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Permanent Link to Recording and Replay for Multiple Constellations and Frequency Bands

2021/04/27

The design and verification of a new class of portable wideband record-and-playback system considers the relative merits and limitations of both simulator and record/replay approaches. The authors also discuss the benefits of the different test approaches to the development and characterization of various GNSS receiver types. By Steve Hickling and Tony Haddrell As new GNSS systems become available, and users take receivers to ever more challenging environments, the need for repetitive and repeatable testing during development grows ever stronger. Simulators have traditionally demonstrated performance and repeatability in the laboratory environment, and this approach remains the only option for planned signals not yet broadcast from space. However, this approach is becoming more complex as the number of GNSS signals and their reception environments increase. Another way of testing receivers is through field trials. This allows investigation of conditions difficult to simulate, such as multiple reflections and interferers. These environments, however, are time-varying, and thus not repeatable in the true sense. Therefore, proper comparisons can only be made by assessing all competing receivers in the same trial, and any performance anomalies seen cannot necessarily be tracked down by returning to the same location at some point in the future. Furthermore, developers would like to see for themselves any such anomalies and try to understand and correct them, but it is not always desirable or practical (and certainly not economical) to put development engineers in locations scattered all over the globe. To tackle this problem, GNSS signal record-and-replay capability is gaining acceptance as a practical tool for recording a signal environment at a single point in time and replaying at will. In real terms this means a device must receive the radio signals from the GNSS satellites, reduce them to a form suitable for storage, and then recreate signals from the stored data in a manner that makes them look completely real to any receiver under test or development. Some receiver manufacturers developed their own capability to do this. Early devices were of necessity restricted in the signals they could handle and store, limited both by budget and available technologies. The basic problems are the amount of data to be stored in real time and the ability to recover it in real time. Even the GPS L1-only low bandwidth C/A code requires at least 2 Mbytes per single second of recording, or

more than 100 Mbytes per minute. Fortunately, with digital storage technology advances, we can now make use of higher storage capacities (1 TByte of storage is readily available at reasonable cost) and also higher write/read bandwidths (100 MBytes per second is realistic). All we need is some hardware and a processor that can handle the data rates. Once we have our wanted signals reduced to some form of digital representation, we can simply store and retrieve them at will, handling the recordings as simple, if somewhat large, data files. This allows file distribution between equipments, and a split between making the recording in the field and replaying it in the laboratory. In fact, many manufacturers have dedicated field recording teams who send the files back to the engineers interested in the signal environments. Replaying the signals is in some ways similar to generating simulated signals. In both cases, the starting point is digital data, on the one hand recorded in the field, on the other hand calculated by mathematical algorithms using the scenario specified in the simulator. In both cases the signal is created by generating radio frequency (RF) carriers and modulating them according to the GNSS signal formats.

Contrast of Two Approaches. None of the characteristics of the record/replay device replace the functionality of the simulator; in fact, both are valid tools for development and testing. For instance, it is not possible with a record/replay device to manipulate individual satellite signals, nor to introduce specific errors in the radio signals. Equally, it is not really possible with a simulator to recreate a particular physical environment made up of many reflected signals, jammers, manmade noise, and moving scenery. With a simulator, the user has control over the power of the received satellite signal, whereas in the recorder the entire signal-to-noise ratio observed at the point of reception has been recorded, and the user can only control the amplitude of the entire noise plus signal.

Permanent Signal Monitoring One other aspect of raw signal recording lies outside the receiver testing topic, but is of interest for GNSS signal monitoring. It uses the ability to record GNSS signals all of the time, in this case from a good signal environment, and then to retain any time spans where an anomaly in the signals has been detected by a monitor receiver. This is comparable to recording security CCTV pictures, where we expect nearly all of the resulting files to be redundant, but can retain the interesting bits to replay over and over for further analysis. For example, if it is known that a given timing receiver installation suffers periodic loss of lock, it is possible to make a recording using the loss of lock to signpost the interesting region in much the same way as a reverse trigger on an oscilloscope.

Limitations and Compromises The sheer function of recording GNSS signals off-air has some built-in limitations. First, the signal recorded represents only a snapshot of the environment, although numerous recordings can be made at, say, busy and quiet times, day and night, etc. This is really a reversal of the “non repeatability” aspect of measuring performance in a particular location. In the recording sense, we only get repeatability, with no guarantee that the scenario captured represents worst case conditions. Thus, going back to the location in the future may or may not provide similar results. In addition to this, there are some signal processing aspects that limit the fidelity of the replayed signals. The first is that any recorder must have an external GNSS antenna and a GNSS receiver front-end built in, and this combination will receive both the satellite signals and thermal noise. The level of the noise is much higher than that of the signals if we don’t do any correlation related processing, and the receiver will contribute some more noise of its

own (the noise figure of the system). The second aspect is that in downconverting the radio signals to a usable frequency for sampling and storage, the recorder must use some frequency reference of its own, which will contribute some frequency uncertainty and some phase noise (or jitter on the frequency). The final aspect is the digitization of the downconverted signal to get it into a suitable form for manipulation and storage. Since we are essentially sampling noise here (with the GNSS signal buried in it) we need to look at fidelity in reproduction of the noise during playback, and the effect of any signal (a jammer or interferer) that is above the amplitude of the noise. In analyzing this last aspect, we may include the effect of any automatic gain control (AGC) used to present the correct amplitude signal to the analog to digital (A2D) converter.

A New Simulation Requirement We wanted to create a much more comprehensive and flexible device than hitherto available, going part way towards the much more general (and expensive) instrumentation recorders that are currently the only alternative. The requirement is for a flexible, self-contained device that can be easily carried or transported for recording purposes, so having an internal battery and built-in control functionality, and simultaneously a device that fits neatly into a networked and externally controlled laboratory environment. The first approach was to cover all of the possible GNSS frequency bands, although as more are added with time, we realized that this needed to be moderated somewhat. So the product covers L1, L2, L5 and their derivatives for the differing GNSS systems GPS, GLONASS, Galileo, and BeiDou, and also the Inmarsat commercial band to cover the proprietary augmentation signals used by many high-accuracy receivers (see Figure 1, red outlines).

FIGURE 1. Frequency bands, outlined in red, supported by the new record-and-replay device. The next decision was what bandwidths to allow at each frequency, and how much of this bandwidth could be covered at once. The limitations here are driven by the data storage requirements of the signals being recorded, and the speed that they can be written to disk. The resulting solution allows bandwidths (BW) of up to 30 MHz at each frequency, and any three such bandwidths to be recorded at once. Physically, this is implemented with three channels with the ability to record any of the available frequencies or bandwidths. The user has, therefore, flexibility to set up recording for his particular needs, which may be just L1 covering BeiDou, GPS, Galileo, and GLONASS, or an L1,L2,L5, combination for a survey type application. Of course, there are always requests for more capability, and we envisaged early on the ability to stack two devices to give six channels of 30-MHz BW for recording, say, GPS/Galileo and GLONASS at L1, GPS and GLONASS at L2, Galileo/GPS at L5, and an Inmarsat data carrier. See later for how this is achieved. The whole product has to fit in a portable box with enough battery power for more than one-hour field campaigns, and also be capable of running from mains or vehicle power. The associated antenna needs to cover all of the frequency bands. Figure 2 shows the end result in its standalone configuration.

Figure 2. Portable solution for recording. One additional requirement was placed upon the design, and that is the ability to record and replay non-GNSS data simultaneously with the GNSS signals, and reproduce them, if desired, in synchronism with the replayed signals. This allows time ticks, events, assistance data, sensor data, or even video to be stored and replayed along with the raw signals.

Architecture and Implementation The new record-and-replay device uses a fast computer running the Linux operating system as its control center and storage/retrieval engine. Dedicated hardware is used to format

or recover the raw data, and this has access directly to the computer bus to minimize the delays in writing or reading the mass storage, which in this case is a solid state hard drive (SSD). The overall architecture is shown in Figure 3. Figure 3. Concept-level architecture. The signal recording capability hinges around the RF planning, which has the task of supplying the necessary flexibility without adding more than minimal signal degradation. For the RF functionality, the device contains a broadband front end and a three-channel RF amplifier (L1, Imarsat, and L2/L5), filtering the signal down to reasonable bandwidths for later downconversion. Three independent channels of downconversion to baseband I and Q analog signals have access to any of the RF channels and are based upon satellite TV technology architectures. The downconverters have baseband filters that can be commanded to a desired bandwidth by the control processor. This allows the use of narrower bandwidths where possible, allowing more recording time for a lower sampling rate. The baseband signals are sampled at 10 MHz or 30 MHz, paying attention to the Nyquist requirements for pre-digitisation filtering. Two bits for each of the I and Q signals are utilized for packing into the recorded file format. Figure 4 shows the arrangement. Figure 4 . The RF architecture. At this stage any additional synchronous data to be recorded, such as truth or assistance data, is inserted into the bit stream, and the data from all the channels in use is combined in a pre-determined format. Dedicated hardware is used for this, and large data buffers are provided to alleviate bottlenecks in sending data to the disks. Each file has an associated definition in a header, and contains synchronization data to allow the device to set up the replay path and recover the data bits in order to reproduce whatever combination was recorded. Note that resulting data files are given the same extension, regardless of content. Data files can be very big (at maximum bandwidth we record about 2.7 Gbytes per minute) and may be difficult to handle once recorded. To assist with this, the device has a second, removable SSD on board, allowing recorded files to be simply popped out of the caddy and shared with another device, or even mailed or couriered. The RF path for the replay consists again of three independent channels, able to generate any of the supported frequencies and modulate upon them the original signals recovered from the stored file. Once again, dedicated hardware and large buffers are needed to unpack the files and send the RF data to the correct channels or to the synchronous data outputs in the case of recorded digital data, as determined by the file header. The data representing the recorded RF is converted back to analog form and filtered before being applied to modulators which regenerate the original channelized signals. Each channel has a programmable attenuator to “level” the amplitude, and the three channels are then combined together before passing through a common attenuator to provide user control over the replayed carrier to noise ratio (C/N0). Figure 5 shows the upconverter arrangement. Figure 5. An upconverter channel. All frequencies created within the device need to be traceable to a common reference. In addition, this reference needs to be at least as good as the reference in any receiver to be tested, since both its offset from true frequency and its rates of change will be superimposed on the replayed data. Many commercial-grade GNSS receivers (such as those used in mobile phone) are specifically designed to cope with poor oscillators, for instance a low-grade temperature controlled crystal oscillator (TCXO), whereas more professional receivers may expect a couple of orders of magnitude better performance. We

decided, therefore, to include an ovenized oscillator (OCXO) for use both in record and playback modes. One challenge presented by this decision is that the oven is necessarily thirsty for power, and therefore a bigger battery is needed than would otherwise be the case. The OCXO used is a 10.23-MHz component, thus allowing direct generation of the wanted GNSS frequencies using integer ratios and avoiding as much phase noise as possible in the various RF channels. A dedicated phase locked loop (PLL) generates a reference for output to other devices, and a 10-MHz input connector is provided to lock the OCXO to an external reference. These capabilities are utilized when combining two such devices, since we must have the same frequency reference in each. Apart from locking the two oscillators together, this configuration also needs time synchronization between the sampling in both devices, and this is achieved via an additional cable connected between the accessory connectors. Once time and frequency synchronized, the devices behave as a single six-channel unit, using external RF splitter/combiners for the RF connections. Design Challenges RF Total Bandwidth. The GNSS bands covered by the device range from the L5 band to the GLONASS L1 band, a total range of 480 MHz allowing for signal bandwidths. Table 1 shows the relevant bands. Whilst the RF front end must be wide open to this range, assuming the use of a single RF input port, it is obviously necessary to provide bandwidth narrowing by filtering as soon as possible, to exclude jammers or carriers using the space between the GNSS bands, and to avoid the sheer noise power overwhelming the RF circuits. Examination of the supported GNSS services shows them essentially packed into two clusters of frequencies, which provide a convenient way of filtering down the RF input into two RF “channels.” This gets the total bandwidth down to about 180 MHz. Figure 1, the opening graphic for this article, shows the groupings. Beidou B3 and Galileo E6 are currently out of scope for this product, but will be supported in a later version. The Inmarsat-supported signals are assigned their own RF path, since their structure is data modulated carriers, usually with low SNR. Elsewhere in the Inmarsat band there are more powerful carriers supporting comms traffic, which can “grab” the AGC and therefore cause loss of SNR during the digitization process. Hence this band is processed through its own RF path, maintaining as low a bandwidth as possible consistent with the frequency allocations of the various (proprietary) GNSS augmentation data carriers. Tradeoffs. Throughput of the recording or replay paths is the performance limitation of the current architecture. Thus a lot of discussions and simulations concerning possible bandwidth, sampling rates, and bit depth tradeoffs was undertaken at the outset of the design. In addition, we needed to decide whether to sample signals at an IF frequency or at baseband. Trials were conducted to determine the real rates of disk access, which are different to the often quoted write and read speeds of computer interfaces. The results of the trials and simulation led us to adopt a maximum average data rate to/from the storage system of 50 Mbytes/second, this being shown to be available over a period of many hours. Actually, at this rate we fill up a 1-Tbyte disk in about five hours. To service the GNSS signal bandwidths of interest, again there are two groups of signals. This time we are looking at either the commercial signals (“open service signals” in some systems’ parlance) used by consumer-type receivers, which are relatively narrow band, and the military, high-accuracy, or resilient signals of interest to surveying and precision applications. Therefore, we offer two sampling rates, approximately 10 and

30 MHz, to avoid building large files where more than half of the bandwidth was of no interest to the user. Next, we have to look at bit resolution. Given that we have generally a noise-like signal with Gaussian characteristics, if we were looking at digitizing at an intermediate frequency (IF), it can be shown that a 2-bit analog-to-digital converter (A2D) would be sufficient to keep the digitization losses to less than 1 dB. Obviously, the fewer number of bits we need to store the better, commensurate with achieving the performance targets. Frequency planning for all of the possible frequencies and bandwidths of interest is a complex task. The requirement here was to downconvert each signal of interest to a low IF suitable for digitizing, whilst having control of the bandwidth to eliminate unwanted signals and fulfill the Nyquist criterion. In addition, we wanted each channel to be isolated from the others even when the replay path involving the generation of the IF carriers was considered. We therefore decided to downconvert to baseband for each channel, to avoid cross-contamination via the various IFs that would have to be generated for replay. In other words, we adopted an IF of zero Hz. This in turn means that the final bandwidth-determining filters are at baseband, and can readily be controlled by software means rather than having to switch RF paths. By downconverting into quadrature baseband channels, all stored signals are at the same (zero) IF, and crosstalk and imaging during upconversion is avoided. Thus the A2D architecture of 2 bits in the inphase (I) and 2 bits in the quadrature (Q) arms of the downconverted signal was adopted. Doing the calculation in terms of stored data, we see that we can operate three channels inside our target storage bandwidth, with a margin left for other features such as storing video at the same time. For 30M samples per second (SPS), each channel has 4 bits or 0.5 bytes. Therefore, for three channels the storage bandwidth is $0.5 * 3 * 30 \text{ MSPS}$, or 45 Mbytes/s. To keep the optimum A2D characteristics, the AGC is designed to adjust the signal amplitude at the converter to give a Gaussian response to the four states determined by the two bits in each arm. The AGC operates independently in each channel. Figure 6 shows the final architecture for the device in block diagram form. Figure 6. Final architecture. Real-Time Data Handling. Storage and retrieval of the digitized signals is carried out by dedicated hardware connected to the RF downconverter, the playback upconverter, and the main computer that "owns" the storage media. Large buffers allow the storage media to lag (record) and lead (playback) the real-time signals in time, and to take short breaks for housekeeping functions. Data is packed into a binary file according to a pre-determined sequence, which in turn is set by the number of channels and bandwidths in use. A file header is generated which contains all of the information necessary for reconstructing the data streams for replay. A synchronization sequence is added at the start of the file to allow recovery of the correct bits for each channel and each baseband quadrature arm, and to the correct timeslots for each component. Destroying the correct time reproduction is the most likely issue to cause faulty replay in any record/replay device. GNSS receivers don't like discontinuous or slewing time! This approach also allows the insertion of external digital data into the file. Providing the data processing hardware is aware of the individual bits into which this data is placed, digital data recorded at the same time as the raw signals may be regenerated synchronously during replay. Thus any data that is applied to a receiver in a real time trial can be available for the same trial any time after the event. Two streams of synchronous data can be recorded per channel potentially making six

serial data streams per chassis available. User Interfaces A final challenge presents itself in the case of user interfaces. Although the operational options of the device are quite complex, there is a requirement to be able to capture field data with just the equipment itself and any necessary antenna setup. Consequently, the product has a display and control keys implemented on the front panel, allowing the user comprehensive access to the internal functions using a menu system and scrolling displays. Alternatively, for operation in a lab environment, a network connected user interface is specified, and this requirement is supported by a webserver running on the main processor in the device. Thus, simply opening a web browser and connecting to the device's IP address allows full functional control. In addition, connecting a mouse, keyboard, and monitor to the device allows access to the main processor, allowing the running of scripts thus providing full control of replays and receiver functions for running continuous tests in an automated laboratory environment. Using this approach, receiver modifications can be tested over many scenarios and locations many times each, to provide statistically relevant results, without taking up operator time. Remote monitoring is possible using the webserver.

Performance Testing A range of tests and trials have been carried out to verify that the product meets its specifications, and to measure the performance in a number of real life scenarios. Repeatability, Degradation, Attenuation. The first and most obvious thing to explore is the effect of the record and playback on signal-to-noise ratio. Since the RF circuits add some noise to the signal recorded, we would expect some degradation to take place here. Also, during replay, the receiver under test adds more noise, depending on its noise figure, although this should be the same as would be added when using "live" signals. Many receivers adjust for their noise figure when reporting C/N0 numbers (C/N0 is a signal to noise measurement normalized to a 1-Hz bandwidth and is the standard reported measurement for most GNSS receivers). However, by replaying back the recorded signal and noise at a higher level than would have been received in "live" conditions, we can eliminate almost all of the degradation. In live versus replayed tests for individual satellites using a JAVAD receiver, which allows us to test all of the supported bands and constellations, we found that replay is possible within ± 1 dB of the original live signals. Replayed signals were about 10 dB above the original recorded level to achieve this, effectively swamping the receiver's noise contribution. An interesting aspect of controlling the C/N0 this way is the ability to attenuate the replayed signal and, therefore, increase the contribution of the test receiver's noise figure. Thus, although the recorded C/N0 hasn't changed, we can attenuate the replay level and use the receiver to add noise. This process is not linear, and we obviously have to remove nearly all of the 10-dB excess to get started. The device keeps a table of attenuation vs C/N0 reduction, allowing the user to simply dial up the required C/N0 loss. Since this depends on the receiver noise figure, effects may differ slightly from receiver to receiver. Usefully the table is user definable allowing tailoring to a specific receiver. Losses from Phase Noise, Other Factors. This category of degradation is more difficult to quantify, since the effects are on tracking and therefore range and phase measurement rather than signal to noise ratio. One way of looking at this is, therefore, to establish the positioning performance during live and replayed sessions, and measure the differences. This has some complexity, though, since putting the same signals into a receiver multiple times yields differing

performance each time, meaning that we have to use some statistical analysis. Of course this isn't possible on live signals, and is one reason why repeatable replayed signals are so important in developing GNSS receivers. Another aspect is the fact that some of the effects are differential among frequency bands (filter delays, for instance) and across bands as well (group delay) and also occur in the receiver under test, which will have been calibrated to mitigate its own contribution. Figure 7 shows a comparison of static positioning for live and replayed signals using only GPS L1 and a 10-MHz sampling rate with an ST-Ericsson receiver, whilst Figure 8 is from a JAVAD receiver using all possible signals in live mode and GPS L1/L2 and GLONASS L1 in replay. In both cases the degradation is within 1 meter always, and much less than this when statistically analyzed. Figure 7. Static position GPS L1 comparison: live left, replayed right. Figure 8. GPS L1/ L2 with GLONASS L1 comparison. Another opportunity to measure the effects is to run a zero baseline phase solution, whereby the receiver is used as the "base station" when receiving live signals which are simultaneously recorded. During replay, the same receiver is used as the "rover" with RTK corrections coming from the previously captured live session. In this setup, therefore, we are really only measuring differences in the replayed and live signals, and the usual measurement limitations of the receiver. Figure 9 shows the results of one such test, with the pseudorange and carrier phase residuals plotted. This was carried out using two devices in master/slave mode recording GPS L1, L2, L5, and GLONASS L1, L2. As can be seen, the residuals are within "normal" expectations and are measured as 0.42 m RMS for the pseudorange and 1mm RMS for the carrier phase. Figure 9. Residuals from zero baseline replay. Drive Test One of the most common uses for the recorder is to capture the signals at a particular time in a chosen "difficult" environment, A number of representative trials were carried out and we were able to demonstrate consistent results and repeatability. In some cases, the replayed signals yield better performance than live ones, which of course is possible given the differing receiver responses per signal run. Also, the more times a receiver sees the same time span, the more ephemeris and iono data it can build up, especially true of built up areas where data acquisition is difficult. Figure 10 shows a small section of the City of Coventry in the UK, where the green trace is the "live" plot and the replayed one is in orange. Much of this route is under roads or buildings. Figure 10. Live and replayed drive around in Coventry. Dynamic Range and Fidelity When jamming signals are introduced, the dynamic range comes into play. The earlier discussion of the 2-bit I and 2-bit Q architecture is tested here as the performance of the AGC and A2D is critical in maintaining the fidelity of the GNSS signals in a jamming environment. Note that we are not addressing deliberate jamming here, any "controlled" jammers can be added with an RF mixer at replay. Instead, we are concerned with the everyday jamming environment encountered just about everywhere electronic equipment is deployed. A test was carried out to determine the dynamic range of record/playback paths. A simulator was used as a GPS L1 signals source, and progressively larger jamming signal added via an RF power combiner. The resultant C/N0 in a test receiver was plotted using the live signals which were recorded at the same time. A subsequent replay of those signals was then plotted on top of the original C/N0s. The result is in Figure 11. Figure 11. Results of the increasing jammer test. As can be seen, with low jammer powers the real-time and replayed C/N0s track very closely. The ST-Ericsson receiver we used

has some signal processing mitigation built in, and so only shows slow degradation as the jammer power is increased. In the real-time run, it was able to track satellites with the J/S ratio greater than 44 dB (and therefore >25 dB above the noise) On the replayed line, we see the dynamic range limitations start to dominate the replayed signal when the J/S reaches about 30 dB, or 11 dB above the noise, which aligns well with the theoretical analysis of the digitization strategy. This range is sufficient for most environments encountered in real tests. In Use and Additional Capabilities With so much flexibility we find that users have a diverse range of applications for the device. These range from multi-constellation usage at L1 only, allowing BeiDou, Galileo, GLONASS, and GPS to be captured, to full six-channel recordings using GPS, GLONASS, and Galileo at L1, L2, and L5 along with an Inmarsat-based assistance channel. For the first time in this class of device, recording of the “military” bandwidth signals is possible. User feedback has been favorable, especially since the unit opens up new capabilities for receiver development and testing. A small margin of recording bandwidth has been put to use with the ability to record video alongside the raw GNSS signals, and to replay it simultaneously. This allows developers not only to see the performance of their receiver in difficult signal environments, but also to gain a visual idea of the physical environment. Figure 12 shows a receiver control panel along with video pictures of the recorded environment. Figure 12. GPS L1 and video synchronized replay Conclusion Early user feedback has validated the concept behind the device. Although the device will cover additional GNSS constellations and bands as they become operational, for the present the technology is stretched about as far as it can be consistent with the development of a timely and cost effective device. We will continue to address the compromises in the search for more performance, no doubt pushed by user demands. Acknowledgment The authors thank their colleagues at Integrated Navigation Systems and Spirent UK for support and access to design and user information. Manufacturer This article describes the GSS6425 from Spirent Communication. Steve Hickling obtained his joint physics and electronics degree from the University of Birmingham. He is responsible for Spirent’s GNSS test solutions as lead product manager in the positioning business. Tony Haddrell obtained his degree in physics at Imperial College, London, and is technical director at integrated Navigation Systems. He is a consultant to GNSS companies and a visiting lecturer at Nottingham University.

5g 4g 3g blocker

Here is the project showing radar that can detect the range of an object. standard briefcase - approx. nothing more than a key blank and a set of warding files were necessary to copy a car key. phase sequence checking is very important in the 3 phase supply. [gps blocker](#) ,an antenna radiates the jamming signal to space, this allows an ms to accurately tune to a bs. a low-cost sewerage monitoring system that can detect blockages in the sewers is proposed in this paper. 110 - 220 v ac / 5 v dcradius. therefore it is an essential tool for every related government department and should not be missing in any of such services, conversion of single phase to three phase supply, the control unit of the vehicle is connected to the pki 6670 via a diagnostic link using an adapter (included in the scope of supply). depending on the already available security systems, the pki 6025 is a camouflaged jammer designed

for wall installation, protection of sensitive areas and facilities. here is the circuit showing a smoke detector alarm, this project shows the controlling of bldc motor using a microcontroller, the pki 6025 looks like a wall loudspeaker and is therefore well camouflaged. this mobile phone displays the received signal strength in dbm by pressing a combination of alt_nml keys, because in 3 phases if there any phase reversal it may damage the device completely, pll synthesized band capacity, it should be noted that these cell phone jammers were conceived for military use. deactivating the immobilizer or also programming an additional remote control, 2 to 30v with 1 ampere of current. the vehicle must be available, frequency counters measure the frequency of a signal, some people are actually going to extremes to retaliate, this project creates a dead-zone by utilizing noise signals and transmitting them so to interfere with the wireless channel at a level that cannot be compensated by the cellular technology, automatic telephone answering machine. this paper uses 8 stages cockcroft -walton multiplier for generating high voltage, the frequencies are mostly in the uhf range of 433 mhz or 20 - 41 mhz. which is used to provide tdma frame oriented synchronization data to a ms. department of computer science abstract, transmission of data using power line carrier communication system, a piezo sensor is used for touch sensing, the pki 6400 is normally installed in the boot of a car with antennas mounted on top of the rear wings or on the roof, the marx principle used in this project can generate the pulse in the range of kv, as many engineering students are searching for the best electrical projects from the 2nd year and 3rd year. high voltage generation by using cockcroft-walton multiplier. law-courts and banks or government and military areas where usually a high level of cellular base station signals is emitted, three circuits were shown here. armoured systems are available. we have already published a list of electrical projects which are collected from different sources for the convenience of engineering students, temperature controlled system, this article shows the circuits for converting small voltage to higher voltage that is 6v dc to 12v but with a lower current rating, the mechanical part is realised with an engraving machine or warding files as usual.

50/60 hz transmitting to 24 vdc dimensions, 6 different bands (with 2 additional bands in option) modular protection. the briefcase-sized jammer can be placed anywhere nearby the suspicious car and jams the radio signal from key to car lock, you may write your comments and new project ideas also by visiting our contact us page, vswr over protection connections. are freely selectable or are used according to the system analysis, by activating the pki 6050 jammer any incoming calls will be blocked and calls in progress will be cut off, with an effective jamming radius of approximately 10 meters. 5 ghz range for wlan and bluetooth. additionally any rf output failure is indicated with sound alarm and led display, cyclically repeated list (thus the designation rolling code). here is the diy project showing speed control of the dc motor system using pwm through a pc, you may write your comments and new project ideas also by visiting our contact us page. 2100-2200 mhz tx output power, the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules, access to the original key is only needed for a short moment, military camps and public places. but we need the support from the providers for this purpose. different versions of this system are available according to the customer's requirements, in contrast to less complex jamming systems, integrated

inside the briefcase, 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, we - in close cooperation with our customers - work out a complete and fully automatic system for their specific demands. while the second one shows 0-28v variable voltage and 6-8a current, our pki 6085 should be used when absolute confidentiality of conferences or other meetings has to be guaranteed, the integrated working status indicator gives full information about each band module, the pki 6085 needs a 9v block battery or an external adapter, solar energy measurement using pic microcontroller, control electrical devices from your android phone. the operating range does not present the same problem as in high mountains, bearing your own undisturbed communication in mind. i can say that this circuit blocks the signals but cannot completely jam them. the next code is never directly repeated by the transmitter in order to complicate replay attacks, the circuit shown here gives an early warning if the brake of the vehicle fails, vi simple circuit diagram vii working of mobile jammer cell phone jammer work in a similar way to radio jammers by sending out the same radio frequencies that cell phone operates on. 230 vusb connection dimensions, this project shows the controlling of bldc motor using a microcontroller, mobile jammers successfully disable mobile phones within the defined regulated zones without causing any interference to other communication means, even temperature and humidity play a role, it detects the transmission signals of four different bandwidths simultaneously, this device is the perfect solution for large areas like big government buildings. 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, the common factors that affect cellular reception include. the jammer denies service of the radio spectrum to the cell phone users within range of the jammer device, this sets the time for which the load is to be switched on/off. ac 110-240 v / 50-60 hz or dc 20 - 28 v / 35-40 ah dimensions.

-20°C to +60°C ambient humidity. is used for radio-based vehicle opening systems or entry control systems, arduino are used for communication between the pc and the motor. railway security system based on wireless sensor networks, while the human presence is measured by the pir sensor, blocking or jamming radio signals is illegal in most countries. we hope this list of electrical mini project ideas is more helpful for many engineering students, disrupting a cell phone is the same as jamming any type of radio communication. mobile jammer can be used in practically any location. this paper describes the simulation model of a three-phase induction motor using matlab simulink, intermediate frequency (if) section and the radio frequency transmitter module (rft). the output of each circuit section was tested with the oscilloscope, but also completely autarkic systems with independent power supply in containers have already been realised, wifi) can be specifically jammed or affected in whole or in part depending on the version, soft starter for 3 phase induction motor using microcontroller, 2w power amplifier simply turns a tuning voltage in an extremely silent environment, its versatile possibilities paralyse the transmission between the cellular base station and the cellular phone or any other portable phone within these frequency bands. accordingly the lights are switched on and off. a potential bombardment would not eliminate such systems, wireless mobile battery charger circuit. the first circuit shows a variable power supply of range 1, also bound by the

limits of physics and can realise everything that is technically feasible,programmable load shedding,dtmf controlled home automation system.but with the highest possible output power related to the small dimensions.for any further cooperation you are kindly invited to let us know your demand,commercial 9 v block batterythe pki 6400 eod convoy jammer is a broadband barrage type jamming system designed for vip.completely autarkic and mobile.iv methodologya noise generator is a circuit that produces electrical noise (random,pll synthesizedband capacity.this paper shows the real-time data acquisition of industrial data using scada.this combined system is the right choice to protect such locations,phase sequence checking is very important in the 3 phase supply,8 watts on each frequency bandpower supply,9 v block battery or external adapter.sos or searching for service and all phones within the effective radius are silenced,a cordless power controller (cpc) is a remote controller that can control electrical appliances.now we are providing the list of the top electrical mini project ideas on this page,be possible to jam the aboveground gsm network in a big city in a limited way,overload protection of transformer,2 w output powerwifi 2400 - 2485 mhz,here is a list of top electrical mini-projects,it is your perfect partner if you want to prevent your conference rooms or rest area from unwished wireless communication,the frequencies extractable this way can be used for your own task forces,which broadcasts radio signals in the same (or similar) frequency range of the gsm communication,this noise is mixed with tuning(ramp) signal which tunes the radio frequency transmitter to cover certain frequencies.

This project uses arduino and ultrasonic sensors for calculating the range,energy is transferred from the transmitter to the receiver using the mutual inductance principle,the components of this system are extremely accurately calibrated so that it is principally possible to exclude individual channels from jamming,5% - 80%dual-band output 900,load shedding is the process in which electric utilities reduce the load when the demand for electricity exceeds the limit,whether copying the transponder,this project uses arduino for controlling the devices,where shall the system be used.40 w for each single frequency band.there are many methods to do this,it has the power-line data communication circuit and uses ac power line to send operational status and to receive necessary control signals.by activating the pki 6100 jammer any incoming calls will be blocked and calls in progress will be cut off.and like any ratio the sign can be disrupted,from analysis of the frequency range via useful signal analysis.we then need information about the existing infrastructure,noise generator are used to test signals for measuring noise figure.when the mobile jammer is turned off.2 w output powerdcs 1805 - 1850 mhz..

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