “Pass” mode allows pre-calculation of satellites that will pass over a particular location during a given time span, including filters for minimum altitude and whether or not a satellite is lit by the Sun and thus potentially visible.
- System alarms can be set to alert you when a pre-computed pass is going to occur – even if PocketSat3 is not running.
- Predicts Iridium flare events. Not just the really bright ones: all of them.
- Does not require an Internet connection to operate, though you will periodically need one in order to download orbital data.
- Uses full “revised” SGP4 and SDP4 orbit propagation algorithms, allowing accurate tracking of any satellite.

Obtaining Satellite Data

The orbital data for a satellite changes with time. While a given set of data is accurate for at least a few weeks to a couple of months for typical naked-eye or radio observation, you will eventually have to update it. PocketSat3 reads data stored in the popular TLE (Two Line Element) text format and if your device can reach the Internet it can import the data directly from one of the many sources that are available – including your own. See the section on importing data later in this manual for more details.

Quick Start

So don't want to slog through the docs, but you want to see what PocketSat3 can do? Try this:

Start PocketSat3

Make sure you have an active Internet connection, because we will be downloading some data.

Set your location

For PocketSat3 to tell you where to look to find satellites, it needs to know where you are. The first time it runs it will query your device for your location, if you allow it to do so. If not, or if it fails to detect where you are, you will have to set your location manually.

Import Satellite data

After finding your location, PocketSat3 will ask if you would like for it to download some data for a set of commonly observed satellites. Say “Yes”. It will connect to a web site and download the data, and then return you to the main Satellite List page. Assuming everything worked, there will be a scrollable list of around 150 satellites, in alphabetical order.

Here are some things to try:

Where is the International Space Station?

Scroll down the list until you see “ISS” (it may be listed as “ISS (Zarya).” Tap on that line of the list (make sure not to “uncheck” it.) ISS is now your “current” satellite. Note that the 2 satellites above and below it become lightly shaded. This indicates that although they are not the *current* satellite, they are being tracked. By default PocketSat3 tracks 5 satellites at a time, 2 above and 2 below the current satellite.

Tap the **Map** tab and you should see a map of the world with ISS displayed on it. The other tracked satellites will be visible as well, but ISS will be highlighted. The curved line extending from either side of it is its orbital path and the deformed “circle” drawn around it encloses the part of the Earth for which it is above the horizon. If the “eye” icon (your location) is inside this circle then it is above the horizon for you.

Use your finger to move the map around, and “pinch” to zoom in and out. You can select one of the other satellites by touching it, or you can use the **previous** and **next** arrow buttons at the top left of the screen to change the current satellite.

What are all of the satellites above the horizon for me right now?

Press the **Sat** tab to go back to the satellites list. Press **Select** and then **Select Sats Above Horizon**. Return to the list by selecting **Done**. Note that almost all of the satellites have become unselected. Scroll up and down the list – any that are checked are above the horizon (or nearly so) for you right now.

Select the **Map** tab and press **previous** and **next** to cycle through the checked satellites – those without a check in the satellites list will be skipped over.

Press the **Sky** tab to see where in your sky the satellite is. **Prev** and **Next** work the same way as in the map view.

I want to see more satellites at a time.

Select **Prefs** from any screen and then press the **Global** tab. Slide the **Simultaneously Tracked Sats** slider to the right until it reads 200 or so.

Now check out the Map and Sky views. Since you previously selected all of the satellites that are above the horizon for you, and are tracking more satellites than are in the list, the satellites that you see represent *all* of the satellites that are currently above the horizon for you.

No, I want to see a LOT of satellites.

Ok, you asked for it. Go back to the Satellite List page and press **Select** → **Select All Satellites** → **Done**. Now have a look at the map. Note that some satellites are yellow, and others are red. The yellow ones are currently lit by the Sun, while the red ones are in shadow (the Earth's shadow). This matters if you are trying to actually see them, since they are not visible if they are in shadow.

Now, for some *real* fun, press the **Time/Date** button at the lower left, then **Clock Rate**, and set the rate to **Fwd 60x** to have it run at 60 times normal speed. Hit **Done** until you are back at the map. Cool, no? Also check out the sky view while the clock is running fast.

Note that the **Time/Date** button appears a different color. This indicates that the simulation is not currently tracking real time. Press **Time/Date** → **Set to Realtime** → **Done**. The clock is now back to the current real time.

You might also want to reset **Prefs** → **Global** → **Tracked Sats** to a smaller number – say, 10 or 20.

I want to see a satellite with my own eyes.

OK, here's the real meat of the program. Many satellites can be seen with the naked eye. The tricky bit is that in order for a satellite to be visible the observer must be in the dark - you can't see satellites in the daylight - but the satellite itself must be in the light - or it'll appear dark, and you won't be able to see it, even though it'll be there. This situation most often occurs soon just after sunset or right before sunrise, though there are exceptions.

Go back to the satellite list and select all of the satellites (**Select** → **Select All Sats**)

Now press the **Pass** tab and select **Prefs**

Make sure they read:

- Minimum Culmination: 30°
- Show: Visible Passes
- Magnitude Filter: 4.0
- Twilight: Nautical
- Always clear list: Checked

Hit **Done**.

Click on the **From** box and press **Set to Current Time**. If it is currently after sunset then roll the time back until it is around 16:00 or so. Press **Done**.

Click on the **Thru** box, and press **Set to Current Time**. Roll the date forward to the next day, and roll the time to about 02:00. Press **Done**.

Now press **Calc**. A progress dialog will appear and run through the satellites as they are checked.

Hopefully there will now be a list of “passes” which met the preferences criteria, meaning that they are most likely all visible to the naked eye (the sample database contains relatively big, bright satellites.)

Tap a pass to make it current (note that this also makes that particular satellite current in the global Satellite List) then tap it again to see the pass in a sky view. If you plot a pass while it is actually occurring, the satellite’s position will be plotted as well. Use the **prev** and **next** to cycle through the passes. Note that where the path is dark the satellite is not being lit by the Sun and so will not be visible.

To actually see a satellite requires a little luck, but you should be able to take your iPhone outside and look in the indicated part of the sky at the right time and see a satellite pass. The hard part is that, with a few exceptions, satellites are relatively dim. On the other hand, any pass listed should be at least 4th magnitude in brightness, so should be visible.

I want to see the International Space Station.

The International Space Station is one of the brightest satellites in the sky and is easy to see if you know when and where to look.

Go back to the satellites list view and **Select** → **Deselect All Satellites**.

Scroll down to the ISS and select it. Make sure it is checked.

Go back to the pass list view and press **From** → **Current Time**.

Press **Thru** → **Current Time** and then select a date about a month in the future.

Press **Calc**. If you don’t get any listings then press **Thru** again and try another month in the future. Unless you’re really unlucky or just too far North or South for ISS to ever be visible you should get a couple of hits.

Go outside when it says to and look where it shows. It’s pretty bright.

PocketSat3 Reference

Application Structure

At its heart, PocketSat3 is a physical simulation of a system consisting of the Earth, the Sun, an Observer and a set of satellites orbiting the Earth. All of this is controlled by a global *Simulation Clock* which can be set to any time – with some limitations imposed

by the satellite data – and set to run at various speeds forward or backwards. Or stopped.

It's important to remember that these are all global objects, and any changes made to them in one part of the application will be reflected in all parts. If you, for instance, tap on a satellite in the Map view, and then switch back to the Satellites List view, the satellite you selected will be shown as the global *current* satellite. There is more information about this in the *Selecting Satellites* section of this manual.

Selecting Modes

PocketSat3 is made up of four basic operational modes, which are accessible by using the buttons along the bottom of the screen. These include:

- **Satellite Selection.** Use this screen to specify which satellites are to be included in calculations performed by the other modes. It is also where you import, modify, update and view detailed satellite data.
- **Map.** This mode displays a zoomable Mercator projection map of the Earth. Overlaid on the map are the positions of satellites, their orbit tracks and visibility zones (areas on the Earth for which they are above the horizon.)
- **Sky.** This mode displays a plot of the overhead sky at the currently specified observer location. If any selected satellites are above the horizon their positions are plotted as well as their path across the sky. In addition, you can plot the position of the Sun, Moon and some (mag 4.5 and brighter) stars.
- **Pass.** This more enables you to calculate in advance times when satellites will pass overhead at the specified observer location. Passes are listed, ranked by “goodness” and can be plotted. Passes that contain Iridium flare events can also be predicted.

Setting the Observer Location

Done Choose Location Edit

Maynard, MA	
Raymond, NH	✓
Peggy's house	

Done Edit Location

Name:	Maynard, MA
Latitude:	42° 25' 47" N
Longitude:	71° 26' 35" W
Altitude:	30 m
Time Zone:	GMT-5.0

		8	1	8
		9	2	9
+	0	0	3	0
-	1	1	4	1
	2	2	5	2

In order for PocketSat3 to determine when and where you should look in order to view satellites, it is necessary for you to tell it where you are on the Earth. The Observer Location is set from the *Global Settings* page. Navigate there by pressing **Prefs** → **Global** from any main page and pressing the **Location** item.

At this point either select a location from the list, or press **Edit** to modify one or create a new one.

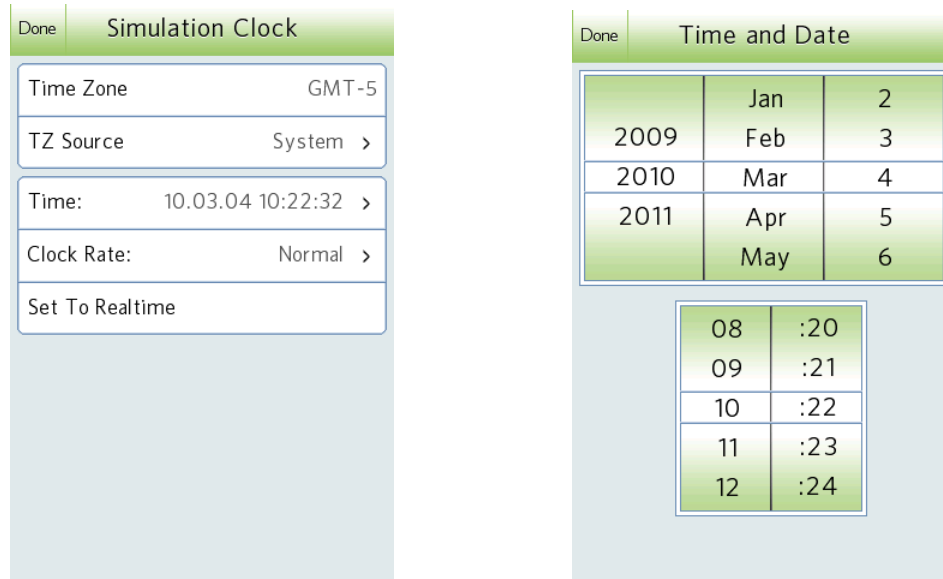
To enter a new location, first select **Add New Location** and enter the location name. A new location will be created containing data copied from the previously displayed location. Now you must enter the following information:

- **Latitude.** Can range from 90 degrees South to 90 degrees North.
- **Longitude.** Can range from 180 degrees West to 180 degrees East. Note that locations in North and South America have West longitudes.
- **Altitude.** Above sea level, in meters. If you don't know, a reasonable guess is probably good enough. Just setting it to 0 is usually a good choice if you have no idea.
- **Time zone.** The default local offset from Greenwich Mean Time. Eastern Standard Time (EST) is GMT-5, Pacific Standard Time (PST) is GMT-8.

You can use the **Fetch Location** item to ask your device to determine where you are and enter your current position into the location fields.

Press **Done** until you are back at a main page.

The Simulation Clock



The Simulation Clock is the heart of the application, and drives everything else. Visible at the lower right corner of the screen in all program modes, it can be set by tapping it. The time is always displayed in 24 hour format as hh:mm:ss and the date is always displayed as yy.mm.dd. When the clock is not set to real time, the date and time display colored orange to remind you.

Using the *Simulation Clock* page, you can set the clock to any time and date, and can set its speed. You can even set the speed to zero or to go backwards!

Time Zone

You will almost always want for the Simulation Clock to display the time using the current time zone as reported by your device. In order to do this, tap **TZ Source** and select "System".

Possible selections include:

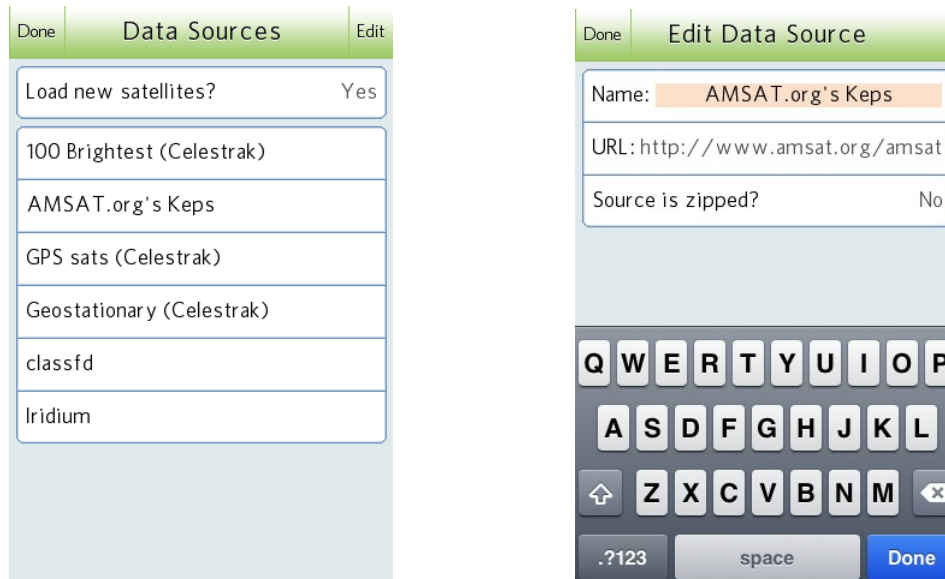
- **System.** This is probably the choice that you want. It asks the operating system for the time zone and Daylight Savings Time offset.
- **Observer Location.** This choice will use the time zone set in the Observer Location page for the currently selected location. It is most useful for situations when you want to compute times for a location other than where you are.
- **Manual.** This choice allows you to manually set the GMT offset. If you select it, you then must tap **Time Zone** in order to bring up the Time Zone spinner. This is especially useful for people who like to use "Zulu" time (GMT) when observing satellites.

Setting the Time

In addition to setting the Time Zone, you can also set the clock's time and date (note that this does not affect your device clock time) and the rate at which it runs. Pressing **Time** will bring up a time/date setting page, and pressing **Clock Rate** will bring up a spinner allowing you to choose various rates from Backwards 60x to Forwards 60x, including “Normal” and “Stopped”.

Pressing the **Set to Realtime** button sets the clock rate to normal and the time and date to the current device time and date.

Loading Satellite Data



PocketSat3 keeps an internal database containing satellite orbital data. As the data ages, it is periodically necessary to replace it with new data from the Internet. This is done by pressing the **Import Data** button on the main Satellites view. If an imported dataset includes a satellite that is already in the PocketSat3 database, the old data will simply be updated, so there is no need to delete old data before performing an import.

After pressing **Import Data** you will either want to select a data source or press **Edit** to add, delete or edit one. PocketSat3 initially knows about 5 commonly used Internet data sources, but you may well want to add your own.

At the top of the page is the question “Load new satellites?” which at first glance may seem a bit silly. Why else would you import data? In practice this is a very handy feature once you have your database set up. If you change the setting to “No” then importing a data source will only load data for satellites that are already in your database, and will not add any new satellites to it.

After selecting a data source you will see the import process progress through its satellites. Afterwards, press **Done**.

Note that if a network connection is not available you will be unable to import data, but all other aspects of PocketSat3 will work just fine.

Adding and Editing Data Sources

A data source is simply a URL where a text file containing “Two-line Element” (TLE) data can be found. To add a new source press **Edit** and then select **Add New Source**.

Give the new source a name and then enter the URL where the file can be found on the Internet.

In some cases TLE files on the web are stored in .zip archives. In that case you will want to set “Source is zipped” to “yes” and enter the name of the TLE file contained in the zip archive.

When finished, press **Done**.

Importing and Categories

There are some points worth noting regarding how the data import process deals with categories. If you are not making use of the category feature (see *The Satellites List* for details) then you can safely ignore these. Otherwise it might be useful to know that:

- If a satellite is already in the database, importing new data for it will not change its category, regardless which category is currently selected.
- Any new satellites will be placed into whatever category is currently selected.
- If the current category is “All”, any new satellites will be placed into the “Unassigned” category.

The Satellites List

All	Satellites	Prefs
✓	Cosmos 2421 ID: 29247 Mag: 0.7 Age: 1d	
✓	Cosmos 2428r ID: 31793 Mag: 2.0 Age: 2 d	
✓	HJ1A LM r ID: 33322 Mag: 1.2 Age: 1d	
✓	HST ID: 20580 Mag: 0.7 Age: 3 d >	
✓	IGS 1H2A r ID: 27700 Mag: 0.5 Age: 2 d	
✓	IGS 3A H2A r ID: 29394 Mag: 1.3 Age: 1d	
✓	ISS ID: 25544 Mag: -3.9 Age: 2 d	
✓	KoronasFr ID: 26874 Mag: 1.6 Age: 2 d	
Import Data		Select
Sats	Map	Sky Pass 09.11.02 15:16:58

Done	Satellite Info	Edit
Display Name:	Amsat-Echo	
Category:	AMSAT	
TLE Name:	AO-51	
NORAD ID:	28375	
Int. Designation:	2004-25K	
Orbital Inclination:	98.1°	
Orbital Period:	100.0 min	
Brightest Mag:	8.5	
Perigee altitude:	692.8 km	
Apogee altitude:	814.0 km	

The *Satellites List* page is selected by pressing the **Sats** tab at the bottom of any of the main pages, and is used to organize and select satellites for use elsewhere in the application.

At the left of the title bar is a button which displays the currently selected category. Pressing it allows you to change the current category or edit the category list.

An entry in the main satellite list displays the name of the satellite, its NORAD Id number, the brightest possible magnitude that it can attain, and the age of the orbital data, in days. For some satellites the operational status will be displayed as well.

Satellite Properties

Satellites in the list may have one or more characteristics that can be modified and that affect how the application deals with them. **Note: it is important to understand these 4 properties in order to understand what PocketSat3 is doing.** They include:

- **Displayed.** In order to be shown at all in the list a satellite must have TLE data loaded and belong to the currently selected category (all satellites belong in the “All” category which is selected by default.) See below for more details on the use of satellite categories.
- **Selected.** All calculations performed throughout the PocketSat3 application are performed only on satellites that are *selected*. Selected satellites have a check mark to the left of their names in the list. See *Selecting Satellites* below for details on various ways to select them.
- **Current.** There is always a single satellite which has PocketSat3's main focus and is considered the *current* satellite. In the Map and Sky views it is displayed with a circle around it and additional information about it is shown in information panes. In the Satellite List it is shown highlit and with a “more information” (>) icon at the right of its box.
- **Tracked.** PocketSat3 can actively track anywhere from 1 to 1000 satellites at the same time and display their positions in the Map and Sky views. Tracked satellites are shown highlit in the Satellites List and the set of tracked satellites moves with the current satellite – which usually stays more-or-less at the center of the set of tracked satellites. **In order to be tracked, a satellite must already be selected.** Note that a satellite need not be tracked in order to be included in Pass calculations. Tracked satellites are all displayed simultaneously in the Map and Sky views.

Satellite Categories

Satellites are organized into *categories*, which are just user-named groups (Palm OS users will be familiar with the concept – it is essentially the same as Palm OS database categories.) The list of categories is user-defined, but always includes at least the “Unassigned” default category. At any given time, PocketSat3 has a single currently selected category, and only satellites in that category are displayed in the Satellite List. A major exception to this rule is that it is possible (and is in fact the default selection) to select “All” as the current PocketSat3 category, in which case all satellites are displayed, no matter to what category they belong.

The current category can be selected either from main *Satellite List* page by pressing the button at the left of the title bar.

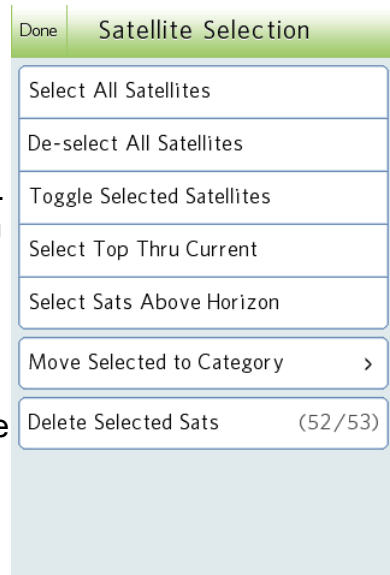
The category for a given satellite is initially set when it is first imported (see **Loading Satellite Data**) but can also be changed by pressing the satellite's "More Info" icon from the Satellite List and then choosing **Edit**. The categories for multiple satellites can be changed by using the "Move Selected to Category" command in the *Satellite Selection* page.

Selecting Satellites

The most direct way to select or deselect a satellite is simply to tap it in the main Satellites List. If it is not already current then tapping it just makes it current and another tap is required to change its selection status.

Tapping individual satellites can get pretty tedious, however. For this reason there are some more sophisticated selection tools available by pressing the **Select** button from the Satellites List to get the the *Satellite Selection* page.

On the page are several buttons to perform "mass" selections. Note that none of these affect the "checked" status for any satellites that are not being displayed because they don't match the current category.



- **Select All.** "Checks" all satellites in the currently displayed list.
- **De-select All.** "Unchecks" all of the displayed satellites.
- **Toggle Selected.** "Flips" the check status for all satellites. This is really handy if you want to select all but one satellite. You can **De-select All**, return to the list and manually check the one you don't want, and then **Toggle Selected**. The result will be all but one satellite selected.
- **Select Top Thru Current.** This selects all currently displayed satellites in the list **above** and **including** the current satellite. Using this feature along with the list *sort order* allows you to select groups of satellites with similar characteristics. For instance, if you sort the main list by brightness you can use this feature to select all satellites brighter than the current satellite.
- **Select Above Horizon.** The application will run through every satellite displayed in the list and calculate its position in the sky given the currently set Observer Location. If the satellite is currently above the horizon it will be selected.

Using combinations of these tools it is possible to make relatively sophisticated selections. For example let's assume I have set up the following categories:

- **AMSAT.** containing satellites of interest to radio operators
- **Bright100.** containing naked-eye satellites from the Celestrak.com Bright100 list
- **GPS.** containing active Global Positioning satellites.

and I am interested in selecting all of the satellites in the Bright100 and AMSAT categories, but none of the GPS satellites.

First I would choose category "All" and press **De-select All**. Now there are no satellites selected. I would then choose category "Bright100" and press **Select All**, then choose category "AMSAT" and press **Select All**.

Now, if I select category "All" again it will once again list all of the satellites, but only the "Bright100" and "AMSAT" satellites will be checked. The "GPS" satellites will be unselected and will not be used in any calculations or displayed in the Map or Sky views.

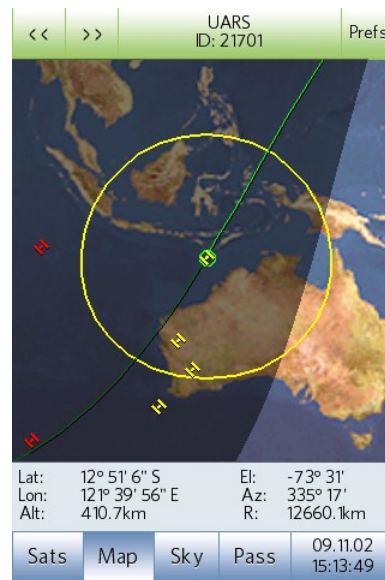
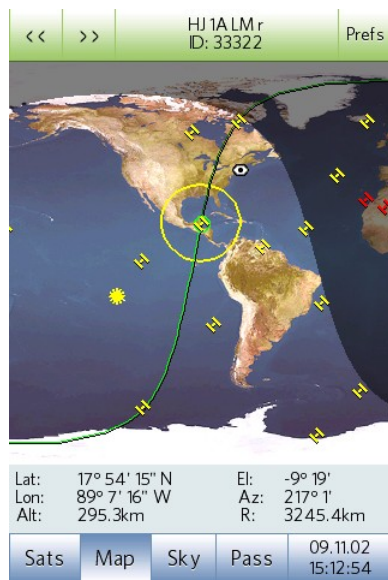
In addition to the "mass selection" buttons there are also buttons to:

- **Move Selected To Category.** Allows you to move all of the currently selected satellites into a particular category.
- **Delete Selected Sats.** Allows you to delete all of the currently selected satellites.

Satellite Details

Pressing the "More info" icon at the right side of the current satellite in the *Satellites List* will bring up the *Satellite Info* page for that satellite. This page contains a list of detailed data regarding the satellite. By pressing **edit** you can also change the name that is displayed for the satellite (it will not be overwritten when new orbital data is downloaded), set the category for the satellite, or delete it from the PocketSat3 database.

Using the Map



After selecting a satellite (or some satellites) press the **Map** button at the bottom of the screen to go into Map mode.

The current satellite will be displayed on a Mercator projection of the Earth along with the observer position (the “eye” icon.) Also on the map is a warped-looking circle enclosing the area of the Earth that can currently see the satellite. If the satellite is currently lit by the Sun it will appear light colored – if unlit it will be dark.

Over the course of a second or so the orbital path of the satellite will “creep” out from the satellite icon until it extends forwards and backwards to show a full orbit. The “forwards” direction is lighter colored than the “backwards” direction.

If more than one satellite is being tracked (see “Global Settings”) the entire set of tracked satellites will be shown on the map - how many being a function of the preferences choice. The current satellite can be distinguished from the others by the extra highlight ring around it.

At the top of the screen the current satellite's name and ID are displayed, and at the bottom is a continually updating display of the satellite's current position, in terms of latitude and longitude, as well as it's position relative to the observer location.

The map will scroll to keep the current satellite centered as much as possible, but you can drag the map with your finger, or zoom it in and out by “pinching”, at which point it will stop trying to center the satellite.

The **prev** (“<<”) and **next** (“>>”) buttons at the top of the screen cause the previous and next selected satellites in the main satellite list to become the current satellite. Note that as described in the Satellites List section of this manual, the set of “tracked” satellites will change as the current satellite changes.

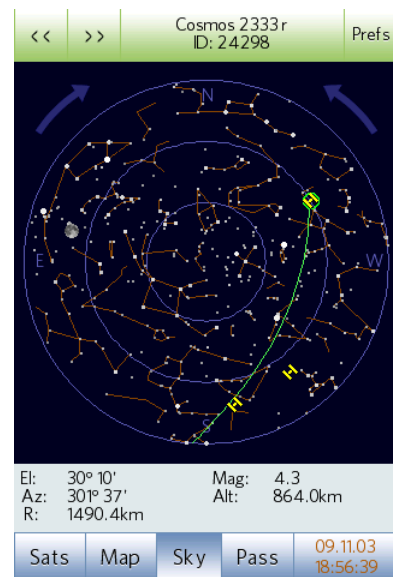
In addition to using the **prev** and **next** buttons to make a satellite current, you can also simply tap a satellite's icon on the map.

Using the Sky View

Once you've decided that a satellite is above the horizon, either because you used the “Select Above Horizon” selection tool or because the observer location icon appeared within the visibility circle on the map, or for whatever reason, select the Sky view by pressing the **Sky** button at the bottom of the screen.

You will see a representation of the whole overhead sky, with the cardinal points labeled, and rings to show 0, 30 and 60 degrees of elevation. Superimposed on this plot will be the current satellite (bright if lit by the Sun, dark if unlit) as well as its future path across the sky extending from it. The path is also bright in color where the satellite will be lit and dark where it will be in shadow.

If the Sun or Moon is above the horizon their locations can also be plotted, as well as the positions of the brighter stars and constellations.



To use the sky plot, go outside and face in the direction of the label closest to the bottom of the screen. Now hold your device up and try to visualize the circle extending up overhead (the center of the circle is the zenith, or the point directly overhead) and over behind you. The outer circle represents the horizon and the inner ones represent 1/3 and 2/3 of the way to the zenith, respectively.

To look in different directions you can either rotate the device itself, or you can rotate the view by pressing the clockwise and counter-clockwise **arrow** buttons on the sky display itself. Each press will rotate 90 degrees in the specified direction. It is generally much easier to view a satellite when it lies in the “bottom” half of the plot.

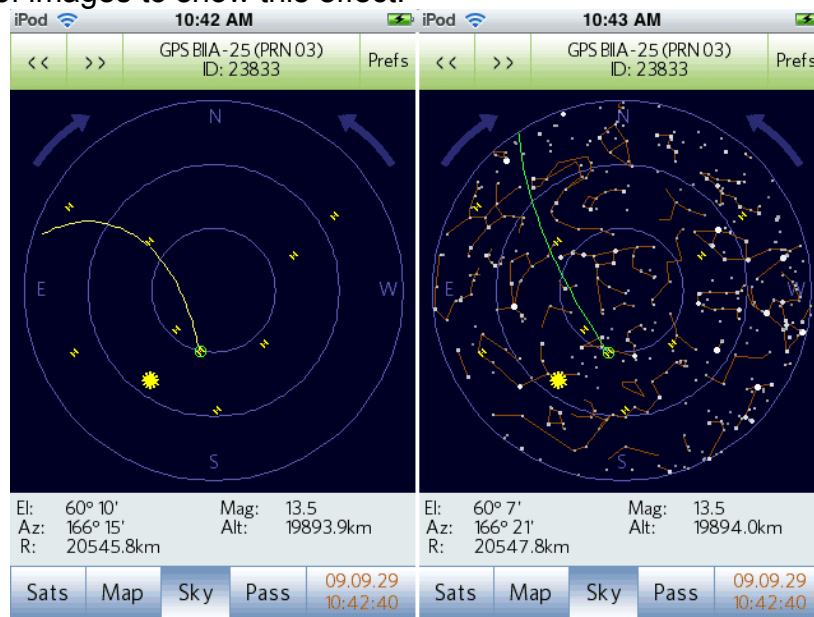
Pressing the **prev** or **next** button at the top of the screen makes current the previous or next selected satellite in the main list, just as it does in Map mode.

Also, as in Map mode, if you are tracking more than one satellite, tapping on a satellite’s icon will make it current.

A Note About Satellite Paths in the Sky

While many bright satellites move fairly quickly across the sky, it is common for other satellites to have higher orbits and to change position more slowly. As a satellite is moving along its displayed path, the Earth's rotation causes the stars to move slowly in the sky as well. This can cause a problem when you try to display the path of a slow moving satellite against the background stars. If the path shows the satellite's position in terms of it's direction (altitude and azimuth) relative to the observer, it will seem to show that the satellite will be moving near stars that it is not, in fact, going to pass near.

Here is a pair of images to show this effect:

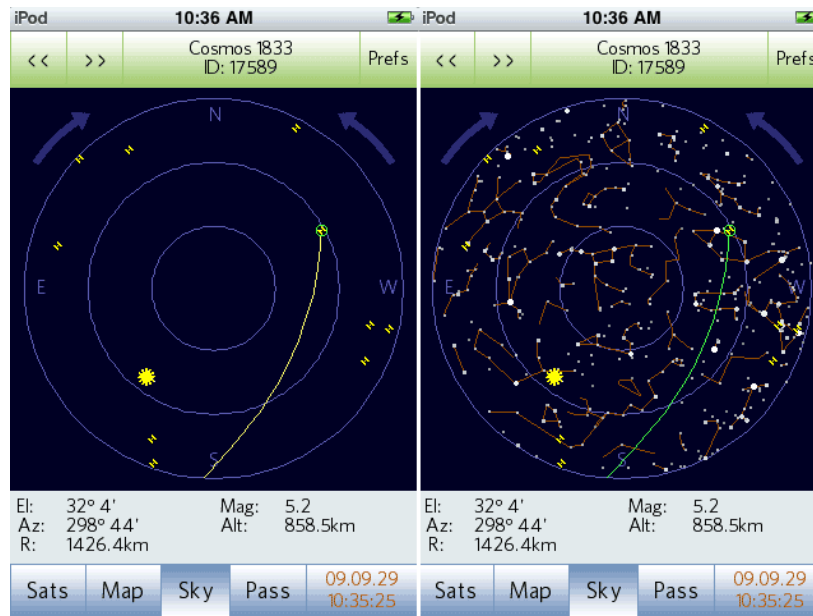


The leftmost plot shows the actual path **through the sky** of the satellite over about 4 hours. The satellite will set very close to due East. On the other hand, by the time the

satellite is going to set the stars that are currently due East will have moved and others will be in that position.

The image on the right shows the satellite's path **through the stars**. As the satellite moves along its path it will pass near the stars that the path passes near – but they will have moved in the sky by then to the location shown in the left image.

This image shows the same thing, but for a fast-moving Low-Earth Orbit satellite:



Note that the problem is barely visible in this case.

In order to deal with this whole issue, PocketSat3 makes the assumption that if you are displaying stars or constellations it is because you care about where satellites are relative to them, and so PocketSat3 will display “Star Relative” paths in green. If you are not displaying stars or constellation lines, then an “Absolute Position” path will be drawn – in yellow.

Satellite Passes

Calculating Passes

Calculating satellite passes is one of the most complex functions of PocketSat3, but also one of the most fun, as it allows you to predict when you can actually see a particular satellite pass overhead. Select Pass mode by pressing the **Pass** button at the bottom of the screen.

The concept here is that as satellites orbit around the Earth, and the Earth turns under them, they occasionally “pass” overhead at any given location. If it happens to be after dark at that location, and the satellite is high enough to be lit by the Sun (out of the Earth's shadow, really) then there's a good chance that the satellite can be seen, in many cases with the naked eye. The effect is the same as looking up in the sky in the early evening when the Sun has just set, but being able to still see sunlight reflecting off an airplane flying high in the sky.

Pass Calculation determines those times when satellites will be overhead, and, if asked to do so, will also filter out passes that occur during the daylight, when the satellite is not lit, or when it doesn't pass high enough in the sky.




To specify the beginning and ending times for the calculation, tap the **From** and **Thru** buttons. A dialog will appear allowing you to set the time and date for each. You will not be allowed to specify a "Thru" time which comes before the "From" time.

Assuming your Observer Location is set, and there are satellites selected (see "Selecting Satellites") you should now press the **Calc** button and calculation will begin. As it proceeds, the name of the satellite that is being checked will appear in a dialog along with a line showing total progress.

The Pass List

When calculation is complete, any passes found will be listed in the table, in chronological order by starting time. Each pass item displays:

- Satellite Name and ID
- Starting Date and Time
- A “score” for the pass
- The brightest magnitude the satellite will attain during the pass
- The pass duration, unless it is already in progress, in which case the time remaining is displayed.
- A clock icon if there is a system alarm set to alert the user that the pass is about to happen.

Passes		Prefs
9:13 - 19:52:12	Mag: 3.4	
Cosmos 1697 r	Score: 9	
9:13 - 19:52:57	Mag: 3.6	
Cosmos 1833 r	Score: 9	
9:13 - 19:58:57	Mag: 3.6	End: 00:03:44
 Cosmos 1980 r	Score: 9	
9:13 - 20:02:24	Mag: 2.7	End: 00:07:16 >
 Cosmos 2428	Score: 7	
9:13 - 20:06:39	Mag: 3.4	End: 00:11:38
Meteor 1-1	Score: 5	
9:13 - 20:11:34	Mag: 3.8	Len: 00:10:19
 Iridium 7	Score: 9FF	
9:13 - 20:14:37	Mag: -1.8	Len: 00:14:50
Cosmos 1954 r	Score: 9	
9:13 - 20:15:16	Mag: 4.0	Len: 00:15:06
Okapi 2 r	Score: 9	
From: 09:13 - 14:00	Thru: 09:14 - 03:00	Calc!
Sats	Map	Sky
Pass	11:09:13	20:11:04

The “score” for a pass is an estimate of how “good” the pass is, taking into account overall altitude and how long it is lit. For visible passes, it ranges from 0 (worst) to 9 (best) or D (daylight) or N (night, but satellite unlit and invisible.) If "Show: All Passes" is selected in *Pass Settings*, this number is just a measure of the maximum pass altitude, and visibility is disregarded. Note that the magnitude does not figure into the score. The score is a measure of how good the pass is *for the particular satellite*. In addition, if the pass includes a “flare” (Solar glint) event the letter “F” will be appended to the score.

Any passes that are currently in progress are displayed in a different color in the list, as well as showing a running display of the amount of time left before the pass ends.

Just as with the Satellites List, there is the concept of a “current” pass, which is shown highlighted in the list, and has a “more info” icon. When a pass is made current, the satellite involved is also made current (except for some rare situations in which it is not possible) in the main satellite list, so selecting a pass and then going to the Sky or Map views will show the location of the satellite in the current pass.

Setting Pass Alarms

When a pass is *current* there is an “alarm clock” icon drawn to the left of the satellite name in the pass list. Pressing this icon will bring you to the **Set Alarm** screen where you can request that a system alarm be set to any time from 30 minutes before to 30 minutes after the start of the pass. The alarm will fire whether or not PocketSat3 is

Done
Pass Alarm

Alarm fires

4 min	
5 min	
6 min	before
7 min	after
8 min	

pass starts.

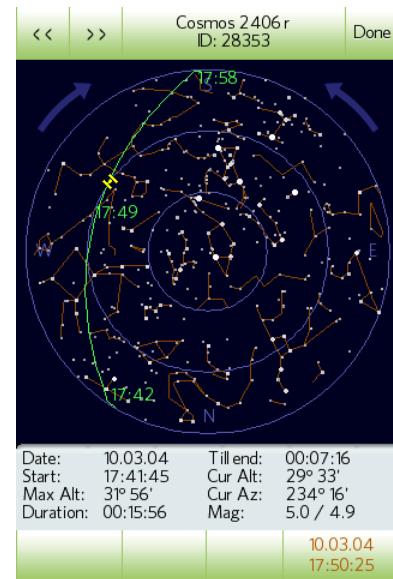
actually running. Once an alarm is set for a pass, the icon appears within the pass listing even if it is no longer the current pass.

Plotting Passes

Tapping the current pass in the Pass List brings up a plot of the sky that shows the satellite's path across the sky during the pass. This plot is in most ways identical to the Sky view, the only real difference being that rise, set and culminations times for the pass are displayed on the plot. In addition, detailed information about the pass is displayed at the bottom of the screen.

As with Sky mode, the idea is that you hold the device out in front of you, facing the direction indicated at the bottom of the plot. You can rotate the plot to the left and right, respectively with the left and right **arrow** buttons on the screen until the desired direction is at the bottom.

You can select the previous or next pass by pressing the **prev** or **next** button at the top.



If you press the **Clock** button while viewing a pass you will notice a **Sync to Pass** button at the bottom of the page. This button will set the *Simulation Clock* to the culmination time for the current pass, and will set the clock rate to “Stopped”. Once this button has been pressed you can go to the various other views in PocketSat3 and examine the state of the simulation during the pass.

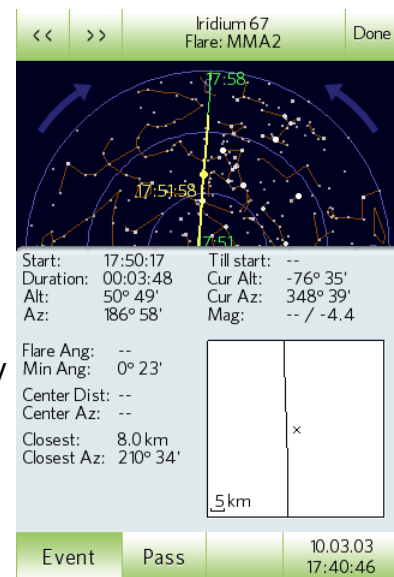
Pass Events

If the pass includes one or more special events – Iridium flares, for instance – there will be a pair of buttons labeled **Event(s)** and **Pass** on the bottom bar. Pressing **Pass** results in the overall pass being displayed, as described above. Pressing **Event(s)** changes the display to focus on a particular event, rather than on the pass as a whole. In this mode, pressing the **prev** and **next** buttons selects the previous or next *event* rather than the previous or next pass.

Iridium Flares

An *Iridium Flare* is an event that occurs when a satellite belonging to the Iridium constellation reflects sunlight off of one of several relatively large flat shiny surfaces directly towards an observer on the Earth. Details regarding how this all works are beyond the scope of this manual, but they can be *very* dramatic.

See *Pass Settings* for see how to specify that PocketSat3 search for passes containing Iridium flares.



When a pass containing an Iridium flare is displayed, the section of its path across the sky where the flare “glint” is brighter than the satellite without the flare is indicated with a yellow line. In addition, the point at which the flare reaches its maximum intensity is indicated with a large yellow dot. If the pass contains more than one flare (it’s possible) all of them are displayed.

When **Event(s)** is pressed the display changes to focus on a single flare, rather than on the whole pass. Not only does the sky display change, but the information at the bottom of the page changes to contain information specific to the flare. Also, you can now “drag” the info pane at the bottom of the screen up to see even more details, including a symbolic map of the position of the flare center relative to the observer on the ground.

User Settings

The behavior of PocketSat3 is in many ways controlled by settings that the user selects in the various Settings pages. These pages are accessed by choosing the **Prefs** button at the top of any of the main views. You can navigate from one Settings page to another by using the button bar at the bottom of each. Press **Done** at the top to return the the main application views.

Global Settings

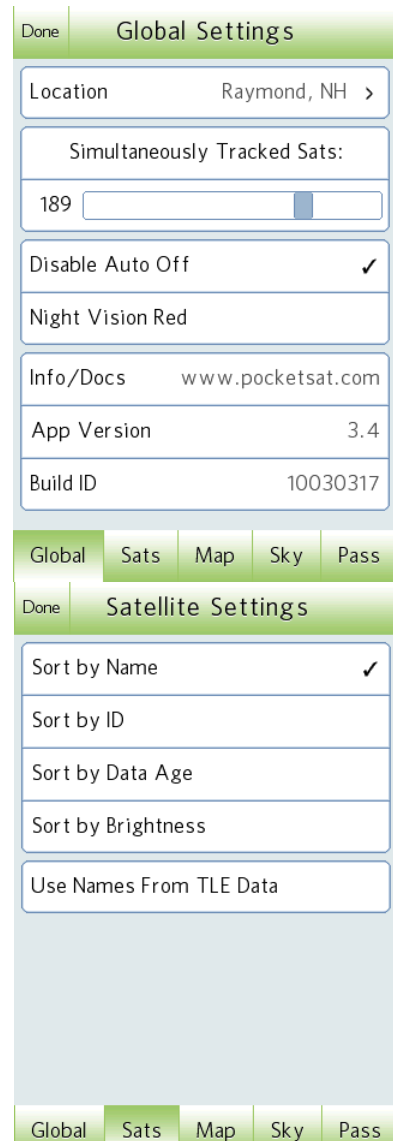
These options control program behavior in all of the modes:

- **Location.** This is where you select the Observer Location
- **Tracked Sats.** (Default: 5) PocketSat3 can track more than one satellite at a time and display them in Map and Sky modes. This value determines how many are tracked. The maximum value is 1000.
- **Disable Auto-off** (Default: Unchecked) Checking this option will prevent your device from powering off (Auto-lock) while PocketSat3 is running. It does not affect auto-lock behavior when PocketSat3 is not active.
- **Night Vision Red** (Default: Unchecked) Selecting this option will cause PocketSat3 to restart in a “mostly black with red” display mode designed to preserve your eyes' dark adaptation at night.

Satellite Settings

These options control display of the Satellite List:

- **Sort by Name.** Sorts alphabetically by the satellite name

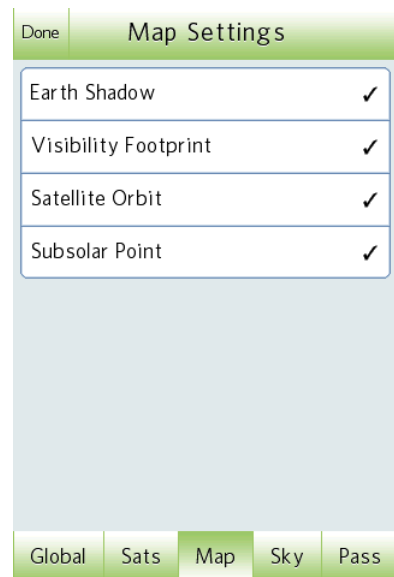


- **Sort by ID.** Sorts numerically by the satellites' NORAD IDs.
- **Sort by Data Age.** Sometimes in order to identify “old” data is it helpful to be able to sort the list by data age, and then update or delete satellite data that is no longer useful.
- **Sort by Brightness.** Sort the list by maximum possible apparent brightness.
- **Use Names from TLE Data.** The TLE orbital data for a satellite includes a satellite name, but the name is generally more related to the type of spacecraft than to it's mission. Normally PocketSat3 uses more “user friendly” names when displaying satellites, but in some situations a user may prefer to see the satellite names exactly as they are named in the TLE data.

Map Settings

These settings affect the Map display:

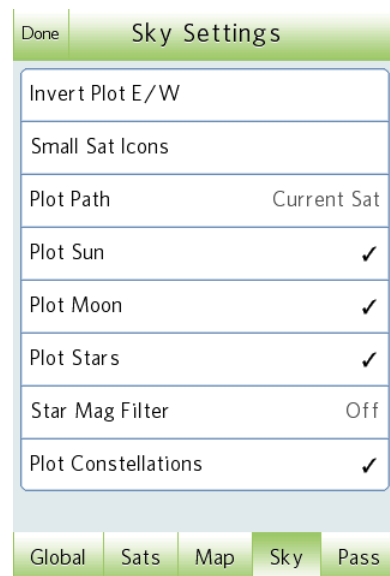
- **Earth Shadow.** (Default: checked) If set, the part of the Earth that is in shadow (where it is night) is darkened.
- **Visibility Footprint.** (Default: checked) If true, the current satellite is displayed on the map along with the circle that defines the region of the Earth for which it is above the horizon.
- **Satellite Orbit.** (Default: checked) If true, a single orbit of the current satellite's path around the Earth is displayed.
- **Subsolar Point.** (Default: checked) If true, an icon of the Sun is displayed at the point on the Earth for which the Sun is exactly overhead.



Sky Settings

These options affect the Sky display:

- **Invert Plot E/W.** (Default: unchecked) Some people would rather that the Sky display be presented looking from the top down – more like a map than a sky chart. Selecting this option reverses East and West in the display, effectively accomplishing this. This choice also affects the Pass plot



- **Small Sat Icons.** (Default: unchecked) Sometimes it is desirable to have smaller satellite icons in the Sky View, especially if you are displaying a lot of satellites or stars.
- **Plot Path.** (Default: Current Sat) options are “No Paths”, “Current Sat” and “All Tracked Sats”. Selecting “All Tracked Sats” can get messy if you have a really large number of visible tracked satellites.
- **Plot Sun.** (Default: checked) If true, the current position of the Sun is plotted if it is above the horizon.
- **Plot Moon.** (Default: checked) If true, the current position of the Moon is plotted if it is above the horizon.
- **Plot Stars.** (Default: Unchecked) If checked, stars are plotted in the sky display. Unless filtered all stars down to magnitude 4.5 will be plotted.
- **Star Mag Filter.** (Default: Off) Allows you to select the dimmest stars that will be plotted when “Plot Stars” is enabled.
- **Plot Constellations.** (Default: Unchecked) If checked then constellation lines will be plotted in the sky.

Pass Settings

These options define the behavior of pass calculations. They are **very** important in determining the results of calculations, so you should take some time to understand their use. Seeming discrepancies between PocketSat3 and other satellite tracking tools often result from these settings.

- **Search for.** (Default: All passes) If “Visible Passes” is selected, only passes that occur at night (defined by the “Twilight” option) **and** when the satellite is lit by the Sun are listed. These passes are potentially visible. If “All Passes” is selected then all passes will be listed, including those during the daylight and when the satellite is in shadow. If “Iridium Flares” is selected then only passes containing Iridium flare events are listed. *Note that in order to search for Iridium flares you must have operational Iridium satellites selected in your main Satellites List.*
- **Elevation Filter.** (Default: 15 degrees) This filter defines the minimum culmination (highest point) that a pass can have and still be listed. Since trees and building can limit a site’s horizon this filter can limit “false positives”: passes that don’t ever get high enough for you to really see. Using this option aggressively can speed up calculation considerably, but it can also result in disagreement between PocketSat3 and other programs (many of which have no such filter.)

Pass Settings	
Search For	Visible Passes
Elevation Filter	20°
Magnitude Filter	2.5
Twilight Type	None
Always Clear List on Calc	<input checked="" type="checkbox"/>

Global Sats Map Sky Pass

- **Magnitude Filter.** (Default: off) If “Show” is set to “Visible Passes” this filter defines how bright a pass must be in order to be listed. On a very, very dark night it is possible to see a magnitude 6 object, but for most people on most nights magnitude 4 or 4.5 defines a worst-case limit for naked eye objects. Remember that a larger magnitude means a dimmer object.
- **Twilight Type.** (Default: Nautical) There are different definitions of the term “Twilight,” differing in the angle of the Sun below the horizon. The three most common are: Civil (6 degrees), Nautical (12 degrees) and Astronomical (18 degrees) From a practical point of view this selection determines how dark the sky must be before it is considered “night.” Depending on your location, it may be too light to actually see a satellite at Civil twilight, in which case you should make a more conservative choice. On the other hand, sometimes a satellite is so bright (ISS, for instance) the no twilight at all is necessary, and for this situation you can select “None”.
- **Always Clear List on Calc.** (Default: checked) If selected, any passes in the list will be deleted when a new calculation is performed. If false, you will be asked if previous passes should be cleared.

Release History

V3.0 – 22 July 2009

First Release. iPhone only.

V3.1 – 11 August 2009

- Added satellite magnitude estimates
- Now supports loading TLEs stored on the web in zip files.
- Put category selector on main satellite list
- Added some satellite selection criteria

V3.2 – 28 September 2009

- Added stars to sky view
- Added Moon to sky view
- Added constellations to sky view
- Added ability to plot multiple simultaneous paths

V3.3 – 11 November 2009

- Added “night vision red” display option
- Added “none” twilight option
- Added “grabbable” scroll bar for long lists

V3.4 – 28 February 2010

- Added Iridium flare calculation
- Added Moon phase display
- Added Sun and Moon Pass Display
- Added “Use TLE Names” option
- Fixed satellite name sort.

V3.5 – August 2011

- First release for Android OS
- Added pass alarms
- Now saves state on exit

Contact Info

The PocketSat3 website can be found at:

<http://www.pocketsat.com>

Please address comments, feature requests and bug reports to Jim Berry at:
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Follow @BigFatTail on Twitter.

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