SAY “HI” TO JUNO EVENT BEGINS IN

0	0	32	8
Days	Hours	Minutes	Seconds

KEY DOWN
:30

KEY UP
:00

What is this?

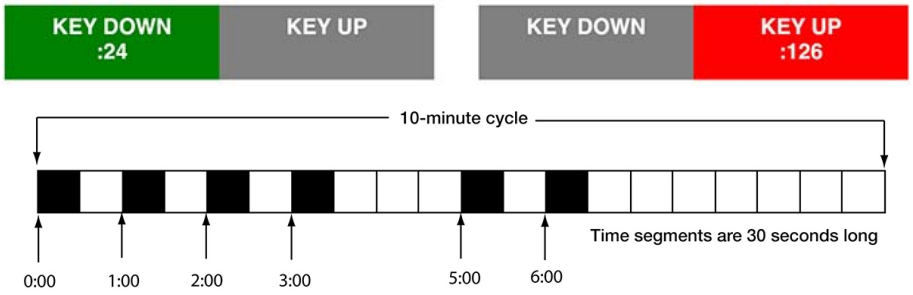
NASA's Juno spacecraft will fly past Earth on October 9, 2013 to receive a gravity assist from our planet, putting it on course for Jupiter. To celebrate this event, the Juno mission is inviting amateur radio operators around the world to say "HI" to Juno in a coordinated Morse Code message. Juno's radio & plasma wave experiment, called Waves, should be able to detect the message if enough people participate. So please join in, and help spread the word to fellow amateur radio enthusiasts!

This page will be updated with additional information as the event approaches. In addition, we have created a Facebook event page where you are welcome to a discuss this activity. We ask only that you be courteous and stay on topic.

Visit Event Page

How do I participate?

1. **Find your transmit frequency in the table at right.**
   The frequency to use is assigned based on the last letter of your call sign.
2. **If you have a directional antenna.**
   If you have a directional antenna (Yagi), determine the headings to use during the event. The map below and a list of major cities (PDF, 96 kb) are provided to assist in determining your headings.
3. **Visit this web page on October 9.**
   The activity will begin at 18:00 UTC on October 9, 2013 and continue until 20:40 UTC. This page will clearly indicate when you should key up or key down to transmit "HI" to Juno in Morse Code (see examples below). The Morse code pattern below can also act as a guide. The "HI" message will be repeated every 10 minutes, beginning at 18:00, 18:10, 18:20, etc.

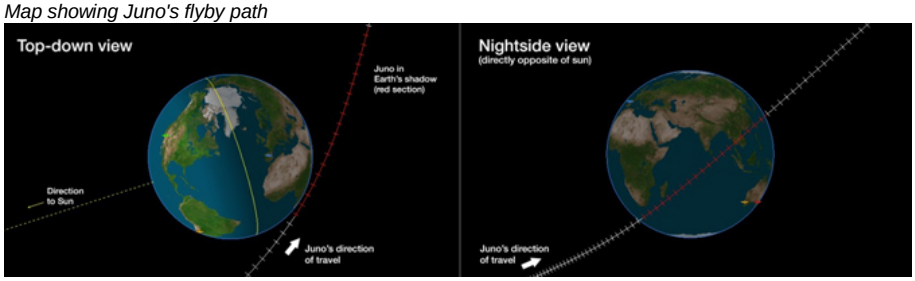


If you participate and would like to receive a **QSL card** for contacting Juno, please send an email with your call sign and mailing address. Cards will be sent to participants who email this information in the months following the event.

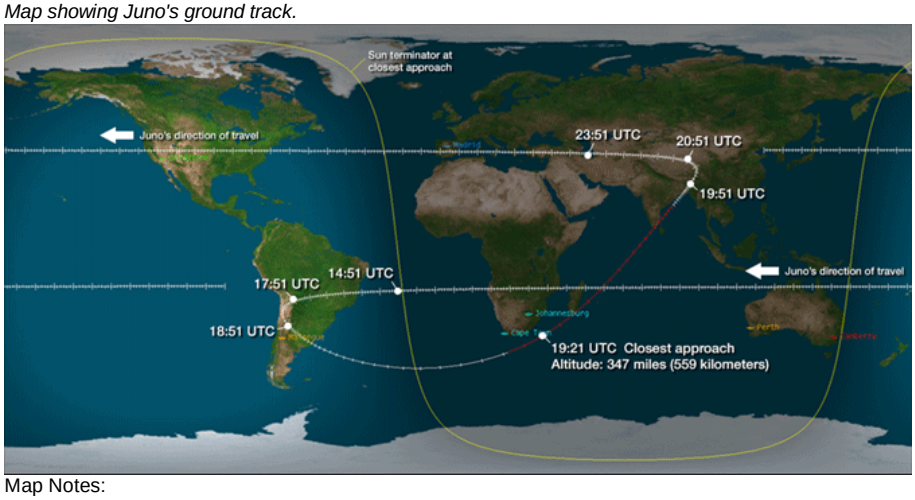
Important:

- Please make sure your computer clock is synchronized to network time prior to this event.
- All transmissions must follow local and national regulations (FCC or the appropriate governing authority), regular ID, etc.
- Please insure adequate cooling and operate your equipment within safe operating limits. While the event's success depends on the maximum possible radiated power, NASA, Caltech/Jet Propulsion Laboratory and institutions affiliated with the Juno mission cannot be responsible for the safe operation of your equipment. Settings for modes such as RTTY or FM which use a constant power output would be appropriate.

Map showing Juno's flyby path



Map showing Juno's ground track.



Map Notes:

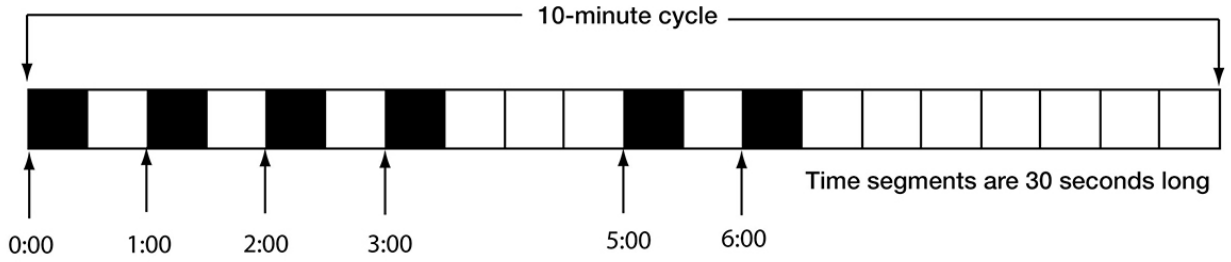
- Operators with directional antennas should use this map and a list of reference cities (coming soon) to help determine their transmit heading.
- Juno is directly above the indicated tick marks at the times they represent.
- Within ± 30 minutes around closest approach (c/a), tick marks are spaced 1 minute apart.
- For times >± 30 minutes around c/a, tick marks are spaced 5 minutes apart.
- Red section of Juno's path is the 20-minute period when the spacecraft is in Earth's shadow.
- Cities named are NASA & ESA Deep Space Network ground stations.

Last Letter of Your Call Sign	Frequency to Use (MHz)
A	28.001
B	28.019
C	28.037
D	28.055
E	28.073
F	28.091
G	28.109
H	28.127
I	28.145
J	28.163
K	28.181
L	28.199
M	28.217
N	28.234
O	28.252
P	28.270
Q	28.288
R	28.306
S	28.324
T	28.342
U	28.360
V	28.378
W	28.396
X	28.414
Y	28.432
Z	28.45

Technical FAQ

What if I have questions?
Email juno_outreach@jpl.nasa.gov with any questions. The Juno team will reply as quickly as possible. (Important topics may be added to this FAQ as a result of your questions.)

Tell me more about the message we are transmitting to Juno.
The "HI" message will be transmitted in Morse code with a dit (or key-down) time of 30 seconds. Sending HI at 1/25th word per minute works out to six 30 second key down intervals in 10 minutes. Participants may transmit for the full 2 hour, 40 minute duration of the activity, or just part of it. See the sketch of the message.



Why have you chosen this specific time period for the activity?
The Juno spacecraft will be within a distance of 50,000 kilometers from 18:00 to 20:40 UTC, and the Waves team has determined that Juno has the best chance of detecting the "HI" signal at this range.

Why are you not using a single frequency? Why must I select from a list of frequencies?
Juno will have a better chance of detecting the signal from many operators if the signal is spread out across the spectrum. The Juno Waves instrument is a broadband receiver, and the detector being used for this event has a band width of 1 MHz. It is better for detection of the signal to have a broadband signal coming in.

For this experiment, we would like to ask those participating to spread out in frequency across the 10 meter band. We have supplied a table of suggested frequencies between 28 and 28.45MHz, based on the last letter of your call. When the HFR receiver is tuned to 28MHz, the center frequency is 28.5MHz. A 50kHz high pass filter limits low frequencies hitting the detector, so the frequency table excludes 28.5MHz±50kHz. The natural signals we expect to measure at Jupiter will consist of a large number of discrete tones, so spreading the signals out in this manner is a good approximation to the signals we expect to detect. But at Jupiter, we don't expect to be able to decode CW in our telemetry!

How will I know when to transmit? How will you indicate when participants should key up or key down?
When the timer at the top of this page reaches 00:00:00, the event will begin. This should be at or very close to 18:00 UTC on October 9, 2013. Please make sure your computer clock is synchronized to network time prior to this event. The current plan is to have two large indicator signs on this page, one indicating to key up and the other to key down. Each will have a timer to indicate how long until you switch from one mode to the other mode.

Why is the CW so slow?
Juno's Waves instrument samples this frequency band once per second. By spreading the signal out in time, we can average to reduce the noise level. In addition, the spacecraft spins at 2 rpm, so a 30 second "dit" time gives us a full spin to see if there is any spin modulation.

How do you suggest we ID?
US regulations (CFR Sec 97.119) require amateur radio stations to identify themselves at the beginning and end of a transmission and at least once every 10 minutes. If you ID at the beginning of the first "dit" of the HI and at the end of the final one before you go QRT, you will meet the US requirements. Others should verify that this will meet your national requirements.

What could go wrong?
Plenty! The frequencies we chose are above the highest plasma frequency that occurs in the ionosphere, so the waves will not reflect back down to the ground. If sunspots are active enough and the ionization goes up, the band opens and waves are refracted back down the ground, potentially on the other side of Earth. If this happens, the waves will not escape into space and Juno would not be able to hear them. We cannot predict solar conditions this far in advance, but given the poor conditions lately we can assume this will continue and cross our fingers. But if we do not try, we know it will not work!

I don't have an internet connection at home, how can I participate?
We will publish a table of on-off times on this page. If you accurately set your clock using a broadcast time standard station, you will be able to follow the table and participate.

My computer is set to automatically sync to network time, is that good enough?
No. Automatic updates are often set to sync every week or so. Your computer internal clock can easily drift many seconds off in that amount of time. Please manually force synchronization to network time (NTP) or set your clock using either a time standard broadcast station or GPS. If using a cell phone for time, please check it against a time standard. Cell phones have been observed to be off from time standards by as much as 1.5 minutes.

I can't tune to the frequency in the table for my call sign. What should I do?
If your station for some reason operates better on a different frequency in our passband, feel free to choose another. But please stay in the range we can detect (28.001MHz-28.45MHz, 28.55MHz-28.999MHz).

The frequency table is a guide to help spread out the energy to duplicate what we expect to see at Jupiter. The analog detector will be sensitive to any signal appearing between either 28.001MHz to 28.45MHz or 28.55MHz and 28.999MHz. The detector sees the baseband down-converted signal, so it cannot tell if your signal is in the upper or lower sideband. We have set the table to spread out the signals in the lower sideband.

Why did you choose this frequency band?
We chose 10 meters for this experiment for several reasons. The Waves instrument is sensitive to radio signals in all amateur bands below 40MHz, but experience with the University of Iowa instruments on the Galileo and Cassini earth flybys shows significant shielding by the ionosphere at lower frequencies. As sad as it sounds, we hope for lousy band conditions on October 9, so an appreciable fraction of the radiated energy escapes the ionosphere into space, and is not refracted back down to the ground somewhere else on the planet.

Can you provide more details about the Juno Waves instrument?
The Waves instrument was built at The University of Iowa Dept. of Physics and Astronomy in Van Allen Hall, for the study of radio and plasma waves at Jupiter. It is specifically targeted at the Jovian auroral region, and we hope to fly directly through the auroral acceleration region where Jovian decametric signals are generated. We estimate the field strength in the source to be as high as 5V/m! Consequently, we have relatively short antennas, in-line switchable attenuators, and the system gain is low. This sacrifices the low amplitude sensitivity somewhat for the science to be gained at the high end of the dynamic range.

The antenna consists of a pair of tapered 2.8 meter long titanium tubes, deployed from the bottom deck of the spacecraft under the +X solar array and magnetometer boom. A high impedance radiation resistant preamp sits at the base of the antenna and buffers the signals from 50Hz to 45MHz. The elements are deployed with an opening angle of about 120 degrees. Ten meters is above the resonant frequency of the antenna and NEC analysis indicates a lobe generally along the spin axis of the spacecraft. This will be good for detection on the inbound part of closest approach to Earth.

The Waves instrument uses four receivers to cover the frequency range of 50Hz to 41MHz. Signals up to 3MHz are bandpass filtered, sampled by A/D converters and FFT processed into spectra using a custom FFT processor developed by The University of Iowa under a grant from the Iowa Space Grant Consortium. Another eight copies of this processor are currently onboard the two Van Allen Probe spacecraft in Earth orbit, studying the radiation belts.

The High Frequency Receiver (HFR) used for this experiment covers 3MHz to 41MHz in 38 1MHz steps. It is a single conversion receiver which selects one of seven octave wide filters on the front end, then uses a quadrature mixer to convert down to identical I and Q baseband channels which use 500kHz low pass filters to give a 1MHz total detection bandwidth. Two copies of this receiver are carried in the Waves instrument; the HFR is used for spectral analysis and makes up to one sweep from 3-41MHz every second. The second copy (High Frequency Wideband Receiver or HFWBR) is used to sample segments of the waveform in the I and Q channels which are then sent to the ground for high resolution spectral analysis. The HFWBR will be tuned to a center frequency of 6.25MHz during closest approach to Earth to detect broadcast shortwave stations, but the small snippets of waveform will not be long enough to detect intelligible modulation. The two receivers can swap functionality and thus serve as backups for each other. While using the HFR in spectral analysis mode, the Q channel is sampled by a wideband analog detector. The dwell time on each 1MHz step is 25ms.

How do I know whether my transmission is capable of reaching Juno? Is there a line of sight to Juno from my location?
At the frequencies we are using for this activity, the ionosphere will refract the signals and give them the ability to bend over the horizon, so the spacecraft will be "visible" even with a negative elevation angle.

Propagation of radio signals at 28MHz is quite variable and we have no way of predicting what conditions in the ionosphere will be like on October 9. Our plan is to pump as much power into the ionosphere as possible and hope the spacecraft can detect it. At closest approach, Juno will just be skimming the top of the F layer, so even if there is not enough ionization to bend the waves back to the ground, we think Juno has a chance of detecting waves from transmitted from almost anywhere on the globe.

We hope that stations will be able to participate for the entire event (2 hours, 40 minutes), but we can offer a few suggestions for those who cannot participate for the entire duration. Stations in North America probably have the best opportunity on the inbound pass. They will be in daylight, and Juno does not enter eclipse until shortly before C/A. It will be night for European stations, but there should be sufficient ionization to reach the spacecraft on both inbound and outbound segments, with more difficulty at closest approach. The best location would be the southern part of Africa, as the spacecraft will never be far below the horizon and the range at closest approach will be under 1240 miles (2000 kilometers)! Asian and South Asian stations probably have the best opportunity on the outbound leg.

How will Juno decode the "HI" message?
Juno will not decode the message itself. Instead, if the activity is successful, the Waves instrument data containing the message will be shared by the Juno team after the flyby.

Should I send my call sign to Juno?
Juno does not need your call sign, but your national authority does (for example, every 10 minutes). That is why we are suggesting an ID at the beginning of each ten minute cycle to comply with regulatory requirements.

Where can I find additional information about the Juno mission and its Earth flyby?
Additional information is available at http://www.nasa.gov/juno and http://missionjuno.swri.edu.

Some key members of the Waves team supporting this activity:
Don Kirchner KD∅L, Waves Principal Engineer
William Robison KC∅JFQ, Waves Software Engineer
William Kurth, Waves Lead Co-Investigator