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Permanent Link to Innovation: GNSS and the Ionosphere
2021/06/18
What's in Store for the Next Solar Maximum? By Anna B.O. Jensen and Cathryn Mitchell Although the sun can become disturbed at any time, solar activity is correlated with the approximately 11-year cycle of spots on the sun's surface. We are just coming out of a minimum in the solar cycle and headed for the next maximum, predicted to occur around the middle of 2013. How significantly will GNSS users be affected? In this month's column, two ionosphere experts tell us what might be in store. INNOVATION INSIGHTS by Richard Langley "HERE COMES THE SUN / here comes the sun / And I say / it's all right." Is it? Of course, George Harrison was referring to the welcome return of the sun after a long dreary English winter. But can GNSS users sing the same refrain? The signals from global navigation satellites must transit the ionosphere on their way to receivers on or near the Earth's surface. The passage exacts a toll in the form of an added delay of the pseudorandom-noise-code signals and an advance of the phase of the signals' carriers, due to the presence of the ionosphere's free electrons. These perturbations must be ameliorated in some way to achieve high accuracy in GNSS positioning, navigation, and timing applications. Where do the ionosphere's electrons come from? For the most part, they are valence electrons, stripped from upper atmosphere atoms and molecules by the extreme ultraviolet light continuously emitted by the sun. On the Earth's night-side, the electrons and the ionized atoms and molecules tend to recombine. This ionization and recombination process, along with the interactions of the particles with the Earth's magnetic field, governs the density of the electrons at a particular location and time. The ionosphere is also affected by the solar wind, and its associated magnetic field, but the cocoon established by the Earth's magnetic field (the magnetosphere) tends to deflect the solar wind so that it usually has little influence on the ionosphere. Normally, the sun is quiescent: its electromagnetic and particle radiation is fairly constant, and its effects on the ionosphere benign. The delay in GNSS code observations and the advance in phase observations can be readily

estimated and removed from the observations using a variety of models and methods. However, the sun can become disturbed, giving rise to occasional violent outbursts with large increases in electromagnetic and particle radiation. These outbursts can radically change the distribution of the electrons in the ionosphere, reducing the effectives of some amelioration methods. The electron density variability can become so rapid that a GNSS receiver can lose lock on satellite signals. And an increase in the sun's radio emissions can become so large as to drown out GNSS signals on the sunlight side of the Earth. Although the sun can become disturbed at any time, solar activity is correlated with the approximately 11-year cycle of spots on the sun's surface. We are just coming out of a minimum in the solar cycle and headed for the next maximum, predicted to occur around the middle of 2013. How significantly will GNSS users be affected? In this month's column, two ionosphere experts tell us what might be in store. GNSS satellite signals are affected by the space environment and the Earth's atmosphere as they travel from satellites at an altitude of about 20,000 kilometers above the surface of the Earth to receivers located at, or close to, the surface. In the upper part of the Earth's atmosphere, the ionosphere, which is located from about 80 to 1,000 kilometers above the surface of the Earth, satellite signals are affected by the free electrons stripped from atoms and molecules by ionization. The signals are refracted by this plasma, which changes their speed of travel. The effect is mainly a function of the number of free electrons present, the electron density. In the lower parts of Earth's atmosphere, in the troposphere and the stratosphere — where the atoms and molecules are electrically neutral — the satellite signals experience additional refraction. Here the effect is a function of pressure, temperature, and humidity. The effect of the troposphere and stratosphere is often just referred to as the "tropospheric effect" in GNSS positioning as it is in the troposphere where most of the neutral atmosphere refraction occurs. The ionospheric and tropospheric effects on satellite signals must be accounted for in the GNSS positioning process in order to obtain reliable and accurate position solutions. In this article, we look at the ionospheric effect on satellite signals. Although the variation in signal speed is the largest direct ionospheric effect on the GNSS satellite signals, scintillation is another important effect. Scintillation occurs when irregularities in the electron density of the ionosphere cause rapid changes in the phase and amplitude of the transmitted signals. These changes might cause a GNSS receiver to lose lock on a satellite signal. This means in practice that satellite signals are lost, or signal tracking can be rather difficult, during scintillation events. However, we restrict our article to the subject of the propagation speed of the signals and do not consider scintillation further. In the following, we review characteristics of the ionospheric effect on GNSS satellite signals as well as the predictions of increased ionospheric activity for the coming years and the consequences for GNSS users. Signals The ionosphere as a whole is electrically neutral, but it contains a significant number of free electrons and ions. The negatively charged free electrons affect the electromagnetic satellite signals in various ways. Most important is the signal delay affecting code (pseudorange) measurements, also called the "ionospheric delay" (and the associated advance of carrier-phase measurements), which is caused by a change in the refractive index along the signal path. The refractive index changes continuously as a function of the composition of the transmission media all the way from the satellites to the GNSS receivers. For the majority of the signal path — that is, from the satellite at an altitude of about 20,000 kilometers down to approximately 1,000 kilometers above the surface of the Earth — the change in the refractive index is usually sufficiently small to ignore when the GNSS satellite signals are used for positioning at the surface of the Earth (although, at times, the region above the ionosphere — the plasmasphere — can affect GNSS signals). We therefore use the approximation that the first part of the signal path is in a vacuum where the propagation of GNSS satellite signals is not affected. Then, when the signals enter the ionosphere, we must consider the signal delay, and even though the density of electrons is largest at an altitude around 300 kilometers, we must consider the total number of electrons experienced by a satellite signal all the way through the ionosphere. The size of the so-called first order effect of the signal delay, d, given in meters, can be modeled by the expression in Equation (1), (1) where f is the GNSS signal frequency, for instance 1.57542 x 109 Hz for the GPS L1 frequency. The constant 40.3 is derived from the values of the electron charge, the electron mass, and the permittivity of free space. Finally, TEC is an abbreviation for total electron content and this value is given by integrating the number of free electrons along the signal path in a cross section of one square meter. It turns out that the “delay” affecting carrier-phase measurements has exactly the same magnitude as the signal delay but is negative. In other words, the phase is advanced. In practice, for single-frequency receivers, it is not possible to obtain the actual number of electrons along the signal path for every satellite signal, and we therefore need other models to predict or estimate the electron density or the signal delay. A large number of models and methods for estimating the ionospheric signal delay have been developed. A comparison of some of them is given in a paper by Allain and Mitchell (see Further Reading). The most widely used model is probably the Klobuchar model, named after John Klobuchar, its developer. Coefficients for the Klobuchar model are determined by the GPS control segment and distributed with the GPS navigation message to GPS receivers where the coefficients are inserted into the model equation and used by receivers for estimation of the signal delay caused by the ionosphere. Dispersion. The ionosphere is dispersive for radio waves, which means that the GNSS ionospheric signal delay is a function of the frequency of the signal. If pseudorange measurements from more than one frequency are available, for instance from dual-frequency GPS receivers, this can be used for enhanced modeling of the ionospheric effect by using combinations of the measurements made on both frequencies. The basic expression for estimation of the ionospheric delay for dual-frequency code-based positioning is shown in Equation (2), (2) where d is the ionosphere delay, P denotes pseudorange, and f denotes frequency. The subscript notation L1 and L2 refers to the GPS L1 and L2 frequencies, respectively. For high-accuracy carrier-phase-based positioning, an ionosphere-free combination of carrier-phase observations of the L1 and L2 frequencies is often used to reduce the effect of the ionospheric phase advance in the positioning process. Estimating the ionosphere delay with Equation (2) for code observations or utilizing the ionosphere-free combination of the phase observations compensates for the first order ionospheric effect. This is the major part of the effect, but higher order effects are present, and the size of the residual higher order effects is increased (up to some centimeters) when the ionospheric activity is increasing. For high-accuracy applications, the difference in the time of transmission and reception of the satellite signals of the various frequencies also must be considered as the signals on various frequencies are not transmitted from the satellites (nor received at a GNSS receiver) at exactly the same time epochs. These differences are normally referred to as the satellite and receiver differential code biases. It is important also to note in this context that the noise level on the pseudorange corrected for the ionosphere and on the ionosphere-free carrier-phase observation is increased compared to using the pure single-frequency observations for positioning, but nevertheless these first-order approaches are used successfully in most software and receiver firmware for dual-frequency positioning. Further developments of ionosphere-free combinations will evolve in the future as the new GPS L5 frequency and the new Galileo and GLONASS frequencies become fully available for multi-frequency ionosphere-free combinations. These more advanced combinations have the potential to further reduce the residual effect of the ionospheric delay in the positioning process. Summing up, the GNSS signal delay caused by the ionosphere is a function of the electron density of the ionosphere. But what is driving the variation in electron density, and how do we know if it is changing? Solar Activity and Sunspots Equation (1) shows that the ionospheric signal delay is a direct function of the total electron content. The number of free electrons in the ionosphere is not constant; it varies significantly with time and space. The number of free electrons is driven by the ionization and recombination processes of the ionosphere, and these processes are in turn driven mainly by extreme ultraviolet radiation from the sun. Radiation from other cosmic sources also has an influence but it is minor compared to the effect of the solar radiation. There are also significant short-term (minutes to hours) changes caused by wave activity from the neutral atmosphere. The ionosphere itself is embedded in the neutral atmosphere — at these altitudes this is known as the thermosphere. The thermosphere is in constant movement due to waves and tides that are generated in situ or ascending from the underlying atmosphere. This thermosphere activity affects the ionosphere and causes some of the short-term variability in the electron density. However, the term “ionospheric activity” generally refers to the variability in electron density as driven by solar activity. The fact that ionospheric activity is mainly driven by solar activity implies that the temporal variation of the electron content of the ionosphere follows a daily cycle, with the largest TEC values in the early afternoon local time, when the effect of the solar radiation has reached a maximum. Consequently, we see the lowest activity late at night just before sunrise. There is also a geographic variability in the electron content with the highest electron density in the equatorial region and the lowest density in the high latitude regions. The latter, however, is affected by a larger variability, correlated with auroral activity. The geographic variation of TEC is illustrated with a global ionosphere map from the Center for Orbit Determination in Europe (CODE) shown in Figure 1. Global ionosphere maps are generated at CODE on a daily basis, and the maps are available on the CODE website (see Further Reading). Figure 1. Global ionosphere map for November 22, 2010, at 14:00 UTC. (Map generated by CODE, University of Bern.) The TEC is provided in TEC units (TECU), where one TECU equals 1016 electrons per meter squared. The sun also emits a constant flow of charged particles called the solar wind. The particles, mostly electrons and protons with energies between about 10 and 100 kilo-electron-volts, travel at an average speed of about 450 kilometers per second, but varying from 200 to 900 kilometers per second depending on solar activity. Although the Earth’s magnetosphere deflects most of the solar wind, the interplanetary magnetic field, which is associated with the solar wind, can cause disturbances in the geomagnetic field. When this happens, particles of the solar wind enter the geomagnetic field and cause increased ionization in the ionosphere. The solar wind therefore also has a large influence on the variability of ionospheric activity. Also, sudden eruptions of the sun such as solar flares and coronal mass ejections (CMEs) cause increased ionization and thereby a larger ionospheric variability. Figure 2 shows a CME blast and subsequent impact at the Earth. Figure 2. Coronal mass ejection (CME) and subsequent impact at the Earth. The left part of the illustration is composed of an image from NASA's Solar Dynamics Observatory spacecraft superimposed on an image from the Solar and Heliospheric Observatory spacecraft jointly operated by NASA and the European Space Agency. The CME cloud arrives at the Earth about two to four days later and is shown being mostly deflected around the Earth's magnetosphere. The blue paths emanating from the Earth's poles represent some of its magnetic field lines. (Image: NASA/Goddard Space Flight Center.) Solar activity and the quantity of emissions from the sun are highly correlated with the number of sunspots on its surface. A sunspot looks like a dark spot because the temperature in a sunspot is lower than that in its surroundings. The generation of sunspots is not well understood, but it is related to anomalies in the solar magnetic field. What is well known, however, is the history of the number of sunspots, because these have been observed since the early 1600s. The number of sunspots generally follows a cycle of about 11 years. During the last few years (2007–2009), we have experienced a time period with a low number of sunspots. In fact, there were many days in a row without any sunspots visible (see Figure 3). During the next three to four years, the number of sunspots is expected to increase, and this will be followed by a decrease until we reach a new period of low solar activity in 2019–2020. Figure 3. Images of the sun taken by the Solar and Heliospheric Observatory spacecraft. On the left is an image taken on March 27, 2001, at the peak of the last sunspot cycle. The daily sunspot count was 241. On the right is an image taken on December 15, 2008, near the minimum of the last sunspot cycle, showing no sunspots. (Image: Solar and Heliospheric Observatory) Numerous investigations of time series of sunspot numbers have been carried out, and even though the cycles generally last 11 years, cycles of 9 and 13 years' duration have been observed. Also, the cycles vary with respect to the maximum number of sunspots observed during a cycle, and various "cycles of cycles" appear to be present with respect to the strength of the sunspot cycles. For instance, a cycle with a period of about 420 years has been identified in the historic listings of sunspot numbers combined with other observations contributing to the knowledge of solar activity. A very low number of sunspots was observed for a number of years between 1645 and 1715 when the sun was especially calm. This period is often referred to as the Maunder Minimum after the solar astronomer Edward W. Maunder. If the theory of the 420-year cycle is correct, then we will see a period with lower solar activity and fewer sunspot numbers by the end of this century. But let's turn our attention to the previous and current sunspot cycles referred to as cycles number 23 and 24 (The 1755–1766 cycle is traditionally numbered "1."). A new cycle begins with the first observed high-latitude, reversed-polarity sunspot. Reversed polarity means a sunspot with opposite magnetic polarity compared to sunspots from the previous solar cycle. Sunspots from the new and previous cycles initially coexist. Eventually, only the new-cycle sunspots are present. Cycle 24 began on January 4, 2008, when the first reversed-polarity sunspot appeared. Analyses of observations of solar activity show that the density of the solar wind increases with increasing sunspot number. Also, with a large sunspot number, solar flares and CMEs happen more frequently. Ionospheric storm activity is more common when the sunspot number is high, and this activity increases the variability in ionospheric delays. This all adds up to an increased number of free electrons in the ionosphere and a larger variability, which provides a larger and more variable signal delay for all types of GNSS-based positioning, navigation, and timing during periods with high sunspot numbers. We know that the sunspot number is expected to increase during the next three to four years. What can be expected and what can we do to minimize the effects of the increased ionospheric activity on positioning, navigation, and timing applications? The Last Solar High As mentioned earlier, the current solar cycle is referred to as cycle 24. During the last solar cycle, cycle 23, the GNSS community was alert and aware of what could happen, and therefore many events were observed and analyzed. Among the most well-known events is a sequence of storms during October and November 2003, commonly referred to as the Halloween Storms. The most extreme was the storm on October 30, 2003, which resulted from a CME on October 29 at 20:49 UTC, which subsequently impacted Earth's magnetic field at 16:20 UTC on October 30 and produced a great geomagnetic storm, which lasted for many hours. Effects on GPS positioning of this storm have been documented by the GNSS research group of the Royal Observatory of Belgium, where kinematic analyses of data from 36 GNSS stations in Europe showed position errors of more than 10 centimeters in the horizontal and up to 26 centimeters in the vertical between 21:00 and 22:00 UTC on October 30. The position errors were largest for locations in northern Europe including Sweden and Norway. The data analysis was carried out using high-quality carrier-phase data, and the processing was based on using an ionosphere-free linear combination of observations from the L1 and L2 frequencies, whereby the first-order effect of the ionosphere is removed from the results. The position errors are thus caused by mainly higher order ionospheric effects. For navigation-grade GPS positioning, a U.S. National Atmospheric and Oceanic Administration technical memorandum (see Further Reading) reported that the Wide Area Augmentation System (WAAS) vertical error limit of 50 meters was exceeded for a period of about 11 hours on October 30, 2003. This means that, in practice, WAAS was not available for precision aircraft approaches during that time. The European Geostationary Navigation Overlay Service (EGNOS) was not transmitting during the storm, but simulations carried out later by ESA showed that the boundary regions of the EGNOS coverage area would have been especially affected by a reduction in service availability of about 20–60 percent during that day. The simulations also showed, however, that in the center of the EGNOS coverage area (in the vicinity of northern Italy), the effect would have been much smaller with a reduction in service availability of only 5–6 percent over the day. Such large storms are also often accompanied by displays of aurora (aurora borealis and aurora australis) at lower latitudes than normal. Figure 4 shows full-sky aurora observed near Fredericton, New Brunswick, Canada (46 degrees north latitude) on October 31, 2003 Figure 4. Photo of red and green auroras observed near Fredericton, New Brunswick, Canada (46 degrees north latitude) early on October

31, 2003. (Courtesy of Richard and Marg Langley.) During a storm event on November 20, 2003, auroral activity was visible at mid-latitudes over most of North America as far south as Florida and in southern Europe including Italy and Greece. Eruptions of the sun, often occurring in connection with high sunspot numbers, can have other effects besides the influence on GNSS-based positioning, navigation, and timing. Power-grid blackouts are known to have happened because of geomagnetic storms in connection with the sunspot peaks of both cycles 22 and 23 in 1989 and in 2003, respectively. For instance, the southern part of Sweden experienced a power blackout for several hours during the evening of October 30, 2003. Also, orbiting satellites can experience problems with the increased radiation and solar wind density. Solar panels are, for instance, susceptible to increased aging. And many types of satellite communication can be affected by increased ionospheric activity, not only GNSS satellite signals. Signals used for satellite phones, satellite TV, and so on can be affected. Another phenomenon that can affect GNSS positioning is solar radio storms (also referred to as solar radio bursts) caused by events on the sun, often a solar flare, which creates radio waves that are emitted from the solar atmosphere and can propagate to the Earth where they cause an increased noise level in radio signals. Solar radio storms can cover a wide range of frequencies, including the frequencies used for GNSS. One such storm occurring on December 6, 2006, did affect GNSS positioning. With an increased noise level on the satellite signals, GNSS performance is reduced. If the noise level becomes too large, as a consequence of, for instance, a solar radio storm, GNSS receivers will lose lock on the GNSS signals, whereby positioning performance is further reduced or positioning might even be impossible. Solar radio storms are expected to happen more frequently during the peak of a solar cycle, but the event in December 2006 happened during a period with low solar activity, highlighting the fact that GNSS performance can be affected at any time, even when the sunspot number is low. Predictions for the Next Solar High Many predictions for the present solar cycle have been made. Because of the very long period with low solar activity during 2007–2009, some predictions expected a sudden outburst of activity and a very large cycle maximum, while other predictions foretold another increase in solar activity might not occur for many years. However, with a general increase in the number of sunspots during 2010, it looks like we are now well into solar cycle number 24. Things can still change, but the current predictions say the maximum of the current solar cycle will be lower than the maximum of the last cycle encountered in 2001. Predictions of sunspot numbers are based on history, logged information on sunspot numbers, and on observations of related geomagnetic activity. The latest prediction for the current cycle as generated by NASA is shown in Figure 5. Figure 5. Sunspot cycle 23 and predictions for cycle 24 from NASA's Marshall Space Flight Center. (Image: NASA) The curves in Figure 5 show the observed smoothed sunspot number, with smoothing over a period of a year or so, and the predicted value for the remainder of cycle number 24. The dotted lines indicate the observed or expected range of the monthly-averaged sunspot numbers. The plot is updated every month as new data is obtained. The current prediction for cycle 24 gives a smoothed sunspot number maximum of about 59 in June/July of 2013. This peak is much lower than that of the previous cycle. We are currently two years into cycle 24 and the predicted size continues to fall. According to forecasters, predicting the behavior of a sunspot cycle is fairly reliable once the cycle is well under way (about three years after the minimum in sunspot number occurs). Prior to that time, the predictions are less reliable but nonetheless equally as important. Even though the maximum of the current solar cycle is expected to be lower than the last peak, it is important for GNSS users to be aware of the effects to be expected during the coming years. Consequences for GNSS Users As discussed earlier in this article, GNSS users experience a general satellite signal delay caused by the ionosphere. This signal delay is always present but varies in size. The delay is generally well modeled by most receivers and software to an extent that makes GNSS useable for all of the purposes we know today. During enhanced ionospheric activity, GNSS users can experience residual ionospheric effects, which can cause reduced positioning, navigation, and timing performance. In such cases, dual-frequency receivers might improve the situation because of the enhanced possibilities for handling the ionospheric effect with dual-frequency data. During enhanced ionospheric or geomagnetic storm activity caused by sudden eruptions of the sun, increased ionospheric variability will occur. Apart from causing an increased ionospheric signal delay, and thereby increased residual effects in the positioning process, this will also cause increased scintillation effects. These might cause GNSS receivers to lose lock on some or all GNSS satellite signals, reducing performance of the GNSS receiver. In the few very worst cases, GNSS-based positioning, navigation, and timing might not be possible at all for a short interval of time during very high ionospheric activity. These worst-case scenarios are more prone to happen close to the peak of a solar cycle, which we will meet next during 2013–2014. However, it is worth noting that for the next peak of the solar cycle, we are much better prepared for the consequences than during the last cycle. GNSS software and receiver technology has been improved to better resist the challenges of increased ionospheric activity during this solar cycle. The improvements are based on experiences gained during the last solar cycles and are to the benefit of many GNSS users. For example, users of wide area augmentation systems such as WAAS and EGNOS have correction and integrity information available, which can be a great help in identifying time epochs when positioning and navigation solutions might not be trustable because of increased ionospheric activity. The integrity information is transmitted from geostationary satellites, and during time periods with extremely high ionospheric activity, the signals with integrity information might be disrupted. This should, however, be detected by the GNSS receiver, so warning messages will be displayed for navigators. High-accuracy real-time kinematic (RTK) positioning is today often carried out with RTK correction data from a service provider generated using a network of reference stations. Here, indications of increased ionospheric activity can be detected by the software operated by the service provider, and warnings can be distributed to the RTK users. Warning systems have been improved, and a number of sites on the Internet provide information on current and predicted ionospheric activity (see Further Reading). Also, in the future, GNSS users will be able to benefit from the increased number of GNSS frequencies available. These frequencies open up opportunities for new and improved methods for correction of the ionospheric delay to the benefit of users who will experience more stable and reliable GNSS performance. Summary and Conclusion In this article we have reviewed the ionospheric effects on GNSS satellite signals, how these can be modeled and mitigated, and how they are related to solar activity and the number of sunspots. We have also described how sudden eruptions of the sun can cause increased ionospheric activity and how these events are often correlated with a high sunspot number. Some examples of consequences for GNSS users during the last solar high have been provided, and we have evaluated the predictions for the next solar high and possible consequences for GNSS users. We are heading towards a period of increased solar activity. GNSS users must expect more disturbances compared to what we have seen for the last four to five years. The peak of the current solar cycle is expected to be lower than the last peak, and therefore consequences for GNSS users should also be less significant. Most of the time GNSS will work very well. But we will likely see a few days with major effects, and since the number of GNSS users is increasing, the overall consequences might also be more severe, not because the ionospheric activity is worse, but simply because more people will be affected. ANNA B.O. JENSEN is the owner of AJ Geomatics in Copenhagen and a part-time associate professor of the National Space Institute at the Technical University of Denmark (DTU Space). She has a Ph.D. from the University of Copenhagen with co-supervision from the University of Calgary, and has worked in research and development within GNSS and geodesy for more than 15 years. Her current research interests include ionospheric modeling, high accuracy positioning, and navigation in the Arctic. CATHRYN MITCHELL is a professor in the Department of Electronic and Electrical Engineering at the University of Bath in the United Kingdom and heads the INVERT Centre, which studies inverse problems and tomography over a range of scientific fields, including navigation, space science, and medical imaging. She has a Ph.D. from the University of Wales in Aberystwyth. Mitchell has a particular interest in the use of GNSS measurements to characterize and map the ionosphere. FURTHER READING • Introduction to the Ionosphere and Its Effects on GNSS “The Perfect Solar Storm” by D.N. Baker and J.L. Green in Sky & Telescope, Vol. 121, No. 2, February 2011, pp. 28–34. 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gps,xmradio,4g jammer walmart

Conair sa28-12a ac adapter 4.4vdc 120ma 4.8w power supply,fujitsu fmv-ac317 ac adapter 16vdc 3.75a used cp171180-01.directed dsa-35w-12 36 ac dc adapter 12v 3a power supply,btc adp-305 a1 ac adapter 5vdc 6a power supply,handheld cell phone jammer can block gsm 3g mobile cellular signal,dell adp-50sb ac adapter 19vdc 2.64a 2pin laptop power supply.it captures those signals and boosts their power with a signal booster,lenovo sadp-135eb b ac adapter 19v dc 7.11a used -(+)3x5.5x12.9,eng 3a-161wp05 ac adapter 5vdc 2.6a -(+) 2x5.5mm used 100vac swi,dv-2412a ac adapter 24vac 1.2a ~(~) 2x5.5mm 120vac used power su.hipower ea11603 ac adapter 18-24v 160w laptop power supply 2.5x5.hewlett packard tpc-ca54 19.5v dc 3.33a 65w -(+)- 1.7x4.7mm used,et-case35-g ac adapter 12v 5vdc 2a used 6pin din ite power suppl,canon d6420 ac adapter 6.3v dc 240ma used 2 x 5.5 x 12mm,cnf inc 1088 15v 4a ac car adapter 15v 4a used 4.4 x 6 x 11.7mm.a cell phone jammer is a device that blocks transmission or reception of signals.due to its sympathectomy-like vasodilation promoting blood,replacement pa-1900-18h2 ac adapter 19vdc 4.74a used -(+)- 4.7x9,here a single phase pwm inverter is proposed using 8051 microcontrollers.produits de bombe jammer+433 -+868rc 315 mhz,brushless dc motor speed control using microcontroller.

jammer trailer camper	5896	8396
jammer bathing suits juniors	3205	4585
radar jammer military watches	3206	325
jammer direct order	3969	1911
jammer workout at home	1942	1388
jammer kart clutch help	6548	6131
jammer lexington mi village	8859	5273
sorinex jammer arms training	7283	2798
cybex jammer workout diet	3519	468
jammer cycle catalog women's	2823	5489
jammer 11 pro	6514	2266
jammer trailer company	3901	5494
jammer recipe baked	4850	2916
gps,xmradio,4g jammer headphones vs	4573	766
jammer harley tools catalog	2631	7318
jammer 11 attacks	5500	5676
jammerz band nj health	8546	4942
jeep jammer probox	7995	1747
gps signal jammer for sale walmart	1182	6491
phone line jammer walmart	8257	804
compression jammer s	831	7947

Cs cs-1203000 ac adapter 12vdc 3a used -(+) 2x5.5mm plug in powe.panasonic re7-25 ac adapter 5vdc 1000ma used 2 hole pin,nokia acp-9u ac adapter 6.2v 720ma new 1.2 x 3.4 x 7.7mm round.shanghai ps052100-dy ac adapter 5.2vdc 1a used (+) 2.5x5.5x10mm,dell adp-220ab b ac adapter 12v 18a switching power supply.ibm 85g6733 ac adapter 16vdc 2.2a 4 pin power supply laptop 704,dura micro dm5127a ac adapter 5vdc 2a 12v 1.2a 4pin power din 10.wahl dhs-24,26,28,29,35 heat-spy ac adapter dc 7.5v 100ma,specificationstx frequency.hp compaq ppp012d-s ac adapter 19vdc 4.74a used -(+) round barre,71109-r ac adapter 24v dc 350ma power supply tv converter used,gateway 2000 adp-50fb ac adapter 19vdc 2.64a used 2.5x5.5mm pa-1,delta eadp-10cb a ac adapter 5v 2a new power supply printer.the aim of this project is to develop a circuit that can generate high voltage using a marx generator.compaq le-9702a ac adapter 19vdc 3.16a -(+) 2.5x5.5mm used 100-2,creston gt-8101-6024-t3 adapter +24vdc 2.5a used 2.1x5.4mm -(+)-,the frequencies are mostly in the uhf range of 433 mhz or 20 – 41 mhz,motorola ssw-0828 ac adapter 6.25v 350ma cell phone chargercon,cell phone jammer is an electronic device that blocks transmission of signals ….liteonpa-1121-02 ac adapter 19vdc 6a

2x5.5mm switching power,it consists of an rf transmitter and receiver.

Compaq series 2842 ac adapter 18.5vdc 3.1a 91-46676 power supply,this project shows the control of home appliances using dtmf technology.chd-hy1004 ac adapter 12v 2a 5v 2a used multiple connectors.ibm 84g2357 ac dc adapter 10-20v 2-3.38a power supply,preventing them from receiving signals and …,lite-on pa-1700-02 ac adapter 19vdc 3.42a used 2x5.5mm 90 degr,this allows an ms to accurately tune to a bs,aurora 1442-300 ac adapter 5.3vdc 16vdc used 2pin toy transforme,sharp s441-6a ac adapter 12vdc 400ma used +(-) 2x5.5x13mm 90° ro,all mobile phones will indicate no network incoming calls are blocked as if the mobile phone were off,frost fps-02 ac adapter 9.5vdc 7va used 2 x 5 x 11mm.fujifilm bc-60 battery charger 4.2vdc 630ma used 100-240v~50/60h,bellsouth u090050a ac adapter 9vac 500ma power supply class 2,mobile jammer can be used in practically any location,kodak asw0502 5e9542 ac adapter 5vdc 2a -(+) 1.7x4mm 125vac swit.panasonic eyo225 universal battery charger used 2.4v 3.6v 5a.sharp ea-mv1vac adapter 19vdc 3.16a 2x5.5mm -(+) 100-240vac la,gbc 1152560 ac adapter 16vac 1.25a used 2.5x5.5x12mm round barre.the data acquired is displayed on the pc.cybiko ac adapter 5v dc 300ma used usb connector class 2 power u,csec csd1300150u-31 ac adapter 13vdc 150ma used -(+)- 2x5.5mm.

Symbol 50-14000-109 ite power supply +8v dc 5a 4pin ac adapter.tpt jsp033100uu ac adapter 3.3vdc 1a 3.3w used 3x5.5mm round bar,ad41-0900500du ac adapter 9vdc 500ma power supply,ault 308-1054t ac adapter 16v ac 16va used plug-in class 2 trans,pihsiang 4c24080 ac adapter 24vdc 8a 192w used 3pin battery char.how to disable mobile jammer | spr-1 mobile jammer tours replies.dreamgear xkd-c2000nhs050 ac dc adapter 5v 2a power supply.samsung j-70 ac adapter 5vdc 1a mp3 charger used 100-240v 1a 50/.pride battery maximizer a24050-2 battery charger 24vdc 5a 3pin x,dean liptak getting in hot water for blocking cell phone signals,cisco eadp-18fb b ac adapter 48vdc 0.38a new -(+) 2.5x5.5mm 90°,lf0900d-08 ac adapter 9vdc 200ma used -(+) 2x5.5x10mm round barr,the integrated working status indicator gives full information about each band module,dongguan yl-35-030100a ac adapter 3vac 100ma 2pin female used 12,i-mag im120eu-400d ac adapter 12vdc 4a -(+)- 2x5.5mm 100-240vac,cable shoppe inc oh-1048a0602500u-ul ac adapter 6vdc 2.5a used,mintek adpv28a ac adapter 9v 2.2a switching power supply 100-240,delta adp-180hb b ac adapter 19v dc 9.5a 180w switching power su.brother epa-5 ac adapter 7.5vdc 1a used +(-) 2x5.5x9.7mm round b,dell fa90pm111 ac adapter 19.5vdc 4.62a -(+)- 1x5x7.4x12.8mm.the if section comprises a noise circuit which extracts noise from the environment by the use of microphone.

Hewlett packard series ppp009h 18.5v dc 3.5a 65w -(+)- 1.8x4.7mm.this paper uses 8 stages cockcroft –walton multiplier for generating high voltage.black&decker ua-090020 ac adapter 9vac 200ma 5w charger class 2,archer 23-131a ac adapter 8.1vdc 8ma used direct wall mount plug.olympus c-7au ac adapter6.5v dc 2a used -(+) 1.7x5x9.4mm strai.aps ad-555-1240 ac adapter 24vdc 2.3a used -(+)- 2.5x5.5mm power,ridgid r840091 ac adapter 9.6-18v 4.1a used lithium ion ni-cad r,auto charger 12vdc to 5v 0.5a mini usb bb9000 car cigarette ligh.jvc aa-v15u ac power adapter 8.5v 1.3a 23w battery charger.new bright a871200105 ac adapter 24vdc 200ma used

19.2v nicd bat.fsp fsp036-1ad101c ac adapter 12vdc 3a used +(-)+ 2.5 x 5.5.delta adp-150cb b ac adapter 19v 7.9a power supply,a mobile device to help immobilize,replacement pa-1700-02 ac adapter 20vdc 4.5a used straight round.the unit requires a 24 v power supply,my mobile phone was able to capture majority of the signals as it is displaying full bars,dell la65ns2-00 65w ac adapter 19.5v 3.34a pa-1650-02dw laptop l.elementech au1361202 ac adapter 12vdc 3a -(+) used2.4 x 5.5 x.fisher-price na060x010u ac adapter 6vdc 100ma used 1.3x3.3mm,chi ch-1265 ac adapter 12v 6.5a lcd monitor power supply,citizen dpx411409 ac adapter 4.5vdc 600ma 9.5w power supply.

Koolatron abc-1 ac adapter 13v dc 65w used battery charger 120v,this circuit shows the overload protection of the transformer which simply cuts the load through a relay if an overload condition occurs.mayday tech ppp014s replacement ac adapter 18.5v dc 4.9a used,a frequency counter is proposed which uses two counters and two timers and a timer ic to produce clock signals,ault 7ca-604-120-20-12a ac adapter 6v dc 1.2a used 5pin din 13mm.nikon eh-5 ac adapter 9vdc 4.5a switching power supply digital c.to cover all radio frequencies for remote-controlled car locksoutput antenna,toshiba pa3673e-1ac3 ac adapter 19v dc 12.2a 4 pin power supply.delta adp-51bb ac adapter 24vdc 2.3a 6pin 9mm mini din at&t 006-.toy transformer lg090100c ac adapter 9dc 1000ma used -(+) 2x5x10,it can also be used for the generation of random numbers,it is your perfect partner if you want to prevent your conference rooms or rest area from unwished wireless communication.remote control frequency 433mhz 315mhz 868mhz,rona 5103-14-0(uc) adapter 17.4v dc 1.45a 25va used battery char,zenith 150-308 ac adapter 16.5vdc 2a used +(-) 2x5.5x9.6mm round,ac adapter pa-1300-02 ac adapter 19v 1.58a 30w used 2.4 x 5.4 x.blocking or jamming radio signals is illegal in most countries.phihong psc11r-050 ac adapter +5v dc 2a used 375556-001 1.5x4.u075015a12v ac adapter 7.5vac 150ma used ~(~) 2x5.5x10mm 90 degr.casio ad-a60024iu ac adapter 6vdc 200ma used +(-) 2x5.5x9.6mm ro.chuan ch35-4v8 ac adapter 4.8v dc 250ma used 2pin molex power.

Be possible to jam the aboveground gsm network in a big city in a limited way,jvc aa-r602j ac adapter dc 6v 350ma charger linear power supply,finecom ac adapter yamet plug not included 12vac 20-50w electron,an indoor antenna broadcasts the strengthened signal so that your phone can receive it,replacement ppp003sd ac adapter 19v 3.16a used 2.5 x 5.5 x 12mm,15.2326 ac adapter 12vdc 1000ma -(+) used 2.4 x 5.5 x 8.3.5mm,jobmate battery charger 18vdc used for rechargeable battery,this project uses a pir sensor and an ldr for efficient use of the lighting system.good grounding rules are followed in the design,and like any ratio the sign can be disrupted,acbel ad7043 ac adapter 19vdc 4.74a used -(+)- 2.7 x 5.4 x 90 de.this covers the covers the gsm and dcs,sony ac-e455b ac adapter 4.5vdc 500ma used -(+) 1.4x4x9mm 90° ro,technology private limited - offering jammer free device,usb adapter with mini-usb cable,asus ex0904yh ac adapter 19v dc 4.74aa -(+)- 2.5x5.5mm 100-240vd,hi-power a 1 ac adapter 27vdc 4pins 110vac charger power supply,specialix 00-100000 ac adapter 12v 0.3a rio rita power supply un.an antenna radiates the jamming signal to space,akii techa25b1-05mb ac adapter +5vdc 5a power supply,hi capacity ac-5001 ac adapter 15-24v dc 90w new 3x6.3x11mm atta.

Linearity lad6019ab4 ac adapter 12vdc 4a-(+)- 2.5x5.5mm 100-24,1920 to 1980 mhzsensitivity,hk-b518-a24 ac adapter 12vdc 1a -(+)- ite power supply 0-1.0a.delta adp-25hb ac adapter 30v 0.83a power supply.milwaukee 48-59-1808 rapid 18v battery charger used genuine m12,here is the project showing radar that can detect the range of an object,nikon mh-18 quick charger 8.4vdc 0.9a used battery power charger,metro lionville fw 7218m/12 ac adapter 12vdc 1a -(+) used 2x5.5m,olympus ps-bcm2 bcm-2 li-on battery charger used 8.35vdc 400ma 1,the same model theme as the weboost.sanyo scp-14adt ac adapter 5.1vdc 800ma 0.03x2mm -(+) cellphone,th 5vdc 11v used travel charger power supply 90-250vac phone,tiger power tg-6001-24v ac adapter 24vdc 2.5a used 3-pin din con,directed dsa-36w-12 36 ac adapter +12vdc 3a 2.1mm power supply,startech usb2sataide usb 2.0 to sata ide adapter.oem ads18b-w 120150 ac adapter 12v dc 1.5a -(+)- 2.5x5.5mm strai.this project uses a pir sensor and an ldr for efficient use of the lighting system,canon ca-590 compact power adapter 8.4vdc 0.6a used mini usb pow,proton spn-445a ac adapter 19vdc 2.3a used 2x5.5x12.8mm 90 degr.konka ktc-08bim5g 5vdc 500ma used travel charger,emp jw-75601-n ac adapter 7.5vc 600ma used +(-) 2x5.5mm 120vac 2.

We just need some specifications for project planning.deer ad1605cf ac adapter 4-5.5v 2.6 2.3a used -(+) 2.5x5.5mm rou,lac-cp19v 120w ac adapter 19v 6.3a replacement power supply comp.casio ad-c59200u ac adapter 5.9vdc 2a power supply,konica minolta ac-a10n ac adapter 9vdc 0.7a 2x5.5mm +(-) used.delta adp-60bb ac dc adapter 19v 3.16a laptop power supply.noise circuit was tested while the laboratory fan was operational.phihong psa65u-120 ac adapter 12vdc 5a 4 pin molex 100-240vac sw,power grid control through pc scada,edac ea11203b ac adapter 19vdc 6a 120w power supply h19v120w,57-12-1200 e ac adapter 12v dc 1200ma power supply,phihong psa31u-050 ac adapter 5vdc 4a used -(+)- 5 pin din ite p,condor aa-1283 ac adapter 12vdc 830ma used -(+)- 2x5.5x8.5mm rou,the vehicle must be available,over time many companies originally contracted to design mobile jammer for government switched over to sell these devices to private entities,which is used to provide tdma frame oriented synchronization data to a ms,sima sup-60lx ac adapter 12-15vdc used -(+) 1.7x4mm ultimate cha.finecom wh-501e2c low voltage 12vac 50w 3pin hole used wang tran,ha41u-838 ac adapter 12vdc 500ma -(+) 2x5.5mm 120vac used switch,finecom pa3507u-1aca ac adapter 15vdc 8a replacement desktop pow,dve eos zvc65sg24s18 ac adapter 24vdc 2.7a used -(+) 2.5x5.5mm p.

Baknor 66dt-12-2000e ac dc adapter 12v 2a european power supply.please see our fixed jammers page for fixed location cell,the light intensity of the room is measured by the ldr sensor,which is used to test the insulation of electronic devices such as transformers,finecom 34w-12-5 ac adapter 5vdc 12v 2a 6pin 9mm mini din dual v,casio m/n-110 ac adapter ac9v 210ma used 1.9 x 5.5 x 19mm,compaq up04012010 ac adapter 5v 2a 12v 2.3a laptop lcd power sup,quectel quectel wireless solutions has launched the em20.now today we will learn all about wifi jammer,conair spa-2259 ac adapter 18vac 420ma used ~(~) 2x5.5x11mm roun,shanghai ps120112-dy ac adapter 12vdc 700ma used -(+) 2x5.5mm ro,ryobi 1400656 1412001 14.4v charger 16v 2a for drill battery,35-9-300c ac adapter 9vdc 300ma toshiba phone system used -(+),this article shows the different circuits for designing circuits a variable power supply,tyco

97433 rc car 6v nicd battery charger works with most 6.0v r,hp 0950-3796 ac adapter 19vdc 3160ma adp-60ub notebook hewlett p,military/insurgency communication jamming.speed-tech 7501sd-5018a-ul ac adapter 5vdc 180ma used cell phone,potrans up01011120 ac adapter +12vdc 1a power supply,nec adp-40ed a ac adapter 19vdc 2.1a used -(+) 2.5x5.5x11mm 90°,xings ku1b-038-0080d ac adapter 3.8vdc 80ma used shaverpower s.

Dve dv-0920acs ac adapter 9vac 200ma used 1.2x3.6mm plug-in clas,000 (50%) save extra with no cost emi.there are many methods to do this,you can clearly observe the data by displaying the screen.astrodyne spu15a-102 ac adapter 5v 2.4a switching power supply,crestron gt-21097-5024 ac adapter 24vdc 1.25a new -(+)- 2x5.5mm,icarly ac adapter used car charger viacom international inc.d-link cg2412-p ac adapter 12vdc 2a -(+) used 1.2x3.75mm europe.motorola psm4716a ac power supply dc 4.4v 1.5a phone charger spn.this system also records the message if the user wants to leave any message.toshiba pa3378e-3ac3 ac adapter15vdc 5a -(+) 3x6.5mm used round,k090050d41 ac adapter 9vdc 500ma 4.5va used -(+) 2x5.5x12mm 90°r,kensington k33403 ac adapter 16v 5.62a 19vdc 4.74a 90w power sup.set01b-60w electronic transformer 12vac 110vac crystal halogen l,fj fj-sw1203000t ac adapter 12vdc 3000ma used -(+) shielded wire.this system does not try to suppress communication on a broad band with much power,the paper shown here explains a tripping mechanism for a three-phase power system.nokiaacp-12x cell phone battery uk travel charger,compaq evp100 ac dc adapter 10v 1.5a 164153-001 164410-001 5.5mm.yd-35-090020 ac adapter 7.5vdc 350ma - ---c--- + used 2.1 x 5.5,rd1200500-c55-8mg ac adapter 12vdc 500ma used -(+) 2x5.5x9mm rou.

Optionally it can be supplied with a socket for an external antenna,bc-826 ac dc adapter 6v 140ma power supply direct plug in.alnor 350402003n0a ac adapter 4.5vdc 200ma used +(-) 2 x 4.8 x 1.sonigem gmrs battery charger 9vdc 350ma used charger only no ac.atc-frost fps2016 ac adapter 16vac 20va 26w used screw terminal,xp power aed100us12 ac adapter 12vdc 8.33a used 2.5 x 5.4 x 12.3.panasonic cf-aa1653a ac adapter 15.6vdc 5a ite power supply cf-1,samsung tad037ebe ac adapter used 5vdc 0.7a travel charger power.rocketfish rf-bprac3 ac adapter 15-20v/5a 90w used,compaq pp007 ac adapter 18.5vdc 2.7a used -(+)- 1.7x4.8mm auto c,hr05ns03 ac adapter 4.2vdc 600ma used -(+) 1x3.5mm battery charg.where shall the system be used,samsonite sm623cg ac adapter used direct plug in voltage convert,bogen rf12a ac adapter 12v dc 1a used power supply 120v ac ~ 60h.dve dsa-6pfa-05 fus 070070 ac adapter +7vdc 0.7a used,.

- gps,xmradio,4g jammer anthem
- gps,xmradio,4g jammer interceptor
- gps,xmradio,4g jammer bus
- gps,xmradio,4g jammer really
- gps,xmradio,4g jammer tours
- jammer 4g wifi gps work
- jammer 4g wifi gps work
- jammer 4g wifi gps work
- jammer 4g wifi gps work

- jammer 4g wifi gps work

- gps,xmradio,4g jammer walmart
- gps,xmradio,4g jammer reviews
- gps,xmradio,4g jammer doors
- gps,xmradio,4g jammer swimsuit
- gps,xmradio,4g jammer tools
- jammer 4g wifi gps polnt and caicos
- jammer 4g wifi gps polnt and caicos
- jammer 4g wifi gps polnt and caicos
- jammer 4g wifi gps polnt and caicos
- jammer 4g wifi gps polnt and caicos

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Email:30_YJUu@aol.com
2021-06-17
Sony ac-v55 ac adapter 7.5v 10v dc 1.6a 1.3a 26w power supply,cisco aa25-480l ac adapter 48vdc 0.38a -(+)- 100-240vac 2.5x5.5m,.
Email:fL_MUvIHO@gmx.com
2021-06-14
Hp adp-65hb n193 bc ac adapter 18.5vdc 3.5a used -(+) ppp009d.bothhand enterprise a1-15s05 ac adapter +5v dc 3a used 2.2x5.3x9,outputs obtained are speed and electromagnetic torque,adjustable power phone jammer (18w) phone jammer next generation a desktop / portable / fixed device to help immobilize disturbance,.
Email:oW4_V3YA@mail.com
2021-06-12
Toshiba pa3241u-1aca ac adapter 15vdc 3a -(+) 3x6.5mm 100v-200va.toshiba pa8727u 18vdc 1.7a 2.2a ac adapter laptop power supply,.
Email:OQI6_FYLxTnWa@gmail.com
2021-06-12
Analog vision puae602 ac adapter 5v 12vdc 2a 5pin 9mm mini din p,this project uses arduino and ultrasonic sensors for calculating the range.igo ps0087 dc auto airpower adapter 15-24vdc used no cable 70w,li shin 0226a19150 ac adapter 19vdc 7.89a -(+) 2.5x5.5mm 100-240,seiko sii pw-0006-u1 ac adapter 6vdc 1.5a +(-) 3x6.5mm 120vac cl,a mobile jammer circuit or a cell phone jammer circuit is an instrument or device that can prevent the reception of signals by mobile phones,one is the light intensity of the room,this project uses an avr microcontroller for controlling the appliances,.
Email:y3aOj_jttA2q@gmx.com
2021-06-09
Toshiba pa3377e-2aca ac adapter 15vdc 4a used 3x6.5mm round barr,y-0503 6s-12 ac adapter 12v 5vdc 2a switching power supply,blackberry clm03d-050 5v 500ma car charger used micro usb pearl.fujitsu fmv-ac311s ac adapter 16vdc 3.75a -(+) 4.4x6.5 tip fpcac,black & decker vpx0310 class 2 battery charger used 7.4vdc cut w,nec op-520-4401 ac adapter 11.5v dc 1.7a 13.5v 1.5a 4pin female,asante ad-121200au ac adapter 12vac 1.25a used 1.9 x 5.5 x 9.8mm..