An improved controller for reactive power sharing in islanded microgrid

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An improved controller for reactive power sharing in islanded microgrid

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Abstract

The control to stabilize the frequency and voltage is the main goal of controlling the islanded microgrid. The microgrid can include different inverters, which are connected in parallel to each other by lines that have different impedances. The loads in the microgrid include local and public loads. With the different line impedances and local loads, it has made the voltage and current controller-type PI (proportional integral) or PID (proportional integral derivative) unable to guarantee the stability for the microgrid, and also, the power sharing between inverters is not made accurate. In this study, an improved power sharing controller is proposed by adjusting the droop voltage slope, in order to increase the accuracy of power sharing, while the microgrid has local loads and the line impedances have significant differences for inverters connected to a microgrid. This controller is combined with a sliding mode control to improve accuracy in power sharing and improve the quality of the voltage supplied to the loads. The control model has been simulated and experimental with two inverters connected in parallel. The simulation and experimental results demonstrate the effectiveness of the proposed control method.

Keywords Droop control · Power sharing · Microgrid control · Parallel inverter · Line impedance

1 Introduction

The microgrid includes many distributed power sources, and it is connected to the grid through inverters. Inverters in the microgrid are connected in parallel to increase the reliability, reduce the overload of each inverter, and give more flexibility. The microgrid is designed to work in stand-alone mode and grid-connected mode. In stand-alone mode, microgrid must perform power sharing between inverters, maintaining their voltage and frequency stability. If the power of loads is not divided according to the rated power ratio of the inverters, this can lead to the inverters being overloaded or the presence of a reactive power line running around in the inverters, leading to overheating and can even damage the inverters [1, 2]. Therefore, the issue of power sharing for parallel-connected inverters in an islanded microgrid has received significant attention in research works, with much research work being developed to solve this problem. However, there are still many issues that have not yet been thoroughly solved in research works, especially when the line impedances connecting from the inverters to the PCC (point of common coupling) are different, as this will make the power sharing between the inverters no longer accurate.

Currently, researchers have used the droop control method to power sharing between parallel-connected inverters in the microgrid [1–6]. According to the droop control method, the inverter's output frequency and voltage are adjusted through the active and reactive power generated by the inverters. However, the droop control method has the following major disadvantages:

- The effectiveness of the droop control method depends very much on the line impedance parameters. When the line impedances connecting from the inverters to the PCC (point of common coupling) are different, the droop controller cannot share the power according to the rated power ratio of the inverters. The droop control method only gives exact power sharing results when the lines have the same impedance.
- The output voltage of the parallel-connected inverters may be mismatched due to the line impedances being different. As such, the reactive power sharing between parallel-connected inverters is difficult and can lead to

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the appearance of reactive currents running in the inverters [1–7].
- In addition, the effectiveness of the droop control method is also affected by the local loads connected at the output of the inverters.

Currently, there are many improved droop methods that have been proposed to solve this problem. However, it still exists with the following disadvantages:
- Improved power sharing methods can reduce the quality of the voltage, such as the virtual output impedance method [8, 9].
- The accuracy of power sharing is negligibly enhanced if local loads are connected at the output of each inverter [10, 11].

In fact, the conventional droop controllers are designed to share the fundamental positive-sequence power components. Therefore, some studies have applied control methods to reduce distortion due to harmonics and to control harmonics between DG units. For example, the virtual output impedance method is introduced to automatically share the harmonic currents [8, 9] between the DG units. With this method, in order to reduce the effect of mismatch of the line impedances in power sharing, a large virtual impedance value is designed. As a result, more voltage distortions exist.

In [7, 12, 13], the authors propose a harmonic droop controller to reduce the voltage harmonics distortion at the PCC and to share harmonics between the inverters. However, this method is complicated. Furthermore, in a low-voltage (LV) microgrid, the total harmonic distortion (THD) is highly affected by the line impedances in the microgrid.

This paper proposes a method by adjusting the droop voltage slope to compensate for the mismatch in the voltage drops across line impedances. This proposed method allows an accurate power sharing ratio between the parallel inverters in islanded microgrids without being affected by:

- The line impedances have significant differences for inverters connected to the point of common coupling (PCC).
- The microgrid has the local loads at the output of inverters.

2 Islanded microgrid control

2.1 The structure of microgrid

The structure of an islanded microgrid is made up of many inverters connected in parallel. In Fig. 1, a block diagram of inverters is provided. Each inverter is connected to a common bus at the PCC through the line impedance. Microgrid has included both the local loads and public loads.

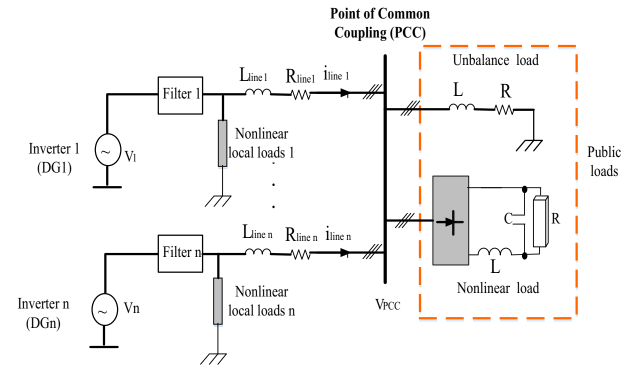


Fig. 1 A block diagram of inverters in islanded microgrid

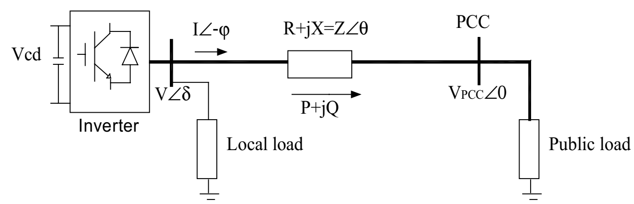


Fig. 2 Equivalent schematic of inverters connected to a load

2.2 The principle of the proposed control method

The principle of the droop control method is explained by considering the equivalent circuit of an inverter connected to an AC bus. The analysis method is based on the Thevenin theorem as shown in Fig. 2.

The active and reactive powers supplied by the inverter are calculated as follows:

$$P = \frac{V}{R^2 + X^2}\left[R\left(V - V_{\mathrm{PCC}}\cos\delta\right) + XV_{\mathrm{PCC}}\sin\delta\right] \tag{1}$$

$$Q = \frac{V}{R^2 + X^2}\left[-RV_{\mathrm{PCC}}\sin\delta + X\left(V - V_{\mathrm{PCC}}\cos\delta\right)\right] \tag{2}$$

When the angle δ is small and $X \gg R$, Eqs. (1) and (2) are rewritten as:

$$\delta \cong \frac{XP}{VV_{\mathrm{PCC}}} \tag{3}$$

$$V - V_{PCC} \cong \frac{XQ}{V} \tag{4}$$

From (3) and (4), the basis of well-known frequency and voltage droop regulation through active and reactive powers are calculated by:

$$\omega = \omega_0 - m_{\mathrm{p}}P \tag{5}$$

$$V = V_0 - m_\mathrm{q} Q \tag{6}$$

where V_0 and ω_0 are the nominal amplitude voltage and frequency of the inverter, V and ω are the measured amplitude voltage and frequency of the inverter, P and Q are the active power and reactive power output of the inverter, and m_p and m_q are the active and reactive droop coefficients, which are calculated as follows:

$$m_\mathrm{p} = \frac{\omega_0 - \omega_{\min}}{P_{\max}}; \quad m_\mathrm{q} = \frac{V_0 - V_{\min}}{Q_{\max}} \tag{7}$$

When the line impedances between the inverters to the point of common coupling (PCC) are different, we can see that the power sharing exactly according to the rated power ratio is very difficult because it depends on the parameters of line impedances. This can be explained by the following expressions or charts:

Combined (5) and (6), the following are obtained:

$$m_{q1} Q_1 = m_{q2} Q_2 = \cdots = m_{qn} Q_n = \Delta V \tag{8}$$

$$m_{p1} P_1 = m_{p2} P_2 = \cdots = m_{pn} P_n = \Delta \tag{9}$$

Combined Eqs. (1), (2), (5), (6), (8) and (9), we have conditions for the accurately rated power sharing for two inverters as in (10):

$$\begin{cases} \frac{m_{p1}}{m_{p2}} = \frac{X_1}{X_2} \\ \delta_1 = \delta_2 \\ V_1 = V_2 \\ \frac{m_{q1}}{m_{q2}} = \frac{X_1}{X_2} \end{cases} \tag{10}$$

To satisfy (10), it is necessary to have droop coefficients that are proportional to the line impedance.

On the other hand, this can also be explained by the following charts:

From Eq. (4), we have a relationship between voltage and reactive power as follows:

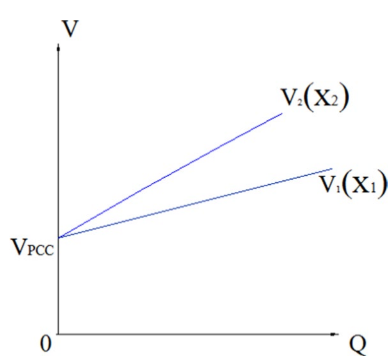


Fig.3 The curve of voltage according to reactive power

$$V = V_\mathrm{PCC} + \frac{Q \cdot X}{V} \tag{11}$$

The curve of (11) is shown in Fig. 3.

According to Fig. 3, when the line impedances are different, then the curve of $Q = f(V)$ is also different.

Figure 4 shows when the line reactance $X_2 > X_1$, $Q_2 < Q_1$, meaning that reactive power shares inaccuracy. The active power sharing base on frequency droop is not affected by the local loads. However, the local load will affect the reactive power sharing during islanding operation, as shown in Fig. 5.

Figure 5 shows that when a microgrid has local loads at the output of the inverters, which changes the output voltage of the inverters, the voltage of the local loads is equal to the voltage at the PCC. Therefore, the local loads make an offset in the output voltage of the inverters, which is the cause of the mismatch for reactive power sharing in islanded microgrids. On the other hand, when the nonlinear local and public loads are connected to the microgrid, harmonic power

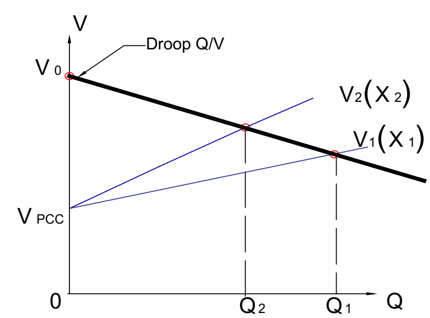


Fig.4 The curve of voltage according to reactive power and voltage droop

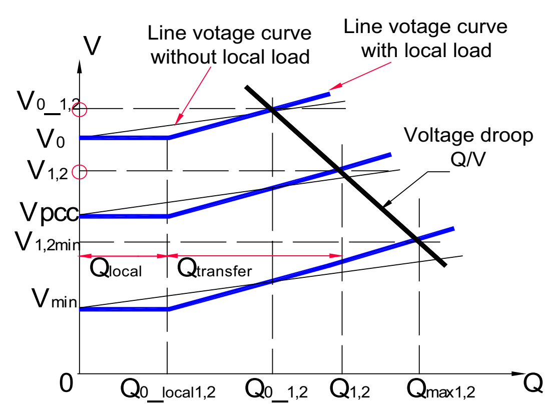


Fig.5 Reactive power sharing of two inverters, where V_0: the nominal amplitude voltage at the PCC. $V_{0\_1,2}$: the nominal amplitude voltage of the inverters 1, 2. $Q_{0\_1,2}$: the nominal reactive power of the inverters 1, 2. $Q_{0\_\mathrm{local}\ 1,2}$: the nominal reactive power of the local loads 1, 2

sharing errors are present due to different inverter ratings and line parameters. Inaccurate sharing of harmonic power can lead to an inverter′s overcapacity, overheating, losses, and distortion in current and voltage waveforms.

Therefore, a controller is proposed to ensure accurate power sharing of parallel inverters; the improved power sharing controller is proposed by adjusting the droop voltage slope. The droop voltage slope is adapted to follow the change of load through the energy management system (EMS). This controller is combined with a sliding mode control (SMC) to improve accuracy in power sharing and improve the quality of the voltage supplied to the loads. The proposed controller is shown in Fig. 6.

3 Proposed controller

The proposed controller consists of the following main blocks:

3.1 Calculation of active power and reactive power

The active and reactive power produced by converters are calculated in a stationary $\alpha\beta$ frame:

$$p = \frac{3}{2}\left(i_{2\alpha}v_{c\alpha} + i_{2\beta}v_{c\beta}\right) \tag{12}$$

$$q = \frac{3}{2}\left(i_{2\alpha}v_{c\beta} - i_{2\beta}v_{c\alpha}\right) \tag{13}$$

This paper has used double second-order generalized integrator–quadrature signal generation (DSOGI–QSG) for calculation of the active power and reactive power. To simplify, although the voltage may contain negative sequence components due to imbalanced load in the system, it is assumed that the negative sequence voltage is relatively small and can be ignored. In this case, when the basic fundamental components are detected, the active, reactive, and unbalanced powers of the three-phase inverters can be calculated as Fig. 7.

3.2 The proposed reactive power sharing controller

The active power sharing by the droop P/f method will not be affected significantly by the difference in line impedances. However, the difference in line impedances will greatly affect the reactive power sharing by the droop *Q*/*V* method. Therefore, in this paper, the proposed controller maintains the droop *P*/*f* Eq. (5). However, the droop *Q*/*V* Eq. (6) is improved as follows:

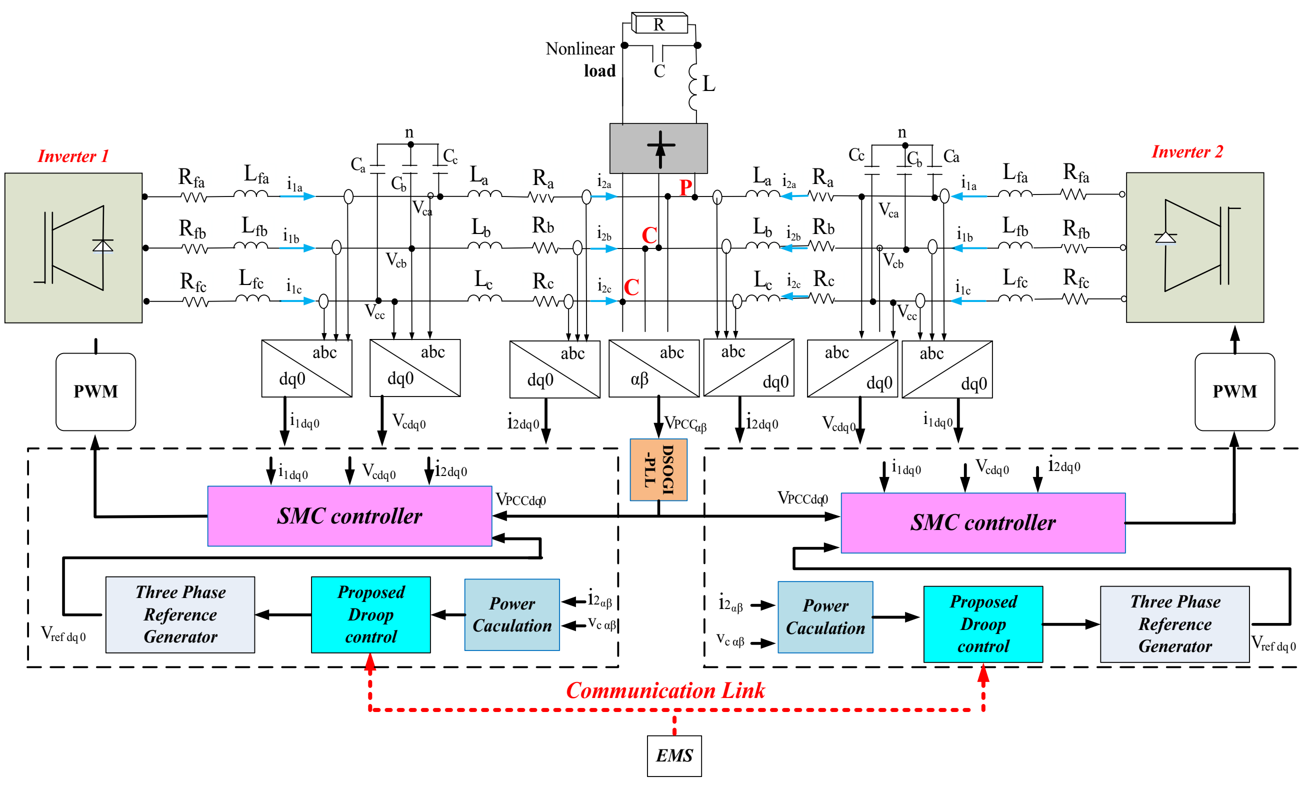


Fig. 6 Block diagram of the proposed controller for islanded microgrid

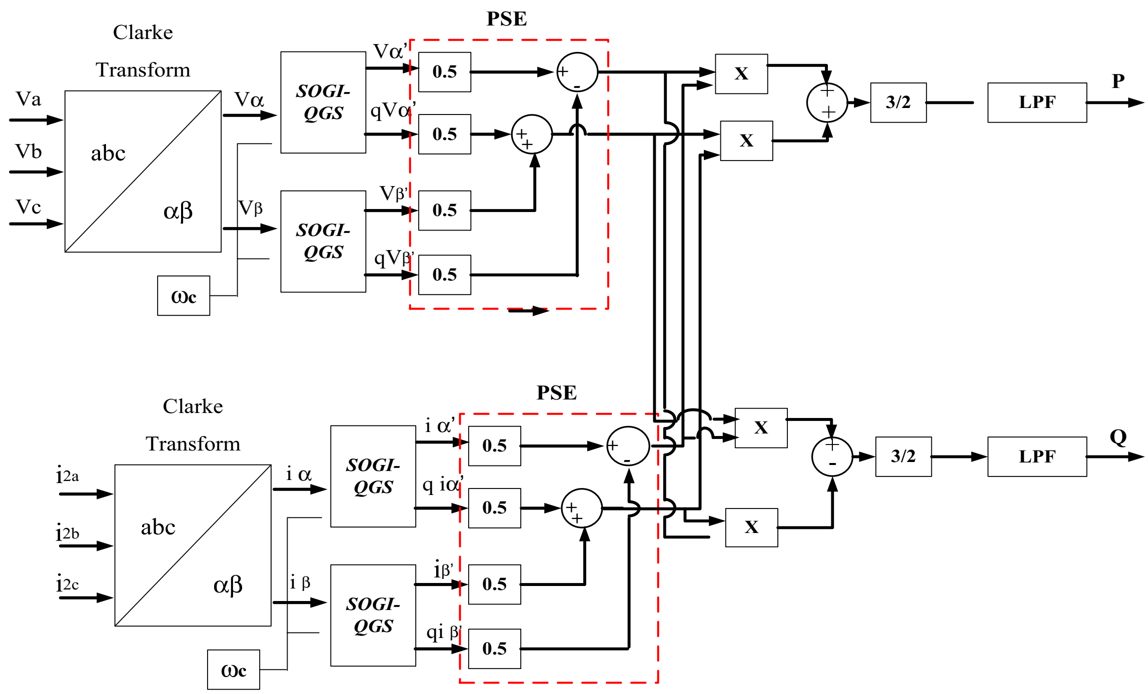


Fig. 7 Block diagram of calculation of active power and reactive powers

$$V = V_0 - (m_q + \Delta m_q)Q \tag{14}$$

where

$$\Delta m_q = k_p \int (Q - Q^*)dt \tag{15}$$

The slope of the voltage droop equation is corrected by adjusting the reactive power value at the output of each inverter, as follows:

Each inverter sends its measurement reactive power (Q) to EMS; EMS calculates the reference reactive power value (Q_i*) ($i = 1, 2, \ldots n$) for each inverter based on the inverter's rated power and total load power (Q*) in the microgrid. Accordingly, each inverter will receive its reference reactive power value (Q_1*, Q_2*,…Q_n*) from EMS back to the controller in Eq. 15 and adjusting the droop voltage slope to compensate for line impedance mismatching.

When loads change, the reference reactive power values (Q_i*) will be adjusted accordingly. Therefore, each DG will use its reference reactive power (Q_i*) to adapt its droop voltage slope, and Q_i* will be a fixed reference reactive power value until the total reactive power of load changes.

The proposed droop controller to adjust the droop voltage slope mq is shown in Fig. 8.

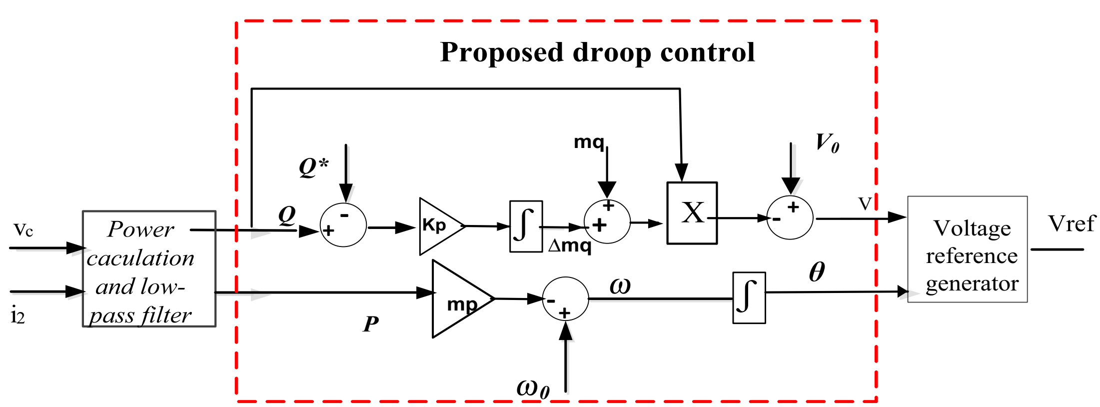


Fig. 8 Block diagram of proposed droop control for an inverter

3.3 Design the SMC controller

The sliding mode control (SMC) is a simple and effective control method, the control rules of the SMC; the controller will control the trajectory of the system along a designed sliding surface. As a result, the signal at the output of the controller is closely controlled according to the reference signal at the input. In this paper, the SMC controller will control the current and the voltage at the output of the inverter to follow the reference current and voltage at the input of the inverter. The proposed method will improve the stability of the system and accuracy in power sharing for parallel-connected inverters in an islanded microgrid.

From Fig. 9, we have the equation:

$$\begin{cases} \frac{di_1}{dt} = \frac{v_{inv}}{L_f} - \frac{1}{L_f}v_c - \frac{R_f}{L_f}i_1 \\ \frac{dv_c}{dt} = \frac{1}{C}i_1 - \frac{1}{C}i_2 \\ \frac{di_2}{dt} = \frac{1}{L}v_c - \frac{1}{L}v_{pcc} - \frac{R}{L}i_2 \end{cases} \tag{16}$$

Expressing Eq. (16) in the dq0 coordinate system, we get Eqs. (17):

$$\begin{cases} \dot{i}_{1d} = \frac{v_{invd}}{L_f} - \frac{1}{L_f}v_{cd} - \frac{R_f}{L_f}i_{1d} + \omega i_{1q} \\ \dot{i}_{1q} = \frac{v_{invq}}{L_f} - \frac{1}{L_f}v_{cq} - \frac{R_f}{L_f}i_{1q} - \omega i_{1d} \\ \dot{v}_{Cd} = \frac{1}{C}i_{1d} - \frac{1}{C}i_{2d} + \omega v_{cq} \\ \dot{v}_{Cq} = \frac{1}{C}i_{1q} - \frac{1}{C}i_{2q} - \omega v_{cd} \\ \dot{i}_{2d} = \frac{v_{cd}}{L} - \frac{1}{L}v_{pccd} - \frac{R}{L}i_{2d} + \omega i_{2q} \\ \dot{i}_{2q} = \frac{v_{cq}}{L} - \frac{1}{L}v_{pccq} - \frac{R}{L}i_{2q} - \omega i_{2d} \end{cases} \tag{17}$$

The design of an SMC controller in the dq coordinate system is to determine the control signal so that the voltage at the inverter output (v_c) follows the reference voltage (v_{ref}). Define state variables on d-axis and q-axis:

$$\begin{cases} x_d = v_{Cd} - v_{Cd}^* \\ x_q = v_{Cq} - v_{Cq}^* \end{cases} \tag{18}$$

where v_{Cd}^* is the reference voltage of v_{cd} ($v_{Cd}^* = v_{refd}$).

v_{Cq}^* is the reference voltage of v_{cq} ($v_{Cq}^* = v_{refq}$).

From Eqs. (18), we choose the sliding surface for d and q-axis:

$$\begin{cases} S_d = \dot{x}_d + a_d x_d = \left(\dot{v}_{Cd} - \dot{v}_{Cd}^*\right) + a_d\left(v_{Cd} - v_{Cd}^*\right) \\ S_q = \dot{x}_q + a_q x_q = \left(\dot{v}_{Cq} - \dot{v}_{Cq}^*\right) + a_q\left(v_{Cq} - v_{Cq}^*\right) \end{cases} \tag{19}$$

$$\begin{cases} \dot{S}_d = \ddot{x}_d + a_d\dot{x}_d = \left(\ddot{v}_{Cd} - \ddot{v}_{Cd}^*\right) + a_d\left(\dot{v}_{Cd} - \dot{v}_{Cd}^*\right) \\ \dot{S}_q = \ddot{x}_q + a_q\dot{x}_q = \left(\ddot{v}_{Cq} - \ddot{v}_{Cq}^*\right) + a_q\left(\dot{v}_{Cq} - \dot{v}_{Cq}^*\right) \end{cases} \tag{20}$$

where a_d, and a_q are positive coefficients.

The control signal will control the system so that when $t \to \infty$, the state variables x_d, $x_q \to 0$, then the equations $S_d = 0$ and $S_q = 0$ will determine the sliding surface S_d and S_q that needs to be designed.

The problem is to define the control law to bring the system's trajectories to the sliding surface $S_d = 0$, $S_q = 0$ and maintain on the sliding surface in a sustainable manner when system parameters are suddenly changed. So we have to make the system always asymptotic stability at $S_d = 0$, the phase trajectory of the system must move on the sliding surface $S_d = 0$; to do this, according to the Lyapunov stability principle, we choose the Lyapunov function: $V_d = \frac{1}{2}S_d^2$. We see $V_d\,(S_d)$ is positive and must have $S_d \cdot \dot{S}_d < 0$. When $S_d > 0$ means that the phase trajectory goes out of the sliding surface, at this time, the control signal must be controlled so that $S_d < 0$ and the phase trajectory returns to the sliding surface. When $S_d < 0$ means that the phase trajectory goes out of the sliding surface, at this time, the control signal must be controlled so that $S_d > 0$ and the phase trajectory returns to the sliding surface. When $S_d = 0$ then $\dot{S}_d = 0$ means that the phase trajectory lies on the sliding surface. So we choose:

$$\begin{cases} \dot{S}_d = -k_d \operatorname{sign}\left(S_d\right) \\ \dot{S}_q = -k_q \operatorname{sign}\left(S_q\right) \end{cases} \tag{21}$$

where k_d, and k_q are positive coefficients.

From Eqs. 17, 20, and 21, we determine the expression of the control signal for the system as Eqs. 22 and 23:

$$\begin{aligned} v_{invd} = CL_f\Big[&-k_d \operatorname{sign}(S_d) + \left(\frac{R_f}{CL_f} - \frac{a_d}{C}\right)i_{1d} + \left(\frac{1}{CL_f} + \frac{1}{CL} + \omega^2\right)v_{Cd} \\ &+ \left(\frac{a_d}{C} - \frac{R}{LC}\right)i_{2d} + \frac{2\omega}{C}i_{2q} - \frac{2\omega}{C}i_{1q} - \omega a_d v_{Cq} \\ &- \frac{1}{CL}v_{pccd} + \ddot{v}_{Cd}^* + a_d\dot{v}_{Cd}^*\Big] \end{aligned} \tag{22}$$

$$\begin{aligned} v_{invq} = CL_f\Big[&-k_q \operatorname{sign}(S_q) + \left(\frac{R_f}{CL_f} - \frac{a_q}{C}\right)i_{1q} + \left(\frac{1}{CL_f} + \frac{1}{CL} + \omega^2\right)v_{Cq} \\ &+ \left(\frac{a_q}{C} - \frac{R}{LC}\right)i_{2q} - \frac{2\omega}{C}i_{2d} + \frac{2\omega}{C}i_{1d} + \omega a_q v_{Cd} \\ &- \frac{1}{CL}v_{pccq} + \ddot{v}_{Cq}^* + a_q\dot{v}_{Cq}^*\Big] \end{aligned} \tag{23}$$

where reference voltage $v_{Cd}^* = v_{refd}$ and $v_{Cq}^* = v_{refq}$.

When the phase trajectory of the system comes from any point to touch the sliding surface, the control signals (v_{invd}

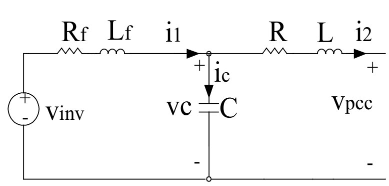


Fig. 9 Equivalent schematic of an inverter connected to loads

and v_{invq}) must always change to bring the system's phase trajectory to the sliding surface ($S_d = 0$ and $S_q = 0$) and keep it steady on the sliding surface.

3.4 Modeling of a three-phase DSOGI-PLL

The DSOGI-PLL (double second-order generalized integrator—phase-locked loop) with a generalized integral block and phase lock loop to monitor the exact voltage magnitude and frequency phase at the PCC, while nonlinear loads will support the information for SMC controller.

Figure 10 shows the structure of a DSOGI-PLL. Both the adaptive filtering technique and the in-quadrature phase detection technique are used in the DSOGI-PLL to generate the frequency and phase outputs. This system has a double feedback loop, i.e., the frequency/phase generator provides both the phase angle to the Park transform and the central frequency to the second-order generalized integrator–quadrature signal generation [13].

4 Simulation results and discussion

A microgrid with two parallel inverters, as shown in Fig. 1, is simulated in MATLAB/Simulink. All of the simulation parameters of the system are given in Table 1.

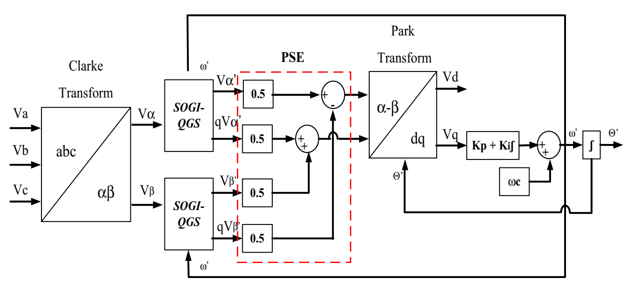


Fig. 10 Modeling of a three-phase DSOGI-PLL

Case 1 Simulation for the power sharing of two identical inverters, where the line impedances are different, and the local loads and public loads are changed.

(a) The simulation results when the controller is combined with the proposed SMC block:

The simulation results for this case including the real power sharing, reactive power sharing, and voltages are shown in Figs. 11, 12, 13 and 14.

Figure 11a and Fig. 11b shows accurate power sharing with a 1:1 ratio by the combination of the SMC controller and the proposed droop controller, while local loads and the impedance of the two lines are different.

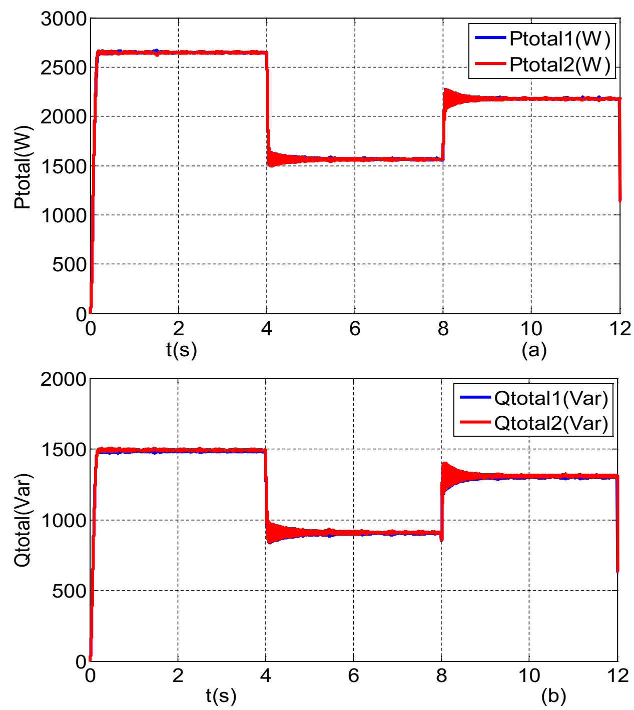


Fig. 11 Power sharing of total loads: **a** real power; **b** reactive power

Table 1 Parameters for the controllers

Parameters	Values	Parameters	Values
Input source voltage V_{cd} (V)	600	Rate frequency f_0 (Hz)	50
Filter inductance L_f (mH)	4.2	Rate power (kVA)	4
Filter resistance R_f (Ω)	0.1	Rate voltage $V_{AC,p}$ (V)	310
Filter capacitance C (μF)	2.2	Droop coefficient m_q (V/Var)	1.05e−4
Switching frequency f_z (kHz)	10	Droop coefficient m_p (rad/s/W)	1e−4
a_d, a_q	1	k_d, k_q	5e−5
Line impedances			
L_1(mH)	2	R_1(Ω)	1.2
L_2(mH)	4	R_2(Ω)	0.8

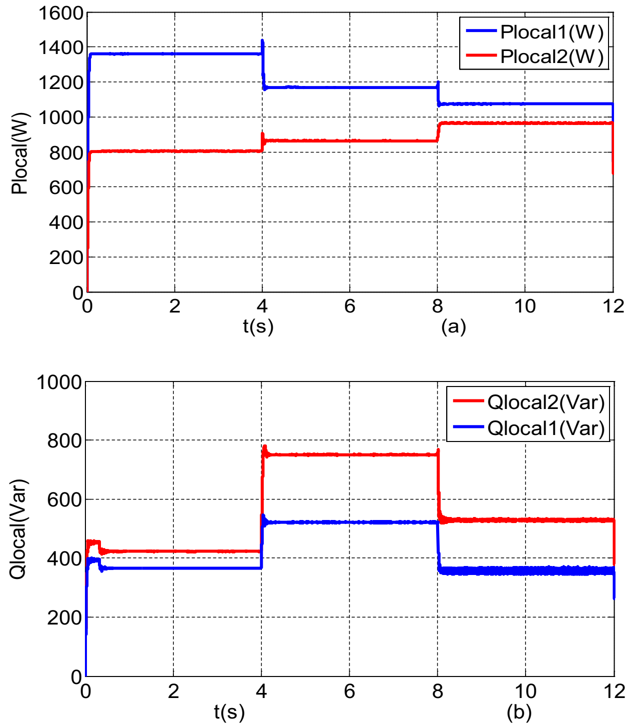


Fig. 12 Power sharing of local loads: **a** real power; **b** reactive power

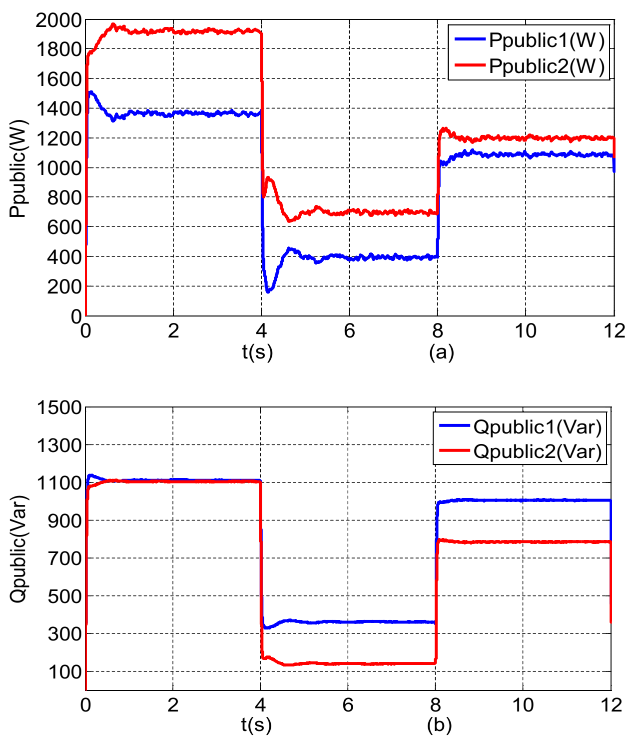


Fig. 13 Power sharing of public loads: **a** real power; **b** reactive power

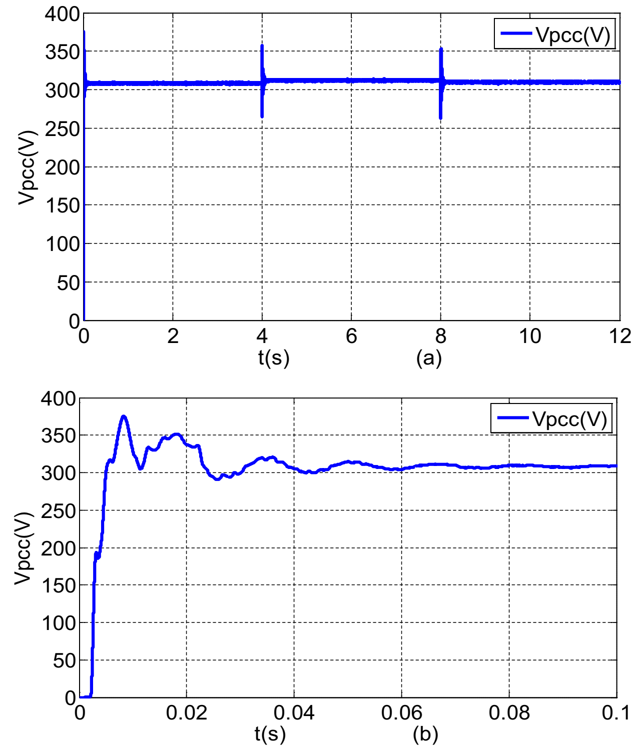


Fig. 14 **a** The voltage at the PCC, **b** transient response of voltage at the PCC

Figure 12 shows that the proposed controller achieves good power sharing of local loads when the power of schematic loads is changed.

Figure 13 shows that the proposed controller achieves good power sharing of public loads when the power of schematic loads is changed.

Figure 14 shows the voltage quality at the PCC. The voltage quality is always guaranteed by the proposed controller.

(b) The simulation results when the controller is combined with the proposed traditional PI blocks:

The simulation results for this case including the real power sharing, reactive power sharing, and voltages are shown in Fig. 15.

Figure 15 shows accurate power sharing with a 1:1:1 ratio by the combination of the PI controller and the proposed droop controller, while local loads and the impedance of the three lines are different. However, the power sharing results in Fig. 15 show that the responses are established in about 2 s, whereas the power sharing results in Figs. 11, 12, 13, and 14 show that the responses are established in about 0.5 s. In addition, the results show that the proposed SMC

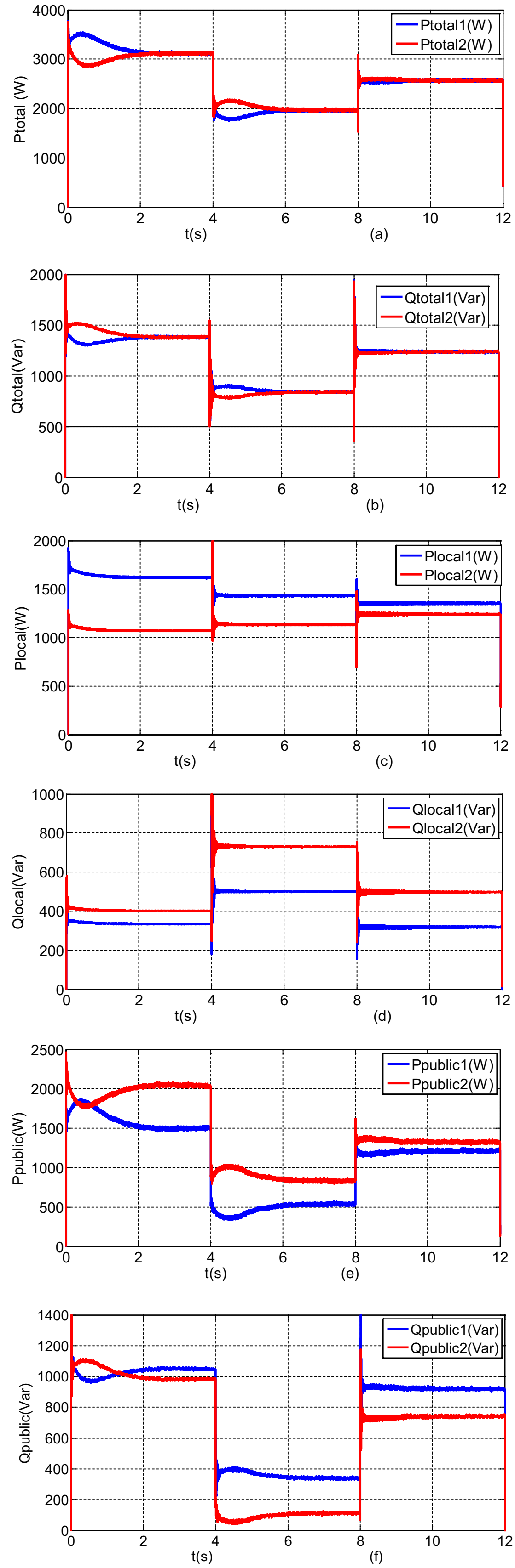


Fig. 15 Power sharing of loads: **a** active power of total loads, **b** reactive power of total loads, **c** active power of local loads, **d** reactive power of local loads, **e** active power of public loads, **f** reactive power of public loads

controller is more stable than the traditional PI controller, because the stability of the closed-loop system is determined according to the Lyapunov standard.

Case 2 Simulation for the power sharing of three identical inverters, where the line impedances are different, and the local loads and public loads are changed.

The simulation results for this case including the real power sharing, reactive power sharing, and voltages are shown in Fig. 16.

Figure 16 shows accurate power sharing with a 1:1:1 ratio by the combination of the SMC controller and the proposed droop controller, while local loads and the impedance of the three lines are different.

5 Experimental results

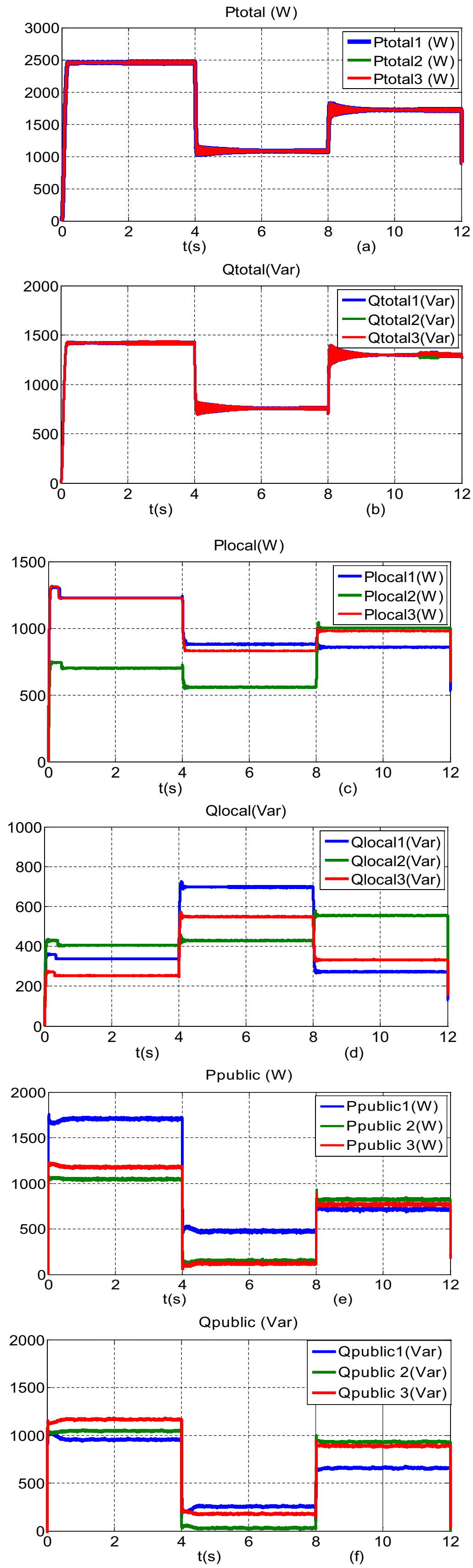
In this paper, a practical model has been developed for testing the proposed method. The developed hardware model consists of three 3-phase inverters: drivers of Semikron, LEM HX 20P, and LV-25P are used as voltage and current sensors as shown in Fig. 17. The proposed control method has been implemented on a TMS320F28335 DSP controller, and the results obtained from the experiment have been captured by a Tektronix TDS2014B oscilloscope and a Fluke 345 PQ clamp meter. The results obtained from the experiment have verified the advantages of the proposed control method through case studies.

The proposed controller is tested for a microgrid which has two inverters, P_1:P_2 = 1:1, Q_1:Q_2 = 1:1, the line impedances are difference, and the load changes.

The experimental results for this case including the real power sharing, reactive power sharing, and voltages are shown in Figs. 18, 19, 20.

The experimental results showed the ratio of the active to reactive powers is 1:1, while local loads and impedances are different. The power sharing errors of results are very small.

Fig. 16 Power sharing of loads: **a** active power of total loads, **b** reactive power of total loads, **c** active power of local loads, **d** reactive power of local loads, **e** active power of public loads, **f** reactive power of public loads ▸



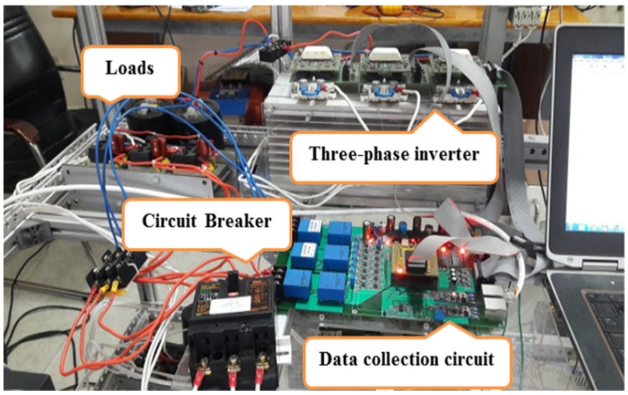


Fig. 17 Hardware setup for the experiment

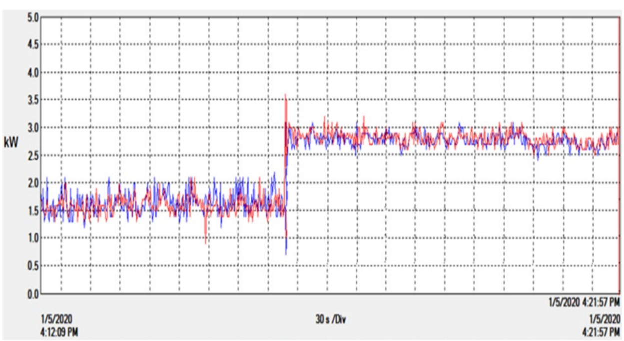


Fig. 18 Real power sharing

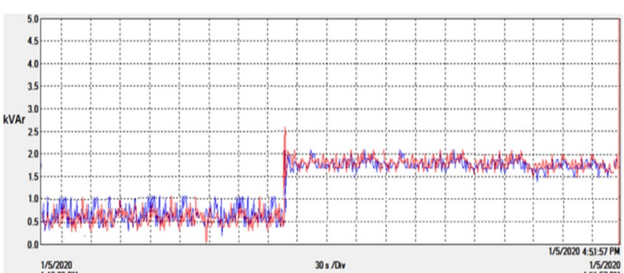


Fig. 19 Reactive power sharing

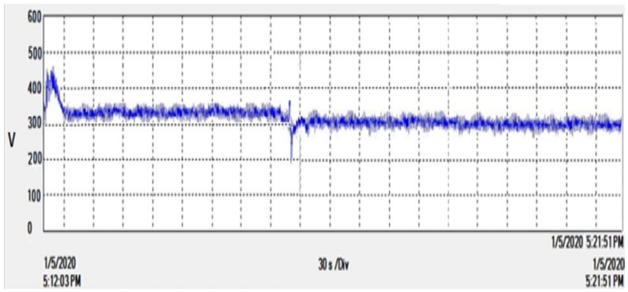


Fig. 20 Voltage at the PCC

6 Conclusion

This paper has proposed an improved power sharing controller by adjusting the droop voltage slope, in order to increase the accuracy of power sharing, while the microgrid has local loads and the line impedances have significant differences for inverters connected to a microgrid. The SMC controller has improved accuracy power sharing and improves the quality of the voltage supplied to the loads. The proposed controller has been simulated and experimental when two inverters are connected in parallel. The simulation and experimental results demonstrate the effectiveness of the proposed control method.

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