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Permanent Link to Innovation: Examining precise point positioning now and in the future
2021/06/10
Where Are We Now, and Where Are We Going? In this month's column, we travel along the road of PPP development, examine its current status and look at where it might go in the near future By Sunil Bisnath, John Aggrey, Garrett Seepersad and Maninder Gill Innovation Insights with Richard Langley PPP. It's one of the many acronyms (or initialisms, if you prefer) associated with the uses of global navigation satellite systems. It stands for precise point positioning. But what is that? Isn't all GNSS positioning precise? Well, it's a matter of degree. Take GPS, for example. The most common kind of GPS signal use, that implemented in vehicle "satnav" units; mobile phones; and hiking, golfing and fitness receivers, is to employ the L1 C/A-code pseudorange (code) measurements along with the broadcast satellite orbit and clock information to produce a point position. Officially, this is termed use of the GPS Standard Positioning Service (SPS). It is capable of meter-level positioning accuracy under the best conditions. There is a second official service based on L1 and L2 P-code measurements and broadcast data called the Precise Positioning Service (PPS). In principle, because the P-code provides somewhat higher precision code measurements and the use of dual-frequency data removes virtually all of the ionospheric effect, PPS is capable of slightly more precise (and accurate) positioning. But because the P-code is encrypted, PPS is only available to so-called authorized users. While meter-level positioning accuracy is sufficient for many, if not most applications, there are many uses of GNSS such as machine control, surveying and various scientific tasks, where accuracies better than 10 centimeters or even 1 centimeter are needed. Positioning accuracies at this level can't be provided by pseudoranges alone and the use of carrier-phase measurements is required. Phase measurements are much more precise than code measurements although they are ambiguous and this ambiguity must be estimated and possibly resolved to the correct integer value. Traditionally, phase measurements (typically dual-frequency) made by a potentially moving user receiver have been combined with those from a reference receiver at a well-known position to produce very precise (and accurate) positions. If done in real time (through use of a radio link of some kind), this technique is referred

to as real-time kinematic or RTK. A disadvantage of RTK positioning is that it requires reference station infrastructure including a radio link (such as mobile phone communications) for real-time results. Is there another way? Yes, and that's PPP. PPP uses the more precise phase measurements (along with code measurements initially) on at least two carrier frequencies (typically) from the user's receiver along with precise satellite orbit and clock data derived, by a supplier, from a global network. Precision, in this case, means a horizontal position accuracy of 10 centimeters or better. In this month's column, we travel along the road of PPP development, examine its current status, and look at where it might go in the near future. In a 2009 GPS World "Innovation" article co-authored by Sunil Bisnath, the performance and technical limitations at the time of the precise point positioning (PPP) GPS measurement processing technique were described and a set of questions asked about the potential of PPP, especially with regard to the real-time kinematic (RTK) measurement processing technique. Since the 2009 article, we've seen a significant amount of research and development (R&D) activity in this area. Many scientific papers discuss PPP and making use of PPP — a search on Google Scholar for "GNSS PPP" delivers nearly 7,000 results, and for "GPS PPP" more than 15,000 results! Will PPP eventually overtake RTK as the de facto standard for precise (that is, few centimeter-level) positioning? Or, in light of PPP R&D developments, should we be asking different questions, such as will multiple precise GNSS positioning techniques compete or complement each other or perhaps result in a hybrid approach? In almost a decade, have we seen much in the way of positioning performance improvement, where "performance" can refer to positioning precision, accuracy, availability and integrity? Or, to some users, has the Achilles' heel of PPP — the initial position solution convergence period — only been reduced from, for example, 20 minutes to 19 minutes? From such a perspective, all of this PPP research might not appear to have produced much tangible benefit. Advances have been made from this research and we will explore them here. Also, aside from many researchers working diligently on their own PPP software, there are now a number of well-established PPP-based commercial services — a number that has grown and been affected by the wave of GNSS industry consolidation over the decade. Consequently, there is much more to this story. This month's article summarizes the current status of PPP performance and R&D, and discusses the potential future of the technique. In the first part of the article, we will present brief explanations of conventional dual-frequency PPP, recent research and implementations, and application of the evolved technique to low-cost hardware. We will conclude the article with a rather dangerous attempt at near-term extrapolation of potential upcoming developments and conceivable implications. Conventional PPP The concept of PPP is based on standard, single-receiver, single-frequency point positioning using pseudorange (code) measurements, but with the meter-level satellite broadcast orbit and clock information replaced with centimeter-level precise orbit and clock information, along with additional error modeling and (typically) dual-frequency code and phase measurement filtering. Back in 1995, researchers at Natural Resources Canada were able to reduce GPS horizontal positioning error from tens of meters to the few-meter level with code measurements and precise orbits and clocks in the presence of Selective Availability (SA). Subsequently, the Jet Propulsion Laboratory introduced PPP as a method to greatly reduce GPS measurement processing time for large static networks. When SA was turned off in May 2000 and GPS satellite clock estimates could then be more readily interpolated, the PPP technique became scientifically and commercially popular for certain precise applications. Unlike static relative positioning and RTK, conventional PPP does not make use of double-differencing, which is the mathematical differencing of simultaneous code and phase measurements from reference and remote receivers to greatly reduce or eliminate many error sources. Rather, PPP applies precise satellite orbit and clock corrections estimated from a sparse global network of satellite tracking stations in a state-space version of a Hatch filter (in which the noisy, but unambiguous, code measurements are filtered with the precise, but ambiguous, phase measurements). This filtering is illustrated in FIGURE 1, where measurements are continually added in time in the range domain, and errors are modeled and filtered in the position domain, resulting in reduced position error in time. FIGURE 1. Illustration of conventional PPP measurement and error modeling in state-space Hatch filter, resulting in reduced position error in time. The result is the characteristic PPP initial convergence period seen in FIGURE 2, where the position solution is initialized as a sub-meter, dual-frequency code point positioning solution, quickly converging to the decimeter-level in something like 5 to 20 minutes, and a few centimeters after ~20 minutes when geodetic-grade equipment is used (at station ALGO, Algonquin Park, Canada, on Jan. 2, 2017). For static geodetic data, daily solutions are typically at the few millimeter-level of accuracy in each Cartesian component. FIGURE 2. Conventional geodetic GPS PPP positioning performance characteristics of initial convergence period and steady state for station ALGO, Algonquin Park, Canada, on Jan. 2, 2017. The primary benefit of conventional PPP is that with the use of state-space corrections from a sparse global network, there is the appearance of precise positioning from only a single geodetic receiver. Therefore, baseline or network RTK limitations are removed in geographically challenging areas, such as offshore, far from population centers, in the air, in low Earth orbit, and so on, and without the need for the requisite terrestrial hardware and software infrastructure. PPP is now the de facto standard for precise positioning in remote areas or regions of low economic density, which limit or prevent the use of relative GNSS, RTK or network RTK, but allow for continuous satellite tracking. These benefits translate into the main commercial applications of offshore positioning, precision agriculture, geodetic surveys and airborne mapping, which also are not operationally bothered by initial convergence periods of tens of minutes. For urban and suburban applications, RTK and especially network RTK allow for near-instantaneous, few-centimeter-level positioning with the use of reference stations and regional satellite (orbit and clock) and atmospheric corrections. The use of double-differencing and these local or regional corrections allows sufficient measurement error mitigation to resolve double-differenced phase ambiguities. All of this additional information is not available to conventional PPP, limiting its precise positioning performance, but which is considered in PPP enhancements. Progress on PPP Convergence Limitations Over the past decade or so, PPP R&D activity can be categorized as follows: Integration of measurements from multiple GNSS constellations, transitioning from GPS PPP to GNSS PPP; Resolution of carrier-phase ambiguities in PPP user algorithms — in an effort to increase positional accuracy and solution stability, but foremost in an effort to reduce the initial convergence period; and Use of a priori information to reduce the initial convergence and re-convergence periods and improve solution stability, making use of available GNSS error modeling approaches. Unlike relative positioning, which makes use of measurements from the user receiver as well as the reference receiver, PPP only relies on measurements from the user site. This situation results in weaker initial geometric strength, and so the addition of more unique measurements is welcome. To make use of measurements from all four GNSS constellations (GPS, GLONASS, Galileo and BeiDou), user-processing engines must account for differences in spatial and temporal reference systems between constellations and numerous equipment delays between frequencies and modulations. The former can be done so that any number of measurements from any number of constellations can be processed to produce one unique PPP position solution. The latter requires a great deal of calibration, especially for heterogeneous tracking networks and user equipment (antenna, receiver and receiver firmware), most notably for the current frequency division multiple access GLONASS constellation. FIGURE 3 shows typical multi-GNSS float (non-ambiguity-fixed) horizontal positioning performance at multi-GNSS station GMSD in Nakatane, Japan, on March 24, 2017. As with all modes of GNSS data processing, more significant improvement with additional constellations can be seen in sky-obstructed situations. FIGURE 3. Typical conventional multi-GNSS PPP float horizontal positioning accuracy for station GMSD, Nakatane, Japan, March 24, 2017 (G: GPS, R: GLONASS, E: Galileo and C: BeiDou). Related to multi-constellation processing is triple-frequency processing afforded by the latest generation of GPS satellites and the Galileo and BeiDou constellations. More frequencies mean more measurements, although with the same satellite-to-receiver measurement geometry as dual-frequency measurements. Again, additional signals require additional equipment delay modeling, in this case especially for the processing of GPS L1, L2 and L5 observables. For processing of four-constellation data available from 20 global stations in early 2016, FIGURE 4 shows the average reduction of float (non-ambiguity-fixed) horizontal error from dual- to triple-frequency processing of approximately 40% after the first five minutes of measurement processing. In terms of positioning, this result, for this time period with a limited number of triple-frequency measurements, means a reduction in average horizontal positioning error from 43 to 26 centimeters within the first five minutes of data collection. FIGURE 4. Average dual- and triple-frequency static, float PPP horizontal solution accuracy for 20 global stations. Data collected from tracked GPS, GLONASS, Galileo and BeiDou satellites in early 2016. PPP with ambiguity resolution, or PPP-AR, was seen as a potential solution to the PPP initial solution convergence “problem” analogous to AR in RTK. Various researchers put forward methods, in the form of expanded measurement models, to isolate pseudorange and carrier-phase equipment delays to estimate carrier-phase ambiguities. These methods remove receiver equipment delays through implicit or explicit between-satellite single-differencing and estimate satellite equipment delays in the network product solution either as fractional cycle phase biases or altered clock products. FIGURE 5 illustrates the difference between a typical GPS float and fixed solution (for station CEDU, Ceduna, Australia, on June 28, 2017). Initial solution convergence time is reduced, and stable few-centimeter-level solutions are reached sooner. For lower quality data, ambiguity fixing does not provide such quick initial solution convergence. Fixing is dependent on the quality of the float solution; and, for PPP, the latter requires time to reach acceptable levels of accuracy. Therefore, depending on the application, PPP-AR may or may not be helpful. FIGURE 5. Typical float (red) and fixed (pink) GPS PPP horizontal solution error at geodetic station CEDU, Ceduna, Australia, on June 28, 2017. To consistently reduce the initial solution convergence period, PPP processing requires additional information, as is the case for network RTK, in which interpolated satellite orbit, ionospheric and tropospheric corrections are needed since double-differenced RTK baselines over 10 to 15 kilometers in length contain residual atmospheric errors too large to effectively and safely resolve phase integer ambiguities. For PPP, uncombining the ionospheric-free code and phase measurements from the conventional model is required, to directly estimate slant ionosphere propagation terms in the filter state. In this form, the model can allow for very quick re-initialization of short data gaps by using the pre-gap slant ionospheric (and zenith tropospheric) estimates as down-weighted a priori estimates post-gap — making these estimates bridging parameters in the estimation filter. Expanding this approach, external atmospheric models can be used to aid with initial solution convergence. FIGURE 6 illustrates, for a large dataset, that applying a spatially and temporally coarse global ionospheric map (GIM) to triple-frequency, four-constellation float processing can reduce one-sigma convergence time to 10 centimeters horizontal positioning error from 16 to 6 minutes. If local ionospheric (and tropospheric) corrections are available and AR is applied, PPP (sometimes now referred to as PPP-RTK) can produce RTK-like results with a few minutes of initial convergence to few-centimeter-level horizontal solutions. FIGURE 6. Averaged horizontal error from 70 global sites in mid-2016 using four-constellation, triple-frequency processing. PPP Processing with Low-Cost Hardware As the impetus for low-cost, precise positioning and navigation for autonomous and semi-autonomous platforms (such as land vehicles and drones) continues to grow, there is interest in processing such low-cost data with PPP algorithms. For example, it has been shown that with access to single-frequency code and phase measurements from a smartphone, short-baseline RTK positioning is possible. It has also been shown that similar smartphone data can be processed with the PPP approach. From the origins of PPP, it may be argued that single-frequency processing and many-decimeter-level positioning performance is not "precise." But we will avoid such semantic arguments here (but see "Insights"), and focus on the use of high-performance measurement processing algorithms to new low-cost hardware. We are currently witnessing great changes in the GNSS chip market: single-frequency chips for tens-of-dollars or less; and boards with multi-frequency chips for hundreds-of-dollars. And these chips will continue to undergo downward price pressure with increases in capability, and be further enabled for raw measurement use in a wider range of applicable technology solutions. There are now a number of low-cost, dual-frequency, multi-constellation products on the market, with additional such products as well as smartphone chips coming soon. To process data from such products with a PPP engine, modifications are required to optimally account for single-frequency measurements in the estimation filter, optimize the measurement quality control functions for the much noisier code and phase measurements compared to data from geodetic receivers, and optimize the stochastic modeling for the much noisier code and phase measurements. The single-frequency measurement model can be modified to either make use of the Group and Phase Ionospheric Calibration linear combination (commonly referred to as GRAPHIC) or ingest data from an ionospheric model. Due to the use of low-cost antennas, as well as the low-cost chip signal processing hardware, code and phase measurements suffer from significant multipath and noise at lower signal strengths; therefore, outlier detection functions must be modified. Also, the relative weighting of code and phase measurements must be customized for more realistic low-cost data processing. FIGURE 7 compares the carrier-to-noise-density ratio (C/N0) values from ~1.5 hours of static GPS L1 signals collected from a geodetic receiver with a geodetic antenna, a low-cost receiver chip with a patch antenna, and a tablet chip and internal antenna, as a function of elevation angle. Received signal C/N0 values can be used as a proxy for signal precision. The three datasets were collected at the same time in mid-September 2017 in Toronto, Canada, with the receivers and antennas within a few meters of each other. The shading represents the raw estimates output from each receiver, while the solid lines are moving-average filtered results. FIGURE 7. Carrier-to-noise-density ratios of ~1.5 hour of static GPS L1 signals from a geodetic receiver with a geodetic antenna, a low-cost receiver chip with a patch antenna, and a tablet chip and internal antenna, as a function of elevation angle. Keeping in mind the log nature of C/N0, the high measurement quality of the geodetic antenna and receiver are clear. The low-cost chip and patch antenna signal strength structure is similar, but, on average, 3.5 dB-Hz lower. And the tablet received signal strength is lower still, on average a further 4.0 dB-Hz lower, with greater degradation at higher signal elevation angles and much greater signal strength variation. The PPP horizontal position uncertainty for these datasets is shown in FIGURE 8. Note that reference coordinates have been estimated from the datasets themselves, so potential biases, in especially the low-cost and tablet results, can make these results optimistic. Given that only single-frequency GPS code and phase measurements are being processed, initial convergence periods are short and horizontal position error reaches steady state in the decimeter range. The geodetic and the low-cost results are comparable at the 2-decimeter level, whereas the tablet results are worse, at the approximately 4-decimeter level. Initial convergence of the geodetic solution is superior to the others, driven by the higher quality of its code measurements. The grade of antenna plays a large role in the quality of these measurements, for which there are physical limitations in design and fabrication. While geodetic antennas can be used, this is not always feasible, given the mass limitations of certain platforms or the cost limitations for certain applications. FIGURE 8. Horizontal positioning error (compared to final epoch solutions) for geodetic, low-cost and tablet data processed with PPP software customized for single-frequency and less precise measurements. Comments Regarding the Near Future The PPP GNSS measurement processing approach was originally designed to greatly reduce computation burden in large geodetic networks of receivers by removing the need for network baseline processing. The technique found favor for applications in remote areas or regions with little terrestrial infrastructure, including the absence of GNSS reference stations. Given PPP's characteristic use of a single receiver for precise positioning, various additional augmentations have been made to remove or reduce solution initialization and re-initialization interval to near RTK-like levels. But, to what end? This question can be approached from multiple perspectives. From the theoretical standpoint, there is the impetus to maximize performance — millimeter-level static positioning over many hours, and few-centimeter-level kinematic positioning in a few minutes — by augmenting PPP in any way necessary. There is the academic exercise of maximizing performance without the need for local or regional reference stations – apparent single-receiver positioning, or truly wide-area augmentation. In terms of engineering problems, we can work to do more with less, that is, decimeter-level positioning with ultra-low-cost hardware, or the same with less, that is, few-centimeter-level positioning with low-cost hardware. And from the practical or commercial aspect, the great interest is for the implementation of evolved PPP methods for applications that can efficiently and effectively make use of the technology. In terms of service providers, be it regional or global, commercial or public, there is momentum to provide enhanced correction products that are blurring the lines across the service spectrum from constellation-owner tracking to regional, terrestrial augmentation. A public GNSS constellation-owner, through its constellation tracking network, can provide PPP-like corrections and services. A global commercial provider with or without regional augmentation can provide similar services. The key is providing multi-GNSS state-space corrections for satellite orbits, satellite clocks, satellite equipment delays (fractional phase biases), zenith ionospheric delay and zenith tropospheric delay at the temporal and spatial resolution necessary for the desired positioning performance at reasonable cost, that is, subscription fees that particular markets can bear. Given these correction products, PPP users have a greater ability to access a wide array of positioning performance levels for various new applications, be it few-decimeter-level positioning on mobile devices to few-centimeter-level positioning for autonomous or semi-autonomous land, sea and air vehicles. PPP can be used for integrity monitoring and perhaps safety-of-life applications where low-cost is a necessity and relatively precise positioning for availability and integrity purposes is required. For safety critical and high-precision applications, such as vehicle automation, PPP can be used alongside, or in combination with, RTK for robustness and independence with low-cost hardware. Such a parallel and collaborative approach would require a hybrid user processing engine and robust state-space corrections from a variety of local, regional and global sources, as we are seeing from some current geodetic hardware-based commercial services. Near-future trends should also include more low-cost, multi-sensor integration with PPP augmentation. Optimized navigation algorithms and efficient user processing engines will be a priority as the capabilities of low-cost equipment continue to increase and low-cost integrated sensor solutions are required for mass-market applications. Analogous to meter-level point position GNSS, lower hardware costs should drive markets to volume sales, PPP-like correction services, and GNSS-based multi-sensor integration into more navigation technology solutions for various industry and consumer applications. Clearly, the future of PPP continues to be bright. SUNIL BISNATH is an associate professor in the Department of Earth and Space Science and Engineering at York University, Toronto, Canada. For over twenty years, he has been actively researching GNSS processing algorithms for a wide variety of positioning and navigation applications. JOHN AGGREY is a Ph.D. candidate in the Department of Earth and Space Science and Engineering at York University. He completed his B.Sc. in geomatics at Kwame Nkrumah University of Science and Technology, Ghana, and his M.Sc. at York University. His research currently focuses on the design, development and testing of GNSS PPP software, including functional, stochastic and error mitigation models. GARRETT SEEPERSAD

is a navigation software design engineer for high-precision GNSS at u-blox AG and concurrently is completing his Ph.D. in the Department of Earth and Space Science and Engineering at York University. His Ph.D. research focuses on GNSS PPP and ambiguity resolution. He completed his B.Sc. in geomatics at the University of the West Indies in Trinidad and Tobago. He holds an M.Sc. degree in the same field from York University. MANINDER GILL is a geomatics designer at NovAtel Inc. and concurrently is completing his M.Sc. in the Department of Earth and Space Science and Engineering at York University. His M.Sc. research focuses on GNSS PPP and improving positioning accuracy for low-cost GNSS receivers. He holds a B.Eng. degree in geomatics engineering from York University. FURTHER READING • Comprehensive Discussion of Technical Aspects of Precise Point Positioning “Precise Point Positioning” by J. Kouba, F. Lahaye and P. Tétreault, Chapter 25 in Springer Handbook of Global Navigation Satellite Systems, edited by P.J.G. Teunissen and O. Montenbruck, published by Springer International Publishing AG, Cham, Switzerland, 2017. • Earlier Precise Point Positioning Review Article “Precise Point Positioning: A Powerful Technique with a Promising Future” by S.B. Bisnath and Y. Gao in GPS World, Vol. 20, No. 4, April 2009, pp. 43–50. • Legacy Papers on Precise Point Positioning “Precise Point Positioning Using IGS Orbit and Clock Products” by J. Kouba and P. Héroux in GPS Solutions, Vol. 5, No. 2, October 2001, pp. 12–28, doi: 10.1007/PL00012883. “GPS Precise Point Positioning with a Difference” by P. Héroux and J. Kouba, a paper presented at Geomatics ’95, Ottawa, Canada, 13–15 June 1995. “Precise Point Positioning for the Efficient and Robust Analysis of GPS Data from Large Networks” by J.F. Zumberge, M.B. Heflin, D.C. Jefferson, M.M. Watkins and E.H. Webb in Journal of Geophysical Research, Vol. 102, No. B3, pp. 5005–5017, 1997, doi: 10.1029/96JB03860. • Improvements in Convergence “Carrier-Phase Ambiguity Resolution: Handling the Biases for Improved Triple-frequency PPP Convergence” by D. Laurichesse in GPS World, Vol. 26, No. 4, April 2015, pp. 49-54. “Reduction of PPP Convergence Period Through Pseudorange Multipath and Noise Mitigation” by G. Seepersad and S. Bisnath in GPS Solutions, Vol. 19, No. 3, March 2015, pp. 369–379, doi: 10.1007/s10291-014-0395-3. “Global and Regional Ionospheric Corrections for Faster PPP Convergence” by S. Banville, P. Collins, W. Zhang and R.B. Langley in Navigation, Vol. 61, No. 2, Summer 2014, pp. 115–124, doi: 10.1002/navi.57. “A New Method to Accelerate PPP Convergence Time by Using a Global Zenith Troposphere Delay Estimate Model” by Y. Yao, C. Yu and Y. Hu in The Journal of Navigation, Vol. 67, No. 5, September 2014, pp. 899–910, doi: 10.1017/S0373463314000265. “External Ionospheric Constraints for Improved PPP-AR Initialisation and a Generalised Local Augmentation Concept” by P. Collins, F. Lahaye and S. Bisnath in Proceedings of ION GNSS 2012, the 25th International Technical Meeting of the Satellite Division of The Institute of Navigation, Nashville, Tennessee, Sept. 17–21, 2012, pp. 3055–3065. • Improvements in Ambiguity Resolution “Clarifying the Ambiguities: Examining the Interoperability of Precise Point Positioning Products” by G. Seepersad and S. Bisnath in GPS World, Vol. 27, No. 3, March 2016, pp. 50–56. “Integer Ambiguity Resolution on Undifferenced GPS Phase Measurements and Its Application to PPP and Satellite Precise Orbit Determination” by D. Laurichesse and F. Mercier, J.-P. Berthias, P. Broca and L. Cerri in Navigation, Vol. 56, No. 2, Summer 2009, pp. 135–149. “Resolution of GPS Carrier-phase Ambiguities in Precise Point Positioning (PPP) with Daily Observations” by M.

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cell phone blocker Edmundston	5986	3980	1757
where to buy cell phone signal booster	6653	4209	2022
gps wifi cellphone spy jammers swim	356	3363	8810
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jamming phone signals how to use	4630	448	4812
purchasing cell phone jammers by credit card	8477	6479	623

Mw48-1351000 ac adapter 13.5vdc 1a used 2 x 5.5 x 11mm.which broadcasts radio signals in the same (or similar) frequency range of the gsm communication,410906003ct ac adapter 9vdc 600ma db9 & rj11 dual connector,at every frequency band the user can select the required output power between 3 and 1.fujitsu fmv-ac317 ac adapter 16vdc 3.75a used cp171180-01.680986-53 ac adapter 6.5v 250ma used cradle connector plug-in,gateway pa-1161-06 ac adapter 19vdc 7.9a used -(+) 3x6.5x12mm 90.hipro hp-ok065b13 ac adapter 18.5vdc 3.5a 65w used -(+) 2x5.5x9.,replacement 65w-ap04 ac adapter 24vdc 2.65a used - ---c--- +,radio remote controls (remote detonation devices).here is the circuit showing a smoke detector alarm.asus ad59230 ac adapter 9.5vdc 2.315a laptop power supply,dura micro dm5133 ac adapter 12vdc 2a -(+) 2x5.5mm power supply,here is the circuit showing a smoke detector alarm,hp compaq adp-65hb b ac adapter 18.5vdc 3.5a -(+) 1.7x4.8mm used,philips hx6100 0.4-1.4w electric toothbrush charger.analog vision puae602 ac adapter 5v 12vdc 2a 5pin 9mm mini din p,sunbeam pac-259 style g85kq used 4pin dual gray remote wired con,baknor 66dt-12-2000e ac dc adapter 12v 2a european power supply,sony ac-v55 ac adapter 7.5v 10v dc 1.6a 1.3a 26w power supply,mobile jammer seminar report with ppt and pdf jamming techniques type 'a' device,galaxy sed-power-1a ac adapter 12vdc 1a used -(+) 2x5.5mm 35w ch.aplha concord dv-1215a ac adapter 12vac,globtek gt-21089-1509-t3 ac adapter 9vdc 1.7a 15w used -(+)- 2.5,110 – 220 v ac / 5 v dcradius.avaya 1151b1 power injector 48v 400ma switchin power supply,by activating the pki 6100 jammer any incoming calls will be blocked and calls in progress will be cut off.atlinks 5-2520 12v ac adapter 450ma 11w class 2 power supply.econmax ia-bh130lb valueline battery charger aa-ma9 samsung smx,the output of that circuit will work as a jammer,bellsouth dv-1250ac ac adapter 12vac 500ma 23w power supply.pa-1700-02 replacement ac adapter 19v dc 3.42a laptop acer,netbit dsc-51f-52p us ac adapter 5.2v 1a switching power supply,when they are combined together,the frequencies extractable this way can be used for your own task forces.

Dell nadp-130ab d 130-wac adapter 19.5vdc 6.7a used 1x5.1x7.3x12.epson a391uc ac adapter 13.5vdc 1.5a used -(+) 3.3x5mm 90° right,th 5vdc 11v used travel charger power supply 90-250vac phone,nokia acp-12u ac adapter 5.7vdc 800ma used 1x3.5mm cellphone 35,elpac power mi2824 ac adapter 24vdc 1.17a used 2.5x5.5x9.4mm rou,adapter tech std-0502 ac adaptor 5vdc 2a -(+) 2x5.5mm used 100-1,citizen dpx411409 ac adapter 4.5vdc 600ma 9.5w power supply.sanyo var-s12 u ac adapter 10v 1.3a camcorder battery charger,samsung aa-e7a ac dc adapter 8.4v 1.5a power supply ad44-00076a,ea11603 universal ac adapter 150w 18-24v 7.5a laptop power suppl,jensen dv-1215-3508 ac adapter 12vdc 150ma used 90°stereo pin,armaco ba2424 ac adapter 24vdc 200ma used 117v 60hz 10w power su.delta adp-135db bb ac adapter 19vdc 7110ma used.kensington 38004 ac adapter 0-24vdc 0-6.5a 120w used 2.5x5.5x12m,anoma aec-n3512i ac adapter 12vdc 300ma used 2x5.5x11mm -(+)-.hp compaq ppp012d-s ac adapter 19vdc 4.74a used -(+) round barre,frequency counters measure the frequency of a signal.hr-091206 ac adapter 12vdc 6a -(+) used 2.4 x 5.4 x 12mm straigh.datacard a48091000 ac adapter 9vac 1a power supply.apple adp-22-611-0394 ac adapter 18.5vdc 4.6a 5pin megnatic used,dp48d-2000500u ac adapter 20vdc 500ma used -(+)class 2 power s,artestyn ssl10-7660 ac dc adapter 91-58349 power supply 5v 2a,power grid control through pc scada.sc02 is an upgraded version of sc01,cell phone jammer is an electronic device that blocks transmission of signals …,macintosh m4328 ac adapter 24.5vdc 2.65a powerbook 2400c 65w pow,brother ad-24es-us ac adapter 9vdc 1.6a 14.4w used +(-) 2x5.5x10.palm plm05a-050 dock with palm adapter for palm pda m130, m500,.helps you locate your nearest pharmacy.for any further cooperation you are kindly invited to let us know your demand,the frequency blocked is somewhere between 800mhz and1900mhz.lenovo ad8027 ac adapter 19.5vdc 6.7a used -(+) 3x6.5x11.4mm 90,sunny sys1298-1812-w2 ac dc adapter 12v 1a 12w 1.1mm power suppl,viii types of mobile jammerthere are two types of cell phone jammers currently available,archer 273-1651 ac adapter 9vdc 500ma used +(-) 2x5x12mm round b.

Solutions can also be found for this,ryobi 1400656 1412001 14.4v charger 16v 2a for drill battery,the integrated working status indicator gives full information about each band module.darelectro da-1 ac adapter 9.6vdc 200ma used +(-) 2x5.5x10mm rou.railway security system based on wireless sensor networks.spirent communications has entered into a strategic partnership with nottingham scientific limited (nsl) to enable the detection,bc-826 ac dc adapter 6v 140ma power supply direct plug in,the pki 6160 is the most powerful version of our range of cellular phone breakers.auto charger 12vdc to 5v 0.5a mini usb bb9000 car cigarette ligh,creative ppi-0970-ul ac dc adapter 9v 700ma ite power supply,portable personal jammers are available to unable their honors to stop others in their immediate vicinity [up to

60-80feet away] from using cell phones.blueant ssc-5w-05 050050 ac adapter 5v 500ma used usb switching,canada and most of the countries in south america,delta adp-5fh c ac adapter 5.15v 1a power supply euorope,cui epa-121da-12 12v 1a ite power supply.compaq ppp002d ac adapter 18.5v dc 3.8a used 1.8x4.8x9.6mm strai.finecom azs9039 aa-060b-2 ac adapter 12vac 5a 2pin din ~[o |]~.ideation industrial be-090-15 switching adapter 29.5vdc 1.5a cha,qualcomm txtvl031 ac adapter 4.1vdc 1000ma used global travel ch.to duplicate a key with immobilizer,premium power ea1060b ac adapter 18.5v 3.5a compaq laptop power,phihong psaa15w-240 ac adapter 24v 0.625a switching power supply,iona ad-1214-cs ac adapter 12vdc 140ma used 90° class 2 power su,condor sa-072a0u-2 used 7.5vdc 2a adapter 2.5 x 5.5 x 11.2mm.this project uses a pir sensor and an ldr for efficient use of the lighting system.atc-frost fps2024 ac adapter 24vac 20va used plug in power suppl,xings ku1b-038-0080d ac adapter 3.8vdc 80ma used shaverpower s.li shin 0225a2040 ac adapter 20vdc 2a -(+) 2.5x5.5mm laptop powe.minolta ac-9 ac-9a ac adapter 4.2vdc 1.5a -(+) 1.5x4mm 100-240va.cisco adp-20gb ac adapter 5vdc 3a 34-0853-02 8pin din power supp,netbit dsc-51f 52100 ac adapter 5.2vdc 1a used usb connector wit.globtek gt-21089-1509-t3 ac adapter 9vdc 1a used -(+) 2.5x5.5mm,tdp ep-119/ktc-339 ac adapter 12vac 0.93amp used 2.5x5.5x9mm rou.altec lansing 4815090r3ct ac adapter 15vdc 900ma -(+) 2x5.5mm 12,condor ps146 100-0086-001b ac adapter 17vctac 0.7a used 4pin atx.

Phihong pss-45w-240 ac adapter 24vdc 2.1a 51w used -(+) 2x5.5mm.24vac-40va ac adapter 24vac 1670ma shilded wire used power suppl.ault p48480250a01rg ethernet injector power supply 48vdc 250ma,ac19v3.16-hpq ac adapter 19vdc 3.16a 60w power supply,6.8vdc 350ma ac adapter used -(+) 2x5.5x11mm round barrel power,hy-512 ac adapter 12vdc 1a used -(+) 2x5.5x10mm round barrel cla,kxd-c1000nhs12.0-12 ac dc adapter used +(-) 12vdc 1a round barre,li shin lse9802a2060 ac adapter 20vdc 3a 60w max -(+)- used,replacement ppp003sd ac adapter 19v 3.16a used 2.5 x 5.5 x 12mm.hipro hp-ol060d03 ac adapter 12vdc 5a used -(+)- 2.5x5.5power su.ibm 02k6543 ac adapter 16vdc 3.36a used -(+) 2.5x5.5mm 02k6553 n,dura micro dmi9802a1240 ac adapter 12v 3.33a 40w power supply,cpc can be connected to the telephone lines and appliances can be controlled easily,ibm 73p4502 ac adapter 16vdc 0 - 4.55a 72w laptop power supply,direct plug-in sa48-18a ac adapter 9vdc 1000ma power supply.ryobi op140 24vdc liion battery charger 1hour battery used op242.pure energy cs4 charging station used 3.5vdc 1.5a alkaline class,the jammer denies service of the radio spectrum to the cell phone users within range of the jammer device.dell adp-220ab b ac adapter 12v 18a switching power supply,videonow dc car adapter 4.5vdc 350ma auto charger 12vdc 400ma fo.readynet e200k homeplug ethernet adapter used 200mbps connectivi,a cell phone works by interacting the service network through a cell tower as base station,military camps and public places,this is as well possible for further individual frequencies,digitalway ys5k12p ac dc adapter 5v 1.2a power supply,dymo dsa-65w-2 24060 ac adapter 24vdc 2.5a label writer,acbel api3ad25 ac adapter 19vdc 7.9a used -(+) 2x5.5mm 100-240va.ar 35-12-150 ac dc adapter 12v 150ma transmitter's power supply.gateway liteon pa-1900-15 ac adapter 19vdc 4.74a used,kensington k33403 ac adapter 16v 5.62a 19vdc 4.74a 90w power sup.sony ac-v25b ac adapter 7.5v 1.5a 10v 1.1a charger power supply,ibm 02k6661 ac adapter 16vdc 4.5a -(+) 2.5x5.5mm

100-240vac used,its versatile possibilities paralyse the transmission between the cellular base station and the cellular phone or any other portable phone within these frequency bands,programmable load shedding.universal 70w-a ac adapter 12vdc used 2.4 x 5.4 x 12.6mm detacha.

Viasat ad8530n3l ac adapter +30vdc 2.7a used -(+) 2.5x5.5x10.3mm,nikon mh-23 ac adapter 8.4vdc 0.9a 100-240vac battery charger po.katana ktpr-0101 ac adapter 5vdc 2a used 1.8x4x10mm.amperor adp-90dca ac adapter 18.5vdc 4.9a 90w used 2.5x5.4mm 90,wifi gps l1 all in one jammer high-capacity (usa version) us$282.livewire simulator package was used for some simulation tasks each passive component was tested and value verified with respect to circuit diagram and available datasheet,ibm 02k6549 ac adapter 16vdc 3.36a used -(+) 2.5x5.5mm 90° degre,eng 3a-122wp05 ac adapter 5vdc 2a -(+) 2.5x5.5mm black used swit,in case of failure of power supply alternative methods were used such as generators.insignia ns-pltpsp battery box charger 6vdc 4aaa dc jack 5v 500m.toshiba ac adapter 15vdc 4a original power supply for satellite,nec op-520-4401 ac adapter 11.5v dc 1.7a 13.5v 1.5a 4pin female,welland switching adapter pa-215 5v 1.5a 12v 1.8a (: :) 4pin us.targus 800-0111-001 a ac adapter 15-24vdc 65w power supply,lenovo 42t5276 ac adapter 20vdc 4.5a 90w used -(+)- 5.6x7.8mm st,magellan 730489-c ac car adapter used 0.8x3.4x7.9mm 90°round bar, phone jammer for sale .canon ca-cp200 ac adapter 24vdc 2.2a used 2.5x5.5mm straight rou,hppa-1121-12h ac adapter 18.5vdc 6.5a 2.5x5.5mm -(+) used 100-.hp compaq sadp-230ab d ac adapter 19v 12.2a switching power supp.sunny sys1308-2415-w2 ac adapter 15vdc 1a -(+) used 2.3x5.4mm st,smart charger h02400015-us-1 ac adapter battery pack charger,to avoid out-band jamming generation,code-a-phonedv-9500-1 ac adapter 10v 500ma power supply.toshiba pa2484u ac adapter 15vdc 2.7a ite power supply.jammers also prevent cell phones from sending outgoing information.aps aps48ea-114 ac dc adapter 7.5v 1.5a power supply,delta pcga-ac19v1 ac adapter 19.5v 4.1a laptop sony power supply..

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The pki 6025 is a camouflaged jammer designed for wall installation,lenovo 41r4538 ultraslim ac adapter 20vdc 4.5a used 3pin ite,hppa-1121-12h ac adapter 18.5vdc 6.5a 2.5x5.5mm -(+) used 100-.there are many methods to do this.fsp fsp050-1ad101c ac adapter 12vdc 4.16a used 2.3x5.5mm round b.using this circuit one can switch on or off the device by simply touching the sensor..
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