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The Inclusion of Power Gyrator Topologies as Energy Processing Cells in Photovoltaic Solar Conversion

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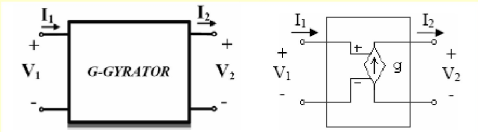
Herminio Martínez García & Encarna García Vílchez

Eastern Barcelona School of Engineering (EEBE)
Department of Electronics Engineering. Technical University of Catalonia (UPC). BarcelonaTech
Eduard Maristany Ave., nº 16. E-08019 - Barcelona. SPAIN
{ herminio.martinez ; encarna.garcia.vilchez }@upc.edu

Aims, Motivation, Introduction, and Concept

- The paper provides a classification of high efficiency switching power-gyrator structures and their use as cells for energy processing in photovoltaic solar facilities. Having into account the properties of these topologies presented in the article, their inclusion in solar facilities allows increasing the performance of the whole installation.
- Thus, the design, simulation and implementation of a *G*-type power gyrator are carried out throughout the text. In addition, in order to obtain the maximum power from the photovoltaic solar panel, a maximum power point tracking (MPPT) is mandatory in the energy processing path.
- Therefore, the practical implementation carried out includes a control loop of the power gyrator in order to track the aforementioned maximum power point of the photovoltaic solar panel.

Concept of 'Power Gyrator'



Basic block of a *G*-type power gyrator.

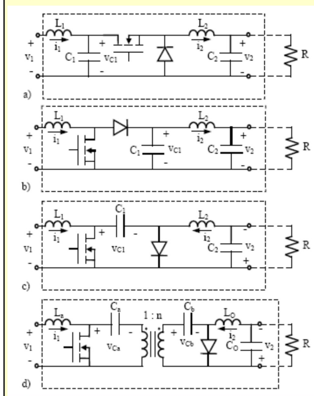
- **A power gyrator type *G* is defined as a switching converter which satisfies next equations and with the characteristic that the input current and output current are not pulsed:**

$$i_1 = gv_2 \qquad i_2 = gv_1$$

- **… where the parameter '*g*' is the conductance of the gyrator.**
- **The *G*-type power gyrator with controlled output current behaves like a current source in its output port.**

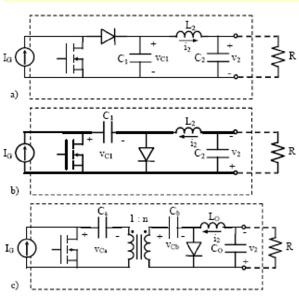
Classification of Power Gyrators

- **The concept of power gyrator relates to a general sort of circuits named POPI, describing the ideal behavior of a switched-mode power converter.**
- **In general, two big groups of power gyrators can be found: *G*-type and *R*-type gyrators.**



Classification of *G*-type power gyrators: **(a)** Buck with input filter (BIF), **(*b*)** boost with output filter (BOF), **(*c*)** Ćuk converter, and **(*d*)** Ćuk isolated.

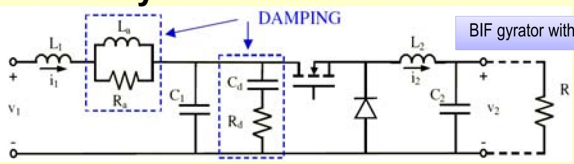
$$i_1 = gv_2 \quad i_2 = gv_1$$



Classification of *R*-type gyrators: **(*a*)** boost with output filter (BOF), **(*b*)** Ćuk converter, and **(*c*)** Ćuk isolated.

$$v_1 = ri_2 \quad v_2 = ri_1$$

Stability Considerations of the BIF Gyrator



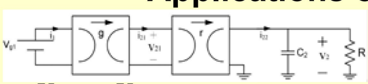
BIF gyrator with damping network.

- **The analysis of the BIF G-type gyrator controlled by means of a sliding control loop shows that the system must meet a series of inequalities or conditions to obtain the necessary stability of the circuit; in particular:**

$$R_d C_d < \frac{C_1 + C_d}{g^2 R} \qquad R_d C_d > g^2 R L_1$$

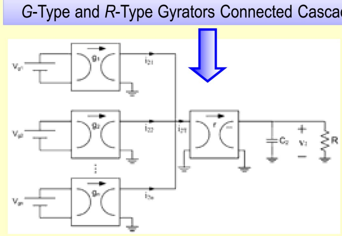
$$g^2 R R_d^2 C_d^2 + g^2 R L_1 (C_1 + C_d) < (g^4 R^2 L_1 + C_d) R_d D_d$$

Applications of Gyrators

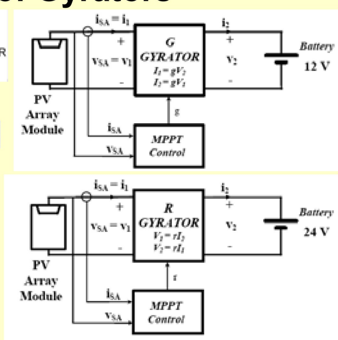


$$V_2 = rgV_{g1} \qquad I_1 = rgI_{22}$$

G-Type and *R*-Type Gyrators Connected Cascade.

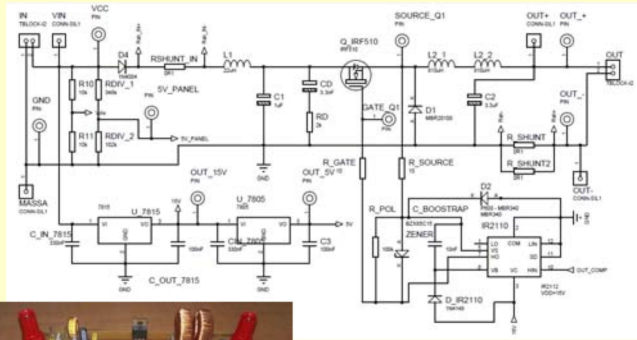


n G-type gyrators cascaded with a single *R*-type gyrator.



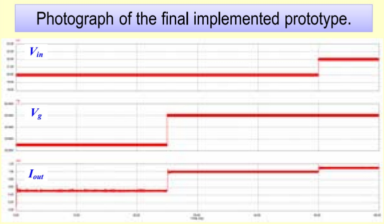
Block diagrams for *G*-type and *R*-type including a MPPT subsystem.

Simulation and Experimental Results

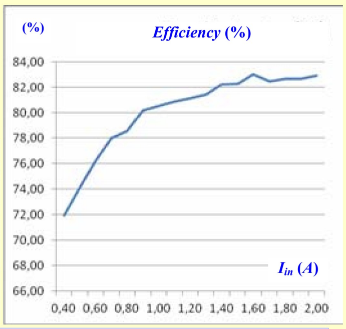


Schematics of the implemented BIF *G*-type gyrator.

Photograph of the final implemented prototype.



Simulation results of the implemented G-type power gyrator.



Experimental efficiency of the G-type power gyrator for different values of the input current.

Main Conclusions

- **The paper has provided the validity of their use as cells for energy processing in photovoltaic solar facilities. In particular, having into account the properties of these topologies presented in the article, their inclusion in solar facilities allows increasing the performance of the whole installation. The design, simulation and implementation of a G-type power gyrator are carried out throughout the article, including a sliding control implemented by means an analog controller.**
- **In addition to the use of the aforementioned switching power gyrator, a MPPT is mandatory in the energy processing path in order to obtain the maximum power from the photovoltaic solar panel. Therefore, the practical implementation carried out includes a control loop of the power gyrator in order to track the aforementioned maximum power point of the photovoltaic solar panel. In the presented design, this MPPT circuit has been implemented by means of a PIC microcontroller that achieves the tracking of the PV-panel MPP. In the case carried out in this article, the MPPT algorithm implemented has been the named 'perturbation and observation' (P&O).**

Acknowledgements

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