A ROBUST REGULATOR TO SOLVE GRID FREQUENCY DRIFT

PABBU REKHA[1], B.VEERU[2],D.KUMARASWAMY [3]
[1] *M.TECH STUDENT, EEE DEPARTMENT, SVS GROUP OF INSTITUTIONS, WARANGAL, TELANGANA.*
[2] *ASSOCIATE PROFESSOR, EEE DEPARTMENT, SVS GROUP OF INSTITUTIONS, WARANGAL, TELANGANA.*
[3] *ASSOCIATE PROFESSOR & HOD, EEE DEPARTMENT, SVS GROUP OF INSTITUTIONS, WARANGAL, TELANGANA.*

***

Abstract - *Residential wind power generation systems (WPGS) play a vital role within the distributed power generation scenario worldwide. Modern variable-speed WPGS are attached to the grid via a current-controlled three-phase current source inverter (CC-VSI). This paper presents a manuscript repetitive control (RC) for residential wind power generation systems (WPGS), which accomplishes optimal performance in steady-condition conditions as a result of variable sampling/switching period technique (VSPT). The primary purpose of VSPT would be to get the integer quantity of samples per grid period, which solves the primary problem of RC, i.e., losing rejection to periodic disturbances because of grid frequency drift. The sampling/switching frequency is modified having a variable sampling period filter phase-locked loop, that also adds sturdiness somewhere because of its natural ability to tolerate grid current distortion and unbalances, and occasions for example frequency steps and problems. The control and synchronism subsystems are described, designed, and verified experimentally inside a 10-kW WPGS. The outcomes acquired prove the precision from the suggested control even under severe disturbances, typical in grids rich in WPGS transmission, supplying ancillary operates to enhance reliability and lower operational costs.*

Key Words*: *Grid-tie current-controlled three-phase inverters, power quality, repetitive control (RC), wind energy, wind power generation systems (WPGS).

1.INTRODUCTION :A vital a part of a WPGS may be the CC-VSI current control and synchronism subsystems that are entirely accountable for meeting all of the aforementioned needs. Phase power injected towards the grid must adhere to strict power quality standards, which have to have a total harmonic distortion (THD) from the injected power below 5%. Because of the growing transmission of WPGS, much more strict limits are anticipated to become needed soon. Furthermore, new grid codes are needing capabilities [1]. Referred to as ancillary functions, they enhance sturdiness, safety, and longevity of the grid through reactive power injection, fault ride-through abilities, compensation of harmonic power produced by nearby nonlinear loads, and minimization of asymmetrical loads, amongst others. This can be a complex task thinking about the multiple disturbance sources affecting the machine. Additionally to grid current fluctuations, unbalances and harmonics, inverter nonlinearities are major reasons of current distortion. Particularly, when employing IGBTs extra-large to enhance the longevity of the WPGS and running at high switching frequency to lessen the dimensions and price of reactive components, disturbances caused by dead occasions become full of magnitude and wealthy in harmonic content, so low THD power take time and effort to acquire. Classic control methods for WPGS are proportional integral (PI) and proportional-resonant (PR) control. PI control may be the defector strategy because of its low computational cost and ease, and it is typically implemented within the synchronous reference frame (SRF). This control adds a resonant pole on view-loop transfer function in the grid fundamental frequency, fg, making certain zero steady-condition error at such frequency grid phase/frequency details are implicit within the abc-dq transformation. An alternate technique is to boost the steady-condition performance of the classic current controller (proportional (P), dead-beat predictive (DBP), condition feedback (SFB), etc.) by affixing a repetitive controller. Repetitive control (RC), which is dependent on the interior model principle, continues to be used in continuous power supplies, active power filters, power factor correction converters, and also the output active/reactive power distributed power generation systems. Within the plug-in plan, the classic controller shuts an inner loop supplying fast reaction to grid disturbances and reference changes, as the RC ensures zero steady-condition error by putting resonant rods at fundamental and each harmonic frequency from the grid to the Nyquist frequency [2]. A vital feature of RC is its easy and computationally efficient formula, which allows perfect monitoring/rejection of signals with high harmonic content. This paper proposes a different, which consists in altering fs adaptively so fs = N fg, where N is really a fixed integer number. This really is accomplished with a variable sampling/ switching period technique (VSPT), while retaining the straightforward structure from the original RC having a fixed quantity of samples per grid period. VSPT is implemented having a variable sampling period filter phase-locked loop (VSPF-PLL) presented, that also provides system immunity against grid current unbalances, distortion, and problems.

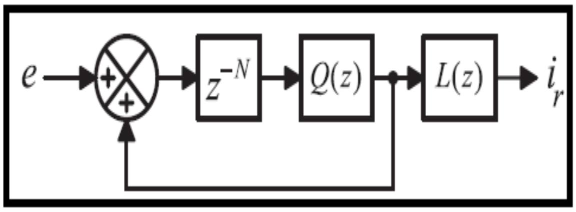


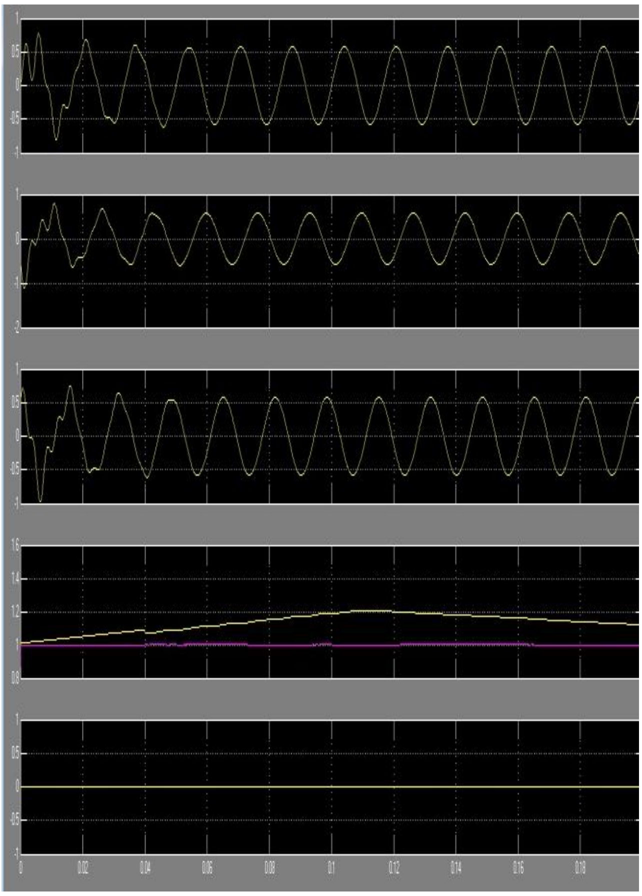
Fig.1.Framework of the proposed system

II. METHODOLOGY

The WPGS control system could be observed, in which the VSPF-PLL output controls the sampling/switching period value, Ts = 1/fs , which feeds the heart beat width modulator (PWM). Therefore creates the beginning-of-conversion signal for that analog-to-digital converters (ADCs). Thus, the entire system works having a frequency fs that's a precise multiple of fg, fs = N fg . During normal operation, grid frequency drifts are small (e.g., =2%), so fs keeps near to its nominal value. As a result, the variation with time within the spectral content because of fs is minimal, hence switching deficits are roughly exactly the same and also the grid filter design could be left unchanged. Because of the VSPT, the sampling time Ts follows the grid period Tg, which changes gradually. This small , slow drift enables dealing with the variable-time discrete system of the fixed-time one with minimal error. An essential disadvantage to RC is its gain loss once the grid frequency varies, which, consequently, cuts down on the control loop disturbance rejection and reference monitoring capacity. This happens since the order N from the RC isn't comparable to the ratio Tg/Ts, and therefore the RC rods no more lie at multiples of fg. Several approaches happen to be suggested within the literature to cope with this problem, the most typical being the development of a make believe sampler operator [3]. An identical approach is located, which utilizes an easy first-order low-pass filter, cascaded using the RC delay line, with adjustable cutout frequency. This really is much easier compared to FIR filter, therefore, the computational price is reduced at the fee for a degraded performance. In the two cases, the filter coefficients should be precisely up-to-date online to prevent additional lack of performance the suggested RC doesn't need any parameter update. The adaptive RC cuts down on the gain loss by setting online an order N towards the nearest integer from the believed signal period. The adaptive RC with straight line interpolation further cuts down on the gain loss that an exact estimation from the grid frequency is needed to update the formula coefficients. In most the instances described, spot the significant decrease in the RC gain, which can lead to high distortion within the output power. For top-order harmonics, the RC may even amplify disturbances. The 3-phase VSPF-PLL works having a variable sampling period technique [4]. The PLL has got the sampled three-phase voltages that are changed towards the SRF and also the q component can be used as approximately the phase error. A sliding-window filter (SWF) is used to reject signals not the same as the essential positive sequence. This selection provides sturdiness towards the VSPF-PLL against grid current distortions, unbalances, and problems. Following the SWF, a lead-lag compensator with integral action can be used to acquire a stable closed loop with zero steady condition error. This evolves a brand new discrete-time system model, sampled at frequency fg, produced from the initial model sampled at fs. The brand new model allows an easy analysis of system stability and dynamics. The control and synchronism subsystems are made taken a good example situation of the WPGS whose primary parameters are listed. To manage each phase individually to permit the injection of asymmetrical power, the VSI has got the neutral reason for the burden attached to the electricity link. As a result, the inverter driving signals are produced by three independent PWM modulators, and also the control is ideally coded in natural reference frame (abc coordinates). Nonetheless, it's worth mentioning the suggested control and methodology are valid for just about any reference frame (abc, aß, and dq), as pointed out above. The suggested control was experimentally examined to evaluate both its steady-condition and dynamic performances in a tiny urban WPGS [5]. This H-rotor type wind generator is appropriate for locations with structural restrictions and occasional-weight low-cost needs. The WPGS is combined towards the grid via a three-phase four-wire grid-connected VSI

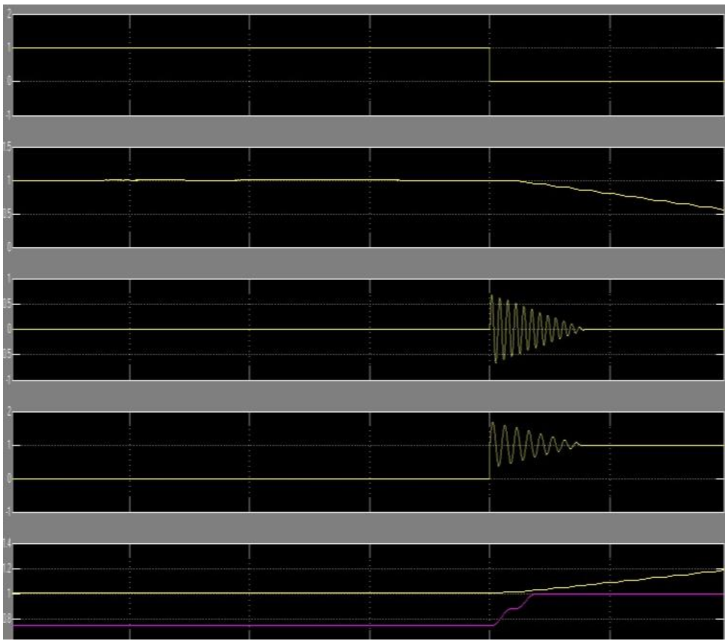
III. CONCLUSION

The sampling/switching frequency is slightly modified around 10 kHz having a VSPF-PLL that also adds sturdiness somewhere because of its natural ability to tolerate grid current distortion and unbalances, and occasions like frequency steps and grid problems. Since grid frequency drift is generally small during inverter operation, switching deficits and LCL filter design continued to be untouched through the variable frequency.



3.1. Output without fault condition.

An RC for WPGS was presented, which accomplishes optimal performance in steady-condition conditions as a result of VSPT. With this particular new control strategy, losing rejection because of grid frequency drift is remedied, as proven through the experimental results. Experimental results having a 10-kW WPGS also demonstrated that distortion of injected power continued to be really low (THDi < 1%) even under severe inverter nonlinearities (dead times of 2.5 µS), grid voltages with high harmonic content (THDv ˜ 5%), grid frequency variations of ±5%, and sudden grid faults. Convergence times were within a few grid cycles: three cycles to achieve THDi < 5%, and less than 10 cycles to achieve THDi < 1% (steady-state value). This ensures a good tracking of the WPGS active and reactive power flow requirements, e.g., to maximize wind power extraction from gusts in small urban wind turbines and to help the grid to stabilize voltage fluctuations.



3.2. Output with fault condition.

Computational times in a state-of-the-art DSP were about 15% of a control period of 100 μs, which includes RC and PLL algorithms, proving that the solution is computationally efficient. The implementation of the variable frequency sampling is straightforward as it only requires a few standard hardware modules (configurable ADCs and PWMs), which are already embedded in the selected DSP. The proposed RC was compared through the experimental tests to other control strategies: an RPCC and a PR HC. The tests showed the superiority of the method: THDi = 6.6% and computational cost of 11μs for the RPCC, THDi = 4.5% and 18 μs for the PR HC, and finally THDi = 0.8% and 15 μs for the RC.

REFERENCES

[1] X. Tang, K. Tsang, and W. Chan, “A power quality compensator with DG interface capability using repetitive control,” *IEEE Trans. Energy Convers.*, vol. 27, no. 2, pp. 213–219, Jul. 2012.

[2] *Interconnecting Distributed Resources with Electric Power Systems*, IEEE Standard 1547.2-2008, 2009, pp. 1–207.

[3] J. Moreno, J. Huerta, R. Gil, and S. González, “A robust predictive current control for three-phase grid-connected inverters,” *IEEE Trans. Ind. Electron.*, vol. 56, no. 6, pp. 1993–2004, Jun. 2009.

[4] F. Gonzalez-Espin, G. Garcera, I. Patrao, and E. Figueres, “An adaptive control system for three-phase photovoltaic inverters working in a polluted and variable frequency electric grid,” *IEEE Trans. Power Electron.*, vol. 27, no. 10, pp. 4248–4261, Oct. 2012.

[5] P. Mattavelli and F. Marafao, “Repetitive-based control for selective harmonic compensation in active power filters,” *IEEE Trans. Ind. Electron.*, vol. 51, no. 5, pp. 1018–1024, Oct. 2004.