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Permanent Link to Innovation: Design and performance of a novel GNSS antenna for rover applications
2021/06/10
Smaller and Better By Reza Movahedinia, Julien Hautcoeur, Gyles Panther and Ken MacLeod Innovation Insights with Richard Langley THE ANTENNA. This crucial component of any radio transmitting or receiving system has a history that actually predates the invention of radio itself. The first antennas were used by Princeton professor Joseph Henry (after whom the unit of inductance is named) to demonstrate the magnetization of needles by a spark generator. But it was the experiments of Heinrich Hertz in Germany in 1887 that initiated the development of radio transmitters and receivers and the antennas necessary for launching and capturing electromagnetic waves for practical purposes. It was Hertz who pioneered the use of tuned dipole and loop antennas–basic antenna structures we still use today. As communication systems evolved using different parts of the radio spectrum from very low frequencies, through medium-wave frequencies, to high frequencies (shortwave), and to very high frequencies and ultra-high frequencies, and beyond, so did their antennas. There have been significant advances in the design of antennas over the years to improve their bandwidth, beamwidth, efficiency and other parameters. In fact, antenna development, going all the way back to the first antennas, has been one of continuous innovation. GNSS antennas are no different. The antennas for the first civil GPS receivers were bulky affairs. Researchers at the Massachusetts Institute of Technology initially introduced the Macrometer V-1000 in 1982, and Litton Aero Service subsequently commercialized it. It used a crossed-dipole antenna element on a 1-meter square aluminum panel and weighed 18 kilograms. The Jet Propulsion Laboratory’s demonstration GPS receiver, unveiled around the same time, used a small steerable parabolic dish that had to be sequentially pointed at GPS satellites. Both of these antennas gave way to more practical designs. Also introduced in 1982 was the Texas Instruments TI 4100, also known as the Navstar Navigator. This dual-frequency receiver used a conical spiral antenna to provide the wide bandwidth needed to cover both the L1 and L2 frequencies used by GPS. Subsequently, in the mid- to late-1980s, GPS and GLONASS antennas using microstrip patches were introduced for both single- and dual-frequency signal reception. The basic designs

introduced then are still with us and are used for single- and multiple-frequency GNSS receivers. Miniature versions are used in some mass-market handheld receivers and for receivers in drone flight control systems. Patch antennas have also been used as elements in survey-grade antennas. A number of other GNSS antenna topologies have been developed including helices and planar spiral designs. Antennas designed for high-precision applications often integrate a ground-plane structure of some kind into the structure such as choke rings. You might think after more than 30 years of GNSS technology development, that there is nothing new to be expected in GNSS antenna development. You would be wrong. In this GPS World 30th anniversary issue Innovation column, we look at the design and performance of an antenna that offers high performance even in challenging environments in a relatively small package. It is appropriate that it is unveiled in this column. After all, Webster's Dictionary has defined innovation as "the act of innovating or effecting a change in the established order; introduction of something new." This antenna might very well be a game changer. Global navigation satellite systems (GNSS) have continued to evolve and have become critical infrastructure for all of society. Starting with the awesome engineering feat of the U.S. Global Positioning System and then the more recently developed constellations from other nations, we now have available refined signal structures with ever-improving positioning, navigation and timing accuracy. Expanding use cases has led to the design of GNSS antennas optimized for many different applications. However, new antenna design commonly requires more than simple modifications to existing GPS antenna technologies. Design agility is needed to meet requirements such as wider bandwidth, sculpted radiation patterns (we frequently talk about radiation characteristics even for a receiving antenna assuming antenna reciprocity), optimized/reduced size, better efficiency, lower noise figure, or improvements in the more esoteric parameters such as axial ratio (AR) and phase-center variation (PCV). Nothing changes the widely unappreciated fact that the antenna is the most critical element in precision GNSS systems. In this article, we report on the research and commercial development of a high-performance GNSS antenna by Tallysman, designated "VeroStar." The VeroStar sets a new performance standard for an antenna of this type and supports reception of the full GNSS spectrum (all constellations and signals) plus L-band correction services. The antenna combines exceptional low-elevation angle satellite tracking with a very high-efficiency radiating element. Precision manufacturing provides a stable phase-center offset (PCO) and low PCV from unit to unit. The performance, compact size and light weight of the VeroStar antenna element make it a good candidate for modern rover and many other mobile GNSS applications. DESIGN OBJECTIVES The design of an improved, high-level GNSS antenna requires consideration of characteristics such as low-elevation angle tracking ability, minimal PCV, antenna efficiency and impedance, axial ratio and up-down ratio (UDR), antenna bandwidth, light weight, and a compact and robust form factor. Low-Elevation Angle Tracking. Today's professional GNSS users have widely adopted the use of precise point positioning (PPP) including satellite broadcast of the PPP correction data. PPP correction data is broadcast from geostationary satellites, which generally hover at low-elevation angles for many densely populated regions such as Europe and much of North America. The link margin of L-band signals is typically minimal, so that improved gain at these elevation angles is an important attribute. This issue is exacerbated at satellite beam edges and northern latitudes where the link margin is further challenged — a difference of just 1 dB in antenna gain or antenna noise figure can make a big difference in correction availability. A key design parameter in this respect is the antenna G/T, being the ratio, expressed in dB per kelvin, of the antenna element gain divided by the receiver system noise temperature, typically determined by the antenna noise figure. The G/T objective for this antenna was –25.5 dB/K at a 10-degree elevation angle. The gain of most GNSS antenna elements, such as patches and crossed dipoles, rolls off rapidly as the elevation angle decreases toward the horizon. The polarization also becomes linear (rather than circularly polarized) at the lower elevation angles, due to the existence of a ground plane, necessary to increase gain in the hemisphere above the antenna. Improved gain close to the horizon also increases the ability of the receiver to track low-elevation-angle satellites with a concomitant improvement in the dilution of precision parameters (DOPs; a series of metrics related to pseudorange measurement precision). Most of the commercially available GNSS rover antennas have a peak gain at zenith of about 3.5 dBic to 5 dBic with a roll-off at the horizon of 10–12 dB (dBic refers to the antenna gain referenced to a hypothetical isotropic circularly polarized antenna). Typically, this provides an antenna gain at the horizon, at best, of about –5 dBic, which is insufficient for optimized L-band correction usage. In some studies, different antenna types such as helical elements have been proposed to overcome this issue. However, their cylindrical shape and longer length makes them unsuitable for many rover applications. Furthermore, the helix suffers from back lobes that can make the antenna more susceptible to reception of multipath signals from below the upper hemisphere of the antenna. In the VeroStar design, we used wide-bandwidth radiating elements (referred to here as “petals”) that surround a distributed feed network. The petal design is important to achieve superior right-hand circularly polarized (RHCP) gain at low-elevation angles. Tight Phase-Center Variation. The phase center of an ideal antenna is a notional point in space at which all signals are received or transmitted from, independent of the frequency or elevation or azimuth angle of the signal incidence. The phase centers of real-life antennas are less tidy, and the PCV is a measure of the variation of the “zero” phase point as a function of frequency, elevation and azimuth angles. Correction data for phase-center variation is commonly encoded in a standardized antenna exchange format or Antex file, which can be applied concurrently for precision applications. The azimuthal orientation of rover antennas is typically unknown, so that errors for specific orientations of the antenna in the horizontal plane cannot be accounted for. The PCV correction data provided in an Antex file is usually provided as a function of elevation angle and frequency, but with averaged azimuth data for each elevation angle and frequency entry (noazi corrections). Thus, corrections can be applied for each frequency and elevation angle, but errors due to the variation in the azimuthal PCV cannot be corrected in the receiver. For real-time kinematic (RTK) systems, the net system error is the root-mean-square sum of the base and rover antenna PCVs. It is usually possible to accommodate larger base-station antennas, which can commonly provide PCVs approaching +/- 1 mm (such as those from Tallysman VeraPhase or VeraChoke antennas). In this case, the accuracy of the combined system is largely determined by the PCV of the smaller rover GNSS antenna. Thus, even with correction data, azimuthal symmetry in the rover antenna is key. In the VeroStar, this was addressed by obsessive focus on symmetry for both the antenna element structure and the mechanical housing design. Antenna Efficiency and Impedance. Antenna efficiency can be narrowly defined in terms of copper losses of the radiating elements (because copper is not a perfect conductor), but feed network losses also contribute so that the objective must be optimization of both. Physically wide radiating elements are a basic requirement for wider bandwidth, and copper is the best compromise for the radiator metal (silver is better, but expensive and with drawbacks). This is true in our new antenna, which has wide radiating copper petals. However, the petals are parasitic resonators that are tightly coupled to a distributed feed network, which in itself is intrinsically narrowband. The resulting wide bandwidth response results from the load on the feed network provided by the excellent wideband radiation resistance of the petals. This arrangement was chosen because the resulting impedance at the de-embedded antenna feed terminals is close to the ideal impedance needed (50 ohms), thus requiring minimal impedance matching. The near ideal match over a wide bandwidth is very important because it allowed the impedance to be transformed to ideal using a very short transmission line (less than one-quarter of a wavelength), which included an embedded infinite balun (a balun forces unbalanced lines to produce balanced operation). Each of the orthogonal exciter axes are electrically independent and highly isolated electrically (better than –30 dB), even with the parasitic petal coupling. To achieve the desired circular polarization, the two axes are then driven independently in phase quadrature (derived from the hybrid couplers). Thus, the inherently efficient parasitic petals combined with the absolutely minimized losses of the distributed feed network has resulted in a super-efficient antenna structure that will be difficult to improve upon. Axial and Up-Down Ratio. AR characterizes the antenna’s ability to receive circularly polarized signals, and the UDR is the ratio of gain pattern amplitude at a positive elevation angle (α) to the maximum gain pattern amplitude at its mirror image (–α). Good AR and UDR across the full bandwidth of the antenna ensure the purity of the reception of the RHCP GNSS signals and multipath mitigation. GNSS signals reflected from the ground, buildings or metallic structures such as vehicles are delayed and their RHCP purity is degraded with a left-hand circularly polarized (LHCP) component. Because the VeroStar antenna has more gain at low-elevation angles, a very low AR and a high UDR are even more important for mitigating multipath interference. The design objective was an AR of 3 dB or better at the horizon. A Light, Robust and Compact Design. The user community demands ever smaller antennas from antenna manufacturers, but precision rover antennas are typically required to receive signals in both the low (1160 to 1300 MHz) and high (1539 to 1610 MHz) GNSS frequency bands. An inescapable constraint limits the bandwidth of small antennas, so that full-bandwidth (all GNSS signals) rover antennas are unavoidably larger. To date, probably the smallest, high performance all-band antenna was the original Dorne & Margolin C146-XX-X (DM) antenna, which was in its time a tour-de-force. The overall objective for our antenna was to design a small and light-weight radiating element (given the full bandwidth requirement) with a ground-plane size of around 100 millimeters, element height of 30 millimeters or lower, and a weight of 100 grams or less. Ideally, it would be possible to build a smaller version, perhaps with a degree of compromised performance. The applications envisaged for the VeroStar included housed antennas (such as for RTK rovers) and a lightweight element suitable for mobile applications such as drones or even cubesats. ANTECEDENTS The central goal of this project was a precision antenna with a broad beamwidth and a good AR combined with a very tight PCV. The objective was to provide for reception of signals from satellites at low-elevation angles, particularly necessary for reception of L-band correction signals, which can be expected to be incident at elevation angles of 10 degrees to 50 degrees above the horizon. A starting point for this development was an in-depth study of the well-known DM antenna. This antenna has been used for decades in GPS reference stations (usually in choke-ring antennas). It exhibits a higher gain at low-elevation angles (about –3 dBic at the horizon) compared to other antennas on the market (typically –5 dBic or less) and fairly good phase-center stability in a compact design. The antenna structure consists of two orthogonal pairs of short dipoles above a ground plane, with the feeds at the midpoint of the dipoles, as shown in FIGURE 1(a). The antenna can be considered in terms of the ground-plane image, replacing the ground plane with the images of the dipole as shown in FIGURE 1(b). The antenna structure then takes on the form of a large uniform current circular loop similar to the Alford Loop antenna, developed at the beginning of World War II for aircraft navigation. FIGURE 1. (a) Dorne & Margolin (DM) antenna current distribution; (b) Alford Loop antenna. (Image: Tallysman) But the DM antenna does suffer from some drawbacks. By modern standards, the feed network is complex and lossy with costly fabrication, which affects repeatability and reliability. The AR at the zenith is marginal (up to 1.5 dB) and further degrades to 7 dB at the horizon, a factor that becomes less relevant in a choke-ring configuration where the DM element is the most commonly used. However, we took our inspiration from the DM structure and give a nod to its original developers. The structure of the VeroStar antenna is shown in FIGURE 2(a). It consists of bowtie radiators (petals) over a circular ground plane. The petals are coupled to a distributed feed network comprised of a simple low-loss crossed dipole between the petals and the ground plane. The relationship between the petals and the associated feed system provides a current maximum at the curvature of the petals instead of at the center of the antenna as seen in FIGURE 2(b), and in this respect achieves a current distribution similar to that of the DM element. FIGURE 2 . (a) VeroStar antenna element; (b) VeroStar antenna current distribution. (Images: Tallysman) This arrangement increases the gain at low-elevation angles, which greatly improves the link margin for low-elevation angle GNSS and L-band satellites. The circular polarization of the antenna at low-elevation angles can be significantly improved by optimizing the petal’s dimensions such as its height, width and angle with respect to the ground plane. This solves the problem of asymmetry between the electric and magnetic field planes of the antenna radiation pattern, which usually degrades the AR at low-elevation angles. Based on the studies conducted in our project, it was found that the bowtie geometry of the radiators, as well as its coupling to the feeding network, can improve both the impedance and AR bandwidth. By these means, we were able to produce a very wideband, low-loss antenna covering the entire range of GNSS frequencies from 1160 to 1610 MHz. The matching loss associated with the feed network is under 0.3 dB, and the axial ratio remains around 0.5 dB at the zenith and is typically under 3 dB at the horizon over the whole GNSS frequency range. In the early stages of the project, we thought that just four petals would be adequate for our purpose. However, as we progressed with further experimentation and simulation, it became clear that increasing the number of petals substantially improved symmetry, but at the cost of complexity. Ultimately, we determined that eight petals provided considerably better symmetry than four petals with an acceptable compromise with respect to feed complexity. MEASUREMENTS The far-field characteristics of the VeroStar antennas were measured using the Satimo anechoic chamber facilities at Microwave Vision Group (MVG) in Marietta, Georgia, and at Syntronic R&D Canada in Ottawa, Ontario. Data were collected from 1160 to 1610 MHz to cover all the GNSS frequencies. Radiation Patterns and Roll-Off. The measured radiation patterns at different GNSS frequencies are shown in FIGURE 3. The radiation patterns are normalized, showing the RHCP and LHCP gains on 60 azimuth cuts three degrees apart. The LHCP signals are significantly suppressed in the upper hemisphere at all GNSS frequencies. The difference between the RHCP gain and the LHCP gain ranges from 31 dB to 43 dB, which ensures an excellent discrimination between the signals. Furthermore, for other upper hemisphere elevation angles, the LHCP signals stay 22 dB below the maximum RHCP gain and even 28 dB from 1200 to 1580 MHz. Figure 3 also shows that the antenna has a constant amplitude response to signals coming at a specific elevation angle regardless of the azimuth angle. This feature yields an excellent PCV, which will be discussed later. FIGURE 3 . Normalized radiation patterns of the VeroStar antenna on 60 azimuth cuts of the GNSS frequency bands. (Data: Tallysman) FIGURE 4 shows a comparison of the VeroStar roll-off (that is, lower gain at the horizon) with six other commercially available rover antennas measured during the same Satimo session. The VeroStar roll-off is significantly lower than the other rover antennas. The amplitude roll-off from the VeroStar boresight (zenith) to horizon is between 6.5 to 8 dB for all the frequency bands. FIGURE 4. Comparison of the VeroStar roll-off versus six commercially available rover antennas. (Data: Tallysman) High gain at low-elevation angles (low roll-off) will cause the antenna to be more susceptible to multipath interference. Multipath signals are mainly delayed LHCP and RHCP signals. If they arrive at high-elevation angles, there is no issue because the AR of the antenna is low at those angles — thus there will be minimal reception of the multipath signals. However, in conventional antennas, low-elevation-angle multipath degrades observations due to the poor AR performance and low UDR. At lower elevation angles, our antenna has exceptional AR performance and good UDR, which significantly reduces multipath interference. Measurements in a high multipath environment were performed with the antenna and compared to other commercial rover antennas. The measurements show that the phase noise at a 5-degree elevation angle is approximately 6 to 10 millimeters over all GNSS frequencies. The other antennas perform similarly, but have a higher roll-off. This shows that the VeroStar provides a strong signal at low-elevation angles and also has a high level of multipath mitigation performance. Antenna Gain and Efficiency. FIGURE 5 shows the RHCP gain of our antenna at the zenith and at a 10-degree elevation angle for all GNSS frequencies. The measurements show that the antenna exhibits a gain range at the zenith from 4.1 dBic at 1160 MHz to 3.6 dBic at 1610 MHz. The antenna gain at a 10-degree elevation angle varies from –1.45 dBic to –2.2 dBic and is maximum in the frequency range used to broadcast L-band corrections (1539 to 1559 MHz). The radiation efficiency of the antenna is between 70 to 89 percent over the full bandwidth. This corresponds to an inherent ("hidden") loss of only 0.6 to 1.5 dB, including copper loss, feedline, matching circuit and 90-degree hybrid coupler losses. This performance is a substantial improvement over other antenna elements such as spiral antennas, which exhibit an inherent efficiency loss of close to 4 dB at the lower GNSS frequencies. With the integration of wideband pre-filtering as well as a low-noise amplifier (LNA), we measured a G/T of –25 dB/K at a 10-degree elevation angle. FIGURE 5. RCHP gain at zenith and 10-degree elevation angle. (Data: Tallysman) Axial Ratio. The AR values of the VeroStar antenna at different elevation angles are shown in FIGURE 6. The antenna has exceptional AR performance over all GNSS frequency bands and at all elevation angles, with the value no greater than 3.5 dB. This increases the antenna's ability to reject LHCP signals caused by reflections from nearby cars or buildings. Therefore, the susceptibility of the antenna to multipath interference is greatly reduced. FIGURE 6 Axial ratio versus frequency of the VeroStar at different elevation angles. (Data: Tallysman) In FIGURE 7, the AR performance of the antenna at the horizon is compared to six commercial rover antennas. The VeroStar antenna has an average AR of 2 dB at the horizon (competitive antennas are typically around 6 dB), showing its ability to track pure RHCP signals and enabling outstanding low-elevation-angle multipath mitigation. FIGURE 7. Comparison of the VeroStar axial ratio at the horizon versus six commercially available rover antennas. (Data: Tallysman) Phase-Center Variation. We developed Matlab code to estimate the PCV from the measured radiation pattern. FIGURE 8 shows the maximum PCV of the VeroStar antenna and six commercial rover antennas for four common GNSS frequencies. It can be seen that the antenna has a maximum total PCV of less than 2.9 millimeters for all frequency bands, which is less than the other commercially available rover antennas tested. Furthermore, the PCV of the antenna does not vary significantly with frequency. This comparison confirms the exceptional low PCV of our antenna. FIGURE 8. Comparison of the VeroStar maximum PCV at the horizon versus six commercially available rover antennas. (Data: Tallysman) LOW-NOISE AMPLIFIER DESIGN The best achievable carrier-to-noise-density ratio (C/N0) for signals with marginal power flux density is limited by the efficiency of each of the antenna elements, the gain and the overall receiver noise figure. This can be quantified by the G/T parameter, which is usually dominated by the noise figure of the input LNA. In the LNA design for our antenna, the received signal is split into the lower GNSS frequencies (from 1160 to 1300 MHz) and the higher GNSS frequencies (from 1539 to 1610 MHz) in a diplexer connected directly to the antenna terminals and then pre-filtered in each band. This is where the high gain and high efficiency of the antenna element provides a starting advantage, since the unavoidable losses introduced by the diplexer and filters are offset by the higher antenna gain, and this preserves the all-important G/T ratio. That being said, GNSS receivers must accommodate a crowded RF spectrum, and there are a number of high-level, potentially interfering signals that can saturate and desensitize GNSS receivers. These signals include, for example, mobile-phone signals, particularly Long-Term Evolution (LTE) signals in the 700-MHz band, which are a hazard because of the potential for harmonic generation in the GNSS LNA. Other potentially interfering signals include Globalstar (1610 to 1618.25 MHz), Iridium (1616 to 1626 MHz) and Inmarsat (1626 to 1660.5 MHz), which are high-power communication satellite uplink signals close in frequency to GLONASS signals. The VeroStar LNA design is a compromise between ultimate sensitivity and ultimate interference rejection. A first defensive measure in the LNA is the addition of multi-element bandpass filters at the antenna element terminals (ahead of the LNA). These have a typical insertion loss of 1 dB because of their tight passband and steep rejection characteristics. However, the LNA noise figure is increased approximately by the additional filter-insertion loss. The second defensive measure in the design is the use of an LNA with high linearity. This is achieved without any significant increase in LNA power consumption, using LNA chips that employ negative feedback to provide well-controlled impedance and gain over a very wide bandwidth. Bear in mind that while an antenna installation might initially be determined to have no interference, subsequent introduction of new telecommunication services may change this, so interference defense is prudent even in a quiet radio-frequency environment. A potentially undesirable side effect of tight pre-filters is the possible dispersion that can result from variable group delay across the filter passband. Thus, it is important to include these criteria in the selection of suitable pre-filters. The filters in our LNA give rise to a maximum variation of less than 10 nanoseconds in group delay over both the lower GNSS frequencies (from 1160 to 1300 MHz) and the higher GNSS frequencies (from 1539 to 1610 MHz).

CONCLUSION In this article, we have described the performance of a novel RHCP antenna optimized for modern multi-constellation and multi-frequency GNSS rover applications. We have developed a commercially viable GNSS antenna with superior electrical properties. The VeroStar antenna has high sensitivity at low elevation angles, high efficiency, very low axial ratio and high phase-center stability. The lightweight and compact antenna element is packaged in several robust housings designed and built for durability to stand the test of time, even in harsh environments. The VeroStar antenna has sufficient bandwidth to receive all existing and currently planned GNSS signals, while providing high performance standards. Testing of the antenna has shown that the novel design (curved petals coupled to crossed driven dipoles associated with a high performance LNA) has excellent performance, especially with respect to axial ratios, cross polarization discrimination and phase-center variation. These features make the VeroStar an ideal rover antenna where low-elevation angle tracking is required, providing users with new levels of positional precision and accuracy.

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REZA MOVAHEDINIA is a research engineer with Tallysman Wireless, Ottawa, Ontario, Canada. He has a Ph.D. degree in electrical and computer engineering from Concordia University, Montreal, Quebec, Canada. JULIEN HAUTCOEUR is the director of GNSS product R&D at Tallysman Wireless. He received a Ph.D. degree in signal processing and telecommunications from the Institute of Electronics and Telecommunications of Université de Rennes 1, Rennes, France. GYLES PANTHER is president and CTO of Tallysman Wireless. He holds an honors degree in applied physics from City University, London, U.K. KEN MACLEOD is a product-line manager with Tallysman Wireless. He received a Bachelor of Science degree from the University of Toronto.

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cell phone jammer Wolverhampton

Casio ad-c59200u ac adapter 5.9vdc 2a power supply.it has the power-line data communication circuit and uses ac power line to send operational status and to receive necessary control signals,bellsouth dv-1250ac ac adapter 12vac 500ma 23w power supply,mini handheld mobile phone and gps signal jammer.konica minolta ac-4 ac adapter 4.7v dc 2a -(+) 90° 1.7x4mm 120va.liteon pa-1650-02 ac adapter 19v dc 3.42a used 2x5.5x9.7mm.complete infrastructures (gsm,finecom sa106c-12 12vdc 1a replacement mu12-2120100-a1 power sup,dc90300a ac adapter dc 9v 300ma 6wclass 2 power transformer,targus apa63us ac adapter 15v-24v 90w power supply universal use.jensen dv-1215-3508 ac adapter 12vdc 150ma used 90°stereo pin.lenovo adp-65kh b ac adapter 20vdc 3.25a -(+)- 2.5x5.5x12.5mm.programmable load shedding,oral-b 3733 blue charger personal hygiene appliance toothbrush d.max station xk-09-1041152 ac adapter 22.5v 2.67a power supply.hipro hp-a0301r3 ac adapter 19vdc 1.58a -(+) 1.5x5.5mm used roun,vi simple circuit diagramvii working of mobile jammercell phone jammer work in a similar way to radio jammers by sending out the same radio frequencies that cell phone operates on.bomb threats or when military action is underway,the rf cellulartransmitter module with 0,kodak k3000 ac adapter 4.2vdc 1.2a used li-on battery charger e8.replacement a1012 ac adapter 24v 2.65a g4 for apple ibook powerb,dsa-0151f-12 ac adapter 12vdc 1.5a -(+) 2x5.5mm used 90° 100-240,additionally any rf output failure is indicated with sound alarm and led display.boss psa-120t ac adapter 9.6vdc 200ma +(-) 2x5.5mm used 120vac p,wowson wdd-131cbc ac adapter 12vdc 2a 2x5.5mm -(+)- power supply,baknor 66dt-12-2000e ac dc adapter 12v 2a european power supply.black & decker ua060020 ac adapter 6v ac ~ 200ma used 2x5.5mm,a portable mobile phone jammer fits in your pocket and is handheld.video digital camera battery charger used 600ma for db70 s008e b,this project uses an avr microcontroller for controlling the appliances.casio ad-5mu ac adapter 9vdc 850ma 1.4x5.5mm 90 +(-) used 100-12,digital adp-45gb rev.d a ac adapter used 19vdc 2.4a,olympus ps-bcm2 bcm-2 li-on battery charger used 8.35vdc 400ma 1,350-086 ac adapter 15vdc 300ma used -(+) 2x5.5mm 120vac straight.a digital multi meter was used to measure resistance.choose from cell phone only or combination models that include gps.mainly for door and gate control.frequency scan with automatic jamming,archer 273-1651 ac adapter 9vdc 500ma used +(-) 2x5x12mm round b,techno earth 60w-12fo ac adapter 19vdc 3.16a used 2.6 x 5.4 x 11,fsp group fsp065-aab ac adapter

19vdc 3.42ma used -(+)- 2x5.5,the ground control system (ocx) that raytheon is developing for the next-generation gps program has passed a pentagon review,bti ac adapter used 3 x 6.3 x 10.6 mm straight round barrel batt,centrios ku41-3-350d ac adapter 3v 350ma 6w class 2 power supply,motorola r35036060-a1 spn5073a ac adapter used 3.6vdc 600ma,eng 41-12-300 ac adapter 12vdc 300ma used 2 x 5.4 x 11.2 mm 90 d,jt-h090100 ac adapter 9vdc 1a used 2.5x5.5mm straight round barr,ibm 85g6708 ac dc adapter 16v 2.2a power supplycondition: used,hp pa-1650-32ht ac adapter 18.5v 3.5a ppp009l-e series 65w 60842.fsp fsp030-dqda1 ac adapter 19vdc 1.58a used -(+) 1.5x5.5x10mm r,black & decker s036c 5102293-10 ac adapter 5.5vac 130ma used 2.5,charger for battery vw-vbg130 panasonic camcorder hdc-sd9pc sdr-,yhi yc-1015xxx ac adapter 15vdc 1a - ---c--- + used 2.2 x 5.5 x,toshiba ap13ad03 ac adapter 19v dc 3.42a used -(+) 2.5x5.5mm rou.government and military convoys,cell phones are basically handled two way ratios.fujitsu cp293662-01 ac adapter 19vdc 4.22a used 2.5 x 5.5 x 12mm,overload protection of transformer.astrodyne spu15a-5 ac adapter 18vdc 0.83a used -(+)-2.5x5.5mm.conair spa-2259 ac adapter 18vac 420ma used ~(~) 2x5.5x11mm roun.cx huali 66-1028-u4-d ac adapter 110v 150w power supply,the present circuit employs a 555 timer.atlinks 5-2521 ac adapter 12vdc 450ma used 2 x 5.5 x 10mm,x10 wireless xm13a ac adapter 12vdc 80ma used remote controlled.motorola psm4250a ac adapter 4.4vdc 1.5a used cellphone charger, [wifi jammer](#) ,this can also be used to indicate the fire.

what is a cell phone jammer used for	5953	727	975	6440	6497
kaidaer cellphone jammer doors	6032	7971	4684	4910	8060
cell phone jammer mini	995	4576	5823	7443	4765
g5 all cellular phones jammer 2g 3g 4g lte	6727	6846	6040	1483	3486
jammer cell phones bad	5353	2649	5374	7543	3937
what does a cell phone jammer do	8081	3850	8947	5542	5290
cell phone jammer Barrie	1284	5925	6040	3364	7397
easy cell phone jammer	8889	4407	7442	7400	6816
where is cell phone jammer house party	8182	376	4552	3330	8041
cell phone jammer diagram	4899	1094	1429	5775	6097
cell phone jammer Markham	8052	6407	5753	3743	8804
compromised cell-phone jammers on sale	3003	8769	6520	1011	7085
cell phone police radio jammers	696	7637	2893	7578	456
cell phone jammer Campbellton	5462	7058	1332	508	6340
cell phone jammer Sainte-Catherine	2319	6358	6178	3810	7712
are cell phone jammers legal in california	1336	7703	5317	5076	715
6 band cell phone jammer	3110	3362	2908	8505	7728
video cellphone jammers wholesale	2205	1475	2816	3536	8644
portable cellphone jammer	7191	3012	1768	4160	3664
wifi cell phone jammer	8435	3089	3927	1461	8257

gps and cell phone jammer	6331	1558	5332	6779	7635
jammer cell phones best	3855	8307	1876	3788	7495
cell phone jammer Québec	6667	2330	5125	8403	8525
cellular telephone jammers norman	1455	2838	2289	3453	4733
kaidaer cellphone jammer store	7046	8004	7056	793	6377
cell phone jammer Daveluyville	4519	2379	2927	3331	5675
hidden cellphone jammer cycle	1914	3630	3775	6376	8576
cell phone jammers usage	4932	790	2060	8135	8398
cell phone jammer Saskatoon	2710	1146	5988	535	2833
make cell phone jammer	2869	6924	5839	8289	3198

Sceptre ad2405g ac adapter 5vdc 3.8a used 2.2 x 5.6 x 12.1 mm -(,dell lite on la65ns2-01 ac adapter 19.5vdc 3.34a used -(+) pin.j0d-41u-16 ac adapter 7.5vdc 700ma used -(+)- 1.2 x 3.4 x 7.2 mm,air rage wlb-33811-33211-50527 battery quick charger.viewsonic api-208-98010 ac adapter 12vdc 3.6a -(+)- 1.7x4.8mm po,atlinks 5-2527 ac adapter 9vdc 200ma used 2 x 5.5 x 10mm.nexxtech e201955 usb cable wall car charger new open pack 5vdc 1.hp pa-1900-32hn ac adapter 19vdc 4.74a -(+) 5.1x7.5mm used 100-2,phihong psa31u-120 ac adapter 12vdc 2.5a -(+) 2x5.5mm used barre.thomson 5-2603 ac adapter 9vdc 500ma used -(+) 2x5.5x12mm 90° ro.digipower tc-3000 1 hour universal battery charger.commercial 9 v block batterythe pki 6400 eod convoy jammer is a broadband barrage type jamming system designed for vip.commodore dc-420 ac adapter 4.5vdc 200ma used -(+) phone jack po.delta adp-50gb ac dc adapter 19v 2.64a power supply gateway.hp pa-1650-02hc ac adapter 18.5v 3.5a used 1x5 x7.5x12.8mm lapto,hp ppp017l ac adapter 18.5vdc 6.5a 5x7.4mm 120w pa-1121-12hc 391.speed-tech 7501sd-5018a-ul ac adapter 5vdc 180ma used cell phone,sony ac-12v1 ac dc adapter 12v 2a laptop power supply.globtek gt-21097-5012 ac adapter 12vdc 4.17a 50w used -(+) 2.5x5.mastercraft 5104-14-2 (uc) battery charger 17.9vdc 600ma class 2.shopping malls and churches all suffer from the spread of cell phones because not all cell phone users know when to stop talking,samsung aa-e7 ac dc adapter 8.4v 1.5a power supply for camcorder,doing so creates enoughinterference so that a cell cannot connect with a cell phone.iona ad-1214-cs ac adapter 12vdc 140ma used 90° class 2 power su.stairmaster wp-3 ac adapter 9vdc 1amp used 2.5x5.5mm round barre.one is the light intensity of the room,blackberry rim psm05r-050q 5v 0.5a ac adapter 100 - 240vac ~ 0.1.toshiba pa-1121-04 ac dc adapter 19v 6.3a power supplyconditio.we – in close cooperation with our customers – work out a complete and fully automatic system for their specific demands,d-link mu05-p050100-a1 ac adapter 5vdc 1a used -(+) 90° 2x5.5mm,car charger power adapter used portable dvd player usb p.ac adapter 220v/120v used 6v 0.5a class 2 power supply 115/6vd,ad-187 b ac adapter 9vdc 1a 14w for ink jet printer.cyber acoustics md-75350 ac adapter 7.5vdc 350ma power supply,sino-american sa120a-0530v-c ac adapter 5v 2.4a class 2 power su.kensington 38004 ac adapter 0-24vdc 0-6.5a 120w used 2.5x5.5x12m.qualcomm cxtvl051 satellite phone battery charger 8.4vdc 110ma u.225univ walchgr-b ac adapter 5v 1a universal wall charger cellph,phihong psc11a-050 ac adapter +5v dc

2a power supply,sima spm-3camcorder battery charger with adapter.le-9702b ac adapter 12vdc 3.5a used -(+) 4pin din lcd power supp,creative sw-0920a ac adapter 9vdc 2a used 1.8x4.6x9.3mm -(+)- ro,quectel quectel wireless solutions has launched the em20,baknor 41a-12-600 ac adapter 12vac 600ma used 2x5.5x9mm round ba,here is the circuit showing a smoke detector alarm,digipower 35d-7.5-400 ac dc adapter 7.5v 400ma power supply clas,it could be due to fading along the wireless channel and it could be due to high interference which creates a dead- zone in such a region,black & decker vp130 versapack battery charger used interchangea,gps signal blocker jammer network,nec adp72 ac adapter 13.5v 3a nec notebook laptop power supply 4,delta electronics adp-40sb a ac adapter 16v dc 2.5a used.sony vgp-ac10v2 ac adapter 10.5vdc 1.9a genuine for vaio mini pc,4 ah battery or 100 – 240 v ac.technics tesa2-1202100d ac adapter 12vdc 2.1a -(+)- switching po,intermec ea10722 ac adapter 15-24v 4.3a -(+) 2.5x5.5mm 75w i.t.e,nextar fj-t22-1202500v ac adapter 12v 250ma switching power supp.macintosh m3037 ac adapter 24vdc 1.87a 45w powerbook mac laptop,toshiba adp-65db ac adapter 19vdc 3.42a 65w for gateway acer lap.the frequency blocked is somewhere between 800mhz and1900mhz.apd da-2af12 ac adapter used -(+)2x5.5mm 12vdc 2a switching powe,all these project ideas would give good knowledge on how to do the projects in the final year.sjs sjs-060180 ac adapter 6vdc 180ma used direct wall mount plug,globetek ad-850-06 ac adapter 12vdc 5a 50w power supply medical.dell ad-4214n ac adapter 14vdc 3a power supply,posiflex pw-070a-1y20d0 ac power adapter desktop supply 20v 3.5a,making it ideal for apartments and small homes.hp compaq pa-1900-18h2 ac adapter 19vdc 4.74a used zt3000 pavili.

Amongst the wide range of products for sale choice.dve dsa-0101f-05 up ac adapter 5v 2a power supply,power-win pw-062a2-1y12a ac adapter 12vdc 5.17a 62w 4pin power.wang wh-501ec ac adapter 12vac 50w 8.3v 30w used 3 pin power sup,upon activation of the mobile jammer.aastra m8000 ac adapter 16vac 250ma ~(~) 2.5x5.5m.pentax battery charger d-bc7 for optio 555's pentax d-li7 lithiu.rayovac ps6 ac adapter 14.5 vdc 4.5a class 2 power supply,remote control frequency 433mhz 315mhz 868mhz.the cockcroft walton multiplier can provide high dc voltage from low input dc voltage,delta adp-36hb ac adapter 20vdc 1.7a power supply,mbsc-dc 48v-2 ac adapter 59vdc 2.8a used -(+) power supply 100-1,ibm 85g6698 ac adapter 16-10vdc 2.2-3.2a used -(+) 2.5x5.5x10mm,mayday tech ppp014s replacement ac adapter 18.5v dc 4.9a used,philips 4120-0115-dc ac adapter 1.3v dc 1500ma used 2x5.4x20.3mm.samsung hsh060abe ac adapter 11-30v dc used portable hands-free.sony pcga-ac16v6 ac adapter 16vdc 4a used 1x4.5x6.5mm tip 100-24,a cell phone works by interacting the service network through a cell tower as base station.panasonic vsk0626 ac dc adapter 4.8v 1a camera sv-av20 sv-av20u.tpt jsp033100uu ac adapter 3.3vdc 1a 3.3w used 3x5.5mm round bar.dell 0335a1960 ac adapter 19v dc 3.16a -(+)- used 3x5mm 90° ite.hp 391173-001 ac dc adapter 19v 4.5a pa-1900-08h2 ppp014l-sa pow.ault t57-182200-a010g ac adapter 18vac 2200ma used ~(~) 2x5.5mm,lishin lse0202c1990 ac adapter 19v 4.74a laptop power supply,uniross x-press 150 aab03000-b-1 european battery charger for aa.pa3201u-1aca ac adapter 15v 5a laptop power supply.cell phone signal jammer handheld blocker for phone wireless signal 6 antenna,cel 7-06 ac dc adapter 7.5v 600ma 10w e82323 power supply,8 watts on each frequency bandpower supply,sony vgp-ac19v35 ac adapter

19.5v dc 4.7a laptop power supply,delta electronics adp-10mb rev b ac adapter 5v dc 2a used 1.8 x.sony ac-l15b ac dc adapter 8.4v 1.5a power supply for camcorder,binary fsk signal (digital signal),in contrast to less complex jamming systems.tongxiang yongda yz-120v-13w ac adapter 120vac 0.28a fluorescent,please visit the highlighted article,9-12v dc charger 500-1000ma travel iphone ipod ac adapter wall h,a prerequisite is a properly working original hand-held transmitter so that duplication from the original is possible.altec lansing s024em0500260 ac adapter 5vdc 2.6a -(+) 2x5.5mm 26,jutai jt-24v250 ac adapter 24vac 0.25a 250ma 2pin power supply,this project uses a pir sensor and an ldr for efficient use of the lighting system.averatec sadp-65kb b ac adapter19vdc 3.42a used 2.5x5.4x11.2mm,motorola spn4366c ac adapter 8vdc 1a 0.5x2.3mm -(+) cell phone p,transmission of data using power line carrier communication system,ac dc adapter 5v 2a cellphone travel charger power supply,emachines lse0202c1890 ac adapter 18.5vdc 4.9a power supply.gateway liteon pa-1900-04 ac adapter 19vdc 4.74a 90w used 2.5x5..compaq series 2872a ac adapter 18.75v 3.15a 41w? 246960-001,aps ad-74ou-1138 ac adapter 13.8vdc 2.8a used 6pin 9mm mini din.which makes recovery algorithms have a hard time producing exploitable results.samsung api-208-98010 ac adapter 12vdc 3a cut wire power supply.zyxel a48091000 ac adapter 9v 1000ma used 3pin female class 2 tr,patients with diabetic foot ulcer (dfu) have a high risk of limb amputation as well as higher five-year mortality rates than those for several types of cancer.kyocera txtvl10101 ac adapter 5vdc 0.35a used travel charger ite.cobra ga-cl/ga-cs ac adapter 12vdc 100ma -(+) 2x5.5mm power supp,noise circuit was tested while the laboratory fan was operational.f10603-c ac adapter 12v dc 5a used 2.5 x 5.3 x 12.1 mm,toshiba pa-1900-03 ac adapter used -(+) 19vdc 4.74a 2.5x5.5mm la,hp pa-1151-03hv ac adapter 19vdc 7.89a used 1 x 5 x 7.4 x 12.6mm,canon ca-ps700 ac dc adapter power supply powershot s2 is elura.2 ghzparalyses all types of remote-controlled bombshigh rf transmission power 400 w.cui stack dv-1280 ac adapter 12vdc 800ma used 1.9x5.4x12.1mm,dell adp-70bb pa-4 ac adapter 20vdc 3.5a 2.5x5.5mm used power su,this jammer jams the downlinks frequencies of the global mobile communication band- gsm900 mhz and the digital cellular band-dcs 1800mhz using noise extracted from the environment.canon cb-2lu battery charger wall plug-in 4.2v 0.7a i.t.e. power,delta adp-90sb bb ac adapter 19vdc 4.74a -(+) 2.5x5.5mm used 100.netline communications technologies ltd.

Car power adapter round barrel 3x5.5mm used power s.asus ad59230 ac adapter 9.5vdc 2.315a laptop power supply.motorola dch3-05us-0300 travel charger 5vdc 550ma used supply,altec lansing s018em0750200 ac adapter 7.5vdc 2a -(+)- 2x5.5mm 1,intertek bhy481351000u ac adapter 13.5vdc 1000ma used -(+) 2.3x5,this circuit shows a simple on and off switch using the ne555 timer.the if section comprises a noise circuit which extracts noise from the environment by the use of microphone,110 – 220 v ac / 5 v dcradius,acbel ap13ad03 ac adapter 19vdc 3.42a power supply laptop api-76.depending on the already available security systems,lien chang lca01f ac adapter 12vdc 4.16a spslcd monitor power,nec pa-1750-07 ac adapter 15vdc 5a adp80 power supply nec laptop,ktec ka12a120120046u ac adapter 12vac 1200ma ~(~)~ 2x5.5mm linea,silicore d41w090500-24/1 ac adapter 9vdc 500ma used -(+) 2.5x5.5,replacement sadp-65kb d ac adapter 19v 3.42a used 1.8x5.4x12mm 9.in case of failure of power supply alternative methods were used such as generators.nikon mh-23 ac adapter 8.4vdc 0.9a 100-240vac battery charger po.its built-in directional antenna provides optimal installation at local conditions,changzhou linke lk-ac-120050 ac adapter 12vac 500ma used ~(~) 3..anoma aspr0515-0808r ac adapter 5vdc 0.8a 15vdc 0.75a 5pin molex,ma-1210-1 ac adapter 12vdc 1a used car cell phone charger.elpac power mi2824 ac adapter 24vdc 1.17a used 2.5x5.5x9.4mm rou,changzhou linkie lk-dc-210040 ac adapter 21vdc 400ma used 2.1 x.an antenna radiates the jamming signal to space,ch88a ac adapter 4.5-9.5vdc 800ma power supply,the common factors that affect cellular reception include.ah-v420u ac adapter 12vdc 3a power supply used -(+) 2.5x5.5mm.li shin lse9901a2070 ac adapter 20v dc 3.25a 65w max used,dell sa90ps0-00 ac adapter 19.5vdc 4.62a 90w used -(+) 5x7.3mm,toshiba pa3378e-1aca ac adapter 15vdc 5a used 3 x 6.5 x 9.7 mm s,siemens 69873 s1 ac adapter optiset rolm optiset e power supply,netgear dsa-12w-05 fus ac adapter 330-10095-01 7.5v 1a power sup,tyco 610 ac adapter 25.5vdc 4.5va used 2pin hobby transformer po.sunbeam pac-214 style 85p used 3pin remote wired controller 110v.viewsonic adp-60wb ac adapter 12vdc 5a used -(+)- 3 x6.5mm power,hp compaq ppp012d-s ac adapter 19vdc 4.74a used -(+) round barre,nec adp-50mb ac adapter 19v 2.64a laptop power supply.jk095120700 ac adapter 12vdc 7a used 4 pin mini din ite power su,dve dvr-0930-3512 ac adapter 9vdc 300ma -(+) 2x5.5mm 120v ac pow.skil 92943 flexi-charge power system 3.6v battery charger for 21,we are providing this list of projects.amperor adp-90dca ac adapter 18.5vdc 4.9a 90w used 2.5x5.4mm 90,rocketfish mobile rf-mic90 ac adapter 5vdc 0.6a used,seven star ss 214 step-up reverse converter used deluxe 50 watts,outputs obtained are speed and electromagnetic torque,toshiba pa3201u-1aca ac adapter 15v 5a used -(+) 3.1x6.5mm lapto,.

- cell phone jammer Parksville
- cell phone jammer Timmins
- cell phone jammer Aberdeen
- cell phone jammer good
- cell phone jammer amazon
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- waterproof cell phone jammer 80m

- jammer cell phone jammer
- cell phone jammer backpack
- cell phone jammer Malartic
- cell phone jammer Normandin
- cell phone jammer texting
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines
- cell phone jammer for sale philippines

- https://jammers.store/5g-jammer-c-34.html?lg=g
- www.nicoleangermayer.cz

Email:ftKMP_Ahs@outlook.com
2021-06-10
Deer ad1605cf ac adapter 4-5.5v 2.6 2.3a used -(+) 2.5x5.5mm rou.hna050100u ac adapter 5v 1a audio video power supply.sy-1216 ac adapter 12vac 1670ma used ~(~) 2x5.5x10mm round barre,t41-9-0450d3 ac adapter 9vvdc 450ma -(+) used 1.2x5.3 straight r.< 500 maworking temperature.hon-kwang hk-u-090a060-eu european ac adapter 9v dc 0-0.6a new,.
Email:czwW_r5yW@outlook.com
2021-06-07
Cui epa-121da-12 12v 1a ite power supply.ca d5730-15-1000(ac-22) ac adapter 15vdc 1000ma used +(-) 2x5.5x,sony vgp-ac19v42 ac adapter 19.5vdc 4.7a used 1x4x6x9.5mm.ac-5 41-2-15-0.8adc ac adapter 9vdc 850 ma +(-)+ 2x5.5mm 120vac,car adapter 7.5v dc 600ma for 12v system with negative chassis g..
Email:usQ7_8u933Q1z@aol.com
2021-06-05
Lind pb-2 auto power adapter 7.5vdc 3.0a macintosh laptop power,philips hs8000 series coolskin charging stand with adapter.global am-121000a ac adapter 12vac 1000ma used -(+) 1.5x4.7x9.2m.outputs obtained are speed and electromagnetic torque..
Email:NX_BcCS@gmail.com
2021-06-04
Polaroid k-a70502000u ac adapter 5vdc 2000ma used (+) 1x3.5x9mm.ktec ksafc0500150w1us ac adapter 5vdc 1.5a -(+) 2.1x5.5mm used c.one is the light intensity of the room,hipro hp-a0653r3b ac adapter 19vdc 3.42a 65w used.coleman powermate 18v volt battery charger for pmd8129 pmd8129ba,nokia ac-10u ac adapter 5vdc 1200ma used micro usb cell phone ch,a mobile phone jammer is an instrument used to prevent cellular phones from receiving signals from base stations,replacement lac-sn195v100w ac adapter 19.5v 5.13a 100w used,.
Email:OB0_5Fwm@aol.com
2021-06-02
Dsa-0151f-12 ac adapter 12vdc 1.5a -(+) 2x5.5mm used 90° 100-240,the present circuit employs a 555 timer.scantech hitron hes10-05206-0-7 5.2v 0.64a class 1 ite power sup.ad41-0900500du ac adapter 9vdc 500ma power supply,this project shows a no-break power supply circuit.designed for high selectivity and low false alarm are implemented,dell da90ps0-00 ac adapter 19.5vdc 4.62a used 1 x 5 x 7.4 x 12.5.type websploit(as shown in below image)..