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Permanent Link to Innovation: A Better Way
2021/06/17
Monitoring the Ionosphere with Integer-Leveled GPS Measurements By Simon Banville, Wei Zhang, and Richard B. Langley INNOVATION INSIGHTS by Richard Langley IT'S NOT JUST FOR POSITIONING, NAVIGATION, AND TIMING. Many people do not realize that GPS is being used in a variety of ways in addition to those of its primary mandate, which is to provide accurate position, velocity, and time information. The radio signals from the GPS satellites must traverse the Earth's atmosphere on their way to receivers on or near the Earth's surface. The signals interact with the atoms, molecules, and charged particles that make up the atmosphere, and the process slightly modifies the signals. It is these modified or perturbed signals that a receiver actually processes. And should a signal be reflected or diffracted by some object in the vicinity of the receiver's antenna, the signal is further perturbed — a phenomenon we call multipath. Now, these perturbations are a bit of a nuisance for conventional users of GPS. The atmospheric effects, if uncorrected, reduce the accuracy of the positions, velocities, and time information derived from the signals. However, GPS receivers have correction algorithms in their microprocessor firmware that attempt to correct for the effects. Multipath, on the other hand, is difficult to model although the use of sophisticated antennas and advanced receiver technologies can minimize its effect. But there are some GPS users who welcome the multipath or atmospheric effects in the signals. By analyzing the fluctuations in signal-to-noise-ratio due to multipath, the characteristics of the reflector can be deduced. If the reflector is the ground, then the amount of moisture in the soil can be measured. And, in wintery climes, changes in snow depth can be tracked from the multipath in GPS signals. The atmospheric effects perturbing GPS signals can be separated into those that are generated in the lower part of the atmosphere, mostly in the troposphere, and those generated in the upper, ionized part of the atmosphere — the ionosphere. Meteorologists are able to extract information on water vapor content in the troposphere and stratosphere from the

measurements made by GPS receivers and regularly use the data from networks of ground-based continuously operating receivers and those operating on some Earth-orbiting satellites to improve weather forecasts. And, thanks to its dispersive nature, the ionosphere can be studied by suitably combining the measurements made on the two legacy frequencies transmitted by all GPS satellites. Ground-based receiver networks can be used to map the electron content of the ionosphere, while Earth-orbiting receivers can profile electron density. Even small variations in the distribution of ionospheric electrons caused by earthquakes; tsunamis; and volcanic, meteorite, and nuclear explosions can be detected using GPS. In this month's column, I am joined by two of my graduate students, who report on an advance in the signal processing procedure for better monitoring of the ionosphere, potentially allowing scientists to get an even better handle on what's going on above our heads. Representation and forecast of the electron content within the ionosphere is now routinely accomplished using GPS measurements. The global distribution of permanent ground-based GPS tracking stations can effectively monitor the evolution of electron structures within the ionosphere, serving a multitude of purposes including satellite-based communication and navigation. It has been recognized early on that GPS measurements could provide an accurate estimate of the total electron content (TEC) along a satellite-receiver path. However, because of their inherent nature, phase observations are biased by an unknown integer number of cycles and do not provide an absolute value of TEC. Code measurements (pseudoranges), although they are not ambiguous, also contain frequency-dependent biases, which again prevent a direct determination of TEC. The main advantage of code over phase is that the biases are satellite- and receiver-dependent, rather than arc-dependent. For this reason, the GPS community initially adopted, as a common practice, fitting the accurate TEC variation provided by phase measurements to the noisy code measurements, therefore removing the arc-dependent biases. Several variations of this process were developed over the years, such as phase leveling, code smoothing, and weighted carrier-phase leveling (see Further Reading for background literature). The main challenge at this point is to separate the code inter-frequency biases (IFBs) from the line-of-sight TEC. Since both terms are linearly dependent, a mathematical representation of the TEC is usually required to obtain an estimate of each quantity. Misspecifications in the model and mapping functions were found to contribute significantly to errors in the IFB estimation, suggesting that this process would be better performed during nighttime when few ionospheric gradients are present. IFB estimation has been an ongoing research topic for the past two decades are still remains an issue for accurate TEC determination. A particular concern with IFBs is the common assumption regarding their stability. It is often assumed that receiver IFBs are constant during the course of a day and that satellite IFBs are constant for a duration of a month or more. Studies have clearly demonstrated that intra-day variations of receiver instrumental biases exist, which could possibly be related to temperature effects. This assumption was shown to possibly introduce errors exceeding 5 TEC units (TECU) in the leveling process, where 1 TECU corresponds to 0.162 meters of code delay or carrier advance at the GPS L1 frequency (1575.42 MHz). To overcome this limitation, one could look into using solely phase measurements in the TEC estimation process, and explicitly deal with the arc-dependent ambiguities. The main advantage of such a strategy is to avoid codeinduced errors, but a larger number of parameters needs to be estimated, thereby weakening the strength of the adjustment. A comparison of the phase-only (arc-dependent) and phase-leveled (satellite-dependent) models showed that no model performs consistently better. It was found that the satellite-dependent model performs better at low-latitudes since the additional ambiguity parameters in the arc-dependent model can absorb some ionospheric features (such as gradients). On the other hand, when the mathematical representation of the ionosphere is realistic, the leveling errors may more significantly impact the accuracy of the approach. The advent of precise point positioning (PPP) opened the door to new possibilities for slant TEC (STEC) determination. Indeed, PPP can be used to estimate undifferenced carrier-phase ambiguity parameters on L1 and L2, which can then be used to remove the ambiguous characteristics of the carrier-phase observations. To obtain undifferenced ambiguities free from ionospheric effects, researchers have either used the widelane/ionosphere-free (IF) combinations, or the Group and Phase Ionospheric Calibration (GRAPHIC) combinations. One critical problem with such approaches is that code biases propagate into the estimated ambiguity parameters. Therefore, the resulting TEC estimates are still biased by unknown quantities, and might suffer from the unstable datum provided by the IFBs. The recent emergence of ambiguity resolution in PPP presented sophisticated means of handling instrumental biases to estimate integer ambiguity parameters. One such technique is the decoupled-clock method, which considers different clock parameters for the carrier-phase and code measurements. In this article, we present an “integer-leveling” method, based on the decoupled-clock model, which uses integer carrier-phase ambiguities obtained through PPP to level the carrier-phase observations. Standard Leveling Procedure This section briefly reviews the basic GPS functional model, as well as the observables usually used in ionospheric studies. A common leveling procedure is also presented, since it will serve as a basis for assessing the performance of our new method. Ionospheric Observables. The standard GPS functional model of dual-frequency carrier-phase and code observations can be expressed as: (1) (2) (3) (4) where Φ_i^j is the carrier-phase measurement to satellite j on the Li link and, similarly, P_i^j is the code measurement on Li. The term is the biased ionosphere-free range between the satellite and receiver, which can be decomposed as: (5) The instantaneous geometric range between the satellite and receiver antenna phase centers is ρ^j. The receiver and satellite clock errors, respectively expressed as dT and dtj, are expressed here in units of meters. The term Tj stands for the tropospheric delay, while the ionospheric delay on L1 is represented by I^j and is scaled by the frequency-dependent constant μ for L2, where . The biased carrier-phase ambiguities are symbolized by and are scaled by their respective wavelengths (λ_i). The ambiguities can be explicitly written as: (6) where N_i^j is the integer ambiguity, b_i is a receiver-dependent bias, and b_i^j is a satellite-dependent bias. Similarly, B_i and B_i^j are instrumental biases associated with code measurements. Finally, ε contains unmodeled quantities such as noise and multipath, specific to the observable. The overbar symbol indicates biased quantities. In ionospheric studies, the geometry-free (GF) signal combinations are formed to virtually eliminate non-dispersive terms and thus provide a better handle on the quantity of interest: (7) (8) where IFB_r and IFB^j represent the code inter-frequency biases for the receiver and satellite, respectively. They are also commonly referred to as differential code biases (DCBs). Note that the noise terms (ε) are neglected in these equations for the sake of simplicity. Weighted-Leveling Procedure. As pointed out in the introduction, the ionospheric observables of Equations (7) and (8) do not provide an absolute level of ionospheric delay due to instrumental biases contained in the measurements. Assuming that these biases do not vary significantly in time, the difference between the phase and code observations for a particular satellite pass should be a constant value (provided that no cycle slip occurred in the phase measurements). The leveling process consists of removing this constant from each geometry-free phase observation in a satellite-receiver arc: (9) where the summation is performed for all observations forming the arc. An elevation-angle-dependent weight (w) can also be applied to minimize the noise and multipath contribution for measurements made at low elevation angles. The double-bar symbol indicates leveled observations. Integer-Leveling Procedure The procedure of fitting a carrier-phase arc to code observations might introduce errors caused by code noise, multipath, or intra-day code-bias variations. Hence, developing a leveling approach that relies solely on carrier-phase observations is highly desirable. Such an approach is now possible with the recent developments in PPP, allowing for ambiguity resolution on undifferenced observations. This procedure has gained significant momentum in the past few years, with several organizations generating “integer clocks” or fractional offset corrections for recovering the integer nature of the undifferenced ambiguities. Among those organizations are, in alphabetical order, the Centre National d’Études Spatiale; GeoForschungsZentrum; GPS Solutions, Inc.; Jet Propulsion Laboratory; Natural Resources Canada (NRCan); and Trimble Navigation. With ongoing research to improve convergence time, it would be no surprise if PPP with ambiguity resolution would become the de facto methodology for processing data on a station-by-station basis. The results presented in this article are based on the products generated at NRCan, referred to as “decoupled clocks.” The idea behind integer leveling is to introduce integer ambiguity parameters on L1 and L2, obtained through PPP processing, into the geometry-free linear combination of Equation (7). The resulting integer-leveled observations, in units of meters, can then be expressed as: (10) where and are the ambiguities obtained from the PPP solution, which should be, preferably, integer values. Since those ambiguities are obtained with respect to a somewhat arbitrary ambiguity datum, they do not allow instant recovery of an unbiased slant ionospheric delay. This fact was highlighted in Equation (10), which indicates that, even though the arc-dependency was removed from the geometry-free combination, there are still receiver- and satellite-dependent biases (br and b j, respectively) remaining in the integer-leveled observations. The latter are thus very similar in nature to the standard-leveled observations, in the sense that the biases br and b j replace the well-known IFBs. As a consequence, integer-leveled observations can be used with any existing software used for the generation of TEC maps. The motivation behind using integer-leveled observations is the mitigation of leveling errors, as explained in the next sections. Slant TEC Evaluation As a first step towards assessing the performance of integer-leveled observations, STEC values are derived on a station-by-station basis. The slant ionospheric delays are then compared for a pair of co-located receivers, as well as with global ionospheric maps (GIMs) produced by the International GNSS Service (IGS). Leveling Error Analysis. Relative leveling errors between two co-located stations can be obtained by computing between-station differences of leveled observations: (11) where subscripts A and B identify the stations involved, and εl is the leveling error. Since the distance between stations is short (within 100 meters, say), the ionospheric delays will cancel, and so will the satellite biases (b j) which are observed at both stations. The remaining quantities will be the (presumably constant) receiver biases and any leveling errors. Since there are no satellite-dependent quantities in Equation (11), the differenced observations obtained should be identical for all satellites observed, provided that there are no leveling errors. The same principles apply to observations leveled using other techniques discussed in the introduction. Hence, Equation (11) allows comparison of the performance of various leveling approaches. This methodology has been applied to a baseline of approximately a couple of meters in length between stations WTZJ and WTZZ, in Wettzell, Germany. The observations of both stations from March 2, 2008, were leveled using a standard leveling approach, as well as the method described in this article. Relative leveling errors computed using Equation (11) are displayed in Figure 1, where each color represents a different satellite. It is clear that code noise and multipath do not necessarily average out over the course of an arc, leading to leveling errors sometimes exceeding a couple of TECU for the standard leveling approach (see panel (a)). On the other hand, integer-leveled observations agree fairly well between stations, where leveling errors were mostly eliminated. In one instance, at the beginning of the session, ambiguity resolution failed at both stations for satellite PRN 18, leading to a relative error of 1.5 TECU, more or less. Still, the advantages associated with integer leveling should be obvious since the relative error of the standard approach is in the vicinity of -6 TECU for this satellite. FIGURE 1. Relative leveling errors between stations WTZJ and WTZZ on March 2, 2008: (a) standard-leveled observations and (b) integer-leveled observations. The magnitude of the leveling errors obtained for the standard approach agrees fairly well with previous studies (see Further Reading). In the event that intra-day variations of the receiver IFBs are observed, even more significant biases were found to contaminate standard-leveled observations. Since the decoupled-clock model used for ambiguity resolution explicitly accounts for possible variations of any equipment delays, the estimated ambiguities are not affected by such effects, leading to improved leveled observations. STEC Comparisons. Once leveled observations are available, the next step consists of separating STEC from instrumental delays. This task can be accomplished on a station-by-station basis using, for example, the single-layer ionospheric model. Replacing the slant ionospheric delays (I j) in Equation (10) by a bilinear polynomial expansion of VTEC leads to: (12) where M(e) is the single-layer mapping function (or obliquity factor) depending on the elevation angle (e) of the satellite. The time-dependent coefficients a0, a1, and a2 determine the mathematical representation of the VTEC above the station. Gradients are modeled using Δλ, the difference between the longitude of the ionospheric pierce point and the longitude of the mean sun, and Δϕ, the difference between the geomagnetic latitude of the ionospheric pierce point and the geomagnetic latitude of the station. The estimation procedure described by Attila Komjathy (see Further Reading) is followed in all subsequent tests. An elevation angle cutoff of 10 degrees was applied and the shell height used was 450 kilometers. Since it is not possible to obtain absolute values for the satellite and receiver biases, the sum of all satellite biases was constrained to a value of zero. As a consequence, all estimated biases will contain a common (unknown) offset. STEC values, in TECU, can then be computed as: (13) where the hat symbol denotes estimated quantities, and is equal to zero (that is, it is not estimated) when biases are obtained on a station-by-station basis. The frequency, f1, is expressed in Hz. The numerical constant 40.3, determined from values of fundamental physical constants, is sufficiently precise for our purposes, but is a rounding of the more precise value of 40.308. While integer-leveled observations from co-located stations show good agreement, an external TEC source is required to make sure that both stations are not affected by common errors. For this purpose, Figure 2 compares STEC values computed from GIMs produced by the IGS and STEC values derived from station WTZJ using both standard- and integer-leveled observations. The IGS claims root-mean-square errors on the order of 2-8 TECU for vertical TEC, although the ionosphere was quiet on the day selected, meaning that errors at the low-end of that range are expected. Errors associated with the mapping function will further contribute to differences in STEC values. As apparent from Figure 2, no significant bias can be identified in integer-leveled observations. On the other hand, negative STEC values (not displayed in Figure 2) were obtained during nighttimes when using standard-leveled observations, a clear indication that leveling errors contaminated the observations. FIGURE 2. Comparison between STEC values obtained from a global ionospheric map and those from station WTZJ using standard- and integer-leveled observations. STEC Evaluation in the Positioning Domain. Validation of slant ionospheric delays can also be performed in the positioning domain. For this purpose, a station's coordinates from processing the observations in static mode (that is, one set of coordinates estimated per session) are estimated using (unsmoothed) single-frequency code observations with precise orbit and clock corrections from the IGS and various ionosphere-correction sources. Figure 3 illustrates the convergence of the 3D position error for station WTZZ, using STEC corrections from the three sources introduced previously, namely: 1) GIMs from the IGS, 2) STEC values from station WTZJ derived from standard leveling, and 3) STEC values from station WTZJ derived from integer leveling. The reference coordinates were obtained from static processing based on dual-frequency carrier-phase and code observations. The benefits of the integer-leveled corrections are obvious, with the solution converging to better than 10 centimeters. Even though the distance between the stations is short, using standard-leveled observations from WTZJ leads to a biased solution as a result of arc-dependent leveling errors. Using a TEC map from the IGS provides a decent solution considering that it is a global model, although the solution is again biased. FIGURE 3. Single-frequency code-based positioning results for station WTZZ (in static mode) using different ionosphere-correction sources: GIM and STEC values from station WTZJ using standard- and integer-leveled observations. This station-level analysis allowed us to confirm that integer-leveled observations can seemingly eliminate leveling errors, provided that carrier-phase ambiguities are fixed to proper integer values. Furthermore, it is possible to retrieve unbiased STEC values from those observations by using common techniques for isolating instrumental delays. The next step consisted of examining the impacts of reducing leveling errors on VTEC. VTEC Evaluation When using the single-layer ionospheric model, vertical TEC values can be derived from the STEC values of Equation (13) using: (14) Dividing STEC by the mapping function will also reduce any bias caused by the leveling procedure. Hence, measures of VTEC made from a satellite at a low elevation angle will be less impacted by leveling errors. When the satellite reaches the zenith, then any bias in the observation will fully propagate into the computed VTEC values. On the other hand, the uncertainty of the mapping function is larger at low-elevation angles, which should be kept in mind when analyzing the results. Using data from a small regional network allows us to assess the compatibility of the VTEC quantities between stations. For this purpose, GPS data collected as a part of the Western Canada Deformation Array (WCDA) network, still from March 2, 2008, was used. The stations of this network, located on and near Vancouver Island in Canada, are indicated in Figure 4. Following the model of Equation (12), all stations were integrated into a single adjustment to estimate receiver and satellite biases as well as a triplet of time-varying coefficients for each station. STEC values were then computed using Equation (13), and VTEC values were finally derived from Equation (14). This procedure was again implemented for both standard- and integer-leveled observations. FIGURE 4. Network of stations used in the VTEC evaluation procedures. To facilitate the comparison of VTEC values spanning a whole day and to account for ionospheric gradients, differences with respect to the IGS GIM were computed. The results, plotted by elevation angle, are displayed in Figure 5 for all seven stations processed (all satellite arcs from the same station are plotted using the same color). The overall agreement between the global model and the station-derived VTECs is fairly good, with a bias of about 1 TECU. Still, the top panel demonstrates that, at high elevation angles, discrepancies between VTEC values derived from standard-leveled observations and the ones obtained from the model have a spread of nearly 6 TECU. With integer-leveled observations (see bottom panel), this spread is reduced to approximately 2 TECU. It is important to realize that the dispersion can be explained by several factors, such as remaining leveling errors, the inexact receiver and satellite bias estimates, and inaccuracies of the global model. It is nonetheless expected that leveling errors account for the most significant part of this error for standard-leveled observations. For satellites observed at a lower elevation angle, the spread between arcs is similar for both methods (except for station UCLU in panel (a) for which the estimated station IFB parameter looks significantly biased). As stated previously, the reason is that leveling errors are reduced when divided by the mapping function. The latter also introduces further errors in the comparisons, which explains why a wider spread should typically be associated with low-elevation-angle satellites. Nevertheless, it should be clear from Figure 5 that integer-leveled observations offer a better consistency than standard-leveled observations. FIGURE 5. VTEC differences, with respect to the IGS GIM, for all satellite arcs as a function of the elevation angle of the satellite, using (a) standard-leveled observations and (b) integer-leveled observations. Conclusion The technique of integer leveling consists of introducing (preferably) integer ambiguity parameters obtained from PPP into the geometry-free combination of observations. This process removes the arc dependency of the signals, and allows integer-leveled observations to be used with any existing TEC estimation software. While leveling errors of a few TECU exist with current procedures, this type of error can be eliminated through use of our procedure, provided that carrier-phase ambiguities are fixed to the proper integer values. As a consequence, STEC values derived from nearby stations are typically more consistent with each other. Unfortunately, subsequent steps involved in generating VTEC maps, such as transforming STEC to VTEC and interpolating VTEC values between stations, attenuate the benefits of using integer-leveled observations. There are still ongoing challenges associated with the GIM-generation process, particularly in terms of latency and three-dimensional modeling. Since ambiguity resolution in PPP can be achieved in real time, we believe that integer-leveled observations could benefit near-real-time ionosphere monitoring. Since ambiguity parameters are constant for a satellite pass (provided that there are no cycle slips), integer ambiguity values (that is, the leveling information) can be carried over from one map generation process to the next. Therefore, this methodology could reduce leveling errors associated with short arcs, for instance. Another prospective benefit of integer-leveled observations is the reduction of leveling errors contaminating data from low-Earth-orbit (LEO) satellites, which is of particular importance for three-dimensional TEC modeling. Due to their low orbits, LEO satellites typically track a GPS satellite for a short period of time. As a consequence, those short arcs do not allow code noise and multipath to average out, potentially leading to important leveling errors. On the other hand, undifferenced ambiguity fixing for LEO satellites already has been demonstrated, and could be a viable solution to this problem. Evidently, more research needs to be conducted to fully assess the benefits of integer-leveled observations. Still, we think that the results shown herein are encouraging and offer potential solutions to current challenges associated with ionosphere monitoring. Acknowledgments We would like to acknowledge the help of Paul Collins from NRCan in producing Figure 4 and the financial contribution of the Natural Sciences and Engineering Research Council of Canada in supporting the second and third authors. This article is based on two conference papers: “Defining the Basis of an ‘Integer-Levelling’ Procedure for Estimating Slant Total Electron Content” presented at ION GNSS 2011 and “Ionospheric Monitoring Using ‘Integer-Levelled’ Observations” presented at ION GNSS 2012. ION GNSS 2011 and 2012 were the 24th and 25th International Technical Meetings of the Satellite Division of The Institute of Navigation, respectively. ION GNSS 2011 was held in Portland, Oregon, September 19–23, 2011, while ION GNSS 2012 was held in Nashville, Tennessee, September 17–21, 2012. SIMON BANVILLE is a Ph.D. candidate in the Department of Geodesy and Geomatics Engineering at the University of New Brunswick (UNB) under the supervision of Dr. Richard B. Langley. His research topic is the detection and correction of cycle slips in GNSS observations. He also works for Natural Resources Canada on real-time precise point positioning and ambiguity resolution. WEI ZHANG received his M.Sc. degree (2009) in space science from the School of Earth and Space Science of Peking University, China. He is currently an M.Sc.E. student in the Department of Geodesy and Geomatics Engineering at UNB under the supervision of Dr. Langley. His research topic is the assessment of three-dimensional regional ionosphere tomographic models using GNSS measurements. 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Nokia acp-7u standard compact charger cell phones adapter 8260,,sanyo scp-03adt ac adapter 5.5vdc 950ma used 1.4x4mm straight ro,6.8vdc 350ma ac adapter used -(+) 2x5.5x11mm round barrel power.htc cru 6800 desktop cradle plus battery charger for xv ppc htc,communication system technology use a technique known as frequency division duple xing (fdd) to serve users with a frequency pair that carries information at the uplink and downlink without interference,replacement ac adapter 15dc 5a 3x6.5mm fo acbel api4ad20 toshiba,ceiva e-awb100-050a ac adapter +5vdc 2a used -(+) 2x5.5mm digita.please pay special attention here,power drivers au48-120-120t ac adapter 12vdc 1200ma +(-)+ new,dell ha90pe1-00 ac adapter 19.5vdc ~ 4.6a new 5.1 x 7.3 x 12.7 m,frequency band with 40 watts max,this article shows the different circuits for designing circuits a variable power supply,replacement m8482 ac adapter 24vdc 2.65a used g4 apple power.navigon ac adapter 12.6vdc 800ma used 110-220v ac,akii a05c1-05mp ac adapter +5vdc 1.6a used 3 x 5.5 x 9.4mm,electro-harmonix mkd-41090500 ac adapter 9v 500ma power supply,recoton ad300 adapter universal power supply multi voltage,when the temperature rises more than a threshold value this system automatically switches on the fan,ibm 85g6733 ac adapter 16vdc 2.2a 4 pin power supply laptop 704.netline communications technologies ltd,hitachi pc-ap4800 ac adapter 19vdc 2.37a used -(+)-

1.9 x 2.7 x,ibm 02k6750 ac adapter 16vdc 4.5a used 2.5x5.5mm 100-240vac roun.they are based on a so-called „rolling code“,the first circuit shows a variable power supply of range 1,delta adp-5vb c ac adapter 5vdc 1a power supply n4000e,nokia no5100 6100 car power adapter 1x3.5mm round barrel new cha.

Conversion of single phase to three phase supply,ahead mw41-1200500a ac adapter ac 12v 500ma straight round barre,toshiba tec 75101u-b ac dc adapter +24v 3.125a 75w power supply.recoton mk-135100 ac adapter 13.5vdc 1a battery charger nicd nim,ac adapter used car charger tm & dc comics s10,nokia acp-12u ac adapter 5.7vdc 800ma used 1x3.5mm cellphone 35,comes in next with its travel 4g 2.arstan dv-9750 ac adapter 9.5vac 750ma wallmount direct plug in.lg sta-p53wr ac adapter 5.6v 0.4a direct plug in poweer supply c.sharp ea-mu01v ac adapter 20vdc 2a laptop power supply.sil ssa-12w-09 us 090120f ac adapter 9vdc 1200ma used -(+) 2x5.5.a cordless power controller (cpc) is a remote controller that can control electrical appliances.pll synthesizedband capacity.wattac ba0362z1-8-b01 ac adapter 5v 12vdc 2a used 5pin mini din.aok ak02g-1200100u ac adapter 12vdc 1a used 2 x 5.5 x 10mm,when the temperature rises more than a threshold value this system automatically switches on the fan,rayovac ps8 9vdc 16ma class 2 battery charger used 120vac 60hz 4,a frequency counter is proposed which uses two counters and two timers and a timer ic to produce clock signals.ibm 02k6746 ac adapter 16vdc 4.5a -(+) 2.5x5.5mm 100-240vac used,fil 35-d09-300 ac adapter 9vdc 300ma power supply cut wire +(-).extra shipping charges for international buyers partial s&h paym.compaq adp-50sb ac dc adapter 18.5v 2.8a power supply,texas instruments adp-9510-19a ac adapter 19vdc 1.9a used -(+)-,datalogic sa115b-12u ac adapter 12vdc 1a used +(-) 2x5.5x11.8mm.ad-0950-cs ac adapter 9vdc 500ma used -(+) 2x5.5x11mm round barr.9-12v dc charger 500-1000ma travel iphone ipod ac adapter wall h.

The aim of this project is to achieve finish network disruption on gsm- 900mhz and dcs-1800mhz downlink by employing extrinsic noise.gateway lishin 0220a1890 ac adapter 18.5v 4.9a laptop power supp,rocketfish blc060501100wu ac adapter 5vdc 1100ma used -(+) 1x3.5,ic-dsi171002 ac adapter 4.6vdc 900ma used usb connector switchin,kensington 33196 notebook ac dc power adapter lightweight slim l.dell pa-1151-06d ac adapter 19.5vdc 7.7a used -(+) 1x4.8x7.5mm i,ibm 02k7085 ac adapter 16vdc 7.5a 120w 4pin 10mm female used 100.incoming calls are blocked as if the mobile phone were off..

- jammer 4g wifi gps polnt and cheese
- jammer 4g wifi gps polnt and shoot
- jammer 4g wifi gps polnt and country
- jammer 4g wifi gps polnt and cons
- jammer 4g wifi gps jammer
- jammer 4g wifi gps polnt and cons
- jammer 4g wifi gps polnt and cons
- jammer 4g wifi gps polnt and cons
- jammer 4g wifi gps polnt and cons
- jammer 4g wifi gps polnt and cons

- jammer 4g wifi gps polnt and company
- jammer 4g wifi gps polnt and caicos
- jammer 4g wifi gps service
- jammer 4g wifi gps cellular
- jammer 4g wifi gps receiver
- 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:PGh_WW9ZXK@gmail.com
2021-06-16
Ibm 92p1044 ac adapter 16v dc 3.5a used 2.5 x 5.5 x 11.1mm,dell pa-1131-02d ac adapter 19.5vdc 6.7aa 918y9 used -(+) 2.5x5.,dve dsa-6pfa-05 fus 070070 ac adapter +7vdc 0.7a used,.
Email:VeXT1_3qv0q0Xy@aol.com
2021-06-14
Thomson 5-2608 ac adapter 9vdc 500ma used -(+) 2x5.5x9mm round b.cui inc 3a-161wu06 ac adapter 6vdc 2.5a used -(+) 2x5.4mm straig,power supply unit was used to supply regulated and variable power to the circuitry during testing,hp f1044b ac adapter 12vdc 3.3a adp-40cb power supply hp omnibo,03-00050-077-b ac adapter 15v 200ma 1.2 x 3.4 x 9.3mm.replacement st-c-075-12000600ct ac adapter 12vdc 4.5-6a -(+) 2.5..
Email:p3y3m_kkIa@outlook.com
2021-06-11
Atlinks 5-2418 ac adapter 9vac 400ma ~(~) 2x5.5mm 120vac class 2.oem ads18b-w120150 ac adapter 12vdc 1.5a -(+)- 2.5x5.5mm i.t.e.,crestron gt-21097-5024 ac adapter 24vdc 1.25a new -(+)- 2x5.5mm,.
Email:6R7_9faWXJVo@gmail.com
2021-06-11
Hp hstnn-da16 ac adapter 19.5v dc 10.3a used 1x5x7.3x12.7mm,ilan f1560 (n) ac adapter 12vdc 2.83a -(+) 2x5.5mm 34w i.t.e pow,41t-d09-500 ac adapter 9vdc 500ma 2x5.5mm -(+) 90° 9w power supp.belkin car cigarette lighter charger for wireless fm transmitter..
Email:a6L9_XDEuLCJ@gmx.com
2021-06-09
Sima sup-60 universal power adapter 9.5v 1.5a for camcorder.usb adapter with mini-usb cable,bluetooth and wifi signals (silver) 1 out of 5 stars 3,dc 90300a ac dc adapter 9v 300ma power supply,jamming these transmission paths with the usual jammers is only feasible for limited areas.canon k30327 ac adapter 32vdc 24vdc triple voltage power supply,avaya sa41-118a ac adapter 9vdc 700ma 13w -(+)- power supply,.