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Permanent Link to Innovation: Improving Dilution of Precision
2021/03/30
A Companion Measure of Systematic Effects By Dennis Milbert GPS receivers must deal with measurements and models that have some degree of error, which gets propagated into the position solution. If the errors are systematically different for the different simultaneous pseudoranges, as is typically the case when trying to correct for ionospheric and tropospheric effects, these errors propagate into the receiver solution in a way that is fundamentally different from the way that random errors propagate. So in addition to dilution of precision, we need a companion measure of systematic effects. In this month's column, we introduce just such a measure. INNOVATION INSIGHTS by Richard Langley WE LIVE IN AN IMPERFECT WORLD. We know this all too well from life's everyday trials and tribulations. But this statement extends to the world of GPS and other global navigation satellite systems, too. A GPS receiver computes its three-dimensional position coordinates and its clock offset from four or more simultaneous pseudoranges. These are measurements of the biased range (hence the term pseudorange) between the receiver's antenna and the antenna of each of the satellites being tracked. The receiver processes these measurements together with a model describing the satellite orbits and clocks and other effects, such as those of the atmosphere, to determine its position. The precision and accuracy of the measured pseudoranges and the fidelity of the model determine, in part, the overall precision and accuracy of the receiver-derived coordinates. If we lived in an ideal world, a receiver could make perfect measurements and model them exactly. Then, we would only need measurements to any four satellites to determine our position perfectly. Unfortunately, the receiver must deal with measurements and models that have some degree of error, which gets propagated into the position solution. Furthermore, the geometrical arrangement of the satellites observed by the receiver — their elevation angles and azimuths — can significantly affect the precision and accuracy of the receiver's solution, typically degrading them. It is common to express the degradation or dilution by dilution of precision (DOP) factors. Multiplying the measurement and model uncertainty by an appropriate DOP value gives an estimate of the position error. These estimates are reasonable if the measurement and model errors are truly random. However, it turns

out that this simple geometrical relationship breaks down if some model errors are systematic. If that systematic error is a constant bias and if it is common to all pseudoranges measured simultaneously, then the receiver can easily estimate it along with its clock offset, leaving the position solution unaffected. But if the errors are systematically different for the different simultaneous pseudoranges, as is typically the case when trying to correct for ionospheric and tropospheric effects, these errors propagate into the receiver solution in a way that is fundamentally different from the way that random errors propagate. This means that in addition to DOP, we need a companion measure of systematic effects. In this month's column, Dennis Milbert introduces just such a measure — the error scale factor or ESF. ESF, combined with DOP, forms a hybrid error model that appears to more realistically portray the real-world GPS precisions and accuracies we actually experience. "Innovation" features discussions about advances in GPS technology, its applications, and the fundamentals of GPS positioning. The column is coordinated by Richard Langley, Department of Geodesy and Geomatics Engineering, University of New Brunswick. The recent edition of the Standard Positioning Service (SPS) Performance Standard (PS) and the corresponding document for the Precise Positioning Service (PPS) both emphasize a key element. They only specify the GPS signal-in-space (SIS) performance. Since these standards do not define performance for any application of a GPS signal, it becomes even more important to understand the relationship of signal statistics to positioning accuracy. Historically, as well as in Appendix B of the SPS-PS and PPS-PS, this relationship is modeled by covariance elements called dilution of precision (DOP). Many references are available which describe DOP. The core of DOP is the equation of random error propagation: Qx = (At Q-1A) -1 where, for n observations, A is the n x 4 matrix of observation equation partial differentials, Q is the n x n covariance matrix of observations, and Qx is the 4 x 4 covariance matrix of position and time parameters (X, Y, Z, T) used to compute DOPs. This equation describes the propagation of random error (noise) in measurements into the noise of the unknown (solved for) parameters. Elements of the Qx matrix are then used to form the DOP. The equation above is linear for any measurement scale factor of Q. For example, halving the dispersion of the measurements will halve the dispersion of the positional error. This scaling behavior is exploited when forming DOP where, by convention, Q is taken as the identity matrix, I. DOPs then become unitless, and are treated as multipliers that convert range error into various forms of positional error. Thus, we see relationships in the SPS-PS Appendix B such as: UHNE = UERE x HDOP where UERE is user equivalent range error, HDOP is horizontal dilution of precision, and UHNE is the resulting user horizontal navigation error. DOP is a model relationship between signal statistics and position statistics based on random error propagation. But, since the cessation of Selective Availability (SA), the GPS signal in space now displays less random dispersion than the average systematic effects of ionosphere and troposphere propagation delay error. It's useful to test if a random error model can capture the current behavior of GPS positioning on the ground. The Federal Aviation Administration collects GPS data at the Wide Area Augmentation System (WAAS) reference stations and analyzes GPS SPS performance. These analyses are documented in a quarterly series called the Performance Analysis (PAN) Reports. To test horizontal and vertical accuracy, the 95th percentile of positional error, taken comprehensively over space and time, without any subsetting whatsoever, is chosen. This measure is always found in Figures 5-1 and 5-2 of the PAN reports. Note that the Appendix A 95% “predictable accuracy” in the reports through PAN report number 51 refers to a worst-site condition and cannot be considered comprehensive. The PAN report 95th percentiles of positional error measured since the cessation of SA are reproduced in FIGURE 1. Figure 1. Accuracy (95th percentile) of horizontal and vertical L1-only point positioning. GPS data are gathered at WAAS reference stations, analyzed quarterly, and published in the PAN reports. The red line is vertical accuracy and the blue line is horizontal accuracy. By the DOP error model, the positional error should be the product of the underlying pseudorange error times HDOP or vertical DOP (VDOP). It is convenient to form the vertical to horizontal positional error ratio, V/H, shown in FIGURE 2. This error ratio should, formally, be independent of the magnitude of the range error. The error ratio should reflect the GPS constellation geometry. One expects the positional error ratio, V/H, to be relatively uniform, and it should also equal the VDOP/HDOP ratio. However, Figure 2 shows a number of spikes (from PAN Reports 37, 40, 44, 64) in the error ratio, and a general increase over the past nine years. The positional error ratios in Figure 2 do not portray the uniform behavior expected for a DOP error model based on random error propagation. Figure 2. Ratio of the vertical/horizontal accuracy (95th percentile). The spikes indicate effects that are not caused by constellation geometry or signal-in-space error. The PAN reports form a challenge to our ability to understand and describe the measured performance of the GPS system. In the past, when SA was imposed on the GPS signal, the measured pseudorange displayed random, albeit time-correlated, statistics. DOP was effective then in relating SA-laden range error to positional error. Now, with SA set to zero, the role of DOP should be revisited. In this article, I will introduce a hybrid error model that takes into account not only the effects of random error but also that of systematic error due to incomplete or inaccurate modeling of observations. But first, let’s examine predicted GPS performance based on DOP calculations alone. Random Error Propagation FIGURE 3 displays detail of a 24-hour HDOP time series. Considerable short wavelength structure is evident. Spikes as thin as 55 seconds duration can be found at higher resolutions. Given the abrupt, second-to-second transitions in DOP, and given that the GPS satellites orbit relative to the Earth at about 4 kilometers per second, one may suspect that short spatial scales as well as short time scales are needed to describe DOP behavior. Figure 3. All-in-view HDOP, July 20, 2007, near the Washington Monument, 5° elevation angle cutoff. Note the abrupt transitions, and that HDOP is around 1.0. VDOP (not pictured) is about 1.5. To investigate DOP transitions, the conterminous United States (CONUS) was selected as a study area. HDOP and VDOP, with a 5° elevation-angle cutoff, were computed using an almanac on a regular 3 minute by 3 minute grid over the region 24°-53° N, 230°-294° E. These DOP grids were computed at 2,880 30-second epochs for July 20, 2007, yielding more than two trillion DOP evaluations. This fine time/space granularity was selected to capture most of the complex DOP structure seen in Figure 3. FIGURE 4 plots the HDOP distribution over CONUS and parts of Canada and Mexico at 02:40:30 GPS Time. This epoch was selected to show an HDOP excursion (HDOP 4 2.58) seen in the red zone just north of Lake Ontario. DOPs are rather uniform within zones, and these zones have curved boundaries. The boundaries are sharply delineated and move geographically in time, which explains the jumps seen in high-rate DOP time series (as in Figure 3). The broad, curved boundaries seen in Figure 4 are the edges of the footprints of the various GPS satellites. The gradual variation in hue within a zone shows the gradual variation of DOP as the spatial mappings of the local elevation angles change for a given set of GPS satellites in a region. Figure 4. HDOP, July 20, 2007, 02:40:30 GPS Time, 5° cutoff. The curved boundaries, which show abrupt transitions in DOP, are the edges of the footprints of various GPS satellites. The 2,880 color images of HDOP (and VDOP) were converted into an animation that runs 4 minutes and 48 seconds at 10 frames per second. The effect is kaleidoscopic, as the various footprints cycle across one another, and as the zones change color. The footprint boundaries transit across the map in various directions and create a changing set of triangular and quadrilateral zones of fairly uniform DOP. There is no lower limit to temporal or spatial scale of a given DOP zone delimited by three transiting boundaries. The size of a zone can increase or shrink in time. Zones can take a local maximum, a local minimum, or just some intermediate DOP value. And the DOP magnitude in a given zone often changes in time. The animation shows that the DOP maximums are quite infrequent, and the DOPs generally cluster around the low end of the color scale. The animations are available. To get a quantitative measure of distribution, the HDOPs (and VDOPs) are histogrammed with a bin width of 0.01 in FIGURE 5. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 1. HDOP ranges from 0.600 to 2.685 and VDOP ranges from 0.806 to 3.810. Figure 5. HDOP, July 20, 2007, 5° cutoff. DOP has a strong central tendency and a tail showing rare instances of large DOP. Here HDOP ranges from 0.600 to 2.685. Chart: GPS World Since the DOP zone boundaries are related to satellites rising and setting, it is natural to expect a relation to a selected cutoff limit of the elevation angle. As a test, DOP was recomputed with a 15° cutoff limit, and histogrammed with a bin width of 0.01 in FIGURE 6. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 2. HDOP ranges from 0.735 to 26.335, and VDOP ranges from 1.045 to 72.648. Figure 6. HDOP, July 20, 2007, 15° cutoff. DOP is sensitive to cutoff angle. Here HDOP ranges from 0.735 to 26.335. This is a large increase over the HDOP with a 5° cutoff. The Figures 5 and 6 and Tables 1 and 2 show that DOPs are markedly sensitive to cutoff angles. The histogram tails increase and the maximum DOPs dramatically increase as the cutoff angle is increased. The 95th percentile HDOP increases by about 50 percent when the cutoff angle increases from 5° to 15°. The solutions weaken to some degree and the poorer solutions get much worse. The effect is somewhat greater for VDOP. One normally considers DOP as a property of the satellite constellation that has a space-time mapping. DOP is seen to strongly depend upon horizon visibility. This is a completely local property that is highly variable throughout the region. Clearly, DOP depends on the antenna site as well as the constellation. Systematic Error Propagation It is known that certain error sources in GPS are systematic. Such errors will display different behaviors from random error. For example, the impact of ionosphere and troposphere error on GPS performance has been recognized in the literature (see "Further Reading"). DOP is not successful in modeling systematic effects. A new metric for systematic positional error is needed. Consider a systematic bias, b, in measured pseudorange, R. One may propagate the bias through the weighted least-squares adjustment: (AtQ-1A) x = AtQ-1y by setting the n x 1 vector, y = b. Vector x will then contain the differential change (error) in coordinates (δx, δy,

δz, δt) induced by the bias. The coordinate rror can then be transformed into the north, east, and up local horizon system (δN, δE, δU). Positional systematic error is defined as horizontal error, $(\delta N2 + \delta E2)^{1/2}$, and vertical error, $|\delta U|$. As with DOP, the equations above are linear for any measurement bias scale factor, k, which applies to all satellite pseudoranges at an epoch. For example, if one halves a bias that applies to all pseudoranges (for example, ky), then one will halve the associated coordinate error, kx. Analogous to DOP, we take bias with a base error b = 1, to create a unitless measure that can be treated as a multiplier. We now designate the horizontal error as horizontal error scale factor (HESF) and vertical error as vertical error scale factor (VESF). This adds a capability of developing error budgets for systematic effects that parallels DOP. Systematic errors in GPS position solutions have a distinctly different behavior than random errors. This is illustrated by a trivial example. If one repeats any of the tests above with a constant value, c, for the bias, one will find that, aside from computer round-off error, no systematic error propagates into the position. The coordinates are recovered perfectly, and the constant bias is absorbed into the receiver time bias parameter, δ t. This is no surprise, since the GPS point position model is constructed to solve for a constant receiver clock bias. The ionosphere and troposphere, on the other hand, cause unequal systematic errors in pseudoranges. These systematic errors are greater for lower elevation angle satellites than for higher elevation angle satellites. So, unlike the trivial example above, these errors cannot be perfectly absorbed into δ t. The systematic errors never vanish, even for satellites at zenith. One may expect some nonzero positional error that does not behave randomly. The systematic effect of the ionosphere and troposphere differ through their mapping functions. These are functions of elevation angle, E, and are scale factors to the systematic effect at zenith (E = 90°). Because of the different altitudes of the atmospheric layers, the mapping functions take different forms. For this reason, systematic error scale factors (ESFs) for the ionosphere and troposphere must be considered separately. Ionosphere Error Scale Factor. Following Figure 20-4 of the Navstar GPS Space Segment/Navigation User Interfaces document, IS-GPS-200D, the ionospheric mapping function associated with the broadcast navigation message, F, is $F = 1.0 + 16.0\,(0.53 - E)3$ where E is in semicircles and where semicircles are angular units of 180 degrees and of π radians. Since the base error is considered to be b = 1 for ESFs, y is simply populated with the various values of F appropriate to the elevation angles, E, of the various satellites visible at a given epoch. The resulting HESF and VESF values will portray how systematic ionosphere error will be magnified into positional error, just as DOPs portray how random pseudorange error is magnified into positional error. As was done with the DOPs, more than two trillion ionosphere HESFs (and VESFs) were computed for CONUS and histogrammed in FIGURE 7. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 3. Ionosphere HESF ranges from 0.0 to 0.440 and VESF ranges from 1.507 to 2.765. Figure 7. HESF, ionosphere, July 20, 2007, 5° cutoff. The HESF-I are much smaller than the HDOP. The VESF-I (not depicted) have an average larger magnitude than the VDOP. The distribution of the HESF-I in Figure 7 differs profoundly from HDOP. Ionosphere error is seen to have a weak mapping into horizontal positional error, with HESF-I values approaching zero, and having a long tail. The VESF-I is roughly comparable to the magnitude of the ionosphere mapping function at a low elevation angle. The VESFs also fall into a fixed range, without long tails, and are skewed to the right. The percentiles in Table 3 show ionosphere error has a greater influence on the height than that predicted by DOP. Systematic Range Error and Height. Both troposphere and ionosphere propagation error leads to error in height. The mechanism underlying the behavior in Table 3 is not obvious. Consider the simplified positioning problem in FIGURE 8, where we solve for two unknowns: the up-component of position and receiver bias, dt (which includes effects common to all pseudoranges measured at the same time, such as the receiver clock offset). The atmosphere will cause the pseudoranges AO, BO, and CO to measure systematically longer. However, the ionosphere error will be about three times larger at low elevation angles than at the zenith. (Troposphere error will be about 10 times larger at low elevation angles than at the zenith.) Figure 8. Schematic of pseudorange positioning. Computing up and receiver clock bias through 3 pseudoranges (AO, BO, CO), BO is biased by +5 meters ionosphere; AO and CO are biased by +15 meters ionosphere. Clock bias will absorb the +15 meters from the conflicting horizontal pseudoranges, and overcorrect the BO pseudorange by 10 meters. In this simplified example, assume the zenith pseudorange, BO, measures 5 meters too long because of unmodeled ionosphere delay. Then the near-horizon pseudoranges, AO and CO, will measure 15 meters too long. AO and CO can’t both be 15 meters too long at the same time, so that bias is absorbed by the receiver bias term, dt. That dt term is also a component of the up solution from BO. While the AO and CO pseudoranges have superb geometry in establishing receiver clock bias, they also have terrible geometry in establishing height. The height is solved from the BO pseudorange that is overcorrected by 10 meters. Point O rises by 10 meters. The presence of the receiver bias term causes atmospheric systematic error to be transferred to the height. It also shows that the horizontal error will largely be canceled in mid-latitude and equatorial scenarios. Troposphere Error Scale Factor. A variety of troposphere models and mapping functions are available in the literature. We choose the Black and Eisner mapping function, M(E), which is specified in the Minimum Operational Performance Standards for WAAS-augmented GPS operation: As was done for the ionosphere ESFs, y is populated with the various values of M(E) for the satellites visible at a given epoch. The troposphere HESFs (and VESFs) are computed for CONUS and histogrammed in FIGURE 9. Tabulations of various percentiles, computed from the bin counts, are displayed in TABLE 4. Troposphere HESF ranges from 0.0 to 5.203, and VESF ranges from 1.882 to 13.689. Figure 9. HESF, troposphere, July 20, 2007, 5° cutoff. The HESF-Ts are significantly larger than the HESF-Is, showing that unmodeled troposphere propagation error can more readily influence horizontal position. The VESF-Ts are substantially larger than the VDOPs and VESF-Is. The troposphere HESFs in Table 4 have similarities with, and differences from, the ionosphere HESFs of Table 3. Troposphere error maps more strongly into the horizontal coordinates than ionosphere error. The VESFs are much larger than the HESFs. And the VESFs still fall into a fixed range, without long tails. Unlike DOP, which is derived from random error propagation, ESF is constructed for systematic error propagation. A good “vest pocket” number for the tropospheric delay of pseudorange at zenith is 2.4 meters at mean sea level. Thus, without a troposphere model, one can expect horizontal error of 1.80 x 2.4 meters = 4.32 meters or less 95 percent of the time according to Table 4. Cutoff Angle. We now briefly consider the behavior of ESF under an increased elevation angle cutoff. The ionosphere ESFs with a 10° cutoff show minor improvements. This is a distinct difference from DOP (see Table 2), which showed degraded precision with a larger cutoff angle. The troposphere ESFs with a 10° cutoff angle are computed from histogram bin counts (TABLE 5). 10° cutoff troposphere HESF ranges from 0.0 to 3.228 and VESF ranges from 1.161 to 9.192. Comparing Table 5 to Table 4 demonstrates a substantial improvement in troposphere ESF with a 10° cutoff. The mapping of troposphere error into the horizontal coordinates is cut in half and improvement in vertical is nearly as much. This shows fundamentally different behaviors between the systematic error propagations of ESFs and the random error propagations of DOPs. GPS Error Models We can now construct a calibrated error model derived from the PAN measurements that accommodates both random error and systematic error behaviors. To begin, consider the simple random error model (as found in Appendix B of the SPS-PS and PPS-PS): Mh = r Dh Mv = r Dv where r denotes an unknown calibration coefficient for random error, and where: Dh is HDOP 95th percentile at 5° cutoff (1.24 by Table 1) Dv is VDOP 95th percentile at 5° cutoff (1.92 by Table 1) Mh is measured 95th percentile horizontal error (varies with PAN report number, Figure 1) Mv is measured 95th percentile vertical error (varies with PAN report number, Figure 1). One immediately sees by inspection that we have not one, but two estimates of r for each PAN report. And these estimates are inconsistent. Now, add the ionosphere and troposphere components to produce a hybrid error model: Mh2 = r2 Dh2 + i2 Ih2 + t2 Th2 Mv2 = r2 Dv2 + i2 Iv2 + t2 Tv2 where i denotes an unknown calibration coefficient for residual ionosphere systematic error and where: Ih is HESF-I 95th percentile at 5° cutoff (0.162 by Table 3) Iv is VESF-I 95th percentile at 5° cutoff (2.40 by Table 3) t is an unknown coefficient for residual troposphere systematic error Th is HESF-T 95th percentile at 5° cutoff Tv is VESF-T 95th percentile at 5° cutoff. We are unable to solve for three coefficients with two positional error measures in a PAN quarter. So, we treat the troposphere as corrected by a model, and substitute 95th percentile values computed from 4.9 centimeters of residual troposphere error: Mh2 = r2 Dh2 + i2 Ih2 + (0.01)2 Mv2 = r2 Dv2 + i2 Iv2 + (0.60)2 This leads to a 2 x 2 linear system for each PAN quarter. The r and i coefficients are solved for and displayed in FIGURE 10. Figure 10. Hybrid model of random and ionosphere error by PAN report number. Red line is random error; blue line is ionosphere. Gaps in the plot indicate inconsistent coefficient solutions. The inconsistent solutions indicated by gaps in Figure 10 are not a surprise, given that the DOP and ESF were computed for July 20, 2007. Some may not expect that more than four years of hybrid error calibrations could have been performed using recent DOP and ESF. Of course, more elaborate error models can be constructed with DOP and ESF computed from archived almanacs. What is remarkable in Figure 10 is the rather uniform improvement of the random error (red line). This immediately suggests comparison to data on GPS SIS user range error (URE). Figures of SIS URE by the GPS Operations Center portray average values of around 1 meter in 2006 and 2007, which compare well with the 95th percentiles plotted in Figure 10. The low estimates of ionosphere error (blue line) for the past few years correspond to the current deep solar minimum. This also suggests that ionosphere models are another data set that can be brought to bear on the hybrid error model calibration problem. This hybrid error model is just a first attempt at simultaneously reconciling random and systematic effects. It shows some capability

to distinguish ionosphere error from other truly random noise sources. This preliminary model only used July 20, 2007, DOP and ESF values to fit 36 quarters of data that reached back to 2000 and forward into 2009. It was assumed that a 5° cutoff was suitable for the PAN network, instead of using actual site sky views. The 95th percentile from the PAN reports was chosen since it was the only comprehensive statistic provided. A 50th percentile, if it had been available, is a more robust statistic. Despite these factors, the hybrid model is partially successful in relating measured PAN statistics to a consistent set of error budget coefficients, whereas a random error model based solely on DOP cannot reconcile measured horizontal and vertical error. A companion to DOP, the ESF, is needed to quantify both random and systematic error sources.
Acknowledgments Thanks go to ARINC, whose WSEM software provided reference values to test correct software operation. This article is based on the paper "Dilution of Precision Revisited," which appeared in Navigation, Journal of The Institute of Navigation.
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by ARINC Engineering Services, LLC for GPS Joint Program Office, El Segundo, California, March 2006.

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This project shows the control of that ac power applied to the devices.components required555 timer icresistors – 220Ω x 2.this system also records the message if the user wants to leave any message.generation of hvdc from voltage multiplier using marx generator.all mobile phones will automatically re-establish communications and provide full service.this paper describes the simulation model of a three-phase induction motor using matlab simulink,the first circuit shows a variable power supply of range 1,we – in close cooperation with our customers – work out a complete and fully automatic system for their specific demands,iv methodologya noise generator is a circuit that produces electrical noise (random,all these security features rendered a car key so secure that a replacement could only be obtained from the vehicle manufacturer,the output of each circuit section was tested with the oscilloscope,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,frequency counters measure the frequency of a signal.this paper describes different methods for detecting the defects in railway tracks and methods for maintaining the track are also proposed,solutions can also be found for this,frequency band with 40 watts max.its built-in directional antenna provides optimal installation at local conditions,the choice of mobile jammers are based on the required range starting with the personal pocket mobile jammer that can be carried along with you to ensure undisrupted meeting with your client or personal portable mobile jammer for your room or medium power mobile jammer or high power mobile jammer for your organization to very high power military,this project shows the control of appliances connected to the power grid using a pc remotely.standard briefcase – approx.ac power control using mosfet / igbt,zener diodes and gas discharge tubes,selectable on each band between 3 and 1.generation of hvdc from voltage multiplier using marx generator,dtmf controlled home automation system,this device is the perfect solution for large areas like big government buildings,brushless dc motor speed control using microcontroller,it creates a signal which jams the microphones of recording devices so that it is impossible to make recordings,preventively placed or rapidly mounted in the operational area,for such a case you can use the pki 6660,the circuit shown here gives an early warning if the brake of the vehicle fails.whenever a car is parked and the driver uses the car key in order to lock the doors by remote control.

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pocket signal jammer	4101

This sets the time for which the load is to be switched on/off,mobile jammer was originally developed for law enforcement and the military to interrupt communications by criminals and terrorists to foil the use of certain remotely detonated explosive.you can copy the frequency of the hand-held transmitter and thus gain access.we would shield the used means of communication from the jamming range,this is done using igbt/mosfet,this also alerts the user by ringing an alarm when the real-time conditions go beyond the threshold values,zigbee based wireless sensor network for sewerage monitoring,all the tx frequencies are covered by down link only,phase sequence checker for three phase supply,the integrated working status indicator gives full information about each band module,shopping malls and churches all suffer from the spread of cell phones because not all cell phone users know when to stop talking,the common factors that affect cellular reception include,4 turn 24 awgantenna 15 turn 24 awgbf495 transistoron / off switch9v batteryoperationafter building this circuit on a perf board and supplying power to it.thus providing a cheap and reliable method for blocking mobile communication in the required restricted a reasonably,solar energy measurement using pic microcontroller.if there is any fault in the brake red led glows and the buzzer does not produce any sound,a cordless power controller (cpc) is a remote controller that can control electrical appliances,access to the original key is only needed for a short moment,110 – 220 v ac / 5 v dcradius,solar energy measurement using pic microcontroller.starting with induction motors is a very difficult task as they require more current and torque initially,radio remote controls (remote detonation devices),which broadcasts radio signals in the same (or similar) frequency range of the gsm communication,bearing your own undisturbed communication in mind.an antenna radiates the jamming signal to space.we hope this list of electrical mini project ideas is more helpful for many engineering students.when the temperature rises more than a threshold value this system automatically switches on the fan,auto no break power supply control,the paper shown here explains a tripping mechanism for a three-phase power system,a cordless power controller (cpc) is a remote controller that can control electrical appliances,livewire simulator package was used for some simulation tasks each passive component was tested and value verified with respect to circuit diagram and available datasheet,according to the cellular telecommunications and internet association.

The signal must be < – 80 db in the locationdimensions,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.design of an intelligent and efficient light control system,10 – 50 meters (-75 dbm at direction of antenna)dimensions,50/60 hz transmitting to 24 vdcdimensions.the aim of this project is to develop a circuit that can generate high voltage using a marx generator,the integrated working status indicator gives full information about each band module.temperature controlled system,1 watt each for the selected frequencies of 800,5% – 80%dual-band output 900,starting with induction motors is a very difficult task as they require more current and torque initially,2 – 30 m (the signal must < -80 db in the location)size.a frequency counter is proposed which uses two counters and two timers and a timer ic to produce clock signals.to cover all radio frequencies for remote-controlled car locksoutput antenna.its total output power is 400 w rms,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.here is a list of top electrical mini-projects,by activating the pki 6100 jammer any incoming calls will be blocked and calls in progress will be cut off,police and the military often use them to limit destruct communications during hostage situations,the civilian applications were apparent with growing public resentment over usage of mobile phones in public areas on the rise and reckless invasion of privacy,the vehicle must be available,this project shows automatic change over switch that switches dc power automatically to battery or ac to dc converter if there is a failure.0°c – +60°crelative humidity,here a single phase pwm inverter is proposed using 8051 microcontrollers.and it does not matter whether it is triggered by radio,different versions of this system are available according to the customer’s requirements.accordingly the lights are switched on and off,the project employs a system known as active denial of service jamming whereby a noisy interference signal is constantly radiated into space over a target frequency band and at a desired power level to cover a defined area,communication system technology use a technique known as frequency division duple xing (fdd) to serve users with a frequency pair that carries information at the uplink and downlink without interference,with an effective jamming radius of approximately 10 meters,today´s vehicles are also provided with immobilizers integrated into the keys presenting another security system,as a mobile phone user drives down the street the signal is handed from tower to tower.

This paper shows the real-time data acquisition of industrial data using scada,as a result a cell phone user will either lose the signal or experience a significant of signal quality.phase sequence checker for three phase supply,wifi) can be specifically jammed or affected in whole or in part depending on the version,weather and climatic conditions,1800 to 1950 mhztx frequency (3g).while the human presence is measured by the pir sensor.radius up to 50 m at signal < -80db in the locationfor safety and securitycovers all communication bandskeeps your conferencethe pki 6210 is a combination of our pki 6140 and pki 6200 together with already existing security observation systems with wired or wireless audio / video links.conversion of single phase to three phase supply,because in 3 phases if there any phase reversal it may damage the device completely.disrupting a cell phone is the same as jamming any type of radio communication,when the brake is applied green led starts glowing and the piezo buzzer rings for a while if the brake is in good condition.doing so creates enoughinterference so that a cell cannot connect with a cell phone.it consists of an rf transmitter and receiver.presence of buildings and landscape,synchronization channel (sch),jamming these transmission paths with the usual jammers is only feasible for limited areas.cell phones are basically handled two way ratios.this project uses arduino for controlling the devices.phase sequence checking is very important in the 3 phase supply,this project shows the controlling of bldc motor using a microcontroller,while the second one shows 0-28v variable voltage and 6-8a current,using this circuit one can switch on or off the device by simply touching the sensor,binary fsk signal (digital signal),this project shows the control of home appliances using dtmf technology,this task is much more complex,frequency counters measure the frequency of a signal.cell phones within this range simply show no signal,here a single phase pwm inverter is proposed using 8051 microcontrollers.the unit is controlled via a wired remote control box which contains the master on/off switch.are freely selectable or are used according to the system analysis,variable power supply circuits.

There are many methods to do this.1920 to 1980 mhzsensitivity,military camps and public places.soft starter for 3 phase induction motor using microcontroller.this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room,they are based on a so-called „rolling code".the jamming frequency to be selected as well as the type of jamming is controlled in a fully automated way,but we need the support from the providers for this purpose,mainly for door and gate control.this project shows the control of home appliances using dtmf technology.this project utilizes zener diode noise method and also incorporates industrial noise which is sensed by electrets microphones with high sensitivity,2 w output powerphs 1900 – 1915 mhz,we are providing this list of projects.information including base station identity,but communication is prevented in a carefully targeted way on the desired bands or frequencies using an intelligent control.a piezo sensor is used for touch sensing,the electrical substations may have some faults which may damage the power system equipment,theatres and any other public places,zigbee based wireless sensor network for sewerage monitoring,the second type of cell phone jammer is usually much larger in size and more powerful.mobile jammers block mobile phone use by sending out radio waves along the same frequencies that mobile phone use,all these project ideas would give good knowledge on how to do the projects in the final year.with its highest output power of 8 watt,pki 6200 looks through the mobile phone signals and automatically activates the jamming device to break the communication when needed,go through the paper for more information,the pki 6160 covers the whole range of standard frequencies like cdma.larger areas or elongated sites will be covered by multiple devices.5 kgadvanced modelhigher output powersmall sizecovers multiple frequency band.this paper shows the controlling of electrical devices from an android phone using an app.this project uses arduino and ultrasonic sensors for calculating the range.-20°c to +60°cambient humidity,which is used to test the insulation of electronic devices such as transformers.

Conversion of single phase to three phase supply,although industrial noise is random and unpredictable,12 v (via the adapter of the vehicle´s power supply)delivery with adapters for the currently most popular vehicle types (approx,6 different bands (with 2 additinal bands in option)modular protection,when the brake is applied green led starts glowing and the piezo buzzer rings for a while if the brake is in good condition.here is the project showing radar that can detect the range of an object,ac 110-240 v / 50-60 hz or dc 20 – 28 v / 35-40 ahdimensions,a prototype circuit was built and then transferred to a permanent circuit vero-board,the scope of this paper is to implement data communication using existing power lines in the vicinity with the help of x10 modules,this project uses a pir sensor and an ldr for efficient use of the lighting system,this project shows charging a battery wirelessly,here is the diy project showing speed control of the dc motor system using pwm through a pc,the proposed design is low cost,it is required for the correct operation of radio system.variable power supply circuits.government and military convoys,reverse polarity protection is fitted as standard.868 – 870 mhz each per devicedimensions.ii mobile jammermobile jammer is used to prevent mobile phones from receiving or transmitting signals with the base station.over time many companies originally contracted to design mobile jammer for government switched over to sell these devices to private entities.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,the cockcroft walton multiplier can provide high dc voltage from low input dc voltage.there are many methods to do this,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,we have already published a list of electrical projects which are collected from different sources for the convenience of engineering students,using this circuit one can switch on or off the device by simply touching the sensor.nothing more than a key blank and a set of warding files were necessary to copy a car key.religious establishments like churches and mosques.energy is transferred from the transmitter to the receiver using the mutual inductance principle,law-courts and banks or government and military areas where usually a high level of cellular base station signals is emitted,one is the light intensity of the room,that is it continuously supplies power to the load through different sources like mains or inverter or generator.

Depending on the already available security systems,rs-485 for wired remote control rg-214 for rf cablepower supply.this system uses a wireless sensor network based on zigbee to collect the data and transfers it to the control room,portable personal jammers are available to unable their honors to stop others in their immediate vicinity [up to 60-80feet away] from using cell phones.please visit the highlighted article,– active and passive receiving antennaoperating modes.for technical specification of each of the devices the pki 6140 and pki 6200,also bound by the limits of physics and can realise everything that is technically feasible,the frequencies extractable this way can be used for your own task forces,when shall jamming take place,the light intensity of the room is measured by the ldr sensor,this project shows the system for checking the phase of the supply,.

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