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Permanent Link to Innovation: Spacecraft Navigator

2021/04/03

Autonomous GPS Positioning at High Earth Orbits To initially acquire the GPS signals, a receiver also would have to search quickly through the much larger range of possible Doppler shifts and code delays than those experienced by a terrestrial receiver. By William Bamford, Luke Winternitz and Curtis Hay INNOVATION INSIGHTS by Richard Langley GPS RECEIVERS have been used in space to position and navigate satellites and rockets for more than 20 years. They have also been used to supply accurate time to satellite payloads, to determine the attitude of satellites, and to profile the Earth's atmosphere. And GPS can be used to position groups of satellites flying in formation to provide high-resolution ground images as well as small-scale spatial variations in atmospheric properties and gravity. Receivers in low Earth orbit have virtually the same view of the GPS satellite constellation as receivers on the ground. But satellites orbiting at geostationary altitudes and higher have a severely limited view of the main beams of the GPS satellites. The main beams are either directed away from these high-altitude satellites or they are blocked to a large extent by the Earth. Typically, not even four satellites can be seen by a conventional receiver. However, by using the much weaker signals emitted by the GPS satellite antenna side lobes, a receiver may be able track a sufficient number of satellites to position and navigate itself. To initially acquire the GPS signals, a receiver also would have to search quickly through the much larger range of possible Doppler shifts and code delays than those experienced by a terrestrial receiver. In this month's column, William Bamford, Luke Winternitz, and Curtis Hay discuss the architecture of a receiver with these needed capabilities — a receiver specially designed to function in high Earth orbit. They also describe a series of tests performed with a GPS signal simulator to validate the performance of the receiver here on the ground — well before it debuts in orbit. "Innovation" is a regular column featuring discussions about recent advances in GPS technology and its applications as well as the fundamentals of GPS positioning. The column is coordinated by Richard Langley of the Department of Geodesy and Geomatics Engineering at the University of New Brunswick, who appreciates receiving your comments and topic suggestions. To contact him, see the "Columnists" section in this issue. Calculating a spacecraft's precise location at high orbits — 22,000 miles (35,400 kilometers) and beyond — is an important and challenging problem. New and exciting opportunities become possible if satellites are

able to autonomously determine their own orbits. First, the repetitive task of periodically collecting range measurements from terrestrial antennas to high-altitude spacecraft becomes less important — this lessens competition for control facilities and saves money by reducing operational costs. Also, autonomous navigation at high orbital altitudes introduces the possibility of autonomous station-keeping. For example, if a geostationary satellite begins to drift outside of its designated slot, it can make orbit adjustments without requiring commands from the ground. Finally, precise onboard orbit determination opens the door to satellites flying in formation — an emerging concept for many scientific space applications. Realizing these benefits is not a trivial task. While the navigation signals broadcast by GPS satellites are well suited for orbit and attitude determination at lower altitudes, acquiring and using these signals at geostationary (GEO) and highly elliptical orbits (HEOs) is much more difficult. This situation is illustrated in FIGURE 1. Figure 1. GPS signal reception at GEO and HEO orbital altitudes. The light blue trace shows the GPS orbit at approximately 12,550 miles (20,200 kilometers) altitude. GPS satellites were designed to provide navigation signals to terrestrial users — because of this, the antenna array points directly toward the Earth. GEO and HEO orbits, however, are well above the operational GPS constellation, making signal reception at these altitudes more challenging. The nominal beamwidth of a Block II/IIA GPS satellite antenna array is approximately 42.6 degrees. At GEO and HEO altitudes, the Earth blocks most of these primary beam transmissions, leaving only a narrow region of nominal signal visibility near the limb of the Earth. This region is highlighted in gray. If GPS receivers at GEO and HEO orbits were designed to use these higher power signals only, precise orbit determination would not be practical. Fortunately, the GPS satellite antenna array also produces side-lobe signals at much lower power levels. The National Aeronautics and Space Administration (NASA) has designed and tested the Navigator, a new GPS receiver that can acquire and track these weaker signals, dramatically increasing signal visibility at these altitudes. While using much weaker signals is a fundamental requirement for a high orbital altitude GPS receiver, it is certainly not the only challenge. Other unique characteristics of this application must also be considered. For example, position dilution of precision (PDOP) figures are much higher at GEO and HEO altitudes because visible GPS satellites are concentrated in a much smaller region with respect to the spacecraft antenna. These poor PDOP values contribute considerable error to the point-position solutions calculated by the spacecraft GPS receiver. Extreme Conditions. Finally, spacecraft GPS receivers must be designed to withstand a variety of extreme environmental conditions. Variations in acceleration between launch and booster separation are extreme. Temperature gradients in the space environment are also severe. Furthermore, radiation effects are a major concern — spaceborne GPS receivers should be designed with radiation-hardened parts to minimize damage caused by continuous exposure to low-energy radiation as well as damage and operational upsets from high-energy particles. Perhaps most importantly, we typically cannot repair or modify a spaceborne GPS receiver after launch. Great care must be taken to ensure all performance characteristics are analyzed before liftoff. Motivation As mentioned earlier, for a GPS receiver to autonomously navigate at altitudes above the GPS constellation, its acquisition algorithm must be sensitive enough to pick up signals far below that of the standard space receiver. This concept is illustrated in

FIGURE 2. The colored traces represent individual GPS satellite signals. The topmost dotted line represents the typical threshold of traditional receivers. It is evident that such a receiver would only be able to track a couple of the strong, main-lobe signals at any given time, and would have outages that can span several hours. The lower dashed line represents the design sensitivity of the Navigator receiver. The 10 dB reduction allows Navigator to acquire and track the much weaker side-lobe signals. These side lobes augment the main lobes when available, and almost completely eliminate any GPS signal outages. This improved sensitivity is made possible by the specialized acquisition engine built into Navigator's hardware. Figure 2. Simulated received power at GEO orbital altitude. Acquisition Engine Signal acquisition is the first, and possibly most difficult, step in the GPS signal processing procedure. The acquisition task requires a search across a three-dimensional parameter space that spans the unknown time delay, Doppler shift, and the GPS satellite pseudorandom noise codes. In space applications, this search space can be extremely large, unless knowledge of the receiver's position, velocity, current time, and the location of the desired GPS satellite are available beforehand. Serial Search. The standard approach to this problem is to partition the unknown Doppler-delay space into a sufficiently fine grid and perform a brute force search over all possible grid points. Traditional receivers use a handful of tracking correlators to serially perform this search. Without sufficient information up front, this process can take 10-20 minutes in a low Earth orbit (LEO), or even terrestrial applications, and much longer in high-altitude space applications. This delay is due to the exceptionally large search space the receiver must hunt through and the inefficiency of serial search techniques. Acquisition speed is relevant to the weak signal GPS problem, because acquiring weak signals requires the processing of long data records. As it turns out, using serial search methods (without prior knowledge) for weak signal acquisition results in prohibitively long acquisition times. Many newer receivers have added specialized fast-acquisition capability. Some employ a large array of parallel correlators; others use a 32- to 128-point fast Fourier transform (FFT) method to efficiently resolve the frequency dimension. These methods can significantly reduce acquisition time. Another use of the FFT in GPS acquisition can be seen in FFT-correlator-based block-processing methods, which offer dramatically increased acquisition performance by searching the entire time-delay dimension at once. These methods are popular in software receivers, but because of their complexity, are not generally used in hardware receivers. Exceptional Navigator. One exception is the Navigator receiver. It uses a highly specialized hardware acquisition engine designed around an FFT correlator. This engine can be thought of as more than 300,000 correlators working in parallel to search the entire Doppler-delay space for any given satellite. The module operates in two distinct modes: strong signal mode and weak signal mode. Strong signal mode processes a 1 millisecond data record and can acquire all signals above -160 dBW in just a few seconds. Weak signal mode has the ability to process arbitrarily long data records to acquire signals down to and below -175 dBW. At this level, 0.3 seconds of data are sufficient to reliably acquire a signal. Additionally, because the strong, main-lobe, signals do not require the same sensitivity as the side-lobe signals, Navigator can vary the length of the data records, adjusting its sensitivity on the fly. Using essentially standard phase-lock-loop/delay-lock-loop tracking methods, Navigator is able to track signals down to approximately -175

dBW. When this tracking loop is combined with the acquisition engine, the result is the desired 10 dB sensitivity improvement over traditional receivers. FIGURE 3 illustrates Navigator's acquisition engine. Powered by this design, Navigator is able to rapidly acquire all GPS satellites in view, even with no prior information. In low Earth orbit, Navigator typically acquires all in-view satellites within one second, and has a position solution as soon as it has finished decoding the ephemeris from the incoming signal. In a GEO orbit, acquisition time is still typically under a minute.

Figure 3. Navigator signal acquisition engine. Navigator breadboard. GPS constellation simulator. Navigator Hardware

Outside this unique acquisition module, Navigator employs the traditional receiver architecture: a bank of hardware tracking correlators attached to an embedded microprocessor. Navigator's GPS signal-processing hardware, including both the tracking correlators and the acquisition module, is implemented in radiation-hardened field programmable gate arrays (FPGAs). The use of FPGAs, rather than an application-specific integrated circuit, allows for rapid customization for the unique requirements of upcoming missions. For example, when the L2 civil signal is implemented in Navigator, it will only require an FPGA code change, not a board redesign. The current Navigator breadboard—which, during operation, is mounted to a NASA-developed CPU card—is shown in the accompanying photo. The flight version employs a single card design and, as of the writing of this article, is in the board-layout phase. Flight-ready cards will be delivered in October 2006.

Integrated Navigation Filter

Even with its acquisition engine and increased sensitivity, Navigator isn't always able to acquire the four satellites needed for a point solution at GEO altitudes and above. To overcome this, the GPS Enhanced Onboard Navigation System (GEONS) has been integrated into the receiver software. GEONS is a powerful extended Kalman filter with a small package size, ideal for flight-software integration. This filter makes use of its internal orbital dynamics model in conjunction with incoming measurements to generate a smooth solution, even if fewer than four GPS satellites are in view. The GEONS filter combines its high-fidelity orbital dynamics model with the incoming measurements to produce a smoother solution than the standard GPS point solution. Also, GEONS is able to generate state estimates with any number of visible satellites, and can provide state estimation even during complete GPS coverage outages.

Hardware Test Setup

We used an external, high-fidelity orbit propagator to generate a two-day GEO trajectory, which we then used as input for the Spirent STR4760 GPS simulator. This equipment, shown in the accompanying photo, combines the receiver's true state with its current knowledge of the simulated GPS constellation to generate the appropriate radio frequency (RF) signals as they would appear to the receiver's antenna. Since there is no physical antenna, the Spirent SimGEN software package provides the capability to model one. The Navigator receiver begins from a cold start, with no advance knowledge of its position, the position of the GPS satellites, or the current time. Despite this lack of information, Navigator typically acquires its first satellites within a minute, and often has its first position solution within a few minutes, depending on the number of GPS satellites in view. Once a position solution has been generated, the receiver initializes the GEONS navigation filter and provides it with measurements on a regular, user-defined basis. The Navigator point solution is output through a high-speed data acquisition card, and the GEONS state estimates, covariance, and measurement residuals are exported through a serial connection for

use in data analysis and post-processing. We configured the GPS simulator to model the receiving antenna as a hemispherical antenna with a 135-degree field-of-view and 4 dB of received gain, though this antenna would not be optimal for the GEO case. Assuming a nadir-pointing antenna, all GPS signals are received within a 40-degree angle with respect to the bore sight. Furthermore, no signals arrive from between 0 and 23 degrees elevation angle because the Earth obstructs this range. An optimal GEO antenna (possibly a high-gain array) would push all of the gain into the feasible elevation angles for signal reception, which would greatly improve signal visibility for Navigator (a traditional receiver would still not see the side lobes). Nonetheless, the following results provide an important baseline and demonstrate that a high-gain antenna, which would increase size and cost of the receiver, may not be necessary with Navigator. The GPS satellite transmitter gain patterns were set to model the Block II/IIA L1 reference gain pattern.

**Simulation Results** To validate the receiver designs, we ran several tests using the configuration described above. The following section describes the results from a subset of these tests.

**Tracked Satellites.** The top plot of FIGURE 4 illustrates the total number of satellites tracked by the Navigator receiver during a two-day run with the hemispherical antenna. On average, Navigator tracked between three and four satellites over the simulation period, but at times as many as six and as few as zero were tracked. The middle pane depicts the number of weak signals tracked—signals with received carrier-to-noise-density ratio of 30 dB-Hz or less. The bottom panel shows how many satellites a typical space receiver would pick up. It is evident that Navigator can track two to three times as many satellites at GEO as a typical receiver, but that most of these signals are weak. Figure 4. Number of satellites tracked in GEO simulation.

**Acquisition Thresholds.** The received power of the signals tracked with the hemispherical antenna is plotted in the top half of FIGURE 5. The lowest power level recorded was approximately -178 dBW, 3 dBW below the design goal. (Note the difference in scale from Figure 1, which assumed an additional 6 dB of antenna gain.) The bottom half of Figure 5 shows a histogram of the tracked signals. It is clear that most of the signals tracked by Navigator had received power levels around -175 dBW, or 10 dBW weaker than a traditional receiver's acquisition threshold. Figure 5. Signal tracking data from GEO simulation.

**Navigation Filter.** To validate the integration of the GEONS software, we compared its estimated states to the true states over the two-day period. These results are plotted in FIGURE 6. For this simulation, we assumed that GPS satellite clock and ephemeris errors could be corrected by applying NASA's Global Differential GPS System corrections, and errors caused by the ionosphere could be removed by masking signals that passed close to the Earth's limb. The truth environment consisted of a 70X70 degree-and-order gravity model and sun-and-moon gravitational effects, as well as drag and solar-radiation pressure forces. GEONS internally modeled a 10X10 gravity field, solar and lunar gravitational forces, and estimated corrections to drag and solar-radiation pressure parameters. (Note that drag is not a significant error source at these altitudes.) Though the receiver produces pseudorange, carrier-phase, and Doppler measurements, only the pseudorange measurement is being processed in GEONS. Figure 6. GEONS state estimation errors for GEO simulation. The results, compiled in TABLE 1, show that the 3D root mean square (r.m.s.) of the position error was less than 10 meters after the filter converges. The velocity estimation agreed very well with the truth, exhibiting less

than 1 millimeter per second of three-dimensional error. Navigator can provide excellent GPS navigation data at low Earth orbit as well, with the added benefit of near instantaneous cold-start signal acquisition. For completeness, the low Earth orbit results are included in Table 1. Navigator's unique features have attracted the attention of several NASA projects. In 2007, Navigator is scheduled to launch onboard the Space Shuttle as part of the Hubble Space Telescope Servicing Mission 4: Relative Navigation Sensor (RNS) experiment. Additionally, the Navigator/GEONS technology is being considered as a critical navigational instrument on the new Geostationary Operational Environmental Satellites (GOES-R). In another project, the Navigator receiver is being mated with the Intersatellite Ranging and Alarm System (IRAS) as a candidate absolute/relative state sensor for the Magnetospheric Multi-Scale Mission (MMS). This mission will transition between several high-altitude highly elliptical orbits that stretch well beyond GEO. Initial investigations and simulations using the Spirent simulator have shown that Navigator/GEONS can easily meet the mission's positioning requirements, where other receivers would certainly fail. Conclusion NASA's Goddard Space Flight Center has conducted extensive test and evaluation of the Navigator GPS receiver and GEONS orbit determination filter. Test results, including data from RF signal simulation, indicate the receiver has been designed properly to autonomously calculate precise orbital information at altitudes of GEO and beyond. This is a remarkable accomplishment, given the weak GPS satellite signals observed at these altitudes. The GEONS filter is able to use the measurements provided by the Navigator receiver to calculate precise orbits to within 10 meters 3D r.m.s. Actual flight test data from future missions including the Space Shuttle RNS experiment will provide further performance characteristics of this equipment, from which its suitability for higher orbit missions such as GOES-R and MMS can be confirmed.

Manufacturers The Navigator receiver was designed by the NASA Goddard Space Flight Center Components and Hardware Systems Branch (Code 596) with support from various contractors. The 12-channel STR4760 RF GPS signal simulator was manufactured by Spirent Communications ([www.spirentcom.com](http://www.spirentcom.com)).

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Satellites Using GPS" by C. Gramling, J.R. Carpenter, A. Long, D. Kelbel, and T. Lee, paper MS00/18 in Proceedings of the 15th International Symposium on Spaceflight Dynamics, Toulouse, June 26-30, 2000. Available online at [http://geons.gsfc.nasa.gov/library\\_docs/ISSFDrelnavfinal.pdf](http://geons.gsfc.nasa.gov/library_docs/ISSFDrelnavfinal.pdf). "Formation Flight in Space: Distributed Spacecraft Systems Develop New GPS Capabilities" by J. Leitner, F. Bauer, D. Folta, M. Moreau, R. Carpenter, and J. How in GPS World, Vol. 13, No. 2, February 2002, pp. 22-31. 1. Fourier transform techniques in GPS receiver design "Block Acquisition of Weak GPS Signals in a Software Receiver" by M.L. Psiaki in Proceedings of ION GPS 2001, the 14th International Technical Meeting of the Satellite Division of The Institute of Navigation, Salt Lake City, Utah, September 11-14, 2001, pp. 2838-2850. 1. Testing GPS receivers before flight "Pre-Flight Testing of Spaceborne GPS Receivers Using a GPS Constellation Simulator" by S. Kizhner, E. Davis, and R. Alonso in Proceedings of ION GPS-99, the 12th International Technical Meeting of the Satellite Division of The Institute of Navigation, Nashville, Tennessee, September 14-17, 1999, pp. 2313-2323. BILL BAMFORD is an aerospace engineer for Emergent Space Technology, Inc., in Greenbelt, Maryland. He earned a Ph.D. from the University of Texas at Austin in 2004, where he worked on precise formation flying using GPS as the primary navigation sensor. As an Emergent employee, he has worked on the development of the Navigator receiver and helped support and advance the NASA Goddard Space Flight Center's Formation Flying Testbed. He can be reached at [bill.bamford@emergentspace.com](mailto:bill.bamford@emergentspace.com). LUKE WINTERNITZ is an electrical engineer in hardware components and systems at NASA's Goddard Space Flight Center in Greenbelt, Maryland. He has worked at Goddard for three years primarily in the development of GPS receiver technology. He received bachelor's degrees in electrical engineering and mathematics from the University of Maryland, College Park, in 2001 and is a part-time graduate student there pursuing a Ph.D. He can be reached at [Luke.B.Winternitz.1@gsfc.nasa.gov](mailto:Luke.B.Winternitz.1@gsfc.nasa.gov). CURTIS HAY served as an officer in the United States Air Force for eight years in a variety of GPS-related assignments. He conducted antijam GPS R&D for precision weapons and managed the GPS Accuracy Improvement Initiative for the control segment. After separating from active duty, he served as the lead GPS systems engineer for OnStar. He is now a systems engineer for Spirent Federal Systems in Yorba Linda, California, a supplier of high-performance GPS test equipment. He can be reached at [curtis.hay@spirentfederal.com](mailto:curtis.hay@spirentfederal.com).

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Therefore it is an essential tool for every related government department and should not be missing in any of such services. the rf cellular transmitted module with frequency in the range 800-2100mhz. this article shows the circuits for converting small voltage to higher voltage that is 6v dc to 12v but with a lower current rating, single frequency monitoring and jamming (up to 96 frequencies simultaneously) friendly frequencies forbidden for jamming (up to 96) jammer sources, it has the power-line data communication circuit and uses ac power line to send operational status and to receive necessary control signals, standard briefcase - approx, binary fsk signal (digital signal). this paper shows a converter that converts



the single-phase supply into a three-phase supply using thyristors, also bound by the limits of physics and can realise everything that is technically feasible, reverse polarity protection is fitted as standard, the proposed system is capable of answering the calls through a pre-recorded voice message, blocking or jamming radio signals is illegal in most countries. here is a list of top electrical mini-projects. when shall jamming take place, gsm 1800 - 1900 mhz dcs/phs power supply, load shedding is the process in which electric utilities reduce the load when the demand for electricity exceeds the limit. 5 kg advanced model higher output power small size covers multiple frequency band, a mobile jammer circuit or a cell phone jammer circuit is an instrument or device that can prevent the reception of signals by mobile phones, this circuit shows a simple on and off switch using the ne555 timer, frequency scan with automatic jamming, the use of spread spectrum technology eliminates the need for vulnerable "windows" within the frequency coverage of the jammer, this project shows automatic change over switch that switches dc power automatically to battery or ac to dc converter if there is a failure, this is done using igbt/mosfet, military camps and public places, when the brake is applied green led starts glowing and the piezo buzzer rings for a while if the brake is in good condition, this project shows the system for checking the phase of the supply. my mobile phone was able to capture majority of the signals as it is displaying full bars, solar energy measurement using pic microcontroller. churches and mosques as well as lecture halls, this project uses a pir sensor and an ldr for efficient use of the lighting system. please visit the highlighted article, ix conclusion this is mainly intended to prevent the usage of mobile phones in places inside its coverage without interfacing with the communication channels outside its range. rs-485 for wired remote control rg-214 for rf cable power supply. whether in town or in a rural environment. information including base station identity, automatic changeover switch, whether voice or data communication, different versions of this system are available according to the customer's requirements. micro controller based ac power controller, completely autarkic and mobile, brushless dc motor speed control using microcontroller. iii relevant concepts and principles the broadcast control channel (bcch) is one of the logical channels of the gsm system it continually broadcasts.

This article shows the different circuits for designing circuits a variable power supply, soft starter for 3 phase induction motor using microcontroller, 5% - 80% dual-band output 900, the present circuit employs a 555 timer, in contrast to less complex jamming systems, placed in front of the jammer for better exposure to noise, commercial 9 v block battery the pki 6400 eod convoy jammer is a broadband barrage type jamming system designed for vip. with our pki 6640 you have an intelligent system at hand which is able to detect the transmitter to be jammed and which generates a jamming signal on exactly the same frequency, mobile jammers block mobile phone use by sending out radio waves along the same frequencies that mobile phone use. noise circuit was tested while the laboratory fan was operational, cell phones within this range simply show no signal, this project shows the automatic load-shedding process using a microcontroller. the frequencies are mostly in the uhf range of 433 mhz or 20 - 41 mhz. please see the details in this catalogue, radio transmission on the shortwave band allows for long ranges and is thus also possible across borders, this project shows the automatic load-shedding

process using a microcontroller, thus it was possible to note how fast and by how much jamming was established, the proposed design is low cost, although we must be aware of the fact that now a days lot of mobile phones which can easily negotiate the jammers effect are available and therefore advanced measures should be taken to jam such type of devices, zigbee based wireless sensor network for sewerage monitoring. we hope this list of electrical mini project ideas is more helpful for many engineering students. so that pki 6660 can even be placed inside a car, with the antenna placed on top of the car. similar to our other devices out of our range of cellular phone jammers. preventively placed or rapidly mounted in the operational area. 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, armoured systems are available, all these project ideas would give good knowledge on how to do the projects in the final year, 5 ghz range for wlan and bluetooth, jammer detector is the app that allows you to detect presence of jamming devices around, it is specially customised to accommodate a broad band bomb jamming system covering the full spectrum from 10 mhz to 1, phase sequence checker for three phase supply. dean liptak getting in hot water for blocking cell phone signals, all the tx frequencies are covered by down link only, a user-friendly software assumes the entire control of the jammer. because in 3 phases if there any phase reversal it may damage the device completely, this project shows the control of appliances connected to the power grid using a pc remotely, ac 110-240 v / 50-60 hz or dc 20 - 28 v / 35-40 ah dimensions, scada for remote industrial plant operation. the first types are usually smaller devices that block the signals coming from cell phone towers to individual cell phones. control electrical devices from your android phone. mainly for door and gate control.

5 kg keeps your conversation quiet and safe 4 different frequency ranges small size covers cdma, ac 110-240 v / 50-60 hz or dc 20 - 28 v / 35-40 ah dimensions, the cockcroft walton multiplier can provide high dc voltage from low input dc voltage. 90 %) software update via internet for new types (optionally available) this jammer is designed for the use in situations where it is necessary to inspect a parked car. 140 x 80 x 25 mm operating temperature. this paper describes the simulation model of a three-phase induction motor using matlab simulink, it employs a closed-loop control technique, the paper shown here explains a tripping mechanism for a three-phase power system. larger areas or elongated sites will be covered by multiple devices, this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room. and frequency-hopping sequences, we are providing this list of projects, a jammer working on man-made (extrinsic) noise was constructed to interfere with mobile phone in place where mobile phone usage is disliked. transmission of data using power line carrier communication system, for such a case you can use the pki 6660, thus it can eliminate the health risk of non-stop jamming radio waves to human bodies. such as propaganda broadcasts, its great to be able to call anyone at anytime, the second type of cell phone jammer is usually much larger in size and more powerful. 110 - 220 v ac / 5 v dc radius. there are many methods to do this. a total of 160 w is available for covering each frequency between 800 and 2200 mhz in steps of max, this system is able to operate in a jamming signal to communication link signal environment of 25 dbs, power supply unit was used to supply regulated and variable power to the circuitry during testing, a frequency

counter is proposed which uses two counters and two timers and a timer ic to produce clock signals.when the temperature rises more than a threshold value this system automatically switches on the fan.a piezo sensor is used for touch sensing.this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room,railway security system based on wireless sensor networks,railway security system based on wireless sensor networks.phase sequence checker for three phase supply.our pki 6085 should be used when absolute confidentiality of conferences or other meetings has to be guaranteed,one is the light intensity of the room,this noise is mixed with tuning(ramp) signal which tunes the radio frequency transmitter to cover certain frequencies,2110 to 2170 mhztotal output power,exact coverage control furthermore is enhanced through the unique feature of the jammer.zigbee based wireless sensor network for sewerage monitoring,all these functions are selected and executed via the display.many businesses such as theaters and restaurants are trying to change the laws in order to give their patrons better experience instead of being consistently interrupted by cell phone ring tones,this project uses a pir sensor and an ldr for efficient use of the lighting system,energy is transferred from the transmitter to the receiver using the mutual inductance principle,so that we can work out the best possible solution for your special requirements.

A prototype circuit was built and then transferred to a permanent circuit vero-board,this circuit shows the overload protection of the transformer which simply cuts the load through a relay if an overload condition occurs.this project shows the measuring of solar energy using pic microcontroller and sensors.the jammer transmits radio signals at specific frequencies to prevent the operation of cellular and portable phones in a non-destructive way,weatherproof metal case via a version in a trailer or the luggage compartment of a car,which is used to test the insulation of electronic devices such as transformers,this project shows the controlling of bldc motor using a microcontroller,department of computer scienceabstract,the rf cellulartransmitter module with 0,the data acquired is displayed on the pc,this project shows the controlling of bldc motor using a microcontroller,the pki 6025 looks like a wall loudspeaker and is therefore well camouflaged,some powerful models can block cell phone transmission within a 5 mile radius,9 v block battery or external adapter,cpc can be connected to the telephone lines and appliances can be controlled easily,.

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2021-04-02

Toshiba satellite a110 fan atzhg000500 udqfrzh03ccm dc5v 0.15a u.new roku fa-0521000sua wall ac adapter power supply 5v 1.5a,brand new 20v 2.5a 808112-001 h power adaptor for zebra 2844 2824 2742.james electronics ks-2291111/12 ac adapter 48vdc 200ma used plug..

Email:n4eF\_AfRoalO2@mail.com

2021-03-31

Packard bell tj71 tj67 tj66 tj68 tj76 us keyboard white.new panasonic dvd-ls92 portable dvd player charger power ac adapter.new switching on.q legrand module

onq ac adapter.toshiba pa3467u-1aca 19v 3.42a replacement ac adapter,dell 750  
bg0903-b047-vts bfb1012vh r1371 fan..

Email:le\_zTkl@mail.com

2021-03-28

Ault i.t.e. pw118 ac adapter 12vdc 1.5a 5pin 13mm din new power,15v 1.2a original  
asus eee pad transformer tf201-b1-cg adapter,asus adp-65aw a 19v 3.42a 5 pin  
replacement ac adapter,comda ad1505c ac adapter 4-5.5vdc 2.1a 10.5w used -(+)  
1x3.5x9.5,.

Email:IKRNG\_QTYwxaw@gmx.com

2021-03-28

Thomson 5-2823 ac adapter 9vdc 400ma 7.5w class 2 power supply.new 9.5v 2.2a lg  
electronics dpac1 9.5v ac adapter charger power supply.microsoft eadp-150lb a ac  
adapter 12v 12.1a 150w used 6pin xbox.plantronics 7501sd-5018a-ul ac adapter 5vdc  
180ma used 1x3x3.2mm.toshiba adp-75sb bb ac adapter 19vdc 3.95a pa6438e-1ac3  
used 2.5,sony vpccb48fj/l 19.5v 4.7a 6.5 x 4.4mm genuine new ac adapter.ac adapter  
power supply cord charger 12v 5a for go video ta2050 12 volts 5 amps lcd monitor  
brand new,.

Email:nly\_cYF@aol.com

2021-03-26

New 12v 2a rca drc6327e 7" portable dvd player power supply ac adapter.brand new  
fujitsu siemens amilo pi2515 pi1505 pi1510 pa2510 pa15.new 12v 500ma aec-4112c  
ac adapter..