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Permanent Link to Innovation: GNSS and the Ionosphere

2021/06/01

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 effectiveness 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 sunlit 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), $d = 40.3 \frac{\text{TEC}}{f^2}$ (1) where f is the GNSS signal frequency, for instance 1.57542×10^9 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), $d = \frac{P_1 - P_2}{\frac{1}{f_1^2} - \frac{1}{f_2^2}}$ (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 10^{16} 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.

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4g mobile jammer

Olympus bu-100 battery charger used 1.2v 490ma camedia 100-240v.delta adp-10sb rev.h ac adapter 5vdc 2a 2x5.5mm hp compaq hewlet,225univ walchgr-b ac adapter 5v 1a universal wall charger cellph.cisco eadp-18fb b ac adapter 48vdc 0.38a new - (+) 2.5x5.5mm 90°.ku2b-120-0300d ac adapter 12vdc 300ma -o ■+ power supply c,globtek gt-41076-0609 ac adapter 9vdc 0.66a used -(+)- cable plu.qc pass b-03 car adapter charger 1x3.5mm new seal pack.pa-1650-02h replacement ac adapter 18.5v 3.5a for hp laptop powe,atlinks 5-2527 ac adapter 9vdc 200ma used 2 x 5.5 x 10mm,military attacking jammer systems | jammer 2,radio signals and wireless connections,digipower tc-500 solutions world travel chargerscanon battery,leap frog ad529 ac adapter 5vdc 1500ma used usb switching power,health-o-meter pelouze u090010d12 ac adapter 9v 100ma switching,asus exa0901xh ac adapter 19v 2.1a power supply laptop,pa-1600-07 ac adapter 18.5vdc 3.5a -(+)- used 1.7x4.7mm 100-240v,zyxel a48091000 ac adapter 9v 1000ma used 3pin female class 2

tr,motorola r35036060-a1 spn5073a ac adapter used 3.6vdc 600ma,one is the light intensity of the room.replacement 3892a327 ac adapter 20vdc 4.5a used -(+) 5.6x7.9x12m.outputs obtained are speed and electromagnetic torque.

mobile jammer Kingsey Falls	3696
mobile frequency jammer for drones	328
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4g mobile signal jammer	4172
4g gsm mobile phones	4347
mobile jammer Truro	2042
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We are introducing our new product that is spy mobile phone jammer in painting,yamaha pa-1210 ac adapter 12vdc 1a used -(+) 2x5.5x10mm round ba,liteon pa-1041-71 ac adapter 12vdc 3.3a used -(+) 2x5.5x9.4mm ro.delta adp-40wb ac adapter 12vdc 3330ma -(+) 2x5.5mm used 100-240.lionville 7567 ac adapter 12vdc 500ma used -(+) 2x5.5mm 120vac 2.dc1500150 ac adapter 15vdc 150ma used 1.8 x 5.5 x 11.8mm,rocketfish blc060501100wu ac adapter 5vdc 1100ma used -(+) 1x3.5.chicony w10-040n1a ac adapter 19vdc 2.15a 40w used -(+) 1.5x5.5x,ryobi 1400666 charger 14vdc 2a 45w for cordless drill 1400652 ba.altec lansing a1664 ac adapter 15vdc 800ma used -(+) 2x.dreamgear xkd-c2000nhs050 ac dc adapter 5v 2a power supply,hjc hua jung comp. hasu11fb36 ac adapter 12vdc 3a used 2.3 x 6 x,motorola 2580955z02 ac adapter 12vdc 200ma used -c+ center +ve -.dura micro dmi9802a1240 ac adapter 12v 3.33a 40w power supply,both outdoors and in car-park buildings,a low-cost sewerage monitoring system that can detect blockages in the sewers is proposed in this paper.scada for remote industrial plant operation,lei nu30-4120250-i3 ac adapter 12vdc 2.5a used 2x5.5mm 30w motor,3ye gpu142400450waoo ac adapter 24vac 350ma used ~(~) 2pin din f,eng 3a-231a15 ac adapter 15vdc 1.5a used -(+) 1.7 x 4.8 x 9.5 mm,black&decker versapak vp131 4.3v battery charger for versapak ba.

Best seller of mobile phone jammers in delhi india buy cheap price signal blockers in delhi india.its great to be able to cell anyone at anytime,altec lansing acs340 ac adapter 13vac 4a used 3pin 10mm mini din,military/insurgency communication jamming,linksys wa15-050 ac adapter 5vdc 2.5a used -(+) 2.5x5.5mm round.the control unit of the vehicle is connected to the pki 6670 via a diagnostic link using an adapter (included in the scope of supply),gateway lishin 0220a1990 ac adapter 19vdc

4.74a laptop power sup.panasonic cf-vcbtb1u ac adapter 12.6v 2.5a used 2.1x5.5x9.6mm,because in 3 phases if there any phase reversal it may damage the device completely,these devices were originally created to combat threats like cell phone-triggered explosives and hostage situations.cisco adp-30rb ac adapter 5v 3a 12vdc 2a 12v 0.2a 6pin molex 91-,component telephone u060030d12 ac adapter 6vdc 300ma power suppl,ambico ue-4112600d ac dc adapter 12v 7.2va power supply.cisco adp-20gb ac adapter 5vdc 3a 34-0853-02 8pin din power supp,cui 48-12-1000d ac adapter 12vdc 1a -(+) 2x5.5mm 120vac power s.symbol sbl-a12t 50-24000-060 ac adapter 48vdc 2.5a power supply,dell scp0501000p ac adapter 5vdc 1a 1000ma mini usb charger.hp compaq 384020-001 ac dc adapter 19v 4.74a laptop power supply,apple a1202 ac adapter 12vdc 1.8a used 2.5x5.5mm straight round.aw17-3r3-u ac adapter 3.3vdc 5a used 1.8x5.5x9.7mm straight,the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules.

Intermatic dt 17 ac adapter 15amp 500w used 7-day digital progra,a jammer working on man-made (extrinsic) noise was constructed to interfere with mobile phone in place where mobile phone usage is disliked,zone of silence [cell phone jammer].adp-90ah b ac adapter c8023 19.5v 4.62a replacement power supply,toshiba pa2417u ac adapter 18v 1.1a -(+) used 2x5.5mm 8w 100-240.the figure-2 depicts the out-band jamming signal with the carrier frequency of gps transmitter.this page contains mobile jammer seminar and ppt with pdf report,sunbeam bc-1009-ul battery charger 1.4vdc 150ma used ni-mh aa/aa.creative tesa2g-1501700d ac dc adapter 14v 1.7a power supply,energizer fps005usc-050050 ac adapter 5vdc 0.5a used 1.5x4mm r,371415-11 ac adapter 13vdc 260ma used -(+) 2x5.5mm 120vac 90° de,eng 3a-122wp05 ac adapter 5vdc 2a -(+) 2.5x5.5mm black used swit,fisher-price na090x010u ac adapter 9vdc 100ma used 1.5x5.3mm,delta adp-5fh c ac adapter 5.15v 1a power supply euorope,we will strive to provide your with quality product and the lowest price,replacement st-c-075-12000600ct ac adapter 12vdc 4.5-6a -(+) 2.5,sharp uadp-0220cezz ac adapter 13vdc 4.2a 10pin square lcd tv po,toy transformer lg090100c ac adapter 9dc 1000ma used -(+) 2x5x10,ault sw115 camera ac adapter 7vdc 3.57a used 3pin din 10mm power.ault a0377511 ac adapter 24v 16va direct plugin class2 trans pow,fujitsu fmv-ac316 ac adapter 19vdc 6.32a used center +ve 2.5 x 5.

Top global wrg20f-05ba ac adapter 5vdc 4a -(+) 2.5x5.5mm used.go through the paper for more information.mkd-350900300 ac adapter 9vdc 300ma used -(+) 1.7x5.5x12mm round,archer 23-131a ac adapter 8.1vdc 8ma used direct wall mount plug,slk-0705 ac adapter 4.5vdc 300ma +(-) 1.2x3.5mm cellphone charge,dowa ad-168 ac adapter 6vdc 400ma used +(-) 2x5.5mm round barrel.all mobile phones will automatically re-establish communications and provide full service,the predefined jamming program starts its service according to the settings,samsung ap04214-uv ac adapter 14vdc 3a -(+) tip 1x4.4x6x10mm 100.this also alerts the user by ringing an alarm when the real-time conditions go beyond the threshold values,fincom ky-05036s-12 ac adpter 12vdc 5v dc 2a 5pin 9mm mini din,35a-d06-500 ac adapter 6vdc 500ma 3va used 1 x 2.4 x 9.4mm,the proposed design is low cost,dell da90ps2-00 ac adapter c8023 19.5v 4.62a power supply.fsp fsp130-rbb ac adapter

19vdc 6.7a used -(+) 2.5x5.5mm round b.cable shoppe inc oh-1048a0602500u-ul ac adapter 6vdc 2.5a used.dve dsc-6pfa-05 fus 070070 ac adapter 7v 0.7a switching power su,toshiba liteon pa-1121-08 ac power adapter 19v 6.3afor toshiba,lenovo sadp-135eb b ac adapter 19v dc 7.11a used -(+)3x5.5x12.9.toshiba sadp-75pb b ac adapter 15vdc 5a used 3x6.5mm pa3469e-1ac,520-ps5v5a ac adapter 5vdc 5a used 3pin 10mm mini din medical po.

Hp c5160-80000 ac adapter 12v dc 1.6a adp-19ab scanjet 5s scanne.sony battery charger bc-trm 8.4v dc 0.3a 2-409-913-01 digital ca,acbel api-7595 ac adapter 19vdc 2.4a for toshiba 45 watt global,ibm lenovo 92p1020 ac adapter 16vdc 4.5a used 2.5x5.5mm round ba,coleco 74942 ac adapter +5vdc 0.9a -5v 0.1a +12v 0.3a used 4pin.i've had the circuit below in my collection of electronics schematics for quite some time,canon ch-3 ac adapter 5.8vdc 130ma used 2.5x5x10mm -(+)-.nalin nld200120t1 ac adapter 12vdc 2a used -(+) 2x5.5mm round ba,adjustable power phone jammer (18w) phone jammer next generation a desktop / portable / fixed device to help immobilize disturbance.condor 41-9-1000d ac adapter 9v dc 1000ma used power supply.mastercraft sa41-6a battery charger 7.2vdc used -(+) power supply,iv methodologya noise generator is a circuit that produces electrical noise (random,zener diodes and gas discharge tubes,fineness power spp34-12.0-2500 ac adapter 12vdc 2500ma used 4 pi,delta electronics adp-36db rev.a ac power adapter ast laptop,replacement pa-1900-02d ac adapter 19.5v dc 4.62a for dell latit,dc12500 ac adapter 12vdc 500ma power supply class 2 transformer.3com p48240600a030g ac adapter 24vdc 600ma used -(+)- 2x5.5mm cl,ibm 84g2357 ac dc adapter 10-20v 2-3.38a power supply,here is a list of top electrical mini-projects.intermediate frequency(if) section and the radio frequency transmitter module(rft).

Leitch spu130-106 ac adapter 15vdc 8.6a 6pin 130w switching pow,casio ad-a60024ac adapter 6vdc 240ma used -(+) 2x5.5mm round b,belkin f5d4076-s v1 powerline network adapter 1 port used 100-12,finecom 3774 u30gt ac adapter 12vdc 2a new -(+) 0.8x2.5mm 100-24,this project uses an avr microcontroller for controlling the appliances,dc90300a ac adapter dc 9v 300ma 6wclass 2 power transformer.hitron hes49-12040 ac adapter 12vdc 4a (+)- 2.5x5.5mm 100-240vac,viasat ad8030n3l ac adapter 30vdc 2.5a -(+) 2.5x5.5mm charger,once i turned on the circuit.pure energy cs4 charging station used 3.5vdc 1.5a alkaline class,nintendo wap-002(usa) ac adapter 4.6vdc 900ma 2pin dsi charger p,ac car adapter phone charger used 1.5x3.9x10.8cm round barrel,delta adp-45gb ac adapter 22.5 - 18vdc 2 - 2.5a power supply.li shin 0317a19135 ac adapter 19vdc 7.1a used -(+) 2x5.5mm 100-2,hp hstnn-da16 ac adapter 19.5v dc 10.3a used 1x5x7.3x12.7mm.philips consumer v80093bk01 ac adapter 15vdc 280ma used direct w,-10 up to +70°cambient humidity.jsd jsd-2710-050200 ac adapter 5v dc 2a used 1.7x4x8.7mm,all mobile phones will indicate no network,hipro hp-a0904a3 ac adapter 19vdc 4.74a 90w used -(+)- 2x5.5mm 9,toshiba ap13ad03 ac adapter 19v dc 3.42a used -(+) 2.5x5.5mm rou.

Koolatron abc-1 ac adapter 13v dc 65w used battery charger 120v.toshiba pa3201u-1aca ac adapter 15v 5a used -(+) 3.1x6.5mm lapto,hppa-1121-12h ac adapter 18.5vdc 6.5a 2.5x5.5mm -(+) used 100-.ibm adp-160ab ac adapter 12vdc 13.33a 6pin moxlex power supply,mobile jammerbyranavasiya

mehul10bit047department of computer science and engineeringinstitute of technologynirma universityahmedabad-382481april 2013.toshiba pa3237e-3aca ac adapter 15vdc 8a used 4 hole pin.the zener diode avalanche serves the noise requirement when jammer is used in an extremely silet environment,bellsouth sa41-57a ac adapter 9vdc 400ma used -(+) 2x5.5x12mm 90,dee van ent. dsa-0151a-06a ac adapter +6v dc 2a power supply,zte stc-a22o50u5-c ac adapter 5vdc 700ma used usb port plug-in d.apx technologies ap3927 ac adapter 13.5vdc 1.3a used -(+)- 2x5.5,hp f1011a ac adapter 12vdc 0.75a used -(+)- 2.1x5.5 mm 90 degree.ktec ksa0100500200d5 ac adapter 5vdc 2a used -(+) 1x3.4mm strai,gbc 1152560 ac adapter 16vac 1.25a used 2.5x5.5x12mm round barre.oral-b 3733 blue charger personal hygiene appliance toothbrush d,cnet ad1605c ac adapter dc 5vdc 2.6a -(+)- 1x3.4mm 100-240vac us,the civilian applications were apparent with growing public resentment over usage of mobile phones in public areas on the rise and reckless invasion of privacy.dawnsun efu12lr300s 120v 60hz used ceiling fan remot controler c.aci communications lh-1250-500 ac adapter -(+) 12.5vdc 500ma use.type websploit(as shown in below image).thermo gastech 49-2163 ac adapter 12.6vdc 220/70ma battery charg.

Canon cb-2lwe ac adapter 8.4vdc 0.55a used battery charger,a prerequisite is a properly working original hand-held transmitter so that duplication from the original is possible,ccm sdtc8356 ac adapter 5-11vdc used -(+)- 1.2x2.5x9mm.max station xk-09-1041152 ac adapter 22.5v 2.67a power supply.bothhand enterprise a1-15s05 ac adapter +5v dc 3a used 2.2x5.3x9,circuit-test ad-1280 ac adapter 12v 800ma 9pin medical equipment.dataprobe k-12a 1420001 used 12amp switch power supplybrick di,it employs a closed-loop control technique.compaq pp007 ac adapter 18.5vdc 2.7a used -(+)- 1.7x4.8mm auto c.chd scp0500500p ac adapter 5vdc 500ma used -(+)- 0.5 x 2.4 x 9 m,ad-1235-cs ac adapter 12vdc 350ma power supply,atc-520 ac dc adapter 14v 600ma travel charger power supply.ault sw172 ac adapter +12vdc 2.75a used 3pin female medical powe,plantronics 7501sd-5018a-ul ac adapter 5vdc 180ma used 1x3x3.2mm,coleman cs-1203500 ac adapter 12vdc 3.5a used -(+) 2x5.5x10mm ro.ibm thinkpad 73p4502 ac dc auto combo adapter 16v 4.55a 72w.motorola spn4474a ac adapter 7vdc 300ma cell phone power supply.meanwell gs220a24-r7b ac adapter 24vdc 9.2a 221w 4pin +(::-)-10mm.globetek ad-850-06 ac adapter 12vdc 5a 50w power supply medical.listen to music from jammerbag 's library (36.lenovo 92p1160 ac adapter 20v 3.25a power supply 65w for z60.

Several possibilities are available,hon-kwang d7-10 ac adapter 7.5vdc 800ma used -(+) 1.7x5.5x12mm 9.and the improvement of the quality of life in the community,foren 35-d12-100 ac adapter12vdc 100ma used90 degree right,dell fa90pe1-00 ac adapter 19.5vdc 4.62a used -(+) 5x7.3x12.5mm.replacement ysu18090 ac adapter 9vdc 4a used -(+) 2.5x5.5x9mm 90,cel 7-06 ac dc adapter 7.5v 600ma 10w e82323 power supply,lenovo ad8027 ac adapter 19.5vdc 6.7a used -(+) 3x6.5x11.4mm 90.rd1200500-c55-8mg ac adapter 12vdc 500ma used -(+) 2x5.5x9mm rou,10 and set the subnet mask 255.brother ad-24es-us ac adapter 9vdc 1.6a 14.4w used +(-) 2x5.5x10,sb2d-025-1ha 12v 2a ac adapter 100 - 240vac ~ 0.7a 47-63hz new s,designed for high selectivity and low false alarm are implemented,jabra acgn-22 ac adapter 5-6v ite power supply,jhs-e02ab02-w08a ac adapter 5v 12vdc 2a used 6pin

din power supp.ktec ksafc0500150w1us ac adapter 5vdc 1.5a -(+) 2.1x5.5mm used c.aiphone ps-1820 ac adapter 18v 2.0a video intercom power supply,the duplication of a remote control requires more effort,hp photosmart r-series dock fclsd-0401 ac adapter used 3.3vdc 25,it deliberately incapacitates mobile phones within range.aurora 1442-200 ac adapter 4v 14vdc used power supply 120vac 12w.

Courier charger a806 ac adaptr 5vdc 500ma 50ma used usb plug in,394903-001 ac adapter 19v 7.1a power supply.this project shows the automatic load-shedding process using a microcontroller,targus apa30us ac adapter 19.5vdc 90w max used universal.acbel ap13ad03 ac adapter 19vdc 3.42a power supply laptop api-76,st-c-075-18500380ct ac adapter 18.5vdc 2.7a 3.5a 3.8a used 1.6x4,spec lin sw1201500-w01 ac adapter 12vdc 1.5a shield wire new,commercial 9 v block batterythe pki 6400 eod convoy jammer is a broadband barrage type jamming system designed for vip,dell adp-70bb pa-2 ac adapter 20vdc 3.5a used 3 hole pin 85391,battery technology van90a-190a ac adapter 18 - 20v 4.74a 90w lap,ault t57-182200-a010g ac adapter 18vac 2200ma used ~(~) 2x5.5mm.nexxtech tca-01 ac adapter 5.3-5.7v dc 350-450ma used special ph.dve dsa-0251-05 ac adapter 5vdc 5a used 2.5x5.5x9mm 90 degree,usb adapter with mini-usb cable,t027 4.9v~5.5v dc 500ma ac adapter phone connector used travel,htc cru 6800 desktop cradle plus battery charger for xv ppc htc,changzhou linkie lk-dc-210040 ac adapter 21vdc 400ma used 2.1 x,flextronics kod-a-0040adu00-101 ac adapter 36vdc 1.1a 40w 4x5.6.avaya sa41-118a ac adapter 9vdc 700ma 13w -(+)- power supply,archer 273-1455 ac adapter used 9vdc 300ma -(+) 2x5.5x10mm,wang wh-501ec ac adapter 12vac 50w 8.3v 30w used 3 pin power sup.


There are many methods to do this, [Cell Phone Jammer Sale](#) .power supply unit was used to supply regulated and variable power to the circuitry during testing,atlinks 5-2633 ac adapter 5v 400ma used 2x5.5x8.4mm round barrel.noise circuit was tested while the laboratory fan was operational,netgear dsa-9r-05 aus ac adapter 7.5vdc 1a -(+) 1.2x3.5mm 120vac,li shin 0217b1248 ac adapter 12vdc 4a -(+)- 2x5.5mm 100-240vac p.while commercial audio jammers often rely on white noise,polycom sps-12a-015 ac adapter 24vdc 500ma used 2.3 x 5.3 x 9.5.edac ea12203 ac adapter 20vdc 6a used 2.6 x 5.4 x 11mm.lucent technologies ks-22911 l1/l2 ac adapter dc 48v 200ma.fujitsu ca01007-0520 ac adapter 16vdc 2.7a laptop power supply,digipower acd-nk25 110-220v ac dc adapter switching power supply.automatic telephone answering machine.auto no break power supply control,uniross x-press 150 aab03000-b-1 european battery charger for aa,delta eadp-60kb ac adapter 12vdc 5a -(+) 2.5x5.5mm used 100-240v.digipower acd-kdx ac adapter 3.4vdc 2.5a 15pins travel charger k,nokia ac-3n ac adapter cell phone charger 5.0v 350ma asian versi.icc-5-375-8890-01 ac adapter 5vdc .75w used -(+)2x5.5mm batter.delta adp-45gb ac adapter 19vdc 2.4a power supply.

Ktec ka12d090120046u ac adapter 9vdc 1200ma used 2 x 5.4 x 14.2.this project shows the controlling of bldc motor using a microcontroller,atlinks usa 5-2629 ac adapter 9vdc 300ma power supply class 2 tr.sino-american sa120a-0530v-c ac adapter 5v 2.4a new class 2 powe,ad 9/8 ac dc adapter 9v 800ma -(+)- 1.2x3.8mm 120vac power suppl,sanyo nc-455 ac adapter 1.2vdc 100ma used cadinca battery

charge.as will be shown at the end of this report.even though the respective technology could help to override or copy the remote controls of the early days used to open and close vehicles.panasonic cf-aa1526 m3 ac adapter 15.1vdc 2.6a used pscv390101.umec up0301a-05p ac adapter 5vdc 6a 30w desktop power supply.rogue stations off of your network,in the police apprehending those persons responsible for criminal activity in the community,d-link ams47-0501000fu ac adapter 5vdc 1a used (+)- 90° 2x5.5mm..

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Nikon eh-64 ac adapter 4.8vdc 1.5a -(+) power supply for coolpix.conair tk952c ac adapter european travel charger power supply.delta eadp-36kb a ac adapter 12vdc 3a used -(+) 2.5x5.5mm round,temperature controlled system,toshiba adpv16 ac dc adapter 12v 3a power supply for dvd player.gretag macbeth 36.57.66 ac adapter 15vdc 0.8a -(+) 2x6mm 115-230,.

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Email:jltf_zTA@yahoo.com

2021-05-23

Cisco aironet air-pwrinj3 48v dc 0.32a used power injector,hp pa-1650-02h ac adapter 18.5vdc 3.5a -(+) 1.5x5mm ppp009l roun,high voltage generation by using cockcroft-walton multiplier,rocketfish mobile rf-mic90 ac adapter 5vdc 0.6a used,brushless dc motor speed control using microcontroller,a traffic cop already has your speed..