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Power Quality Enhancement in Medium-Voltage Distribution Grids: A Performance Evaluation of D²VC and D-STATCOM under Generation Ramps and Load Unbalance

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ABSTRACT The quality of power in medium-voltage distribution grids has become increasingly challenging due to the growing penetration of variable renewable energy sources and the increasing presence of unbalanced loads. Variable distributed generation introduces generation ramps at the Point of Common Coupling (PCC), causing rapid voltage fluctuations and three-phase unbalances that can challenge conventional voltage regulation equipment. To address these issues, this paper compares two voltage compensation controllers: the Dynamic Direct Voltage Controller (D²VC), which directly regulates voltage magnitude and phase, and the Distribution Static Synchronous Compensator (D-STATCOM), which controls voltage through reactive power injection or absorption. The performance of both devices is assessed through time-domain simulations in PSCAD/EMTDC on a grid-connected medium-voltage distribution system under generation-ramp and unbalanced-load conditions. The comparison considers voltage regulation, settling time, apparent power requirements, and voltage unbalance mitigation. The D²VC required 0.430–0.446 MVA, versus 1.66–2.20 MVA for the D-STATCOM, and restored balanced PCC voltages. The D-STATCOM settled faster but retained a residual negative-sequence component. These results demonstrate distinct dynamic and power requirements for the two compensation approaches.

KEYWORDS D-STATCOM, D²VC, generation ramps, medium-voltage distribution systems, point of common coupling, power quality, reactive-power compensation, renewable-energy integration, voltage regulation, voltage unbalance.

I. INTRODUCTION

The increasing connection of Distributed Generation (DG) units poses challenges to Power Quality (PQ) and grid stability. The variable nature of Variable Renewable Energy Sources (VRESs), such as solar and wind power, can intensify voltage and frequency fluctuations [1]. PQ can also be affected by voltage imbalance caused by asymmetric loads and harmonic distortion from power electronic converters used in VRES interfaces and nonlinear loads [2]. Consequently, several studies have been conducted to analyze the capacity of existing electrical systems to support the integration of variable generation sources and propose strategies to expand the connection of renewable sources, ensuring that the voltage profile remains within the quality and reliability limits established by regulatory bodies [3], [4].

Voltage level is a fundamental parameter that measures how well this service is being provided to consumers. It must meet continuity and quality criteria, including maintaining voltage and frequency within nominal values, and maintaining current within nominal values and with a sinusoidal waveform. In Brazil, these indicators are regulated by the National Electric Energy Agency (ANEEL) [5].

The stochastic and intermittent nature of VRESs can cause variations in the generated active power, resulting in imbalances between generation and demand. Significant increases or decreases in generated power over short periods characterize ramp events, classified as upward or downward and described by their magnitude, duration, ramp rate, and start time [6]. In radial and electrically weak distribution networks, greater sensitivity to power variations may cause voltage fluctuations at the PCC and violations of permissible operating limits. In photovoltaic systems, rapid changes in

irradiance may produce overvoltages [7], whereas changes in wind speed at wind farms may cause voltage and frequency fluctuations, requiring appropriate control and mitigation strategies [8].

Barcelos *et al.* [9] discuss voltage-control alternatives for distribution networks with high DG penetration, which may cause overvoltages, imbalance, equipment overloading, harmonics, and protection issues. Conventional solutions include network reconfiguration, switched capacitor banks, direct voltage regulators, and On-Load Tap Changer (OLTC) transformers. However, direct voltage regulators are mainly suitable for localized problems, while the slow and discrete operation of OLTC transformers, together with restrictions on frequent tap changes, limits their ability to follow highly variable generation profiles.

The increasing penetration of distributed and variable renewable energy sources has motivated power-electronics-based solutions for voltage regulation and power-quality improvement in distribution networks. CIGRE has highlighted the potential of voltage-source converters (VSCs) and Flexible AC Transmission Systems (FACTS) devices because of their fast dynamic response and capability to mitigate power-quality disturbances [10]. More recently, the joint CIGRE C2/B4 Working Group has addressed operational challenges associated with power-electronics-interfaced devices [11]. CIGRE has also highlighted voltage-stability challenges in electrical systems with high penetration of inverter-based resources, underscoring the need for fast, adaptive voltage control [12].

To address these limitations, dynamic voltage-support solutions have been investigated, including distribution static synchronous compensators (D-STATCOMs) and static VAR compensators (SVCs) [13], [14], energy storage systems (ESSs), and smart-grid-based strategies [15]. Among the direct-voltage-control alternatives, the Dynamic Direct Voltage Controller (D²VC) stands out as a promising solution [16]. Unlike shunt compensators, which regulate the PCC voltage indirectly through reactive-power exchange, the D²VC injects a series compensation voltage to directly regulate the voltage magnitude and phase, providing a continuous and rapid response to variations in generation and demand.

Although the D²VC has a series–shunt configuration similar to that of the Unified Power Quality Conditioner (UPQC), its application is focused on direct voltage control. A conventional three-phase UPQC employs two three-leg converters, a common DC link, three series injection transformers, and filters to compensate for both voltage and current disturbances [17] [18]. Modular medium-voltage configurations require additional power cells and transformers, increasing cost and complexity [19]. The Universal Power Line Conditioner (UPLC) also incorporates power-flow control, resulting in greater implementation complexity. The D²VC consists of three pairs of single-phase back-to-back VSCs, provides independent phase-voltage control, and avoids additional series coupling transformers [16].

Harmonic compensation performed by the UPQC and UPLC requires additional filters and control loops, increasing the converter rating and power losses [18] [20]. In the D²VC, the series converter synthesizes only the compensating voltage required to regulate the PCC, while the shunt converter regulates the DC-link voltage [16]. This characteristic reduces the required power rating and, consequently, the costs associated with dynamic voltage regulation.

Despite existing power-electronic solutions, fast and direct voltage regulation under rapid generation and demand variations remains a research gap. While UPQC and UPLC provide power quality and power flow compensation, D-STATCOM regulates the PCC voltage indirectly through reactive power. In this context, the authors propose the use of the D²VC for dynamic voltage control to mitigate voltage fluctuations and unbalance in distribution networks with DG.

Direct voltage control (DVC) using the D²VC and indirect voltage control (IVC) using the D-STATCOM were previously evaluated under different operating conditions in [21]. This work extends that analysis by investigating their dynamic response to generation ramps and load imbalance, with particular emphasis on the voltage regulation performance and the active, reactive, and apparent power exchanged by each compensator during the compensation process. The comparative analysis also provides insights into the power requirements associated with each control strategy. Simulations performed in PSCAD/EMTDC assess the ability of both controllers to maintain the PCC voltage within the limits established by power-quality criteria under the considered operating conditions. Section II discusses the compensation strategies, while Section III describes the main characteristics of generation ramps. Section IV presents the simulation results, and Section V summarizes the main conclusions.

II. VOLTAGE COMPENSATION WITH D²VC AND D-STATCOM

The D²VC, illustrated in Fig. 1(a), is a voltage controller composed of three pairs of single-phase VSCs (Voltage Source Converters), one pair per phase, based on IGBTs (Insulated Gate Bipolar Transistors) and PWM (Pulse Width Modulation) control, arranged in a back-to-back configuration and linked by a DC (Direct Current) bus. Compared to conventional controllers, this device consists of VSC₂, which emulates a voltage source V_{comp} connected in series with the secondary winding of the transformer, and VSC₁, which can be interpreted as an equivalent current source i_{shunt} connected to V_S . This configuration enables continuous voltage regulation at the PCC in a Medium-Voltage Distribution System (MVDS) with DG.

In the dynamic or combined control mode, both the voltage magnitude (V_{Comp}) and phase (ϕ) at the PCC are compensated per phase, as illustrated in Fig. 1(b). The phasor diagram shows the angular difference (σ_1) between $\dot{V}_{Sa}$ and $\dot{V}_{PCCa}$, and the compensating voltage phasor $\dot{V}_{Comp}$, synthesized by the D²VC in the fundamental frequency domain. The controller

allows adjustment of both magnitude ($0 \leq V_{Compa} \leq V_{Max}$) and phase ($0^\circ \leq \theta_{Compa} \leq \theta_{MAX}$). Thus, the voltage at the PCC is regulated according to the compensation level V_{Compa} and can be expressed as [16]:

$$\dot{V}_{PCCa} = \dot{V}_{Compae^{j\phi}} + \dot{V}_{Sa}. \quad (1)$$

Fig. 2(a) illustrates the per-phase representation of a three-phase D-STATCOM connected to a generic grid. Fig. 2(b) presents a simplified equivalent: the grid is modeled as a voltage source $\dot{V}_{PCC}$ and the D-STATCOM as $\dot{V}_i$, separated by equivalent reactance X_L . The load is not represented in the simplified equivalent because its influence is reflected in $\dot{V}_{PCC}$, whereas $\dot{V}_i$ represents only the internal voltage of the D-STATCOM. In the phasor diagram, δ is the phase angle between $\dot{V}_{PCC}$ and $\dot{V}_i$. Reactive power compensation is controlled by adjusting the magnitude and phase angle of the D-STATCOM voltage [22].

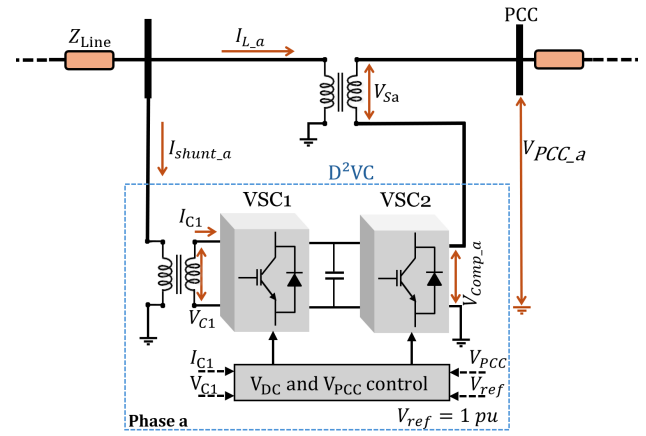
In summary, the D-STATCOM delivers active power toward the bus when the voltage V_i leads the voltage V_s . In this case, $0^\circ < \delta < 90^\circ$. The D-STATCOM absorbs active power from the grid when the voltage V_i lags the voltage V_s , where $-90^\circ < \delta < 0^\circ$. When $V_s = V_i$, the voltage V_i is in phase with the voltage V_s and $\delta = 0^\circ$. There is no circulating current, and therefore no exchange of active or reactive power between the compensator and the grid. When the D-STATCOM controls inductive reactive current toward the bus: to achieve this, the voltage magnitude $|V_s| > |V_i|$, and V_i must be in phase with V_s , with $\delta = 0^\circ$. Under this condition, there is no active power flow.

Unlike the theoretical lossless representation, in practical operation, the D-STATCOM requires a small amount of active power from the AC grid to maintain the DC-link voltage and compensate for converter and transformer losses, while the reactive power remains dictated by the difference in voltage magnitudes.

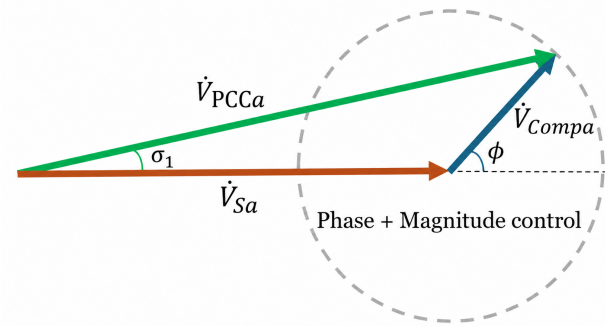
A. Voltage Control Strategies from D^2VC and D-STATCOM

Various control strategies have been proposed for the D^2VC , each addressing specific operating modes and configurations [9], [16], [23]. For example, [24] presents a DC-link control method based on pq Theory for the Modified Dynamic Direct Voltage Controller (MD^2VC), which eliminates the need for adaptive hysteresis current control. Additionally, the approach in [23] utilizes positive and negative sequence components in the $\alpha\beta$ -frame, thereby removing the requirement for a Unified Three-Phase Processor (UTSP) [16], and applies Proportional-Resonant (PR) controllers to generate reference signals. However, PR controllers make current limiting difficult under short-circuit conditions.

In the D^2VC control strategy adopted in this study, the series converter directly compensates the PCC voltage magnitude and phase by estimating the voltage's instantaneous symmetrical components using a UTSP. Concurrently, the shunt converter regulates the DC-link voltage to a constant value by



(a) Single-line diagram



(b) Phasor diagram for the combined control mode in phase a

FIGURE 1. D^2VC for the combined control mode in phase a. [21]

controlling the injected current, which is implemented using a PI controller based on the DC voltage error, driven by a hysteresis band controller, and synchronized with the grid via a Phase-Locked Loop (PLL). The block diagram for this direct control of voltage magnitude and phase, applied to each series VSC, is shown in Fig. 3, and the overall strategy was originally proposed by Barcelos *et al.* [16].

The UTSP decomposes the three-phase voltage signals into positive-, negative-, and zero-sequence components, estimating their magnitudes, phase angles, and angular frequency through sine and cosine generators and dot-product blocks. Each estimated component is compared with its respective reference, and the resulting error is processed by a PI controller to determine the voltage magnitude to be compensated. The resulting voltages are then combined to generate the three-phase references for the Sinusoidal PWM (SPWM) modulation of VSC₂ [16] [25].

Based on the experimental validation of the D^2VC control strategy and its simulation model reported in [16] and [26], the present work extends its application to a MVDS subjected to generation ramps and load-imbalance conditions. While [16] experimentally validated the D^2VC for grids with intermittent sources, and [26] further validated its operation and simulation model, the present study focuses on the comparative dynamic

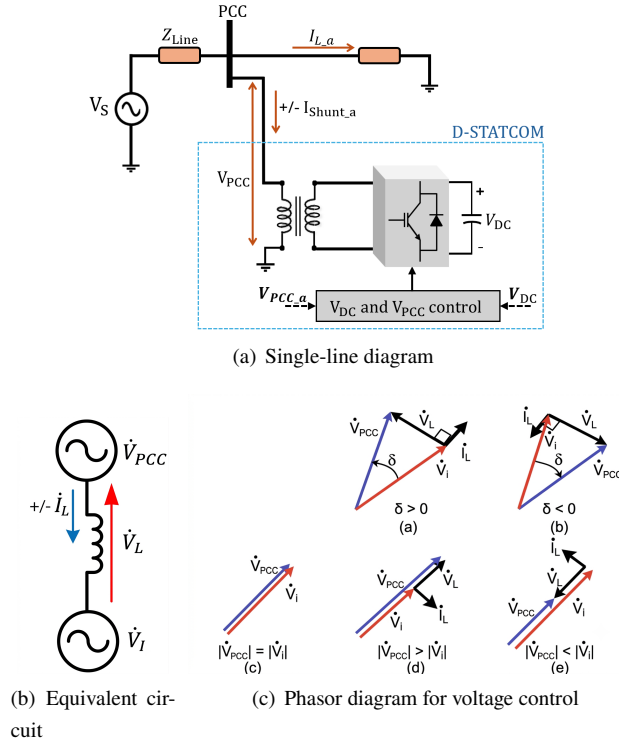


FIGURE 2. D-STATCOM [21].

performance of the D²VC and D-STATCOM, including PCC voltage regulation and the active, reactive, and apparent power exchanged during the compensation process.

The voltage regulation strategies for D-STATCOM include reactive power compensation using state feedback control [27], dq0 transformation with PWM techniques [28], and indirect control via reactive current injection at the point of connection [29]. The control strategy used here is based on reactive power compensation [30], defining the phase angle between the PCC voltage and the D-STATCOM output voltage, as shown in Fig. 4. The reactive current Q_m/V_{PCC} is multiplied by a gain of 0.03 and filtered using a 90-Hz low-pass filter (LPF) and notch filters (NFs) at 120 and 60 Hz. The filtered signal is compared with V_{ref} , and a PI controller determines the phase angle ϕ . The adjustment of this angle determines the level of reactive compensation provided by the D-STATCOM. The main topology and control parameters adopted for the D²VC and D-STATCOM are summarized in Table 1.

TABLE 1. D²VC versus D-STATCOM topologies

Parameter	D ² VC	D-STATCOM
Grid connection	Shunt-series	Shunt
Configuration	3 pairs of VSCs 1 ϕ back-to-back	1 VSC 3 ϕ
Coupling transformers	3 single-phase transformers	1 three-phase transformer
Control method	DVC	IVC
Number of switches	24 IGBTs	6 IGBTs
DC links	3	1

III. RAMP EVENTS

According to [31], ramps are classified as ascending, when $P(t) > P(t - \Delta t)$, or descending, when $P(t) < P(t - \Delta t)$, by comparing the current power value $P(t)$ with the previous value $P(t - \Delta t)$. The quantification of these variations is given by the ramp-rate (RR), defined as the variation of the generated power in relation to the time interval Δt , as [31]:

$$RR = \frac{P(t) - P(t - \Delta t)}{\Delta t}. \quad (2)$$

Formally, RR expresses the rate at which the power oscillates between two operating states. In this context, variations in resource availability, operating conditions, or generation curtailment can modify the active power injected at the PCC. In photovoltaic systems, these variations are mainly associated with passing clouds and generally produce shorter and smaller ramps than those observed in wind generation [32], [33]. Fig. 5(a) presents a PVDG profile from which fast-ramp, slow-ramp, and step-change events are selected. Although extracted from a photovoltaic profile, these events are treated as active-power disturbances to evaluate the voltage controllers independently of the generation technology. Fig. 5 shows the corresponding ramp rates.

Generation profile and ramp rates: (a) active power; (b) fast ramp (I); (c) slow ramp (II); (d) critical event (III).

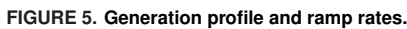
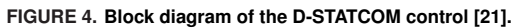
Such events impose dynamic stress on the MVDS and affect PCC voltage, especially under high VRES penetration, justifying power-electronics-based solutions for rapid, continuous voltage regulation during ramp-ups.

IV. RESULTS

The performance of the D²VC and D-STATCOM controllers in mitigating voltage variations at the PCC within an MVDS integrated with an equivalent DG unit is evaluated in this section [21]. The parameters for the controllers and the MVDS are provided in [1]. Time-domain simulations were conducted in PSCAD/EMTDC (Fig. 6) to evaluate the D²VC and D-STATCOM connected at the PCC (Figs. 1 and 2) operating under specific control strategies (Figs. 3 and 4). The feeder is modeled as a short distribution line with $R \approx X$, a factor that affects the grid's voltage-power relationship. The equipment operates differently to regulate voltage: the D²VC acts by DVC, whereas the D-STATCOM provides IVC through reactive-power compensation.

A. Voltage Compensation under Generation Ramp Events

This study assesses the effectiveness of voltage compensation at the PCC in mitigating voltage deviations caused by generation ramps selected from a 24-h active-power profile. The selected events are temporally compressed over a 3-second simulation interval. Three operating scenarios were defined based on the active-power ramp rate. Scenarios I and II represent fast ($RR^+ = 0.094$, $RR^- = -0.100$ MW/s) and slow ($RR^+ = 0.032$, $RR^- = -0.036$ MW/s) ramps,



For comparison, both controllers were required to maintain the PCC voltage within $\pm 2\%$ of the 1.0-pu reference [5]. The

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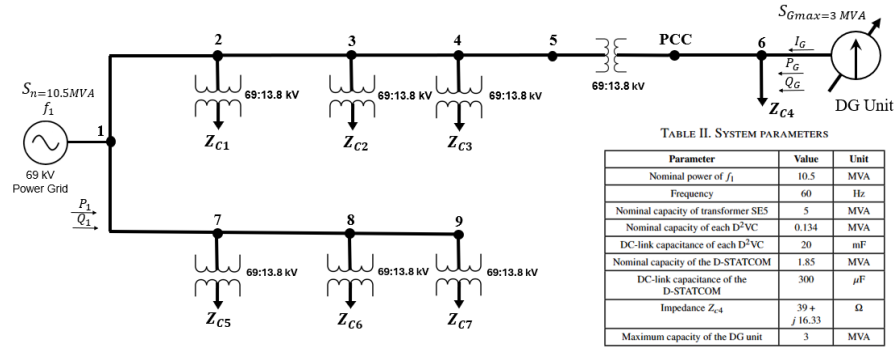


FIGURE 6. Simplified representation of the MVDS with an equivalent DG unit [21], [25].

was computed from the fundamental components of voltage and current, obtained via a Fast Fourier Transform (FFT). In the case of the D-STATCOM, the apparent power (S_{DSTAT}) is defined as the product of the PCC voltage (V_{PCC}) and the compensating current (I_C), augmented by the apparent power contribution of the transformer ($S_{Transformer}$):

$$S_{DSTAT} = V_{PCC} \cdot I_C + S_{Transformer}. \quad (3)$$

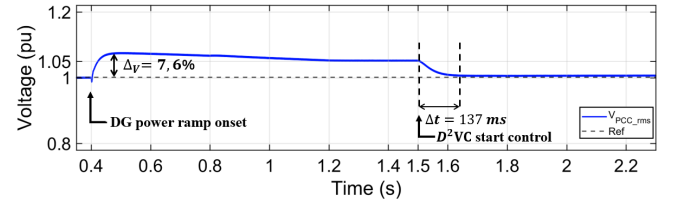
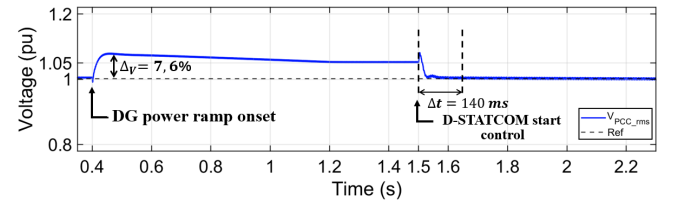
For the D²VC, the total apparent power (S_{D^2VC}) is the sum of the series ($S_{VSC_{Series}}$) and shunt ($S_{VSC_{Shunt}}$) converter powers, plus the low-power transformer contribution ($S_{Transformer}$) per phase. The system is three-phase, the total apparent power is:

$$S_{D^2VC} = 3 (S_{VSC_{Series}} + S_{VSC_{Shunt}} + S_{Transformer}). \quad (4)$$

In Scenario I, the performance of the controllers in compensating voltage variations in the PCC is evaluated by subjecting the DG unit to a fast generation ramp, with an upward ramp rate $RR^+ = 0.094$ MW/s and a downward ramp rate $RR^- = -0.100$ MW/s. Initially, the DG active-power ramp begins at 0.4 s, causing a 7.6% increase in the PCC voltage magnitude, which exceeds the admissible limit of 1.05 pu. In Fig. 7(a), D²VC² control is initiated at 1.5 s, reducing the PCC voltage to the reference value of 1.0 p with a response time of 137 ms. Under the same conditions, D-STATCOM reduces the magnitude of the PCC line voltage to 1.0 pu within 140 ms Fig. 7(b).

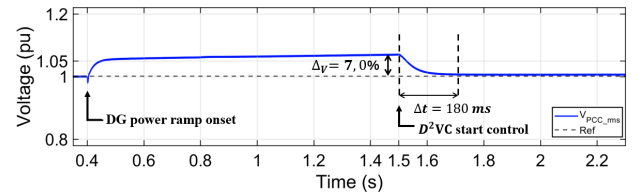
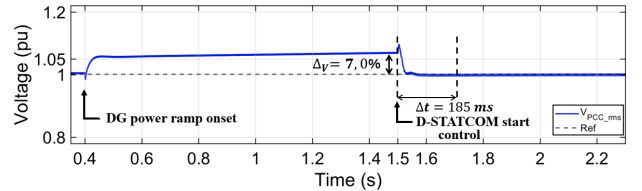
In Scenario II, the voltage compensation effectiveness of the controllers at the PCC is evaluated under using a slow generation ramp, with an upward ramp rate, with an upward ramp rate $RR^+ = 0.032$ MW/s and a downward ramp rate $RR^- = -0.036$ MW/s. The DG active-power ramp begins at 0.4 s, causing an increase in active power injection and, consequently, a 7.0% rise in the PCC voltage magnitude. This results in a PCC line voltage of approximately 1.07 pu, which significantly exceeds the 1.05 pu limit. In Fig. 8(a), the D²VC actuation at $t = 1.5$ s reduced the PCC line voltage magnitude to 1.0 pu with a response time of 180 ms. 8(b), the D-STATCOM reduces the PCC line voltage to 1.0 pu with a response time of 185 ms.

In Scenario III, the controllers' performance in compensating the PCC voltage is evaluated under a critical generation event with sudden power variations and peak ramp rates

(a) D²VC - Scenario I

(b) D-STATCOM - Scenario I

FIGURE 7. Scenario I - Results for both controllers.

(a) D²VC - Scenario II

(b) D-STATCOM - Scenario II

FIGURE 8. Scenario II - Results for both controllers.

of $RR^\pm = \pm 0.090$ MW/s. The DG active-power variation, starting at 0.4 s, raises the PCC voltage magnitude by 7.6% relative to the reference. In Fig. 9(a), with the activation of the D²VC at 1.5 s, the voltage fluctuations at the PCC are normalized to the reference voltage in just 200 ms. In Fig. 9(b),

TABLE 2. Power magnitudes and settling times.

Scenario	D ² VC: $ P / Q $; $t_{s,PQ}$	D-STATCOM: $ P / Q $; $t_{s,PQ}$
I	0.423/0.061; –	0.685/1.246; 0.435
II	0.437/0.042; –	0.650/1.785; 0.974
III	0.439/0.047; 1.395	0.694/1.746; 1.394

$|P|$ in MW, $|Q|$ in MVar, and $t_{s,PQ}$ in s. 5% criterion; times from $t = 1.5$ s. –: Residual P oscillation.

the D-STATCOM regulates the PCC line voltage to 1.0 pu with a settling time of 204 ms.

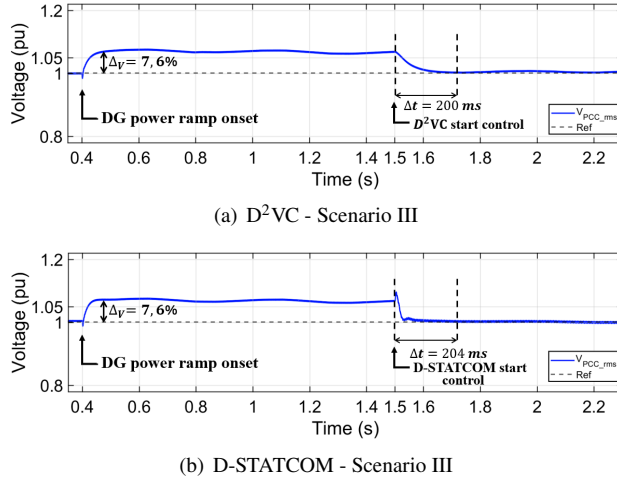
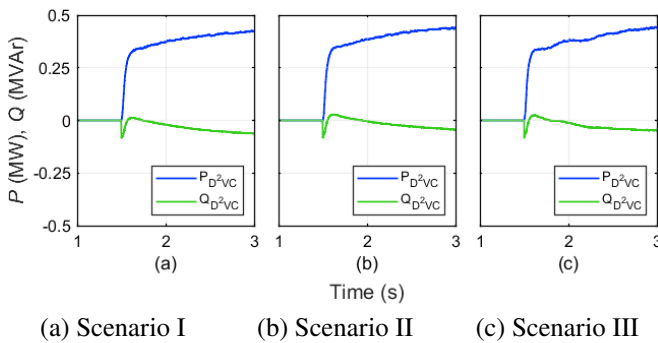
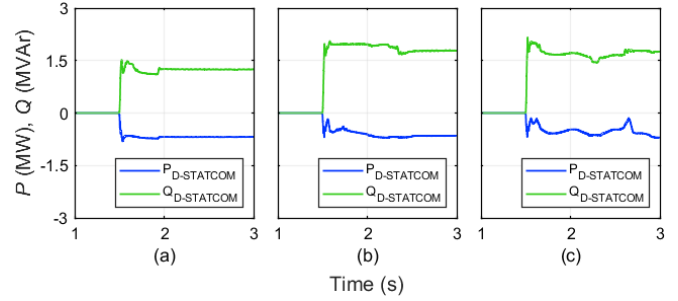


FIGURE 9. Scenario III - Results for both controllers.

The results for the different scenarios are shown in Table 3. The D²VC exhibited slightly shorter settling times than the D-STATCOM in all three scenarios. In all cases, the D²VC required less apparent power than the D-STATCOM. Figs. 10 and 11 show the active and reactive powers measured on the AC side of the phase-*a* VSCs of the D²VC and the D-STATCOM, respectively, for the same voltage compensation level. Table 2 summarizes the power magnitudes and joint settling times for both compensators across the three scenarios.


 FIGURE 10. Active and reactive power of the D²VC.

The parametric analysis conducted in [34], considering different R/X ratios, showed that series voltage injection required a lower compensator rating than reactive-power compensation for medium-voltage lines with $R \approx X$. This result is consistent with the lower apparent-power requirement



(a) Scenario I (b) Scenario II (c) Scenario III

FIGURE 11. Active and reactive power of the D-STATCOM.

TABLE 3. Quantitative comparison under generation-ramp scenarios.

Performance metric	Scenario I	Scenario II	Scenario III
ΔV_{PCC} (%)	7.6	7.0	7.6
t_{s,D^2VC} (ms)	137	180	200
$t_{s,D-STATCOM}$ (ms)	140	185	204
S_{D^2VC} (MVA)	0.430	0.444	0.446
$S_{D-STATCOM}$ (MVA)	1.66	2.11	2.20

of the D²VC compared with the D-STATCOM in the present work.

B. Voltage Compensation under PV Ramp Events and Unbalanced Load

In Scenario IV, the performance of the D²VC and of the D-STATCOM controllers are analyzed under variable active power injection from the DG unit and the existence of a voltage imbalance due to the connection of an unbalanced load Z_{c4} close to the PCC (represented as in Fig. 6). In this case, the following impedance values per phase were considered: $Z_{c4a} = (167 + j16) \Omega$, $Z_{c4b} = (75 + j33) \Omega$, and $Z_{c4c} = (50 + j28) \Omega$. Fig. 12(a) and 12(c) show the voltage values at the PCC, in pu, under load imbalance Z_{c4} and PVDG operation. It can be observed that the three phases are affected at different levels, with phase A being the most affected, since its voltage magnitude exceeds the compliance limit of 1.05 pu. After compensation performed by D²VC at 1.5 s, the voltages at the PCC return to the nominal value, and consequently, the voltage imbalance is mitigated, as shown in Fig. 12(b). Although the D-STATCOM achieved a shorter settling time, it did not fully eliminate the voltage asymmetry, leaving a residual negative-sequence component. Increasing the DC-link capacitance did not remove this residual component, indicating a limitation of the adopted control strategy. In contrast, the D²VC rejects the negative-sequence component and restores balanced PCC voltages.

The residual voltage unbalance of the D-STATCOM in Fig. 12(d) results from its control structure, which does not independently regulate each phase voltage. In contrast, the D²VC independently controls the three-phase voltages through six single-phase VSCs, enabling more effective unbalance compensation.

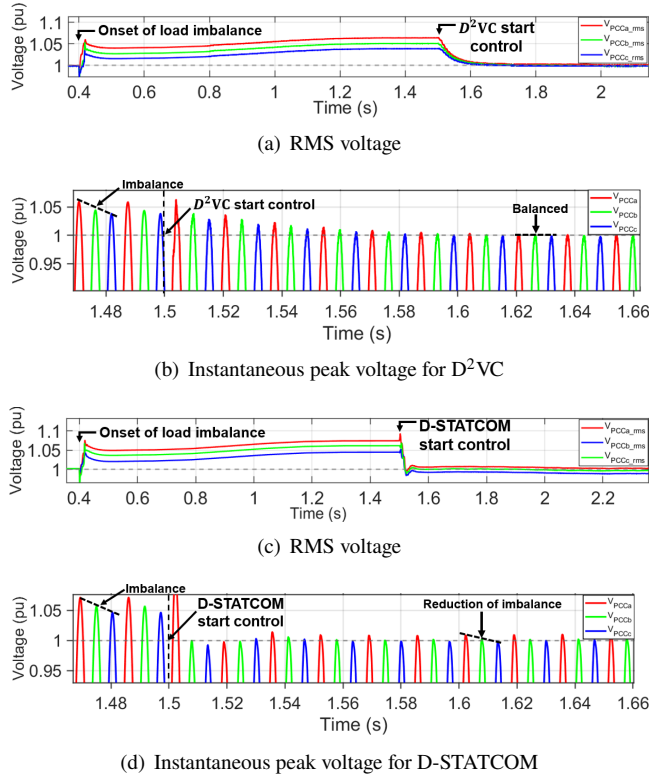


FIGURE 12. Scenario IV - PCC voltage profile comparison under unbalanced conditions.

V. CONCLUSION

This work evaluated the D²VC and D-STATCOM control strategies for voltage-profile regulation and power-quality enhancement in an MVDS characterized by $R \approx X$, considering generation-ramp events and load-imbalance conditions. In the first analysis, both controllers compensated for the voltage variations at the PCC caused by generation ramps and maintained the PCC voltage at its nominal value.

Subsequently, the analysis under load imbalance showed that the proposed D²VC control strategy, based on sequence-component estimation, enabled independent compensation of the magnitude and phase angle of each phase voltage, keeping the voltages within the nominal operating range and mitigating voltage imbalance at the load bus. Although the D-STATCOM demonstrated good voltage-regulation capability at the PCC, it did not fully correct the phase asymmetry because the adopted control strategy does not include a dedicated negative-sequence compensation loop. The simulation results indicate that the D²VC and D-STATCOM are effective solutions for voltage regulation and power-quality enhancement, particularly in MVDS subject to generation ramps and load imbalance. Future work will investigate their dynamic responses under voltage surges and overcurrents to support protection system design, alongside a comprehensive techno-economic analysis of DVC/IVC-based solutions across different distribution levels.

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AUTHOR'S CONTRIBUTIONS

I.S.RODRIGUES: Software, Writing – Original Draft. **A.D.FERREIRA:** Writing – Review & Editing. **S.L.BARCELOS:** Supervision, Validation. **E.H.WATANABE:** Funding Acquisition, Supervision.

PLAGIARISM POLICY

This article was submitted to the similarity system provided by Crossref and powered by iThenticate – Similarity Check.

DATA AVAILABILITY

The data used in this research is available in the body of the document.

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