




|   |  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
|---|--|---|---|--|---|-----------|--------------|---------|------------------|-----------------|----------------|--|---|--|---|-----------------------|----------------------|---------|---------------|----------|------------------|----------------|----------|--|--|--|--|----------------------|------------------|
| <b>Prüfbericht-Nr.:</b><br><i>Test Report No.:</i>  | <b>28119678 001</b>  | <b>Auftrags-Nr.:</b><br><i>Order No.:</i>   | 7971112   | Seite 2 von 131<br>Page 2 of 131                 |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Kunden-Referenz-Nr.:</b><br><i>Client Reference No.:</i>   | 1984729  | <b>Auftragsdatum:</b><br><i>Order date:</i> | 04.05.2020  |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Auftraggeber:</b><br><i>Client:</i>  | Enertronica Santerno S.p.A.<br>Via Della Concia, 7 - 40023 – Castel Guelfo (BO) – Italy  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Prüfgegenstand:</b><br><i>Test item:</i>   | Grid-tied photovoltaic inverter  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Bezeichnung / Typ-Nr.:</b><br><i>Identification / Type No.:</i>  | SUNWAY TG900(1800) TE – YYY ZZZ  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Auftrags-Inhalt:</b><br><i>Order content:</i>  | Grid Connection  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Prüfgrundlage:</b><br><i>Test specification:</i>   | <b>CEI 0-16:2019-04</b><br>Regola tecnica di riferimento per la connessione di Utenti attivi e passivi alle reti AT ed MT delle imprese distributrici di energia elettrica<br><i>/ Reference technical rules for the connection of active and passive consumers to the HV and MV electrical networks of distribution Company</i> |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Wareneingangsdatum:</b><br><i>Date of receipt:</i>   | TMP Procedure  |   |                                |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Prüfmuster-Nr.:</b><br><i>Test sample No.:</i>   | ZZEG900EOY03 90000   |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Prüfzeitraum:</b><br><i>Testing period:</i>  | From: 07.02.2020<br>To: 19.03.2020   |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Ort der Prüfung:</b><br><i>Place of testing:</i>   | TÜV Rheinland Italia S.r.l.  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Prüflaboratorium:</b><br><i>Testing laboratory:</i>  | TÜV Rheinland Italia S.r.l.  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Risultato dei test:</b><br><i>Testing results:</i>   | <b>Pass</b>  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>geprüft von / tested by:</b>   |  |   | <b>kontrolliert von / reviewed by:</b>  |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| 23.06.2020/ Luca Li Vecchi (Tester)    |  |   | 23.06.2020/ Marco Piva (TC)  |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Datum</b><br><i>Date</i>   | <b>Name / Stellung</b><br><i>Name / Position</i>   | <b>Unterschrift</b><br><i>Signature</i>     | <b>Datum</b><br><i>Date</i>   | <b>Name / Stellung</b><br><i>Name / Position</i> | <b>Unterschrift</b><br><i>Signature</i> |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Sonstiges / Other:</b>   |  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Zustand des Prüfgegenstandes bei Anlieferung:</b><br><i>Condition of the test item at delivery:</i>  |  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <table border="0"> <tr> <td>*Legende:</td> <td>1 = sehr gut</td> <td>2 = gut</td> <td>3 = befriedigend</td> <td>4 = ausreichend</td> <td>5 = mangelhaft</td> </tr> <tr> <td></td> <td>P(ass) = entspricht o.g. Prüfgrundlage(n)</td> <td></td> <td>F(ail) = entspricht nicht o.g. Prüfgrundlage(n)</td> <td>N/A = nicht anwendbar</td> <td>N/T = nicht getestet</td> </tr> <tr> <td>Legend:</td> <td>1 = very good</td> <td>2 = good</td> <td>3 = satisfactory</td> <td>4 = sufficient</td> <td>5 = poor</td> </tr> <tr> <td></td> <td>P(ass) = passed a.m. test specification(s)</td> <td></td> <td>F(ail) = failed a.m. test specification(s)</td> <td>N/A = not applicable</td> <td>N/T = not tested</td> </tr> </table> |  |   |   |  |   | *Legende: | 1 = sehr gut | 2 = gut | 3 = befriedigend | 4 = ausreichend | 5 = mangelhaft |  | P(ass) = entspricht o.g. Prüfgrundlage(n) |  | F(ail) = entspricht nicht o.g. Prüfgrundlage(n) | N/A = nicht anwendbar | N/T = nicht getestet | Legend: | 1 = very good | 2 = good | 3 = satisfactory | 4 = sufficient | 5 = poor |  | P(ass) = passed a.m. test specification(s) |  | F(ail) = failed a.m. test specification(s) | N/A = not applicable | N/T = not tested |
| *Legende:   | 1 = sehr gut   | 2 = gut                                     | 3 = befriedigend  | 4 = ausreichend                                  | 5 = mangelhaft                          |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
|   | P(ass) = entspricht o.g. Prüfgrundlage(n)  |   | F(ail) = entspricht nicht o.g. Prüfgrundlage(n)   | N/A = nicht anwendbar                            | N/T = nicht getestet                    |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| Legend:   | 1 = very good  | 2 = good                                    | 3 = satisfactory  | 4 = sufficient                                   | 5 = poor                                |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
|   | P(ass) = passed a.m. test specification(s)   |   | F(ail) = failed a.m. test specification(s)  | N/A = not applicable                             | N/T = not tested                        |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |
| <b>Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.</b><br><i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>  |  |   |   |  |   |           |              |         |                  |                 |                |  |   |  |   |                       |                      |         |               |          |                  |                |          |  |  |  |  |                      |                  |

## TEST REPORT

**CEI 0-16:2019-04**

**Regola tecnica di riferimento per la connessione di Utenti attivi e passivi alle reti AT ed MT delle imprese distributrici di energia elettrica**

*/ Reference technical rules for the connection of active and passive consumers to the HV and MV electrical networks of distribution Company*

**Report reference no. ....: 28119678 001**

Tested by (name + signature).....: Luca Li Vcchi (Tester) (signature on first page)

Approved by (name + signature).....: Marco Piva (TC) (signature on first page)

Date of issue.....: 23.06.2020

Total number of pages.....: 131

**Testing Laboratory** .....: TÜV Rheinland Italia S.r.l.

Address.....: Via Mattei 3 - 20010 - Pogliano Milanese (MI) – Italy

**Applicant's name** .....: Enertronica Santerno S.p.A.

Address.....: Via Della Concia, 7 - 40023 – Castel Guelfo (BO) – Italy

**Test item description** .....: Solar Grid Tied Inverter

Trade Mark .....:



Manufacturer .....: Enertronica Santerno S.p.A.

Model/Type reference.....: SUNWAY TG900(1800) TE – YYY ZZZ  
*See general product information section for complete list of models*

Ratings.....: Input: up to 1500V  
Output: 580 – 690Vac 50/60Hz phase-phase

**Sample** .....: Prototype selected by the customer

Samples received on .....: TMP Procedure

TUV reference samples.....: TMP Procedure


Samples tested n.....: 1

I risultati del rapporto di prova si riferiscono esclusivamente ai campioni sotto test. Senza l'autorizzazione scritta di TÜV Rheinland Italia S.r.l., questo documento può essere riprodotto solo integralmente

*The results in this Test Report are exclusively referred to the tested samples. Without the written authorization of TÜV Rheinland Italia S.r.l., this document can be reproduced only integrally*

|  |  |
|--|--|
| Testing procedure and testing location:  |  |
| <input checked="" type="checkbox"/> <b>Testing Laboratory:</b><br>Testing location/ address ..... :<br><input type="checkbox"/> <b>Associated Laboratory:</b><br>Testing location/ address ..... :       | TÜV Rheinland Italia S.r.l.<br>Via Mattei 3, Pogliano Milanese, 20010 MI, Italy<br><br>Tested by (name + signature) ..... : Luca Li Vecchi / Tester (signature on first page)<br>Approved by (+ signature) ..... : Marco Piva / TC (signature on first page) |
| <input checked="" type="checkbox"/> Testing procedure: TMP<br>Testing location/ address ..... :<br>Tested by (name + signature) ..... :<br>Approved by (+ signature) ..... :                             | Enertronica Santerno S.p.A.<br>Via Della Concia, 7 - 40023 – Castel Guelfo (BO) – Italy<br>Luca Li Vecchi / Tester (signature on first page)<br>Marco Piva / TC (signature on first page)  |
| <input type="checkbox"/> Testing procedure: WMT<br>Testing location/ address ..... :<br>Tested by (name + signature) ..... :<br>Witnessed by (+ signature) ..... :<br>Approved by (+ signature) ..... :  |  |
| <input type="checkbox"/> Testing procedure: SMT<br>Testing location/ address ..... :<br>Tested by (name + signature) ..... :<br>Approved by (+ signature) ..... :<br>Supervised by (+ signature) ..... : |  |
| <input type="checkbox"/> Testing procedure: RMT<br>Testing location/ address ..... :<br>Tested by (name + signature) ..... :<br>Approved by (+ signature) ..... :<br>Supervised by (+ signature) ..... : |  |



| Informazioni generali sul prodotto / General product information: |   |
|---|---|
| <b>Product:</b>   | <input checked="" type="checkbox"/> Static generator (Grid-tied photovoltaic inverter)<br><input type="checkbox"/> Energy Storage System (EES)<br><input type="checkbox"/> Synchronous generator<br><input type="checkbox"/> Asynchronous generator<br><input type="checkbox"/> Wind Full converter (FC)<br><input type="checkbox"/> Wind Doubly Fed Induction Generator                |
| <b>License Holder:</b><br>Address:                                | Enertronica Santerno S.p.A.<br>   |
| <b>Manufacturing plant:</b><br>Address:                           | Via Della Concia, 7 - 40023 – Castel Guelfo (BO) – Italy  |
| <b>Model(s):</b>  | SUNWAY TG900(1800) TE – YYY ZZZ   |
| <b>N°serie / Serial n°:</b>                                       | TMP Procedure   |
| <b>Testing Location:</b><br>Address:                              | <b>§. N.1 Esecuzione delle prove – accreditamento</b><br>N.1 Testing - Accreditation<br><input type="checkbox"/> EA - ISO/EN 17025 testing Laboratory<br><i>(See testing laboratory address)</i><br><input checked="" type="checkbox"/> Manufacturing Plant / Customer facility<br><i>EA - ISO/EN 17025 testing Laboratory (witnessing)</i><br><i>(see Manufacturing plant address)</i> |
| <b>Testing Laboratory:</b><br>Address:                            | TÜV Rheinland Italia S.r.l<br>Via Mattei 3 - 20010 - Pogliano Milanese (MI) – Italy<br>Accreditation N. 1356  |
| <b>Input Voltage (Rated):</b>                                     | Input: up to 1500V  |
| <b>Output Voltage (Rated):</b>                                    | Output: 580 – 690Vac 50/60Hz phase-phase  |
| <b>Software version:</b>  | MOTOROLA 1.718  |



**General Product information:**

The SUNWAY TG TE line comprises medium-power and large-power three-phase solar inverters for the connection to the LV and MV grid.

The new product range includes modular models designed to ensure optimum reliability and performance at the most convenient costs for the shortest time-to-market of custom solutions as well.

The following versions are available:

- 1100V Version, suitable for PV field voltage ratings up to max 1100 Vdc maximum.
- 1500V Version, for PV field voltage ratings up to 1500 Vdc maximum.

The SUNWAY TG TE inverters are designed for optimum conversion efficiency and reliability. They are fully protected against short-circuits and surge and are compliant with the strictest Italian and European directives regulating the safety and energy feed-in systems.

All the SUNWAY TG TE inverters are fully compatible with Tracker applications.

Thanks to these features, the SUNWAY TG TE inverters represent the state-of-the-art solution for the production of energy from PV field.



**Models of the same family:**

| Model   | Input Voltage [V] | Rated Output Voltage [V] | Rated Output Current [A] | Maximum Apparent Power [kVA] | Nominal Active Power [kW] | cos( $\phi$ ) rating | Maximum full power operating ambient [°C] |
|---|-------------------|--------------------------|--------------------------|------------------------------|---------------------------|----------------------|---|
| <b>Sunway TG900 1500V TE – YYY<br/>ZZZ</b>  | 1500              | YYY                      | 800                      | (*)                          | (*)                       | Circular Capability  | 45  |
| <b>Sunway TG1800 1500V TE – YYY<br/>ZZZ</b>   | 1500              | YYY                      | 1600<br>[2 x 800]        | (**)                         | (**)                      | Circular Capability  | 45  |
| <p>(*) This reference indicates the equipment between 803 kW and 956 kW of AC nominal active power, 803 kVA and 956 kVA of AC nominal apparent power</p> <p>(**) This reference indicates the equipment between 1606 kW and 1912 kW of AC nominal active power, 1606 kVA and 1912 kVA of AC nominal apparent power</p> <p>YYY = 580..690 (AC voltage)</p> <p>ZZZ = OD (outdoor), STD (indoor)</p> |                   |                          |                          |                              |                           |                      |   |

**Ratings:**
**Electrical:**

PV inverter with AC voltage ranging from 580 V to 690 V

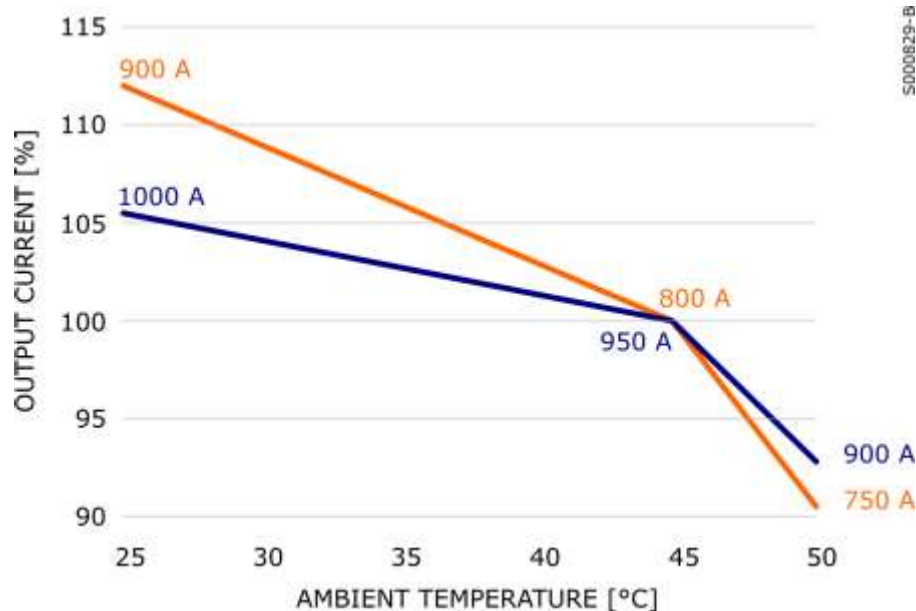
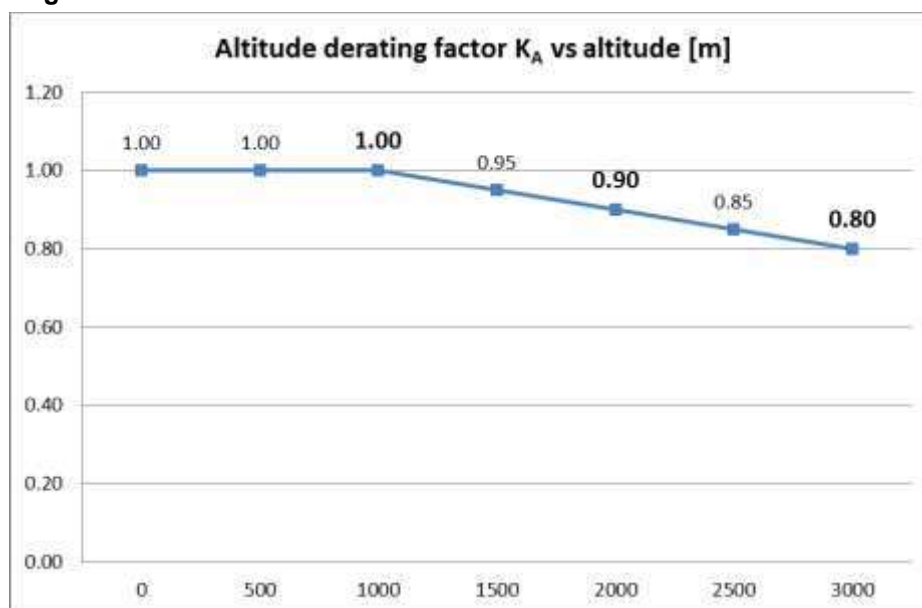
| INPUT (DC)                         |                                |
|------------------------------------|--------------------------------|
| Voltage MPP min                    | $(V_{AC} * \sqrt{2}) + 30$     |
| Voltage MPP max                    | 1200 V                         |
| Maximum Voltage                    | 1500 V                         |
| Maximum Current                    | 1500 A                         |
| OUTPUT (AC)                        |                                |
| Power                              | $(\sqrt{3} * V_{AC} * I_{AC})$ |
| Current @ 25°C/ @ 45 °C<br>/@ 50°C | 900 A/ 800 A/ 750 A            |
| Rated Voltage                      | 580 V .. 690 V                 |
| Frequency                          | 50/60 Hz                       |
| Software version                   | 1.73                           |

**Environmental:**
**Installation specifications for MODULAR SUNWAY TG TE OD**

|                               |   |
|-------------------------------|---|
| Operating ambient temperature | Minimum temperature: -25 °C<br>Maximum temperature: 50°C (With derating)  |
| Operating ambient humidity    | From 4% to 100%   |
| Altitude                      | Up to 1000 m ASL  |
| Installation site             | Outdoor   |
| Degree of protection          | IP54 (Declared by customer)   |
| Degree of pollution           | Class 3S2 or better, according to IEC 60721-3-3<br>(Declared by customer) |
| Transformer                   | External LV/MV  |

**Noise:**

| Model                   | Noise [dBA] |
|-------------------------|-------------|
| SUNWAY TG 900 1500V TE  | 69          |
| SUNWAY TG 1800 1500V TE | 71          |

**Thermal Derating:**

**Altitude Derating:**


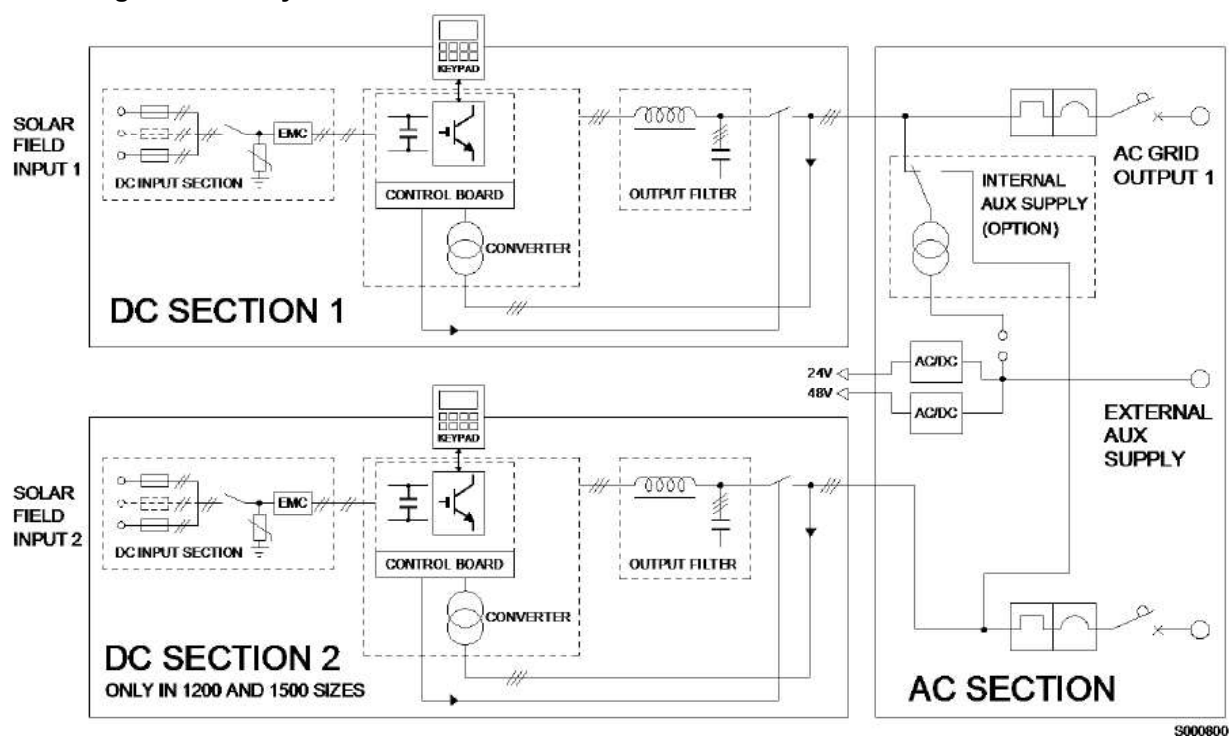
**Dimension of the unit:**

| Inverter Model      | Roofless Inverter        |             | Roof                     |                |
|---------------------|--------------------------|-------------|--------------------------|----------------|
|                     | Dimensions<br>WxHxD [mm] | Weight [kg] | Dimensions<br>WxHxD [mm] | Weight<br>[kg] |
| TG 900 1500V TE OD  | 2000 x 2350 x 1110       | 1770        | 2130 x 495 x 1110        | 200            |
| TG 1800 1500V TE OD | 3200 x 2350 x 1110       | 2770        | 3330 x 495 x 1110        | 300            |

**List of options:**

| P/N       | Kit option                      |
|-----------|---------------------------------|
| ZZ4502647 | External fans control kit       |
| ZZ4502677 | EMI filters kit                 |
| ZZ4502655 | Self supply kit                 |
| ZZ4502682 | String Boxes Power Supply kit   |
| ZZ4502685 | Auxiliaries Self Supply kit     |
| ZZ4502669 | Power Meter kit                 |
| ZZ4502674 | AC SPD kit                      |
| ZZ4502678 | AC Insulation Fault kit         |
| ZZ4502662 | Sunway Bridge kit               |
| ZZ4502653 | 3G HDSPA Router kit             |
| ZZ4505134 | LSIS AC Contactor kit           |
| ZZ4502637 | NH1X-L Fuses kit                |
| ZZ4502638 | NH2 Fuses kit                   |
| ZZ4502648 | NH3-L Fuses kit                 |
| ZZ4502689 | Zone Monitoring kit fuse NH1X-L |
| ZZ4502688 | Zone Monitoring kit fuse NH2    |
| ZZ4502687 | Zone Monitoring kit fuse NH3-L  |

**Block Diagram of the system:**





|  |  |
|--|--|
| <b>Test item particulars</b> .....   | <b>Solar Grid tied inverter</b>  |
| Equipment mobility .....   | <input checked="" type="checkbox"/> stationary <input checked="" type="checkbox"/> fixed   |
| Connection to the mains .....  | <input checked="" type="checkbox"/> permanent connection   |
| Environmental category .....   | <input checked="" type="checkbox"/> outdoor  |
| Over voltage category Mains for Basic insulation .....   | <input checked="" type="checkbox"/> OVC III (when used in TT or TN systems)<br><input checked="" type="checkbox"/> OVC II (when used in IT system) |
| Over voltage category PV for Basic insulation .....  | <input checked="" type="checkbox"/> OVC II   |
| Mains supply tolerance (%) .....   | See "General product information" section  |
| Tested for power systems .....   | TT or TN systems;<br>IT system   |
| IT testing, phase-phase voltage (V) .....  | 750V OVCII   |
| Class of equipment.....  | <input checked="" type="checkbox"/> Class I  |
| Mass of equipment (kg) .....   | <3100 Kg   |
| Pollution degree.....  | PD3 environment (PD2 inside the IP54 enclosure)<br>Enclosure provides means to prevent condensation inside the enclosure                           |
| IP protection class .....  | IP54 (Declared by manufacturer)  |
| <b>Testing</b>   |  |
| Date of receipt of test item(s) .....  | See page 1   |
| Dates tests performed .....  | See page 1   |
| <b>Possible test case verdicts:</b>  |  |
| test case does not apply to the test object .....  | N/A  |
| test object does meet the requirement .....  | Pass (P)   |
| test object does not meet the requirement.....   | Fail (F)   |
| <b>General remarks:</b>  |  |
| This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory. |  |
| The test results presented in this report relate only to the items tested.   |  |
| "(see remark #)" refers to a remark appended to the report.  |  |
| "(see annex #)" refers to an annex appended to the report.   |  |
| "(see enclosure #)" refers to additional information appended to the report.   |  |
| "(see appended table)" refers to a table appended to the report.   |  |
| Throughout this report a point is used as the decimal separator.   |  |

**Reference Standard:**

CEI 0-16:2019-04

Regola tecnica di riferimento per la connessione di Utenti attivi e passivi alle reti AT ed MT delle imprese distributrici di energia elettrica

*/Reference technical rules for the connection of active and passive consumers to the HV and MV electrical networks of distribution Company*

The standard refers to the following standards:

IEC 61400-21:2008-08 Ed.2 (§. 7.4)

Wind turbines

Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

FGW TR3

Technical Guidelines for Power Generating Units - Part 3

Determination of electrical characteristics of power generating units connected to MV, HV and EHV grids

| <b>N.2 Elenco delle prove e condizioni di riferimento</b><br><i>/Testing list at reference conditions</i>   |            |   |                   |
|---|------------|---|-------------------|
| <b>Test</b>   | <b>§</b>   | <b>Ref. standard</b>                    | <b>Result</b>     |
| EMC   | <b>N.2</b> | CEI EN 61000-6-2<br>CEI EN 61000-6-3/-4 | Note <sup>1</sup> |
| Misure per la qualità della tensione<br><i>/Voltage quality measure</i>   | <b>N.3</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica del campo di funzionamento in tensione e frequenza<br><i>/Voltage-frequency working range</i>  | <b>N.4</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica delle condizioni di sincronizzazione e presa di carico<br><i>/synchronization and re-connection</i>  | <b>N.5</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica dei requisiti costruttivi circa lo scambio di potenza reattiva<br><i>/Reactive power capability</i>  | <b>N.6</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica dei requisiti costruttivi circa la regolazione di potenza attiva<br><i>/Active power regulation</i>  | <b>N.7</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica della insensibilità agli abbassamenti di tensione<br><i>/LVRT capability</i>   | <b>N.8</b> | CEI 0-16:2019-04                        | PASS              |
| Verifica della insensibilità alle richiuse automatiche in discordanza di fase<br><i>/Check of the insensibility to the re-closures when phases are in discordance</i> | <b>N.9</b> | CEI 0-16:2019-04                        | PASS              |

Note <sup>1</sup>: refer to EMC test report No. 28112226 003 issued by TÜV Rheinland Italia S.r.l.

| <b>N.3 Misure per la qualità della tensione</b><br><i>/Voltage quality measure</i>  |                |             |                  |        |         |
|---|----------------|-------------|------------------|--------|---------|
| Test  | §              | Requirement | Ref. standard    | Result | Sample  |
| Misura di correnti armoniche<br><i>/Harmonics current</i>   | N.3.1          | N.3         | CEI 0-16:2019-04 | PASS   | Sample1 |
|   | 7.4            | --          | IEC 61400-21     | PASS   | Sample1 |
| Misura di fluttuazioni di tensione dovute a manovre di sezionamento/separazione<br><i>/ Voltage fluctuactions caused by Switching operations</i>            | N.3.2          | N.3         | CEI 0-16:2019-04 | PASS   | Sample1 |
|   | 7.3.4          | --          | IEC 61400-21     | PASS   | Sample1 |
| Misura di fluttuazioni di tensione (flicker) in condizioni di funzionamento continuo<br><i>/Voltage fluctuations (Flickers) during Continuous operation</i> | N.3.3          | N.3         | CEI 0-16:2019-04 | PASS   | Sample1 |
|   | 6.3.2<br>7.3.3 | --          | IEC 61400-21     | PASS   | Sample1 |

| <b>N.4 Verifica del campo di funzionamento in tensione e frequenza</b><br><i>/Voltage-frequency working range</i> |                  |                  |        |         |
|---|------------------|------------------|--------|---------|
| Test  | Ref.<br>CEI 0-16 | Ref. standard    | Result | Sample  |
| Prove a piena potenza su rete simulata<br><i>/full power test with grid simulator</i>                             | N.4.1.1          | CEI 0-16:2019-04 | PASS   | Sample1 |

| <b>N.5 Verifica delle condizioni di sincronizzazione e presa di carico</b><br><i>/synchronization and re-connection</i> |                  |                  |        |         |
|---|------------------|------------------|--------|---------|
| Test  | Ref.<br>CEI 0-16 | Ref. standard    | Result | Sample  |
| Sincronizzazione e riconnessione.<br><i>/Synchronization</i>  | N.5.1            | CEI 0-16:2019-04 | PASS   | Sample1 |
| Verifica della erogazione graduale della potenza attiva (presa di carico)<br><i>/ gradually erogation of the power</i>  | N.5.2            | CEI 0-16:2019-04 | PASS   | Sample1 |

| <b>N. 6 Verifica dei requisiti costruttivi circa lo scambio di potenza reattiva</b><br><i>/Reactive power capability</i>   |                          |                      |               |               |
|--|--------------------------|----------------------|---------------|---------------|
| <b>Test</b>  | <b>Ref.<br/>CEI 0-16</b> | <b>Ref. standard</b> | <b>Result</b> | <b>Sample</b> |
| Verifica della capability di erogazione della potenza reattiva<br><i>/reactive power production capability</i>   | N.6.1                    | CEI 0-16:2019-04     | PASS          | Sample1       |
| Scambio di potenza reattiva secondo un livello assegnato<br><i>/Reactive power production according to an assigned level</i>   | N.6.2<br>Annex I         | CEI 0-16:2019-04     | PASS          | Sample1       |
| Tempo di risposta ad una variazione a gradino del livello assegnato<br><i>/Reaction time after a step variation of the assigned level.</i>   | N.6.2.1                  | CEI 0-16:2019-04     | PASS          | Sample1       |
| Regolazione automatica di potenza reattiva secondo una curva caratteristica $\cos\phi = f(P)$<br><i>/Automatic reactive power production according to a characteristic curve <math>\cos(\phi)=f(P)</math></i>  | N.6.3                    | CEI 0-16:2019-04     | PASS          | Sample1       |
| Erogazione/assorbimento automatico di potenza reattiva secondo una curva caratteristica $Q=f(V)$ applicabile a generatori con capability rettangolare<br><i>/Automatic reactive power production according to a characteristic curve <math>Q=f(V)</math></i> | N.6.4                    | CEI 0-16:2019-04     | PASS          | Sample1       |

| <b>N. 7 Verifica dei requisiti costruttivi circa lo scambio di potenza reattiva</b><br><i>/Reactive power capability</i>   |  |                  |        |         |
|--|--|------------------|--------|---------|
| Test   | Ref.<br>CEI 0-16                       | Ref. standard    | Result | Sample  |
| Limitazione automatica in logica locale,<br>per valori di tensione prossimi al 110%<br><br><i>/ Active power limitation for voltage values near to<br/>100 % di Un</i>   | N.7.1<br>8.8.6.4.1<br>Annex J (§. J.2) | CEI 0-16:2019-04 | PASS   | Sample1 |
| Limitazione automatica per transitori di<br>sovrafrequenza originatisi sulla rete<br><br><i>/ Active power regulation in coincidence with<br/>transitory on the transmission grid</i>                                      | N.7.2<br>8.8.6.4.2<br>Annex J (§. J.3) | CEI 0-16:2019-04 | PASS   | Sample1 |
| Limitazione su comando esterno<br>proveniente dal Distributore, e/o in logica<br>centralizzata<br><br><i>/Active power limitation in coincidence with<br/>external command coming from the Electricity<br/>Distributor</i> | N.7.4<br>8.8.6.3<br>Annex M            | CEI 0-16:2019-04 | PASS   | Sample1 |
| Verifica del tempo di assestamento ad<br>un comando di riduzione di potenza<br><br><i>/settling time verification after a power limitation<br/>command.</i>  | N.7.4.1                                | CEI 0-16:2019-04 | PASS   | Sample1 |



**N.8 VFRT capability**

| Test                                   | Ref.<br>CEI 0-16 | Ref. standard    | Result | Sample  |
|--|------------------|------------------|--------|---------|
| LVRT Capability                        | N.8<br>8.8.6.1   | CEI 0-16:2019-04 | PASS   | Sample1 |
| Test procedure for static<br>converter | N.8.1            | CEI 0-16:2019-04 |        |         |
| OVRT – Capability                      | N.8.5            | CEI 0-16:2019-04 | PASS   | Sample1 |

**N.9 Verifica della insensibilità alle richiuse automatiche in discordanza di fase**

*/Check of the insensibility to the re-closures when phases are in discordance*

| Test   | Ref.<br>CEI 0-16 | Ref. standard    | Result | Sample  |
|--|------------------|------------------|--------|---------|
| Verifica della insensibilità alle<br>richiuse automatiche in<br>discordanza di fase<br><br><i>/Check of the insensibility to the re-<br/>closures when phases are in<br/>discordance</i> | N.9              | CEI 0-16:2019-04 | PASS   | Sample1 |





|                                |   |   |
|--------------------------------|---|---|
| N. 8                           | <b>VFRT Capability</b><br>/ VFRT Capability |   |
| N.8.1                          | <b>LVRT Capability</b>                      |   |
| Ambient temperature (°C) ..... |   | 20°C ± 2°C  |
| Humidity (RH %) .....          |   | 65% RH  |
| Instrumentation list.....      |   | See table "Measurement equipment and instrumentation" |
| Uncertainty .....              |   | See table   |

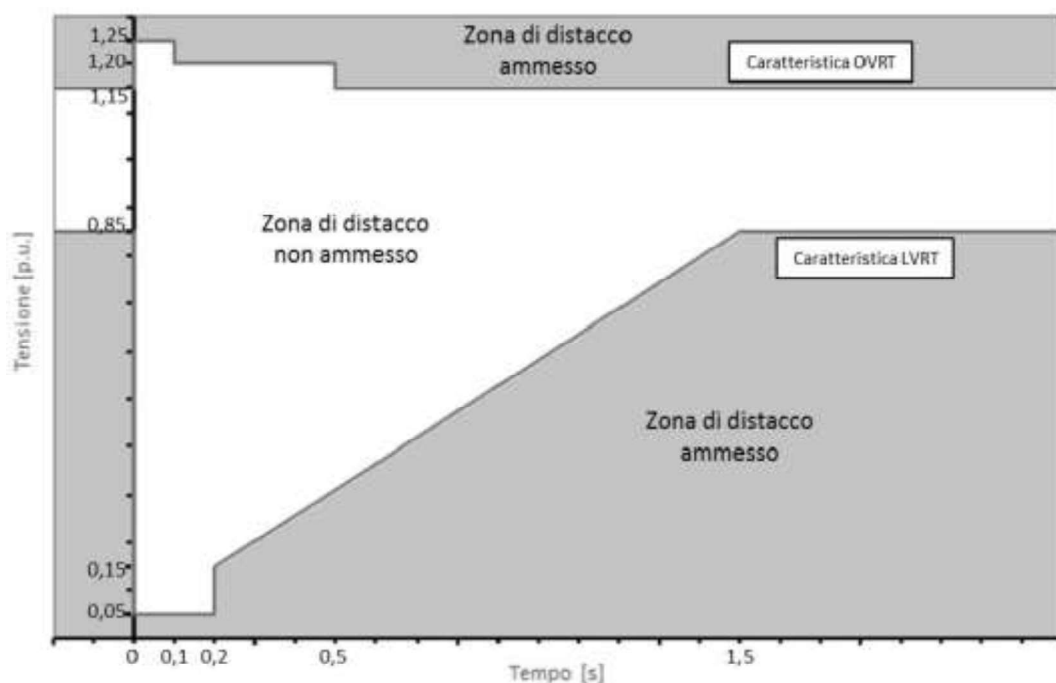


Figura 24 – Caratteristica (V - t): LVRT e OVRT. per i generatori statici

Supplementary information:

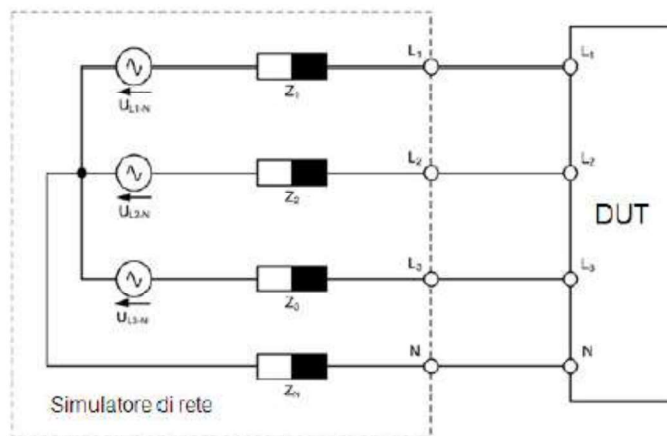
Test is performed in the following conditions:

- MPPT Input Voltage: 1200Vdc
- Output Voltage: 600Vac p-n @ 50Hz

|                  |                |
|------------------|----------------|
| Operator .....   | Luca Li Vecchi |
| Supervisor ..... | Marco Piva     |
| Test Date .....  | 19/03/2020     |



DIAGRAM



| Output power: 720 kW   |   |             |             | Limit: from > 90% P <sub>nom</sub> |                |                |                  |           |
|--|---|-------------|-------------|------------------------------------|----------------|----------------|------------------|-----------|
| Test   | Residual magnitude<br>[V/V <sub>n</sub> ] |             |             | phase angle<br>[°]                 |                |                | Recovery<br>time | Duration  |
|  | R   | S           | T           | φ <sub>1</sub>                     | φ <sub>2</sub> | φ <sub>3</sub> | [ms]             | [ms]      |
| 1s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.10 ± 0.05                               | 0.10 ± 0.05 | 0.10 ± 0.05 | 0°                                 | -120°          | 120°           | 207.6            | 200 ± 20  |
| 1a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.87 ± 0.05                               | 0.87 ± 0.05 | 0.10 ± 0.05 | 27°                                | -147°          | 120°           | 207.6            | 200 ± 20  |
| 2s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.25 ± 0.05                               | 0.25 ± 0.05 | 0.25 ± 0.05 | 0°                                 | -120°          | 120°           | 409.8            | 400 ± 20  |
| 2a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.88 ± 0.05                               | 0.88 ± 0.05 | 0.25 ± 0.05 | 22°                                | -142°          | 120°           | 409.8            | 400 ± 20  |
| 3s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.50 ± 0.05                               | 0.50 ± 0.05 | 0.50 ± 0.05 | 0°                                 | -120°          | 120°           | 866.3            | 850 ± 20  |
| 3a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.90 ± 0.05                               | 0.90 ± 0.05 | 0.50 ± 0.05 | 14°                                | -134°          | 120°           | 866.3            | 850 ± 20  |
| 4s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.75 ± 0.05                               | 0.75 ± 0.05 | 0.75 ± 0.05 | 0°                                 | -120°          | 120°           | 1309.0           | 1300 ± 20 |
| 4a -- guasto simmetrico bifase<br>/ two phases asymmetric<br>failure   | 0.94 ± 0.05                               | 0.94 ± 0.05 | 0.75 ± 0.05 | 7°                                 | -127°          | 120°           | 1309.0           | 1300 ± 20 |

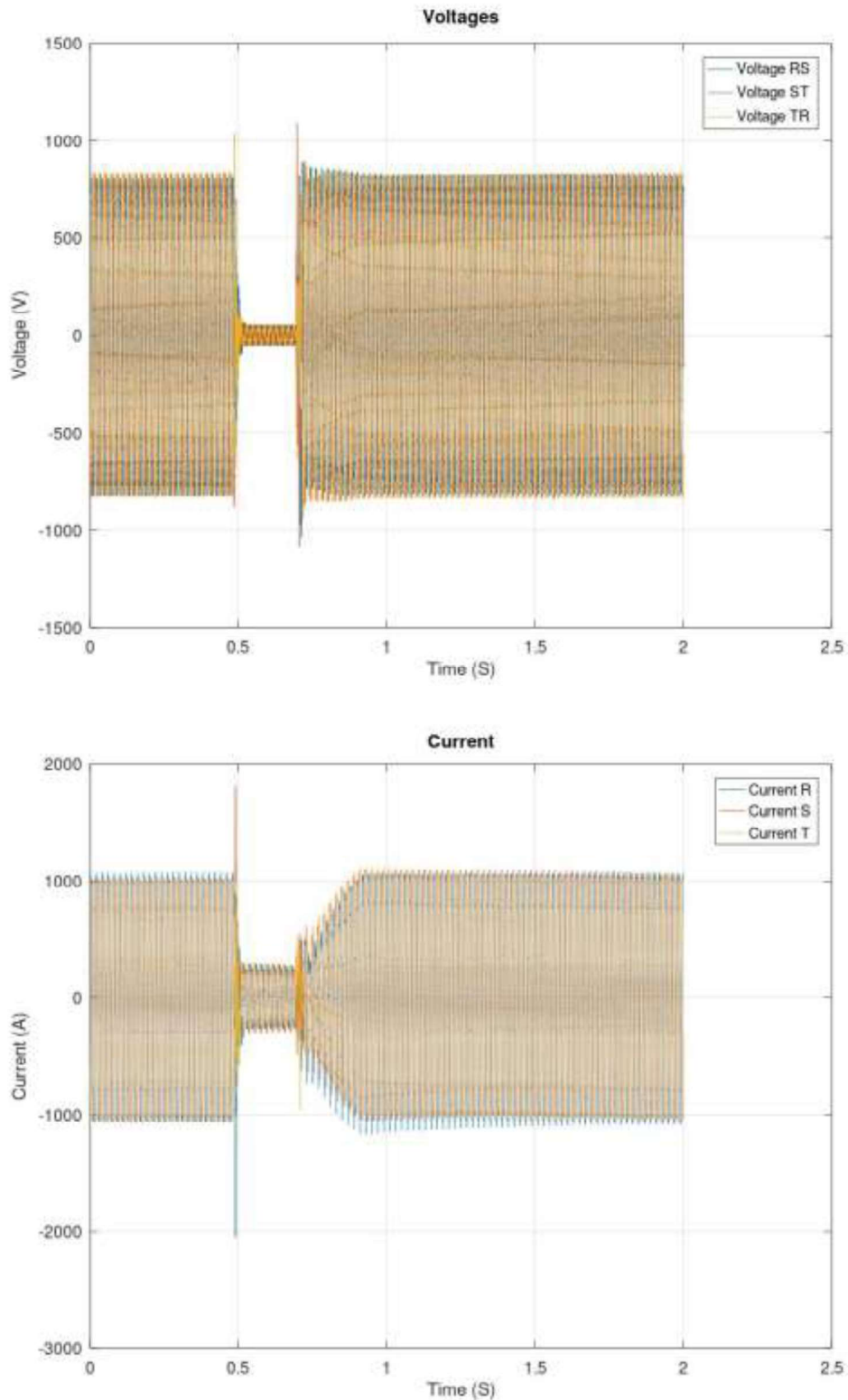


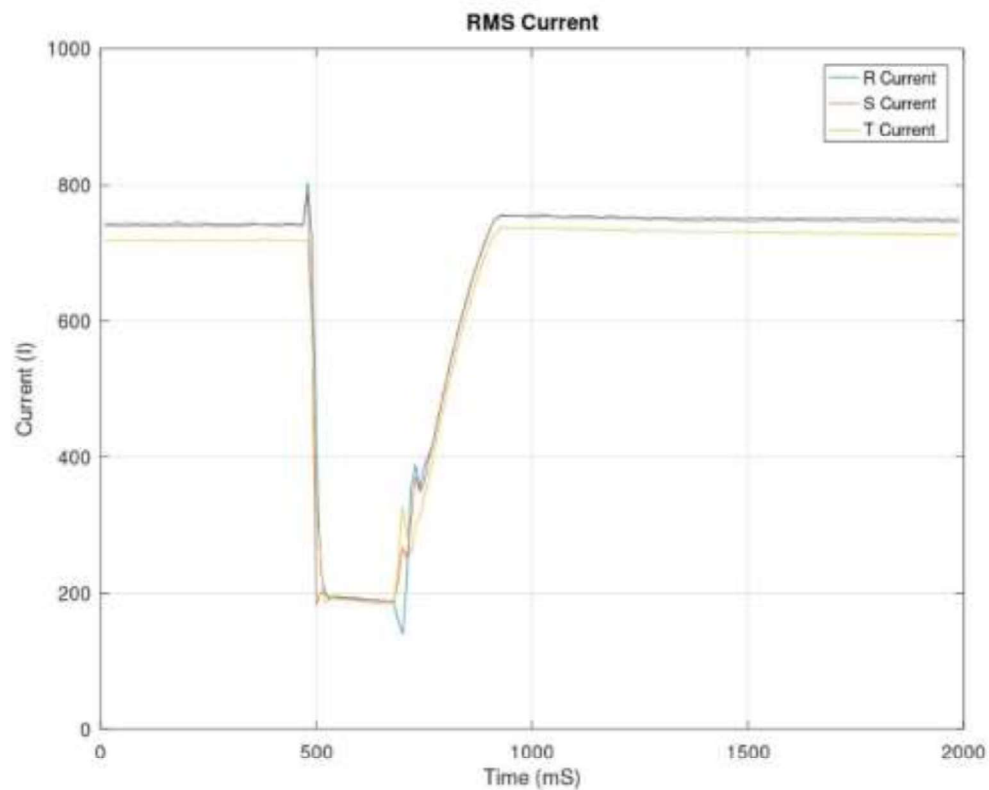
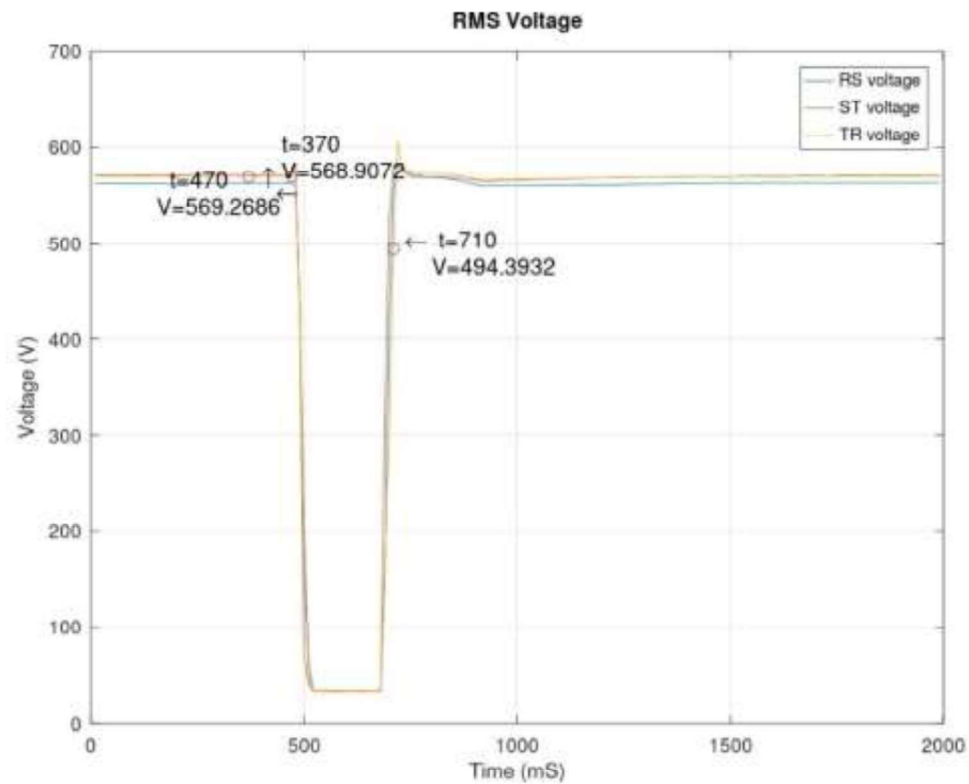
**Grafici: LVFRT**

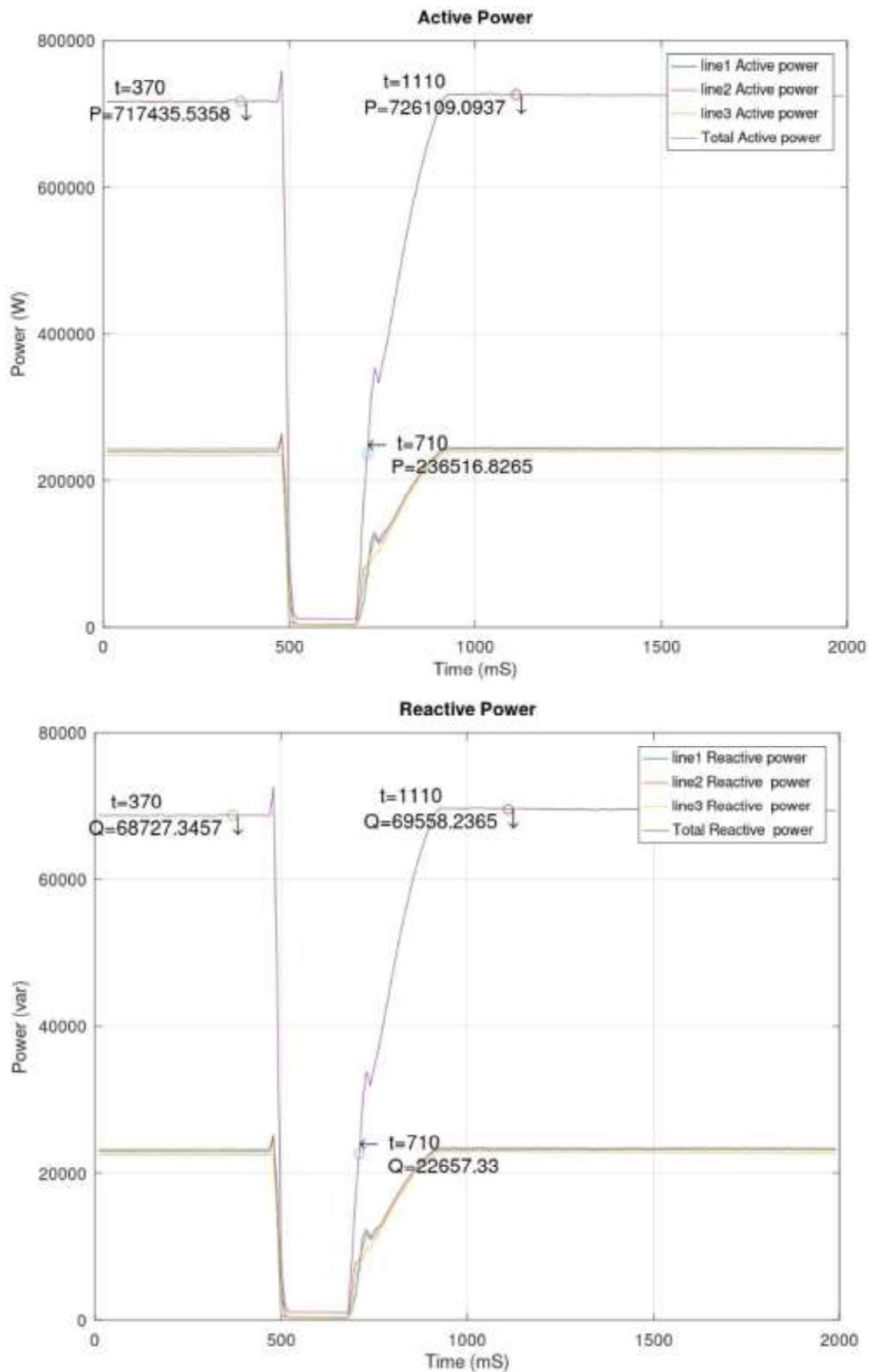
/ Graphs: LVFRT

**Test 1s -- guasto simmetrico trifase**

/ three phases symmetric failure

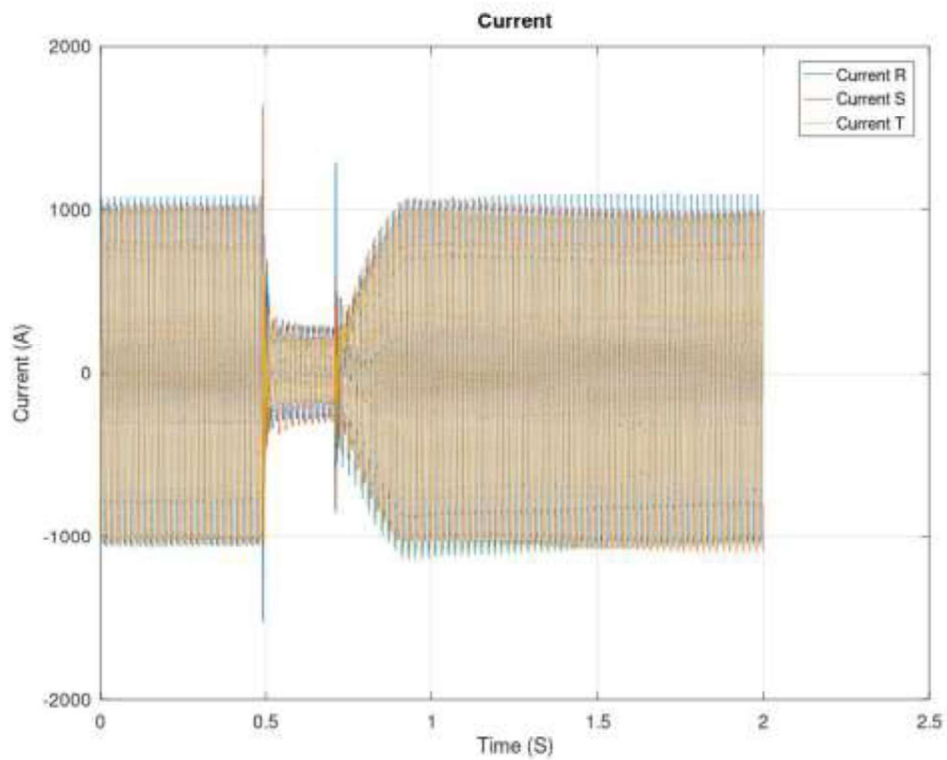
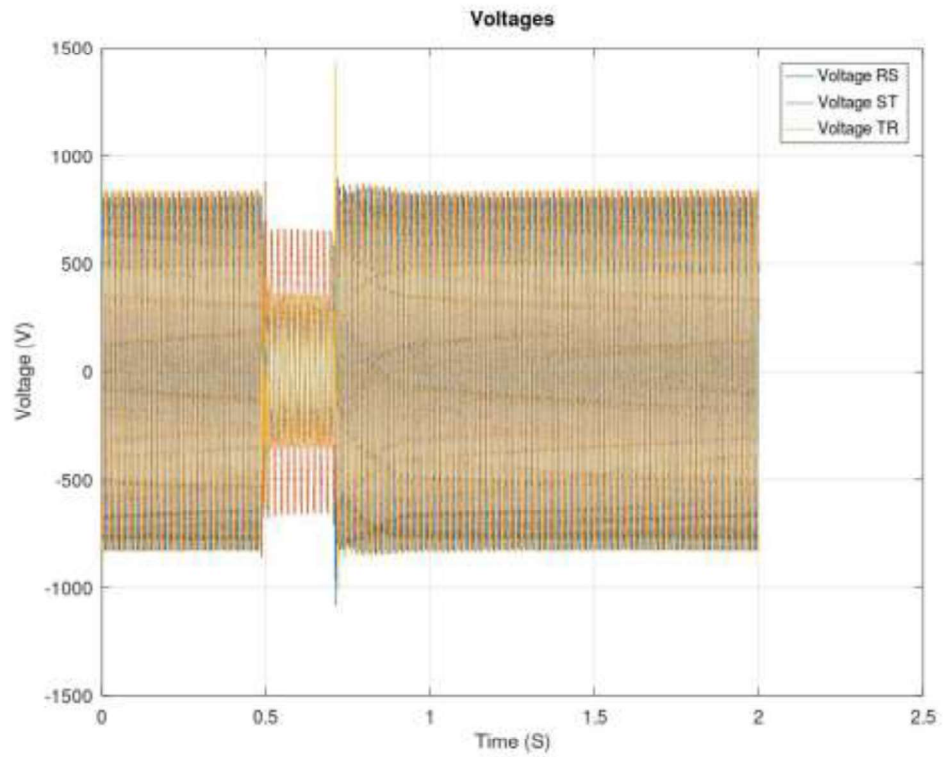




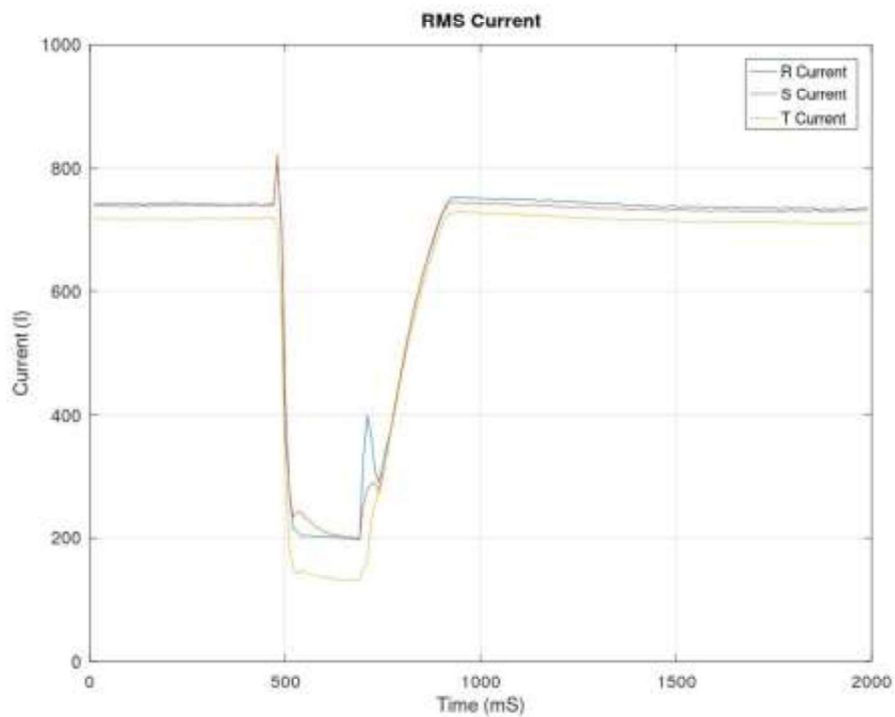
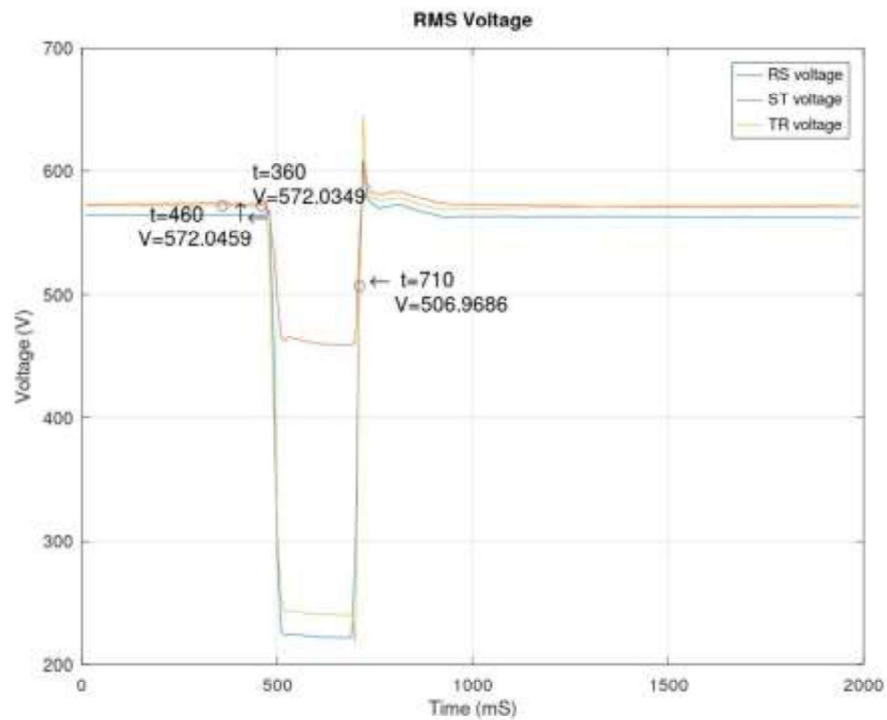


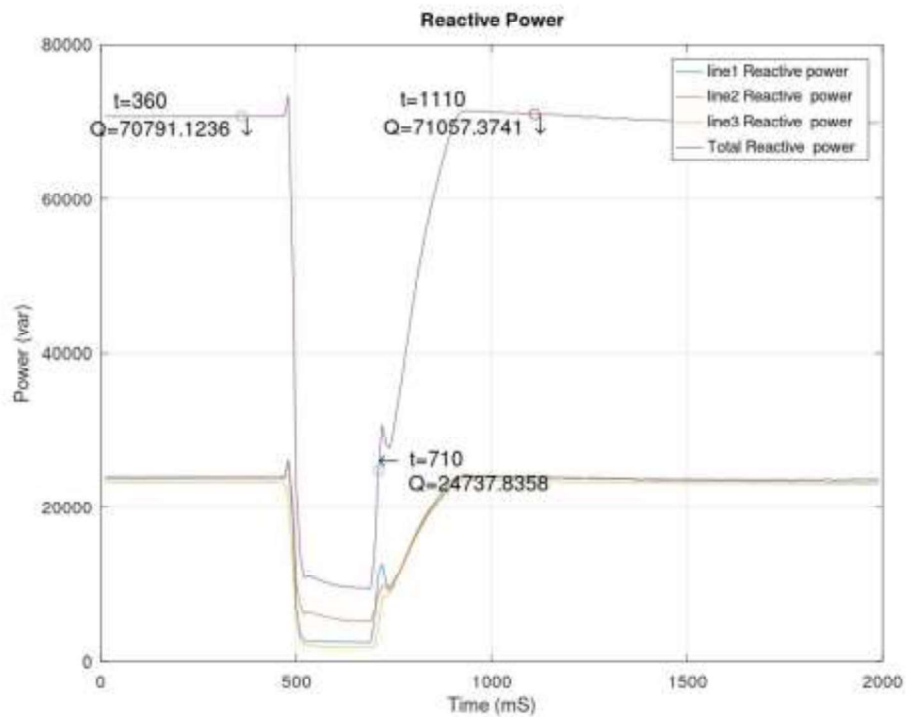
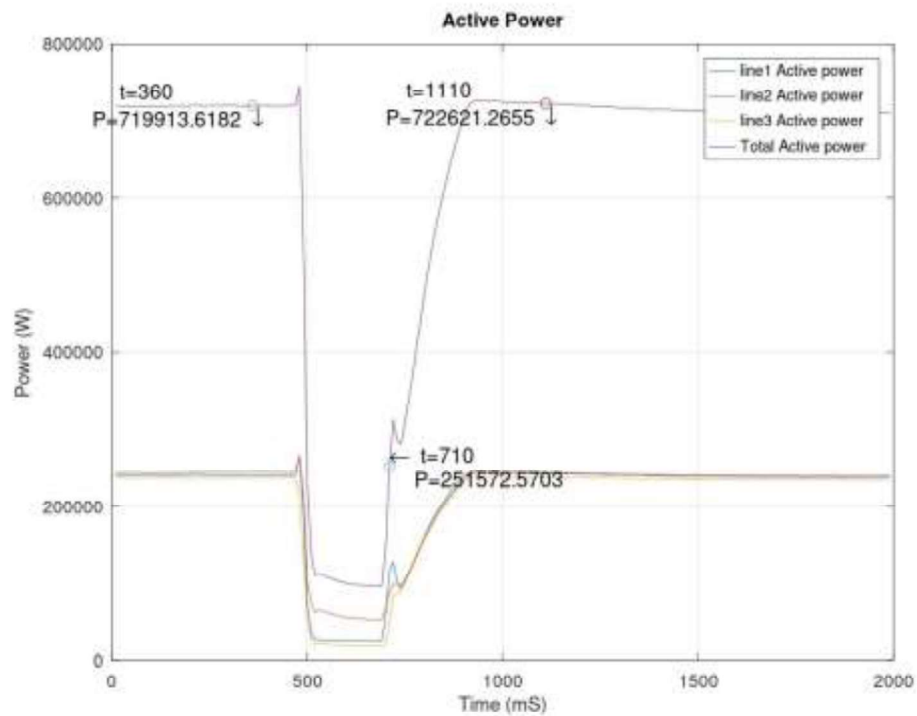


**Test 1a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*



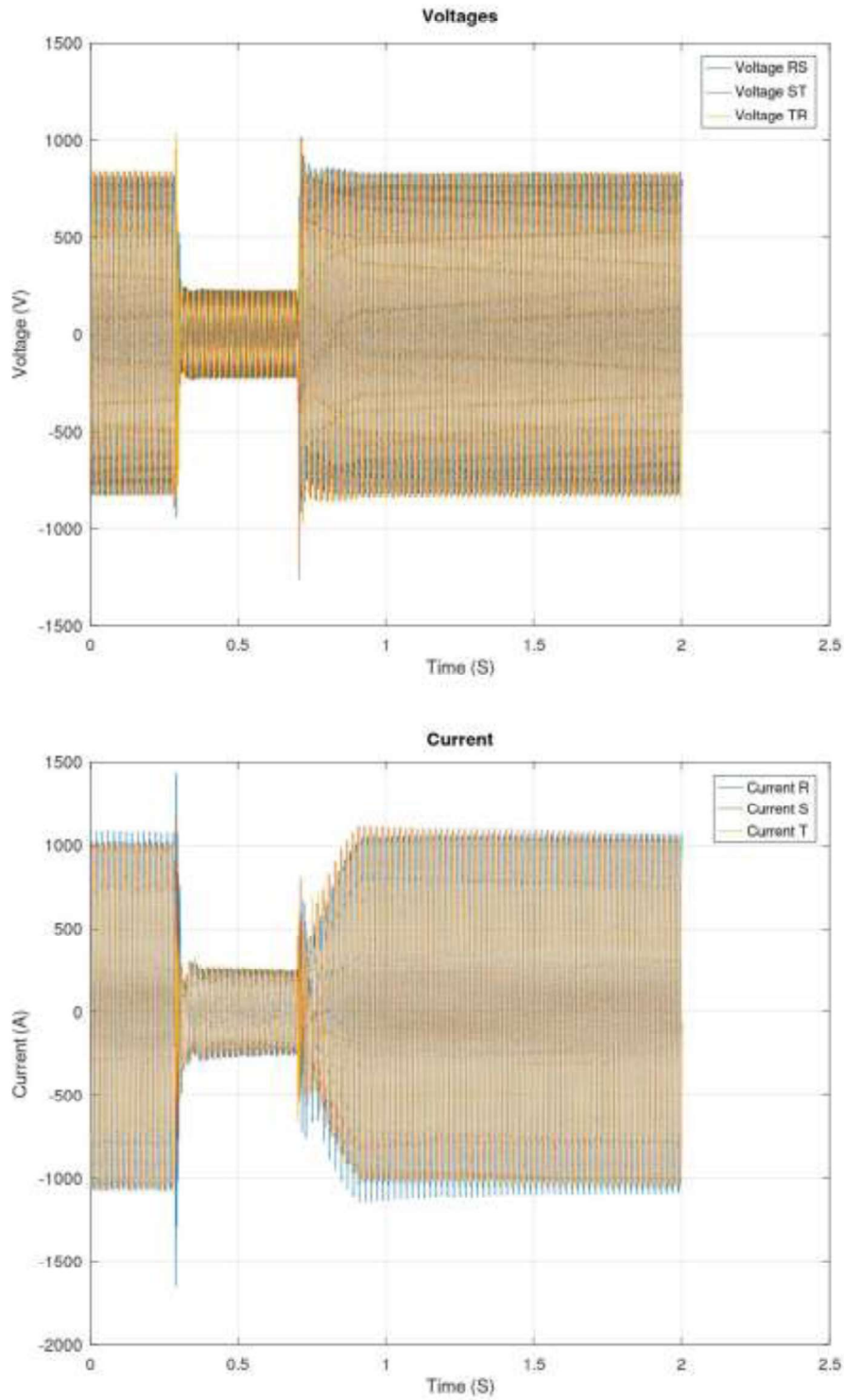


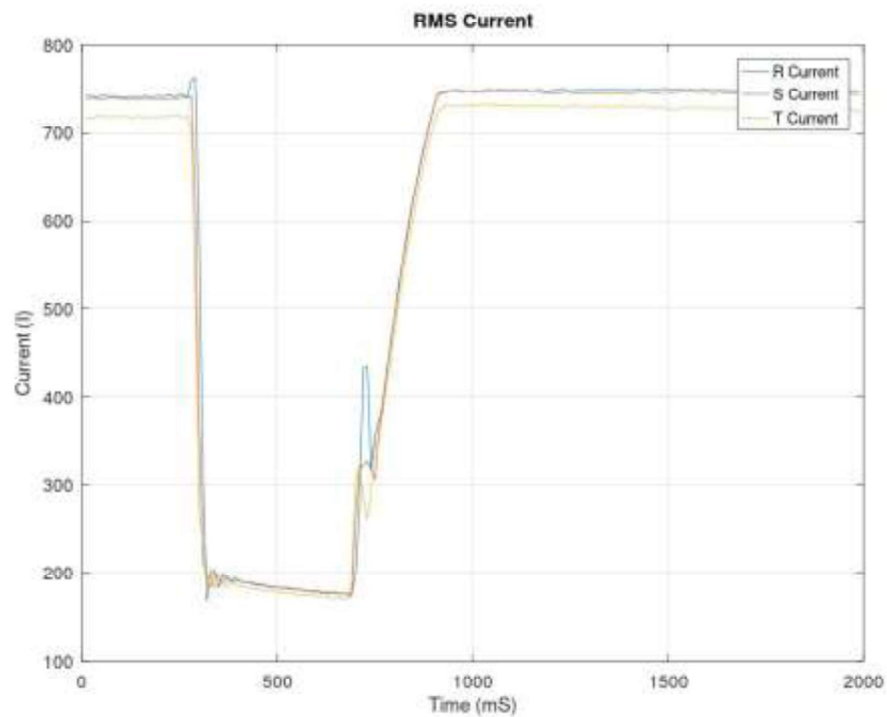
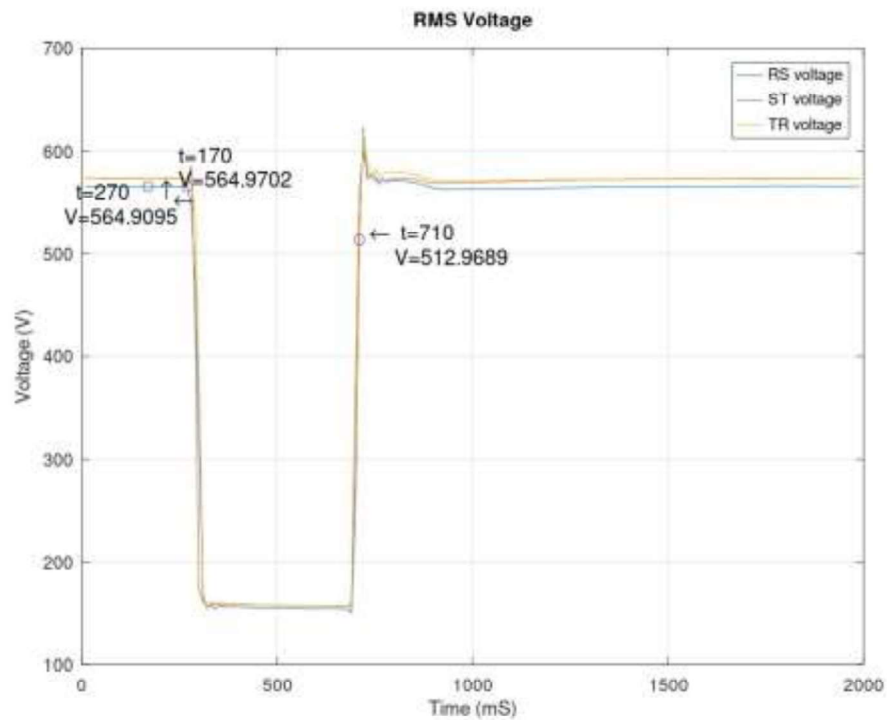


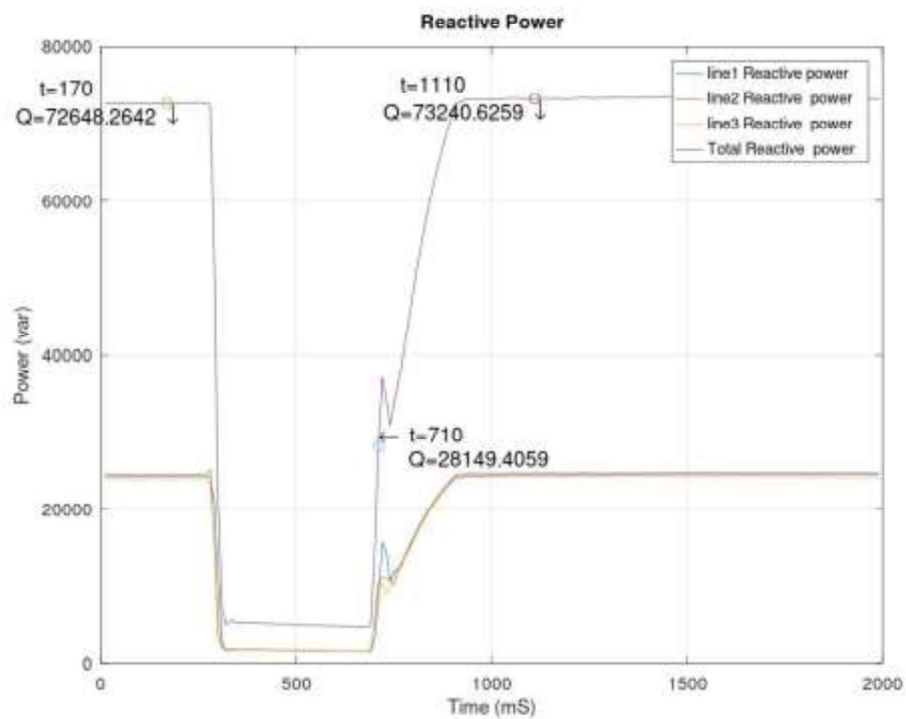
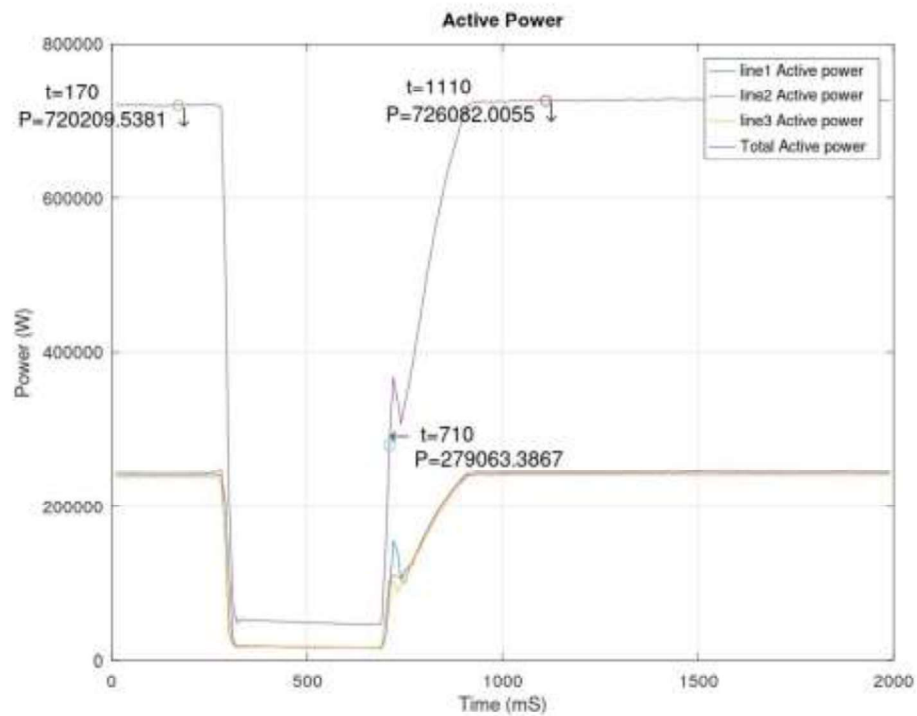




**Test 2s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*

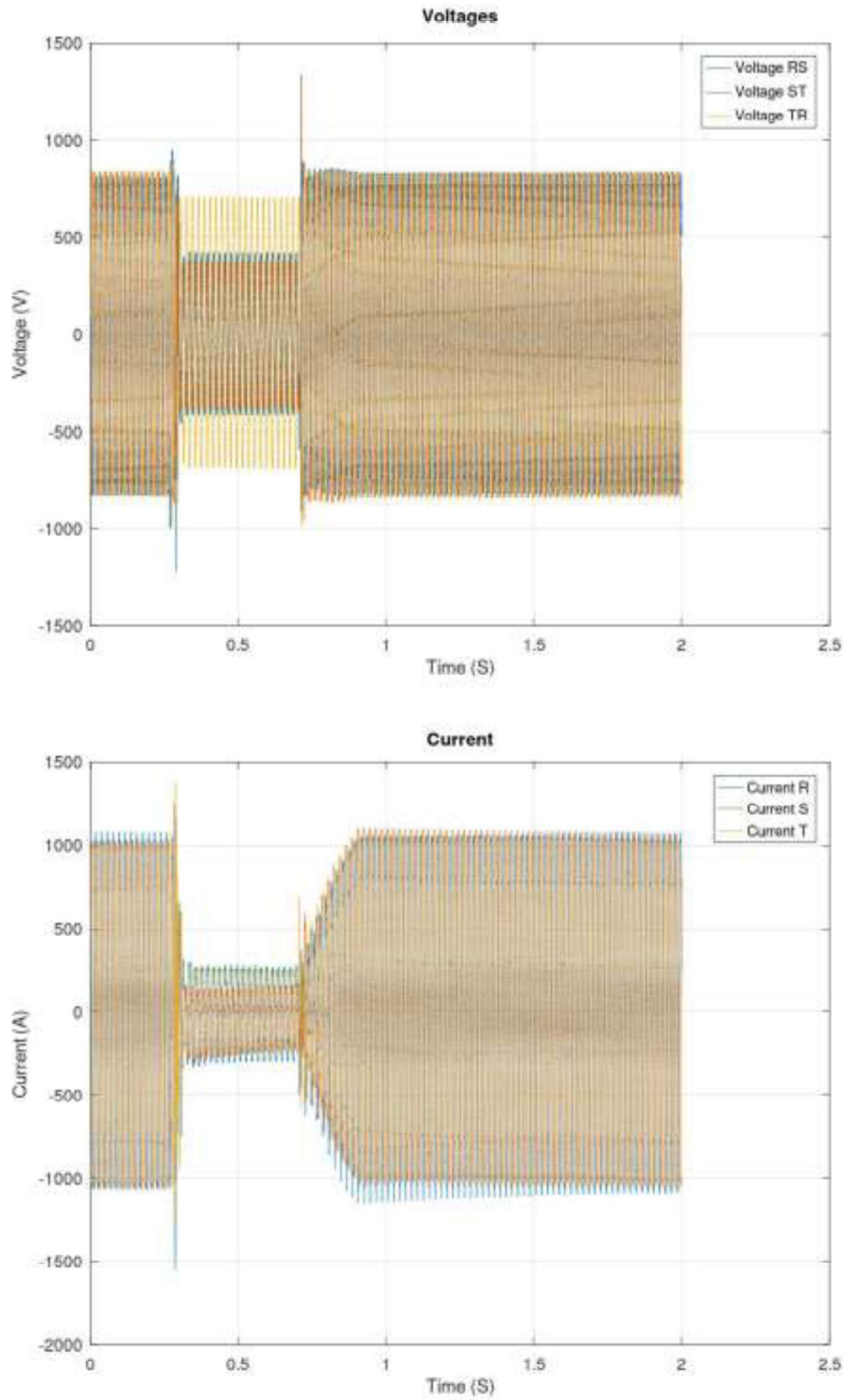


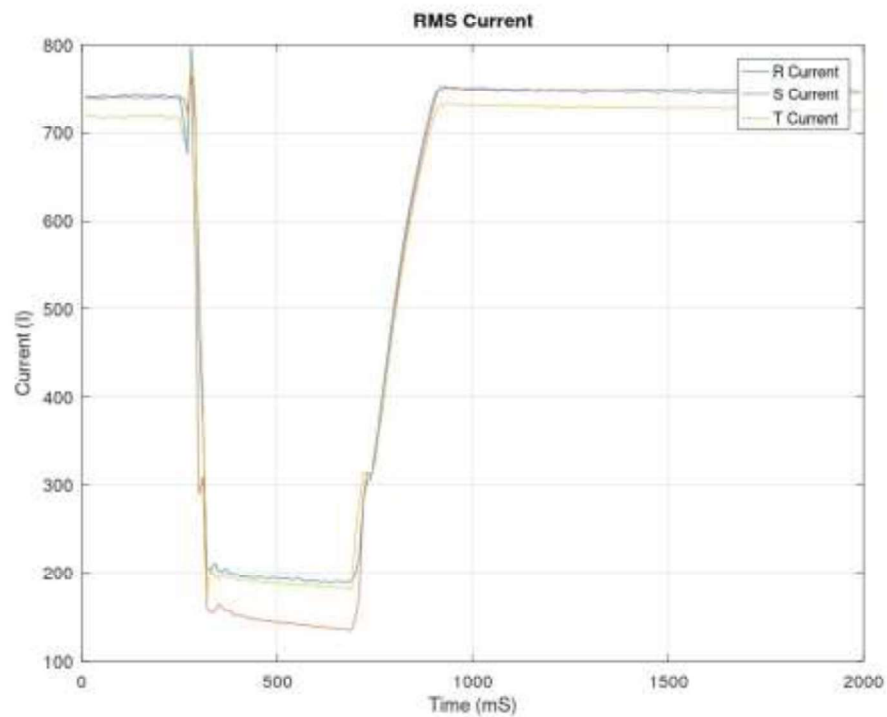
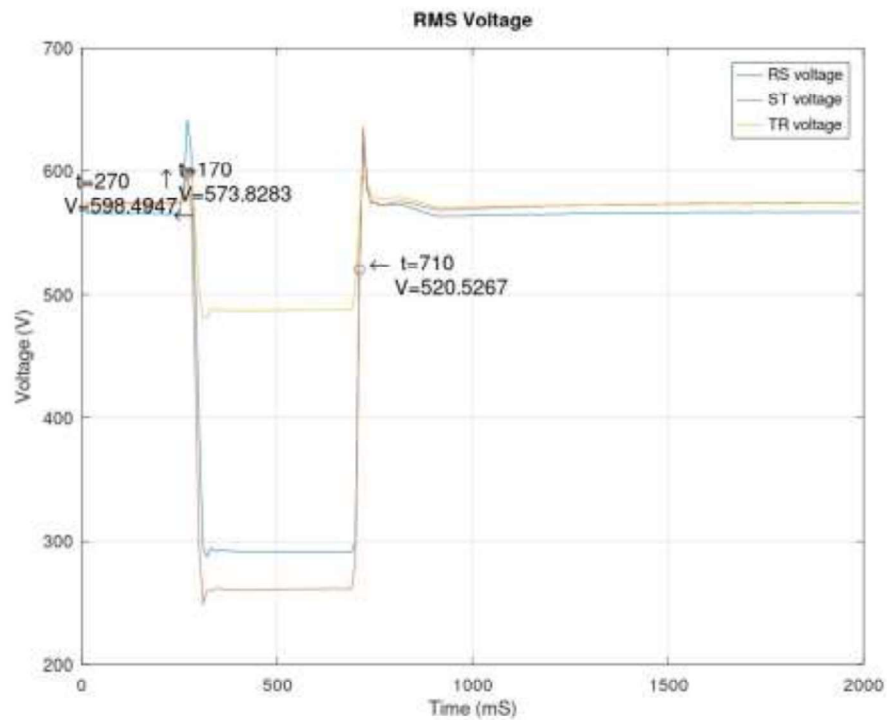




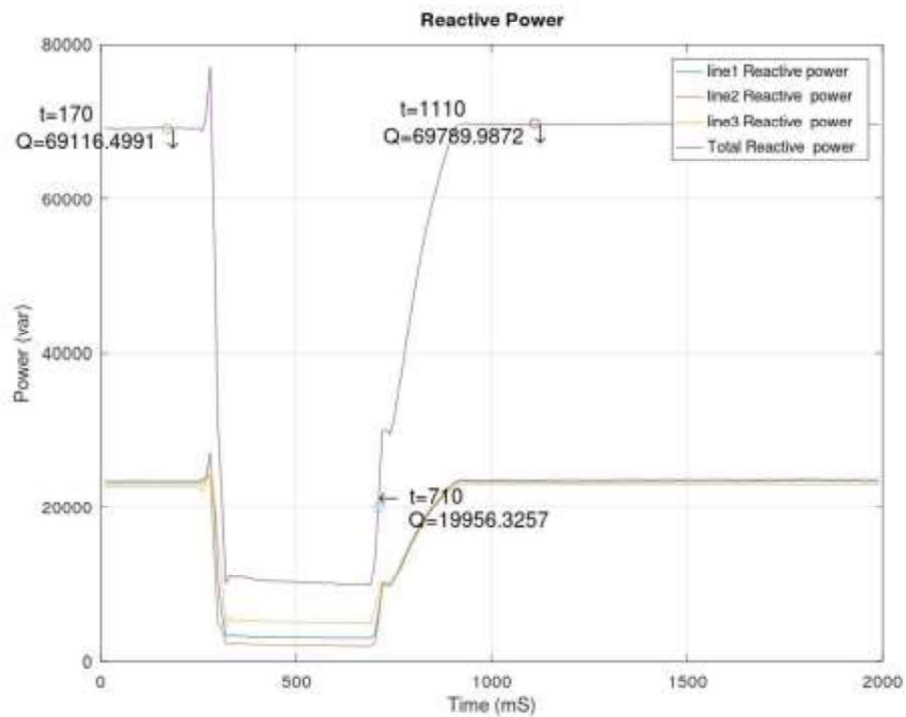
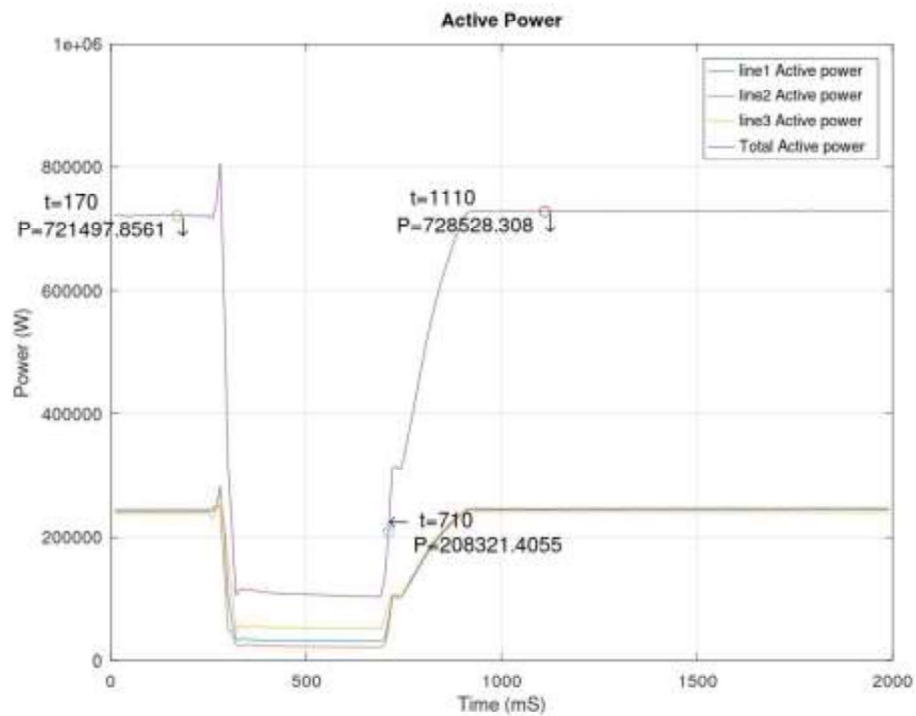


**Test 2a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*



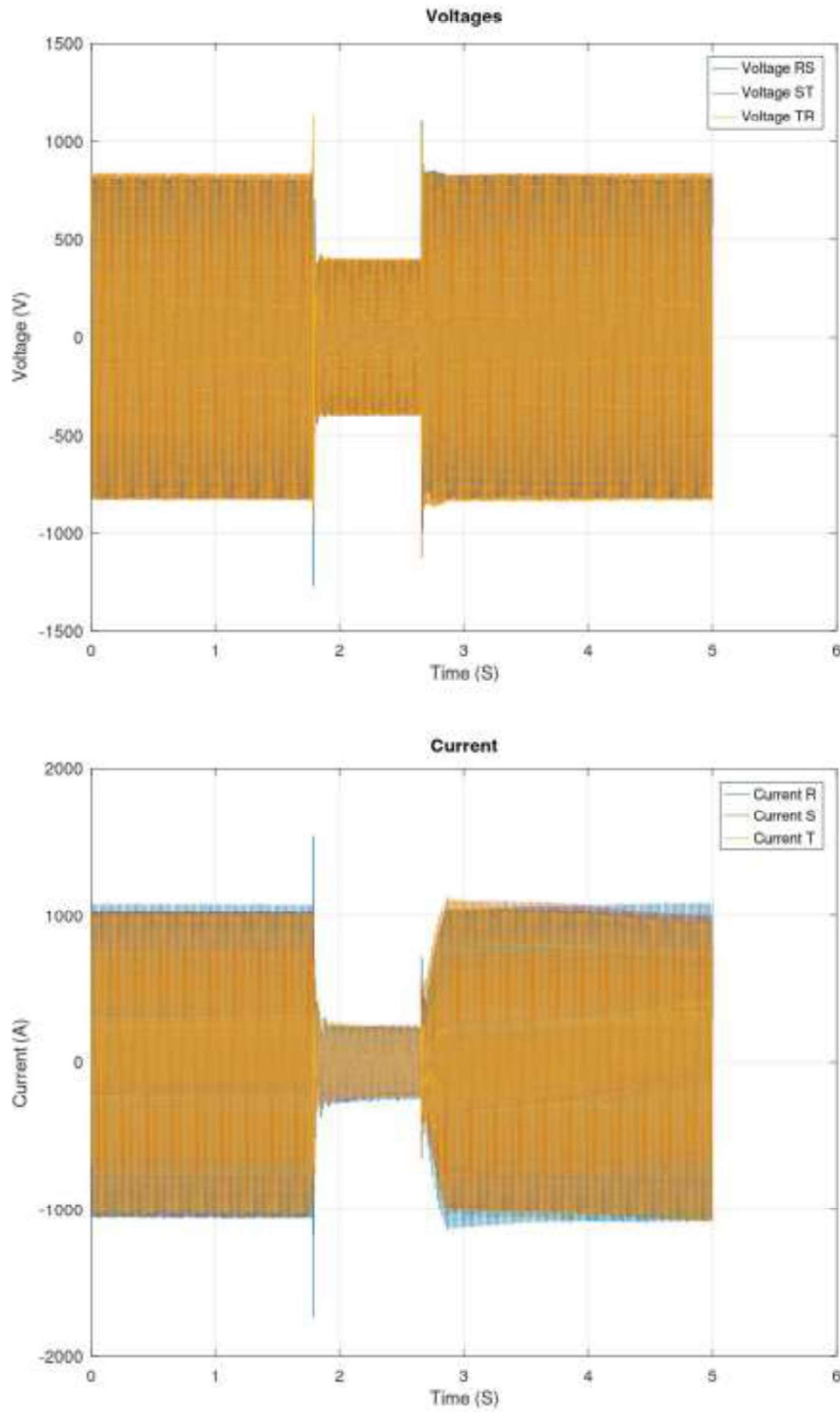


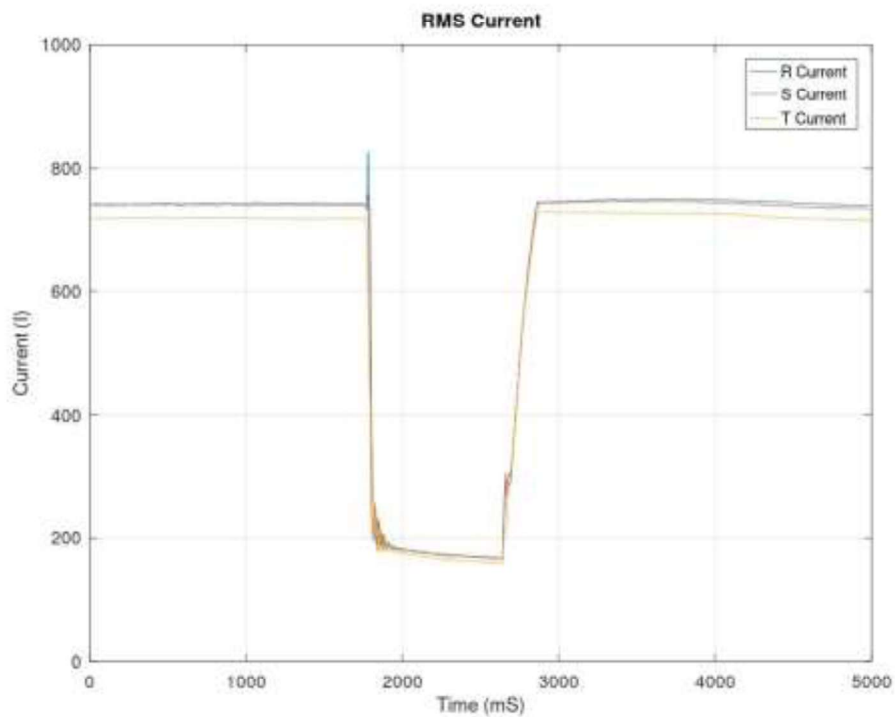
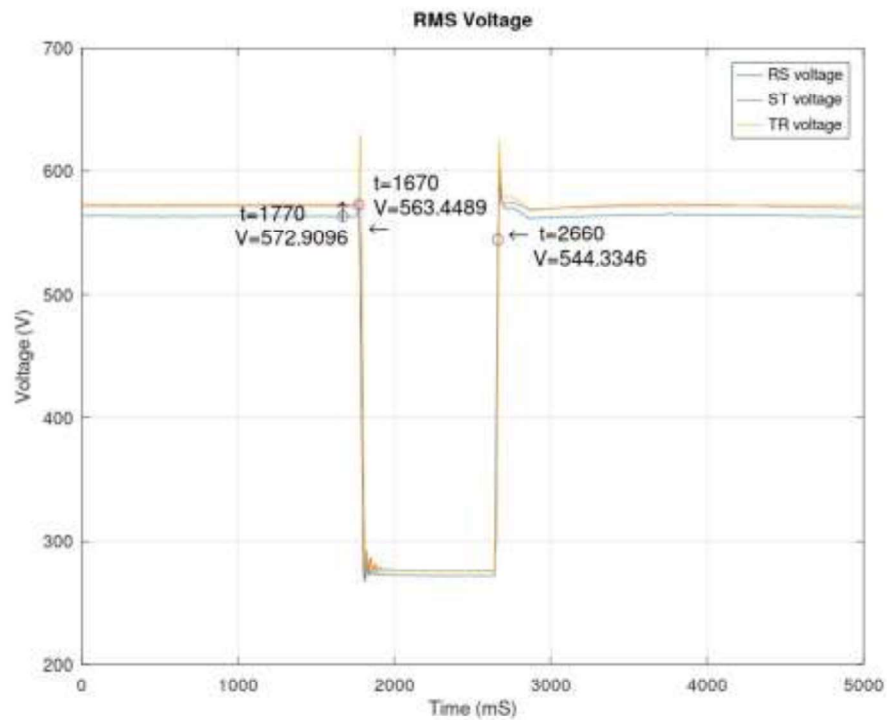


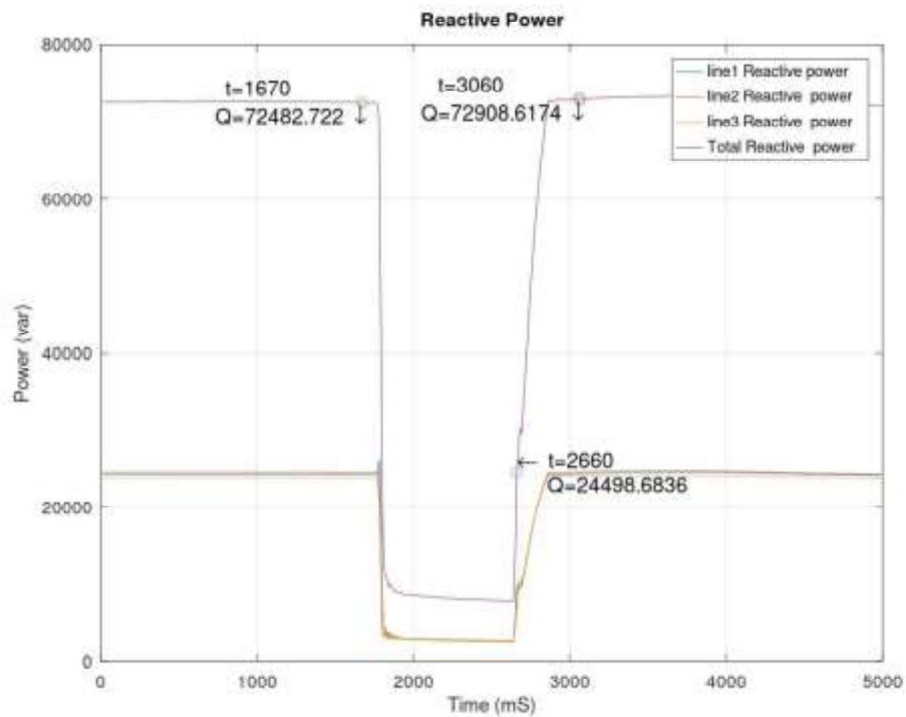
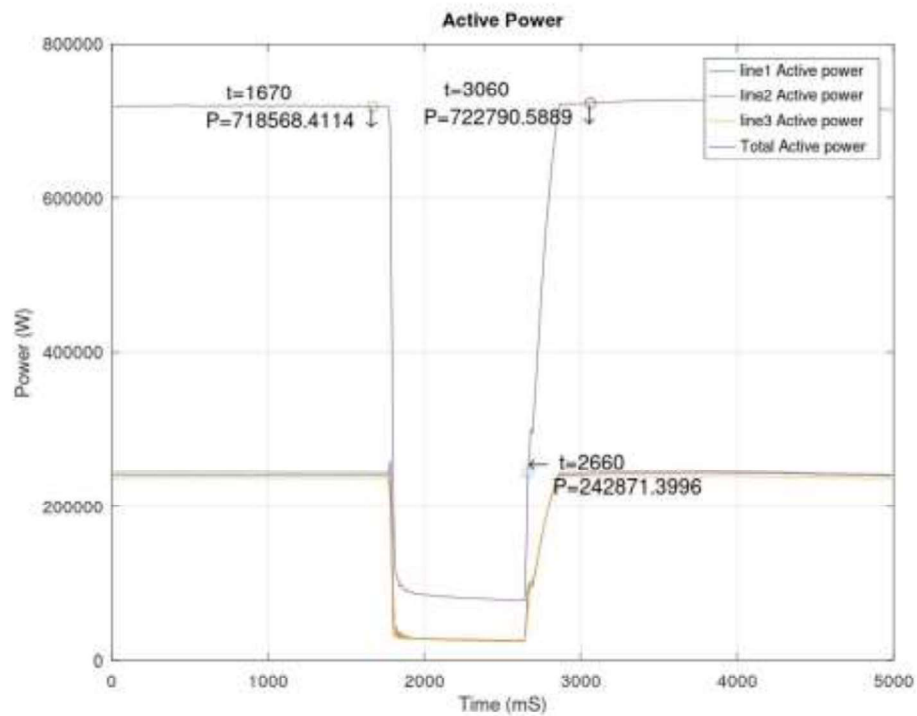




**Test 3s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*

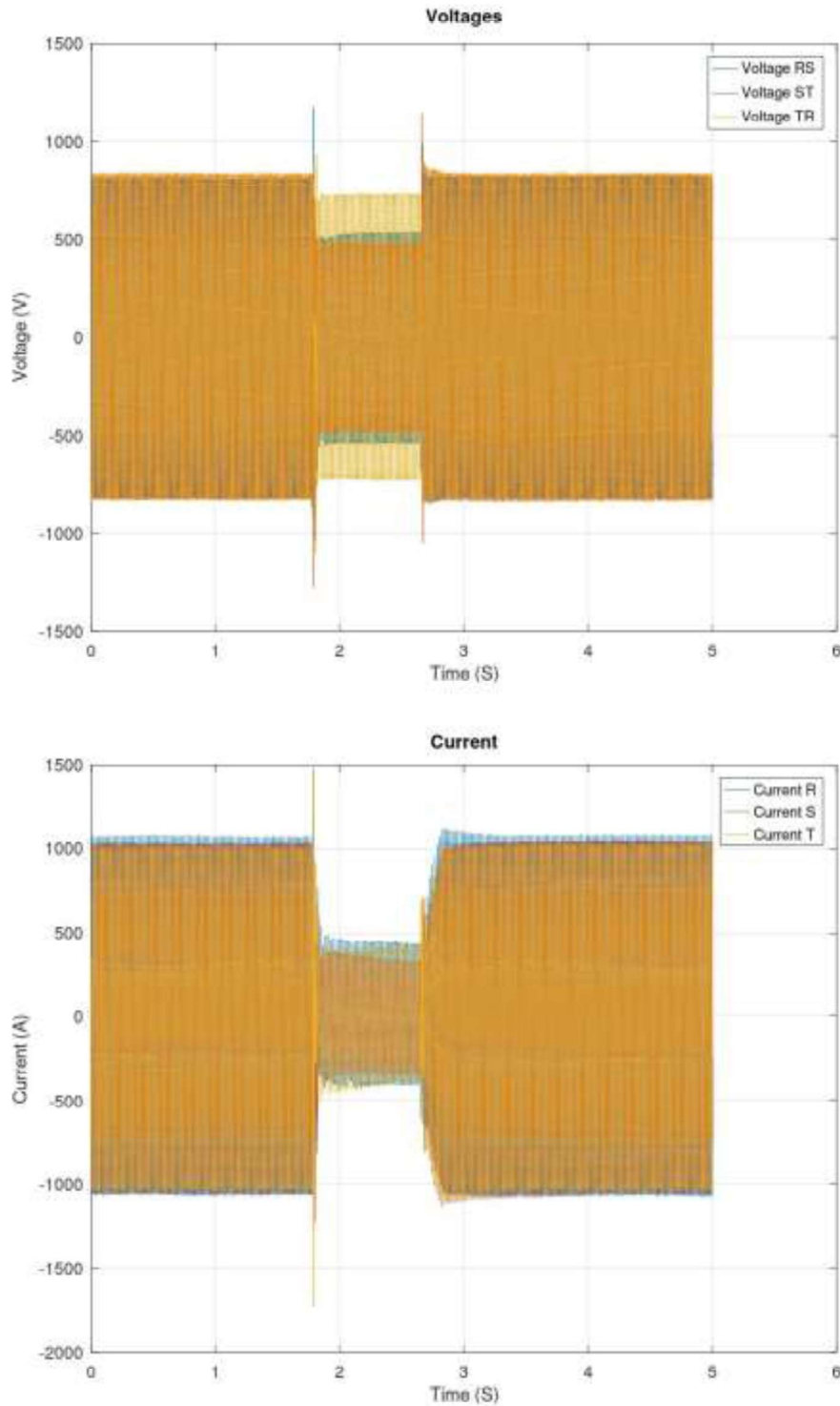


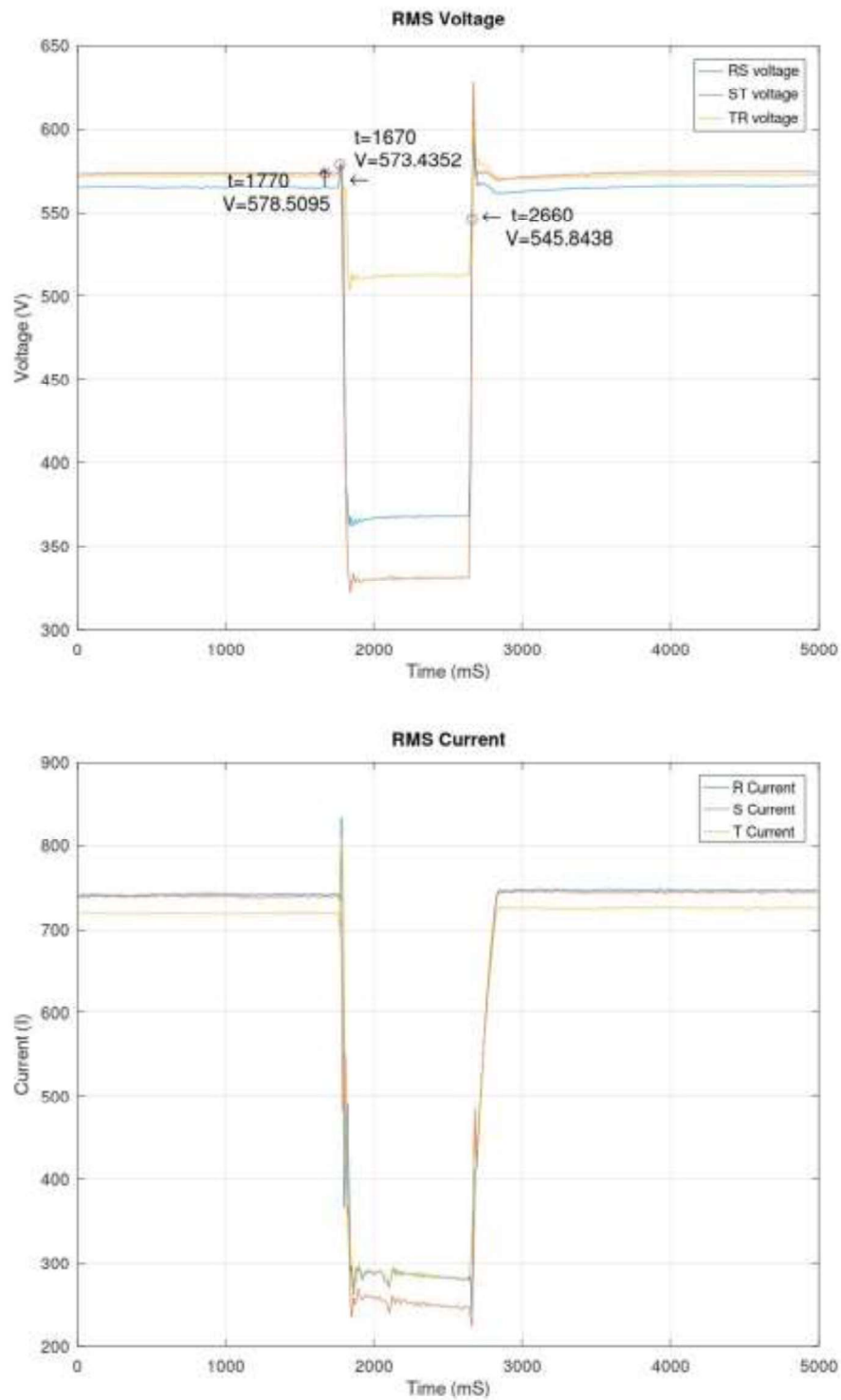


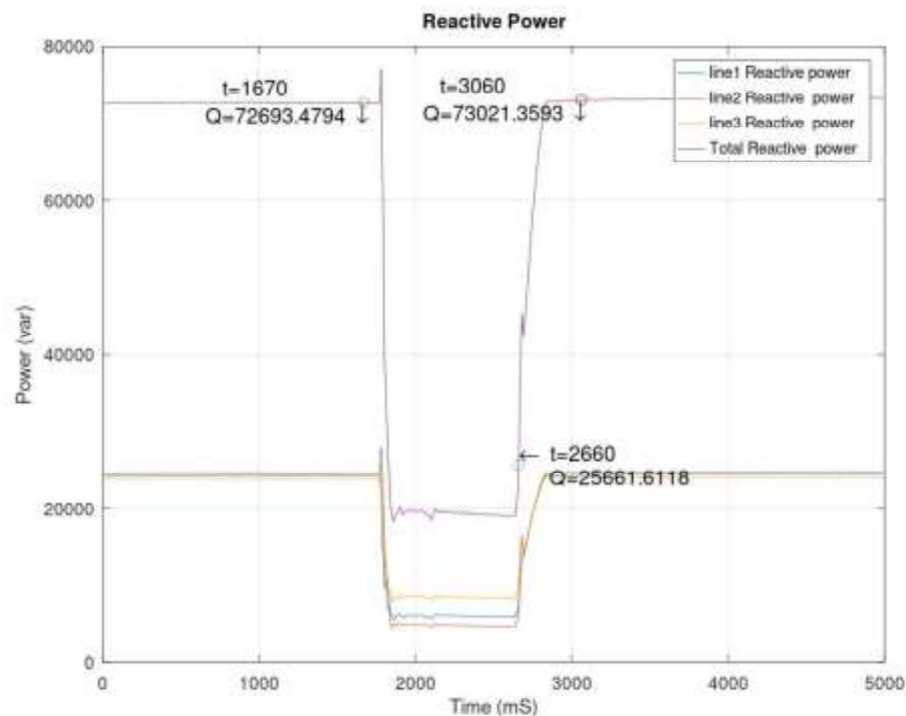
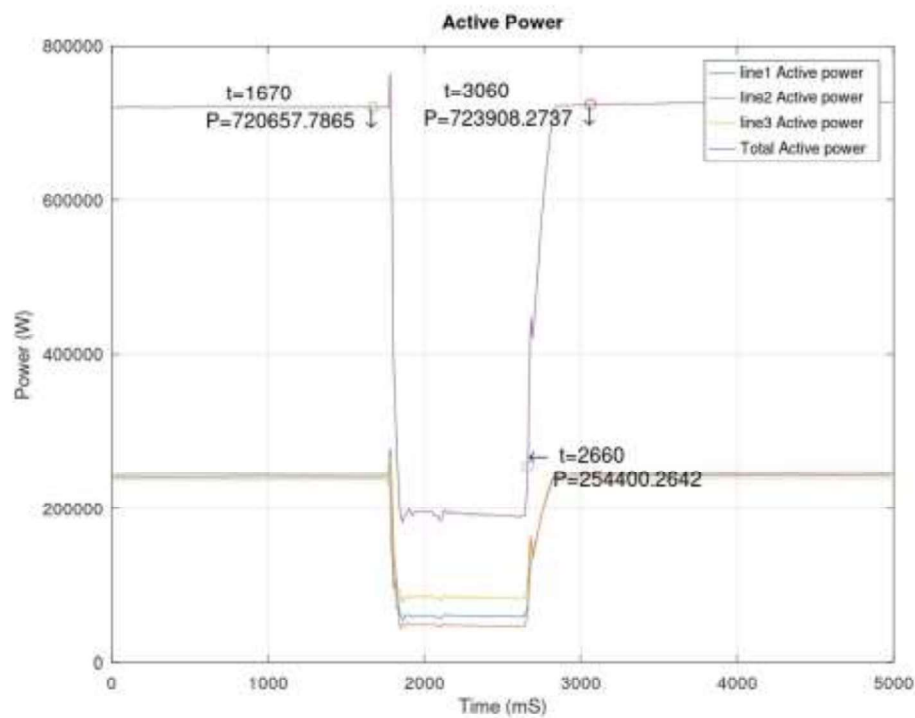




**Test 3a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*



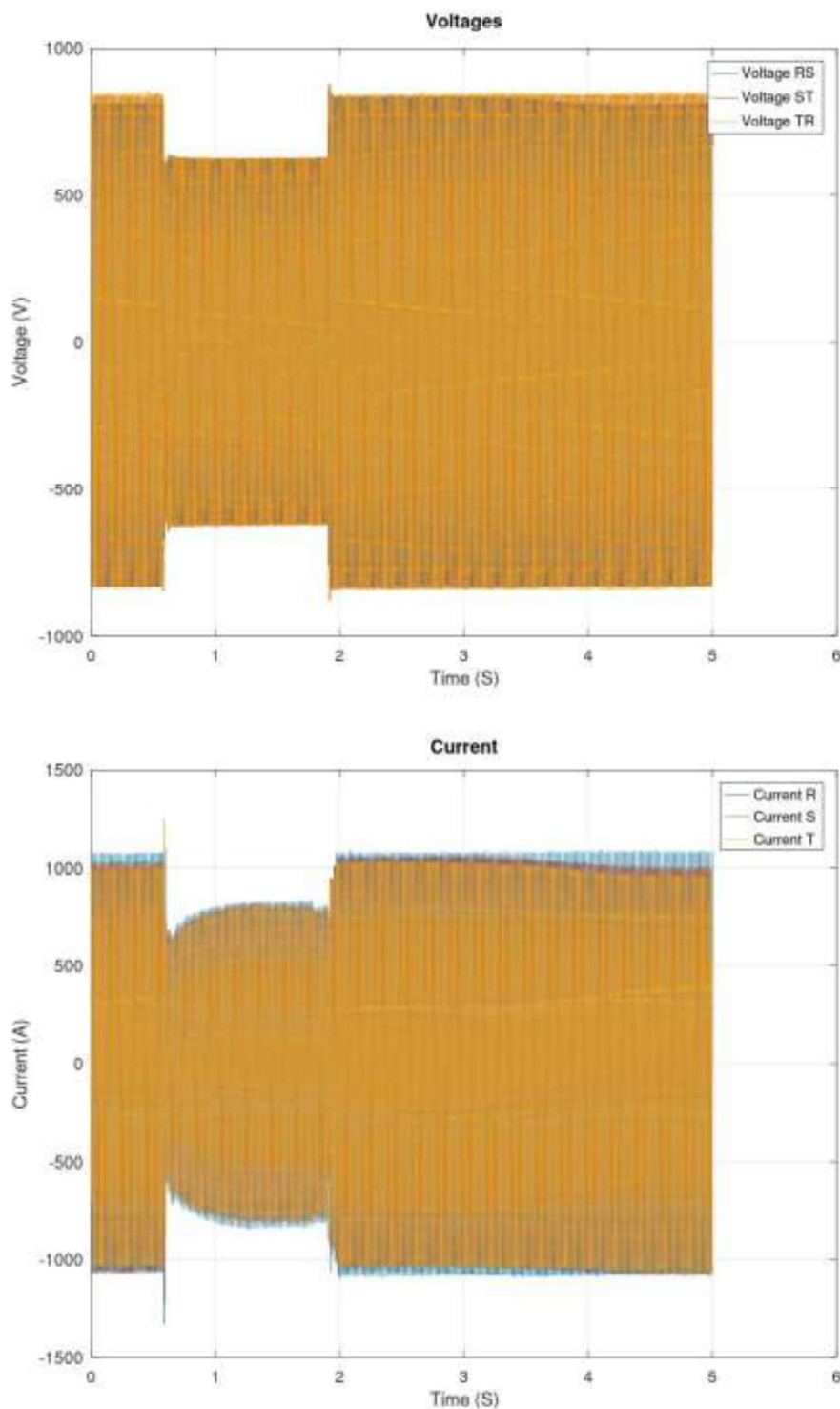




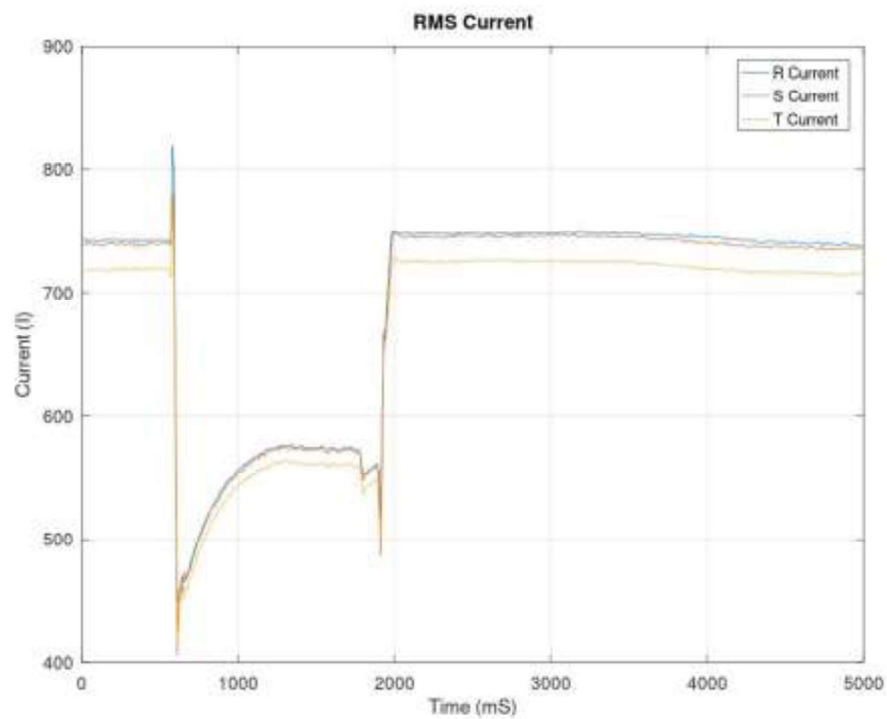
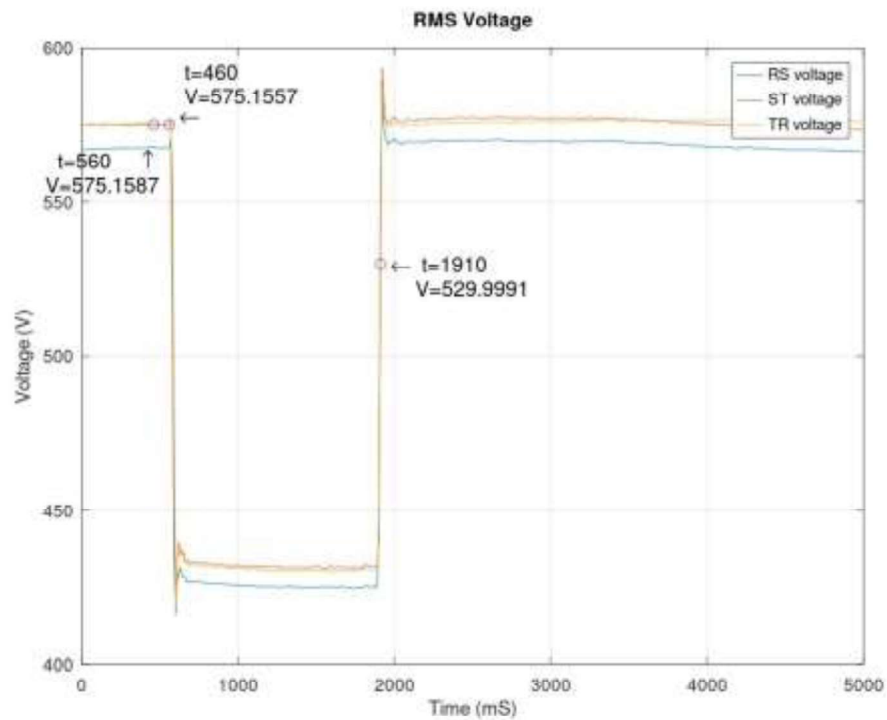


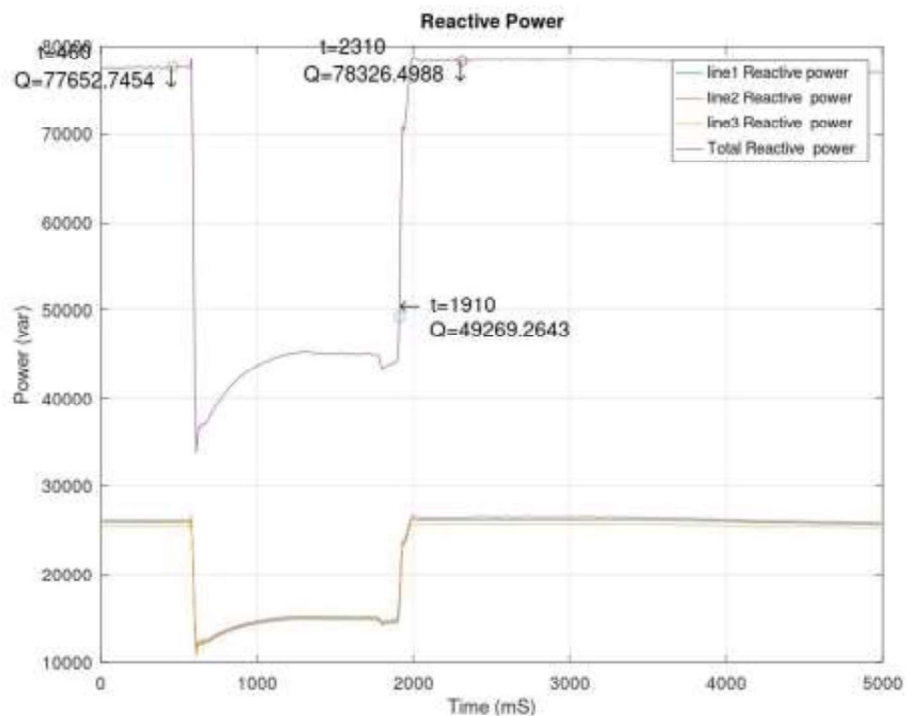
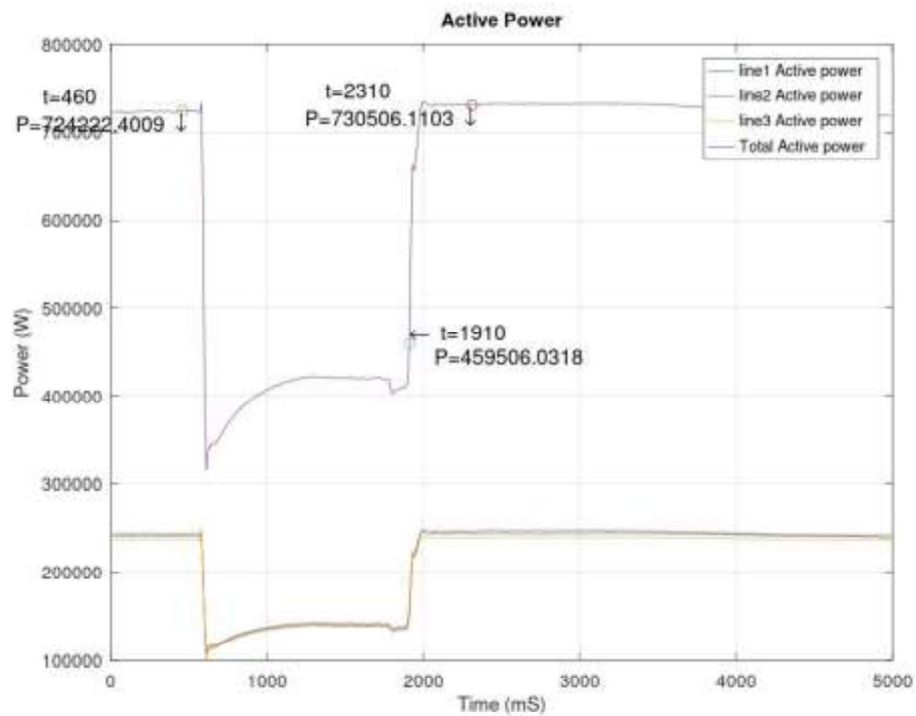


**Test 4s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*





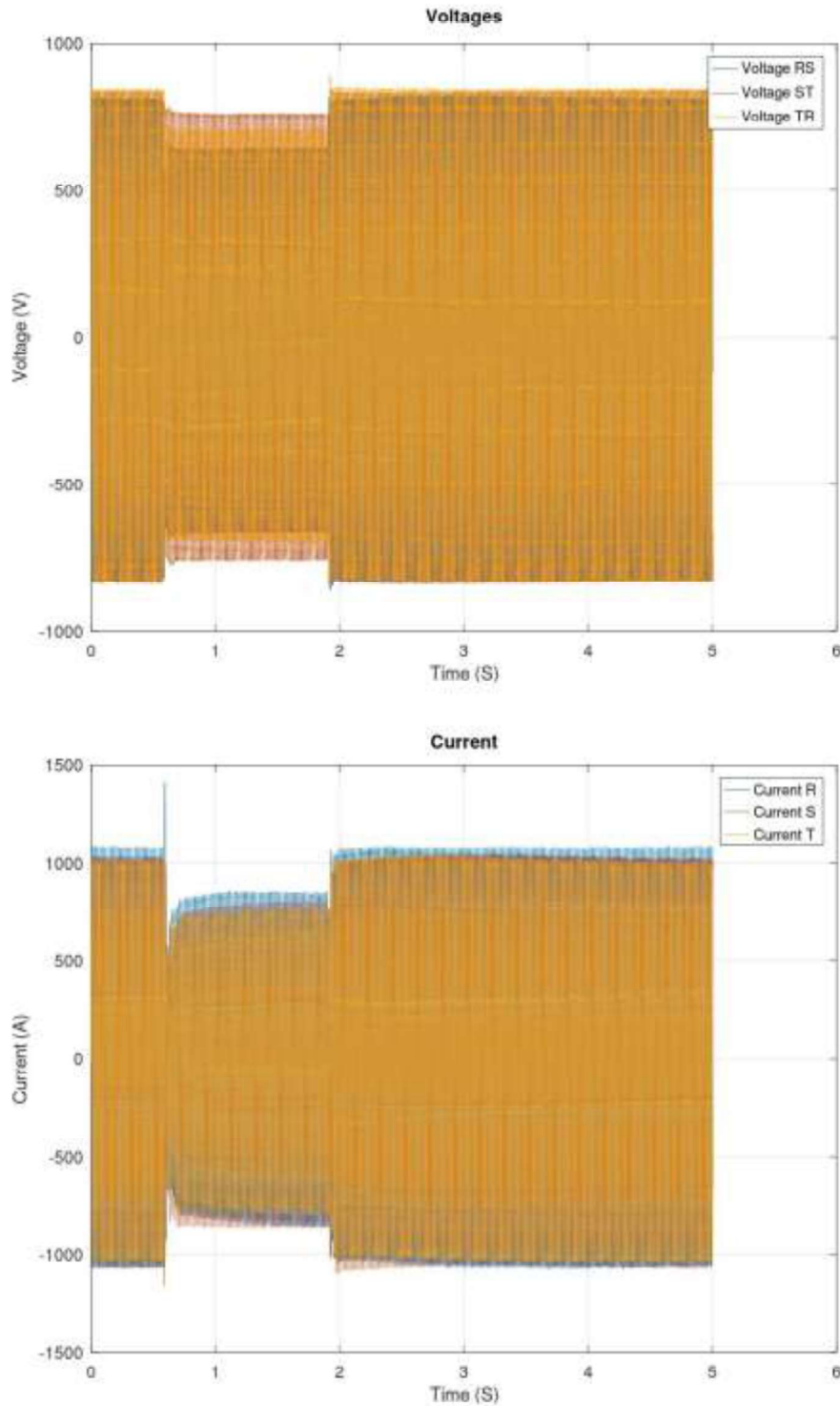


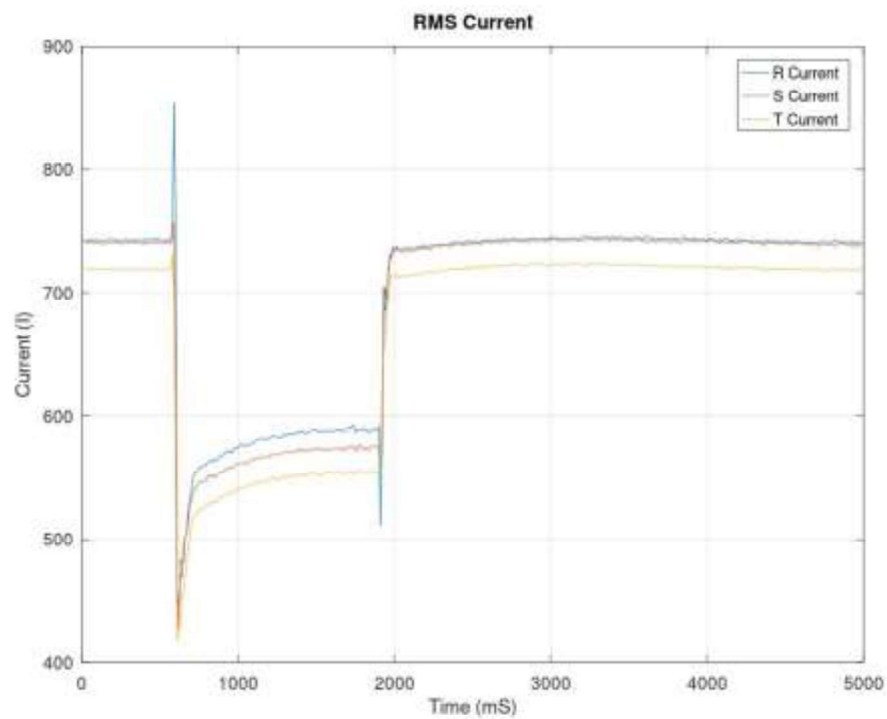
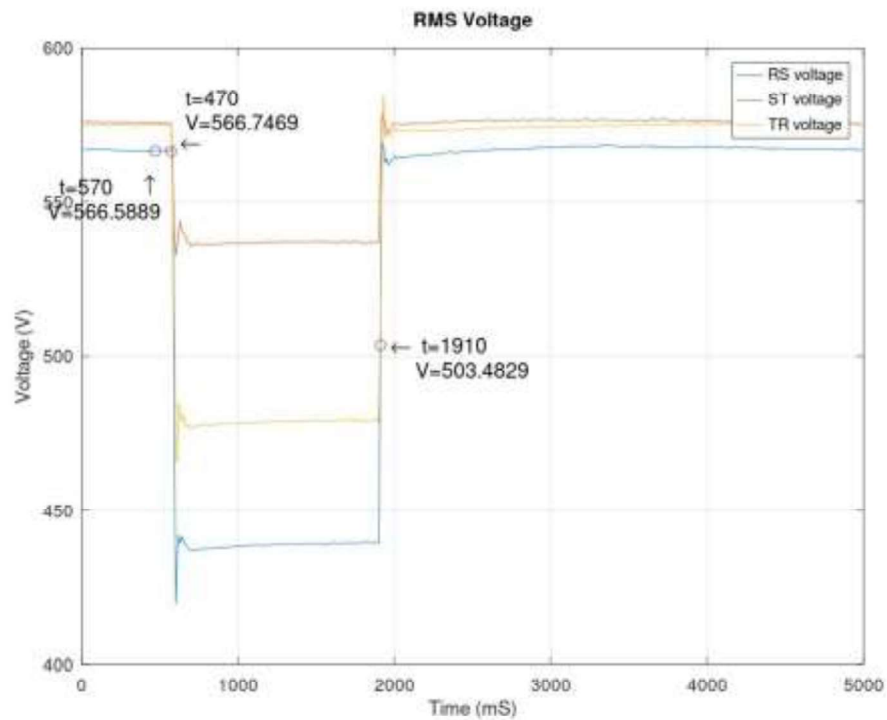


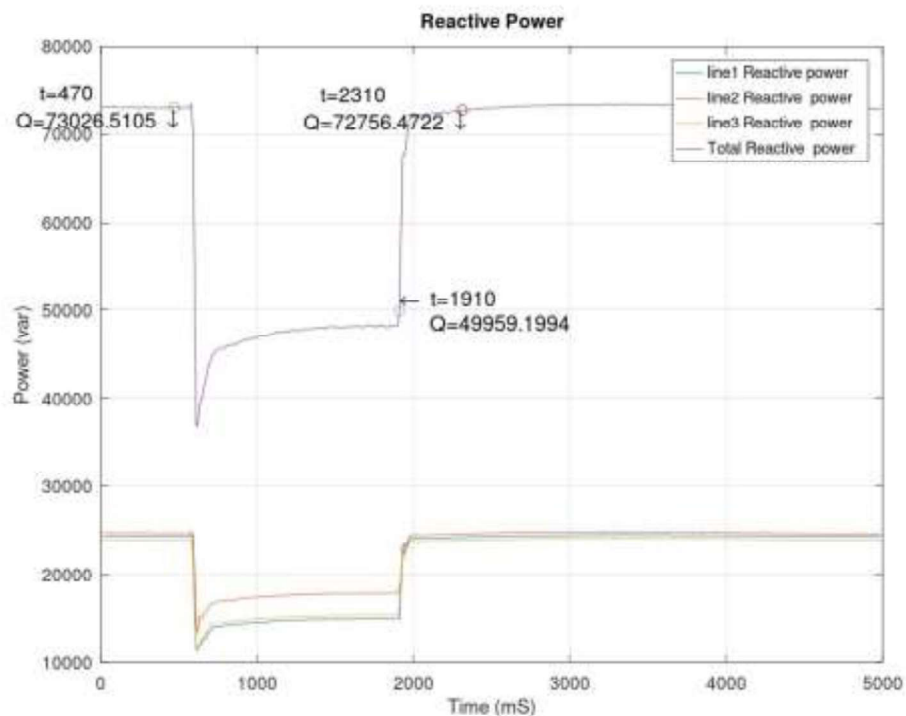
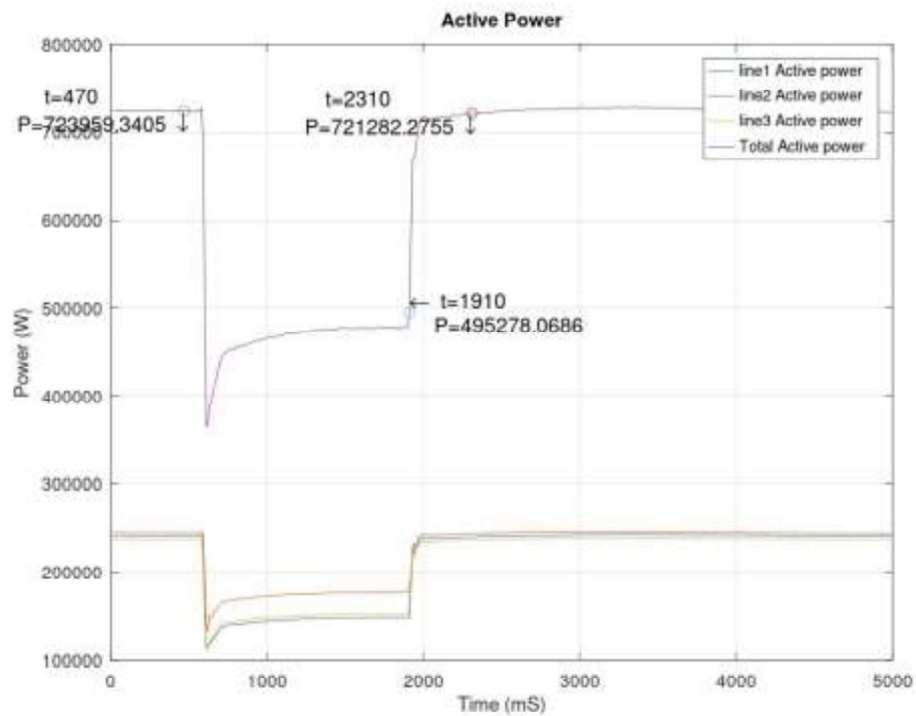


**Test 4a -- guasto simmetrico bifase**

*/ two phases asymmetric failure*







| Output power: 160 kW   |   |             |             | Limit: from 10 % to 30% P <sub>nom.</sub> |                |                |                  |           |
|--|---|-------------|-------------|---|----------------|----------------|------------------|-----------|
| Test   | Residual magnitude<br>[V/V <sub>n</sub> ] |             |             | phase angle<br>[°]                        |                |                | Recovery<br>time | Duration  |
|  | R   | S           | T           | φ <sub>1</sub>                            | φ <sub>2</sub> | φ <sub>3</sub> | [ms]             | [ms]      |
| 1s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.10 ± 0.05                               | 0.10 ± 0.05 | 0.10 ± 0.05 | 0°  | -120°          | 120°           | 207.6            | 200 ± 20  |
| 1a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.87 ± 0.05                               | 0.87 ± 0.05 | 0.10 ± 0.05 | 27°                                       | -147°          | 120°           | 207.6            | 200 ± 20  |
| 2s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.25 ± 0.05                               | 0.25 ± 0.05 | 0.25 ± 0.05 | 0°  | -120°          | 120°           | 409.8            | 400 ± 20  |
| 2a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.88 ± 0.05                               | 0.88 ± 0.05 | 0.25 ± 0.05 | 22°                                       | -142°          | 120°           | 409.8            | 400 ± 20  |
| 3s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.50 ± 0.05                               | 0.50 ± 0.05 | 0.50 ± 0.05 | 0°  | -120°          | 120°           | 866.3            | 850 ± 20  |
| 3a -- guasto asimmetrico bifase<br>/ two phases asymmetric<br>failure  | 0.90 ± 0.05                               | 0.90 ± 0.05 | 0.50 ± 0.05 | 14°                                       | -134°          | 120°           | 866.3            | 850 ± 20  |
| 4s -- guasto simmetrico trifase<br>/ three phases symmetric<br>failure | 0.75 ± 0.05                               | 0.75 ± 0.05 | 0.75 ± 0.05 | 0°  | -120°          | 120°           | 1309.0           | 1300 ± 20 |
| 4a -- guasto simmetrico bifase<br>/ two phases asymmetric<br>failure   | 0.94 ± 0.05                               | 0.94 ± 0.05 | 0.75 ± 0.05 | 7°  | -127°          | 120°           | 1309.0           | 1300 ± 20 |

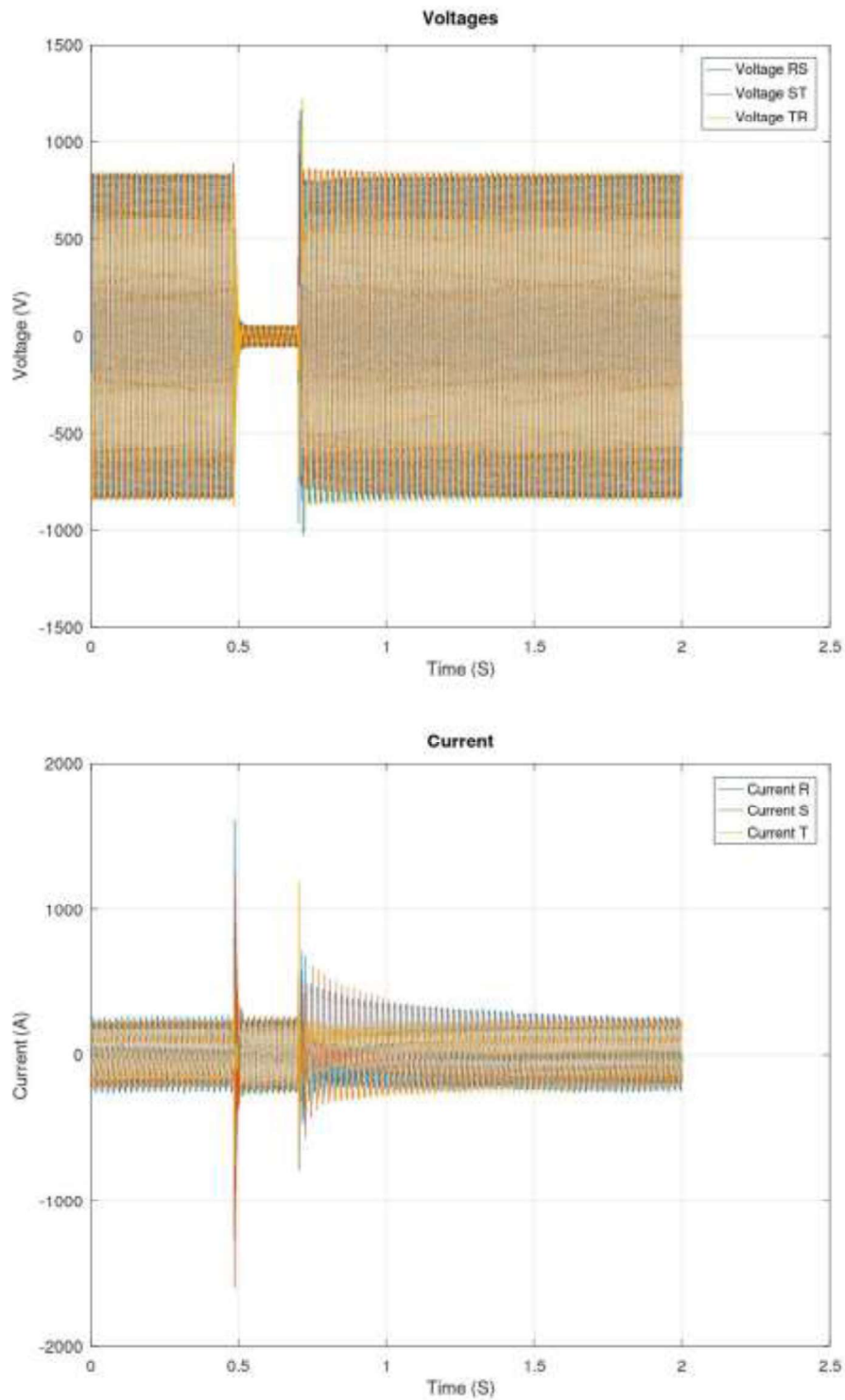


**Grafici: LVFRT**

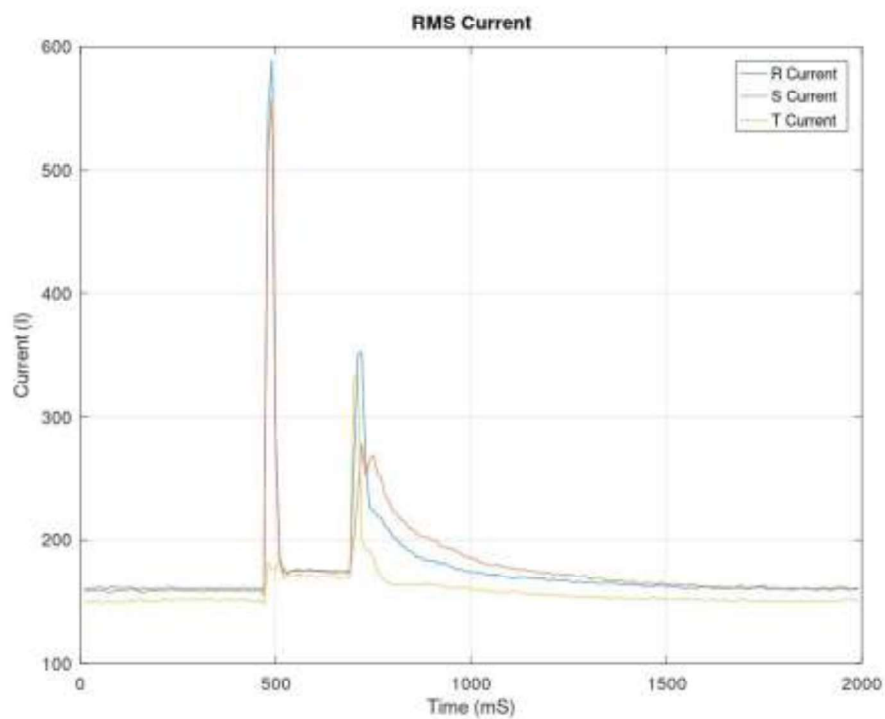
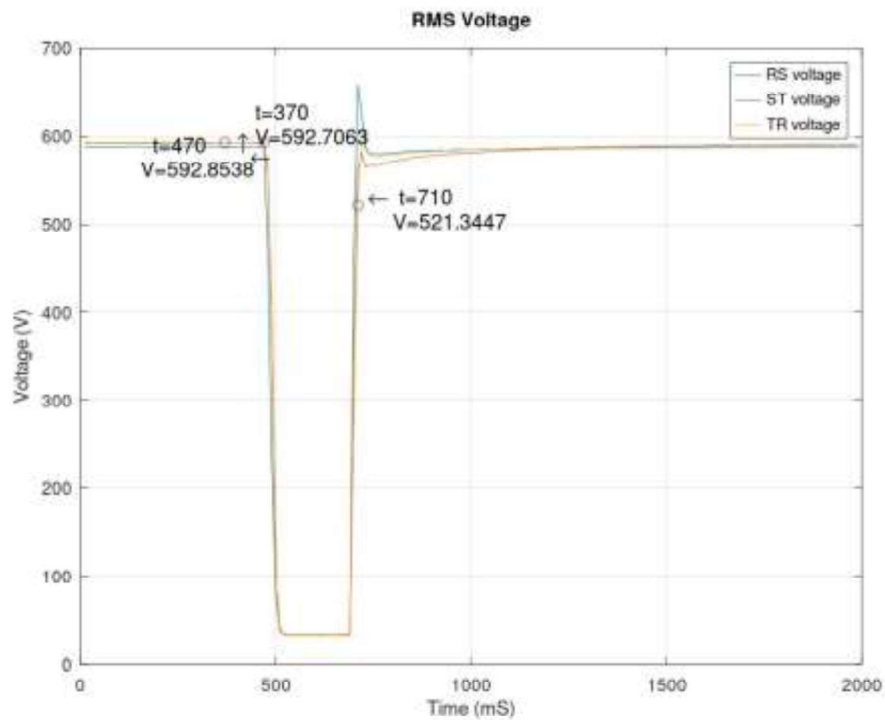
/ Graphs: LVFRT

**Test 1s -- guasto simmetrico trifase**

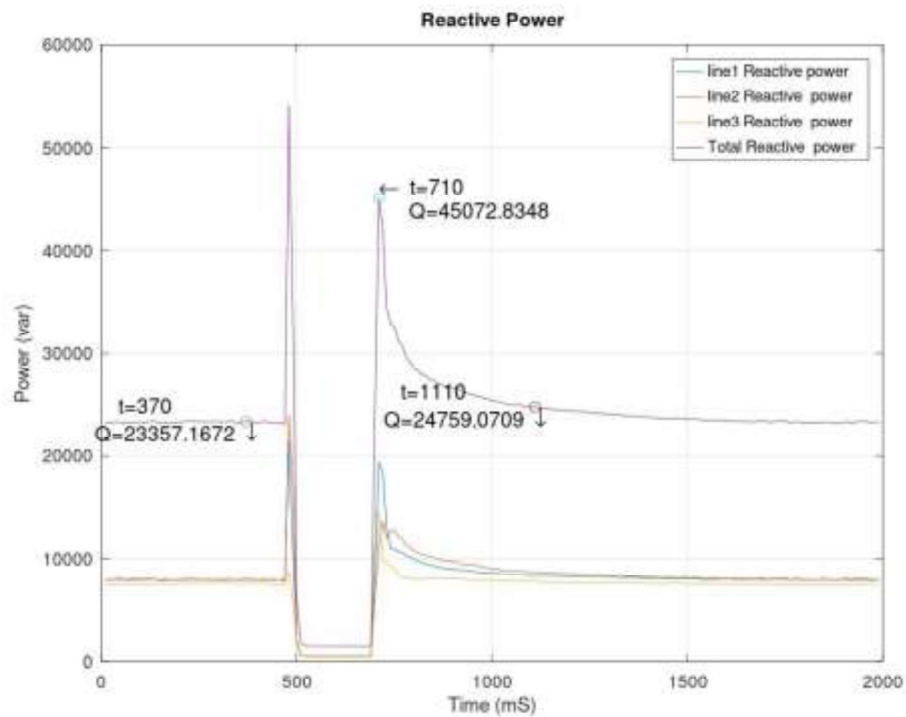
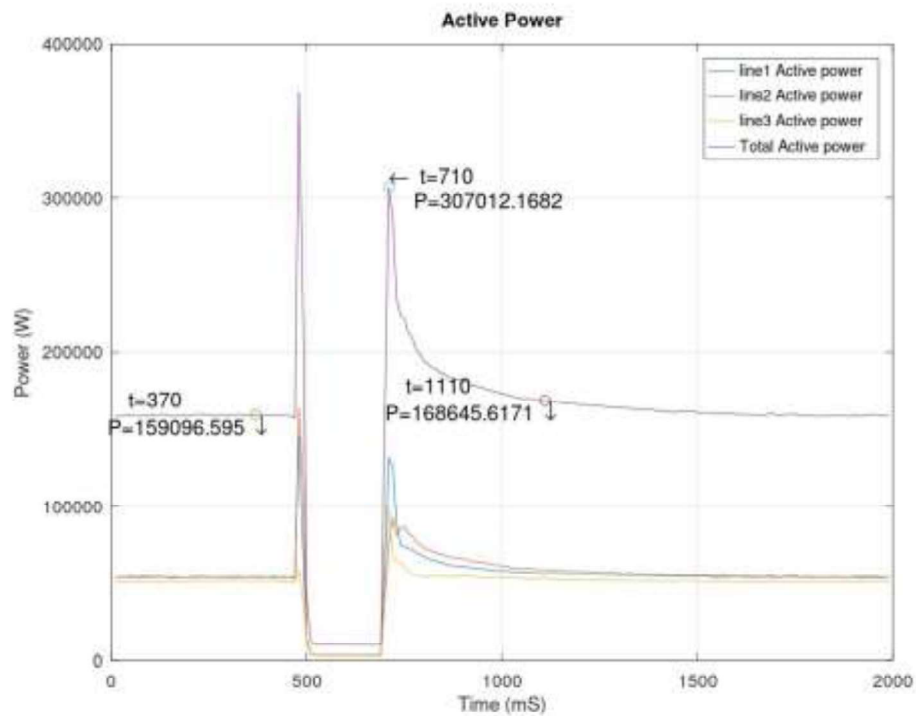
/ three phases symmetric failure





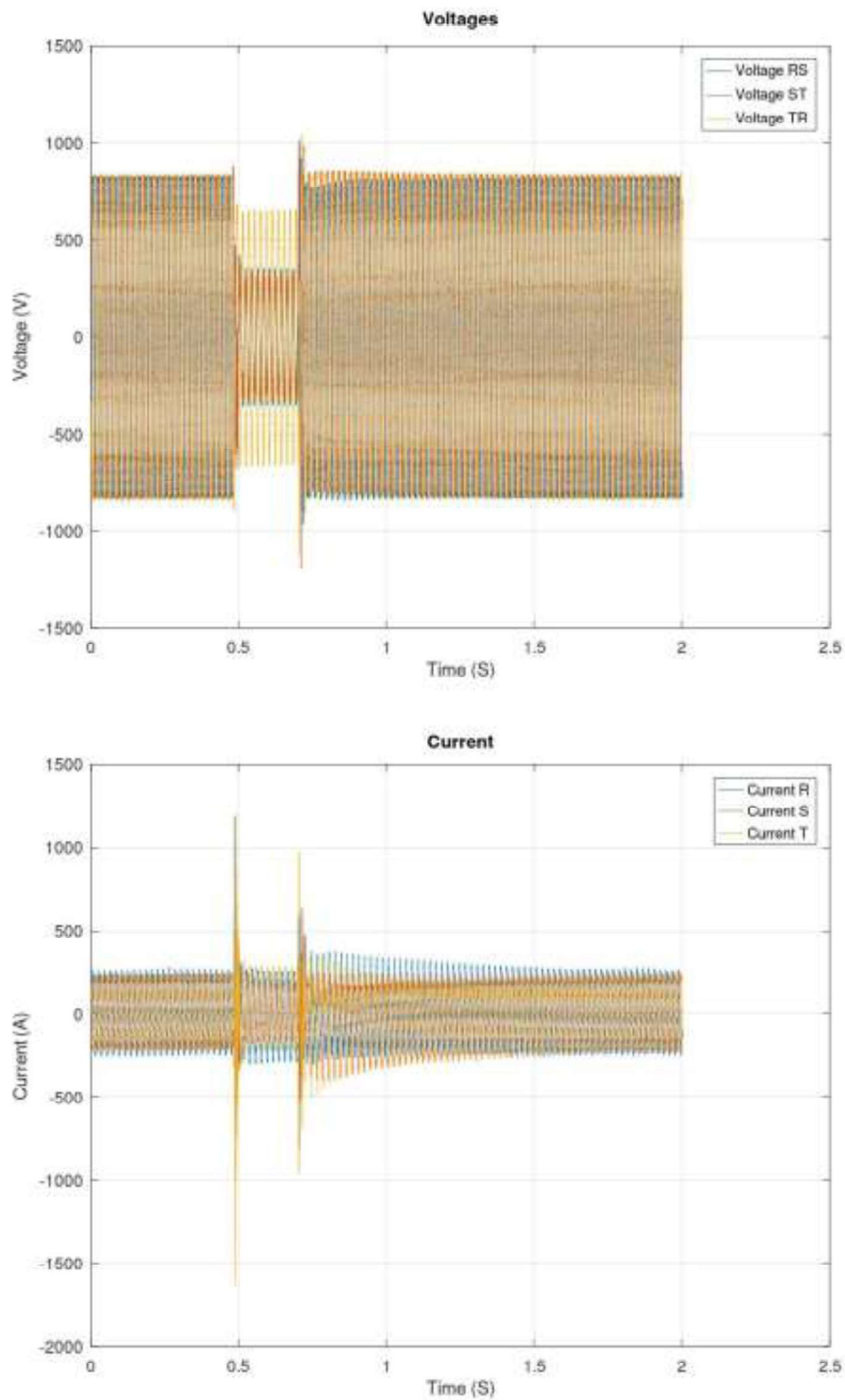


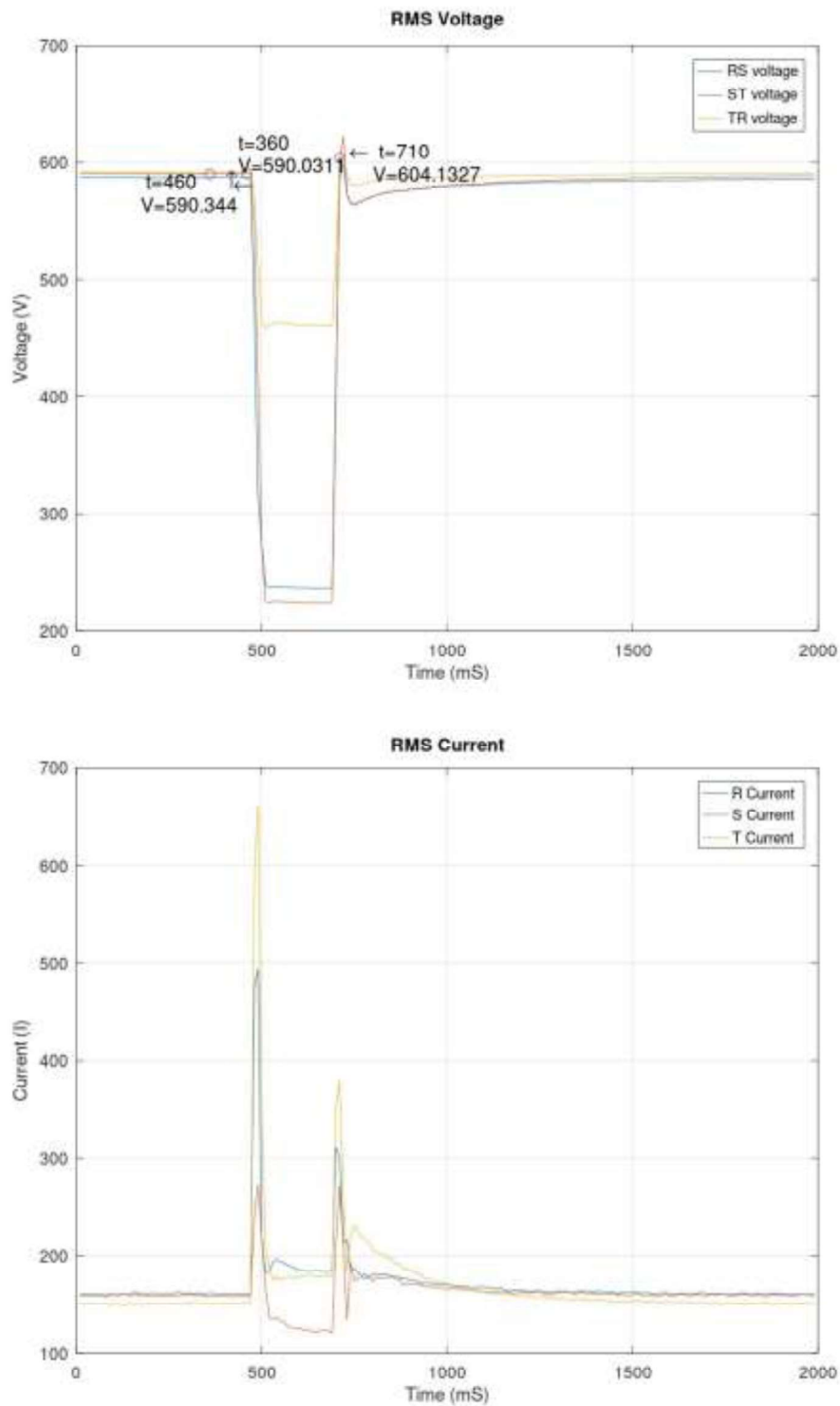


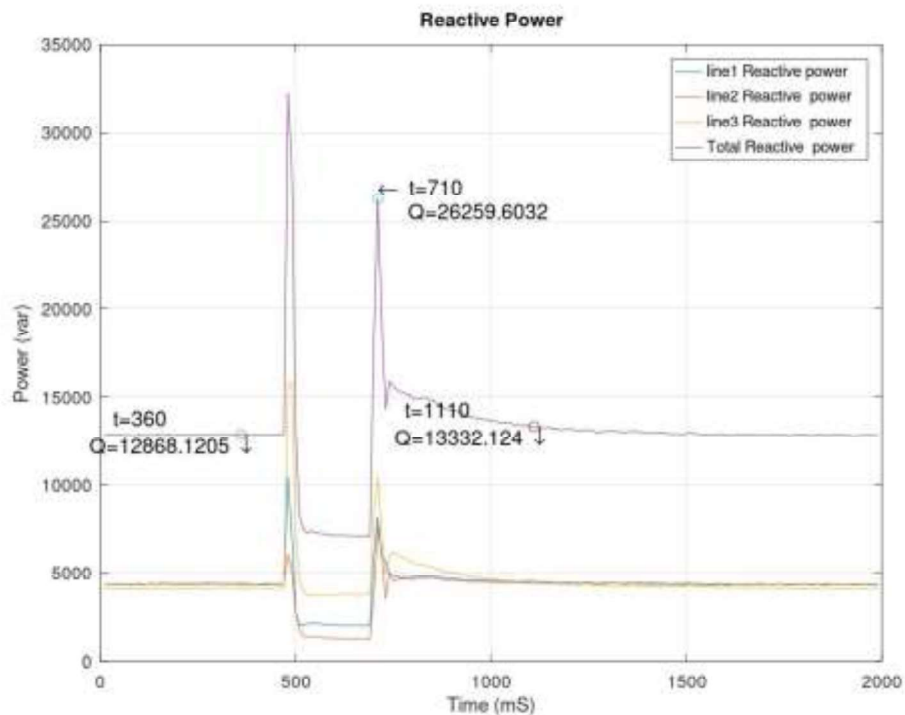
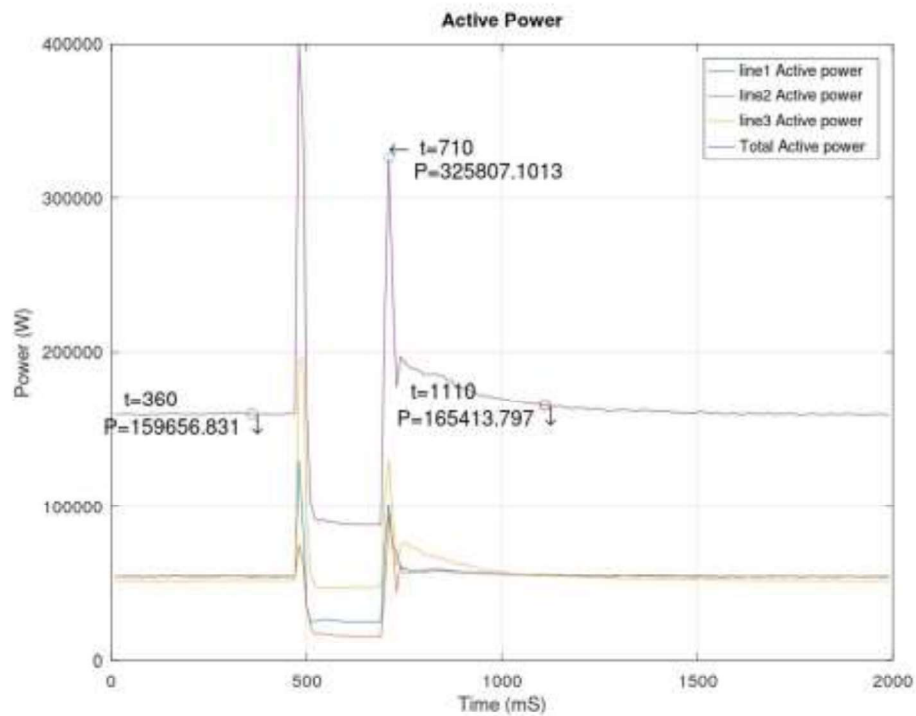




**Test 1a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*

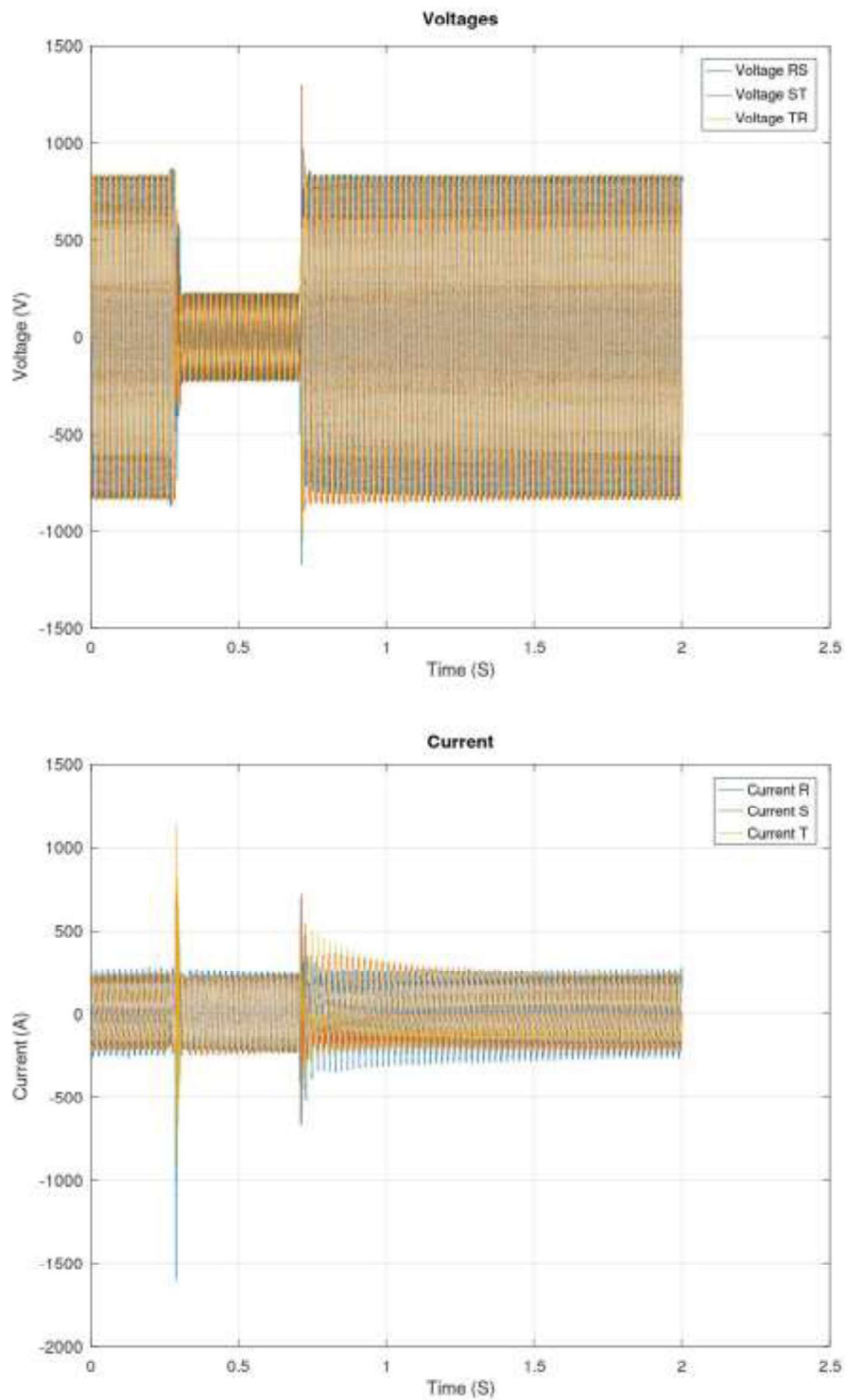


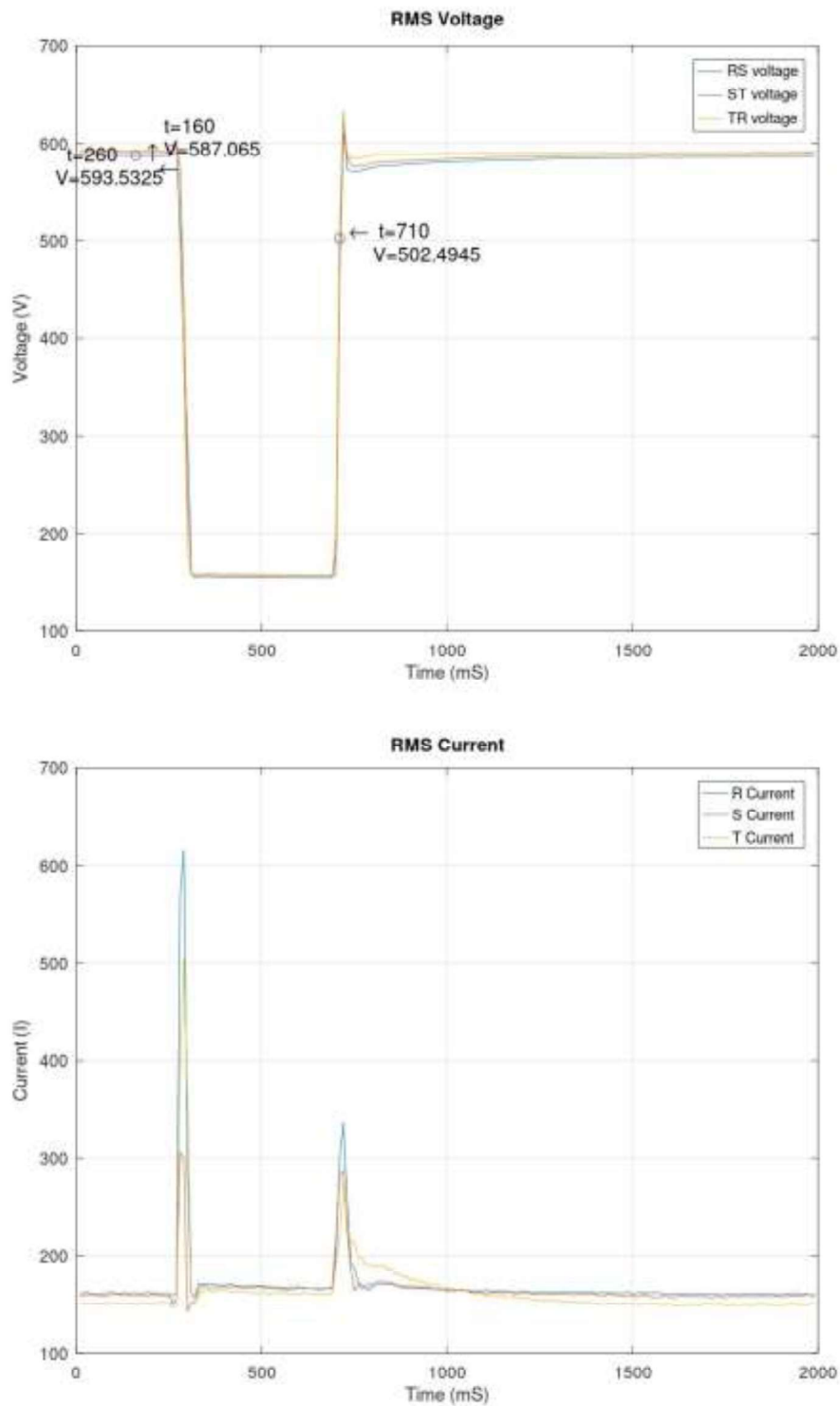


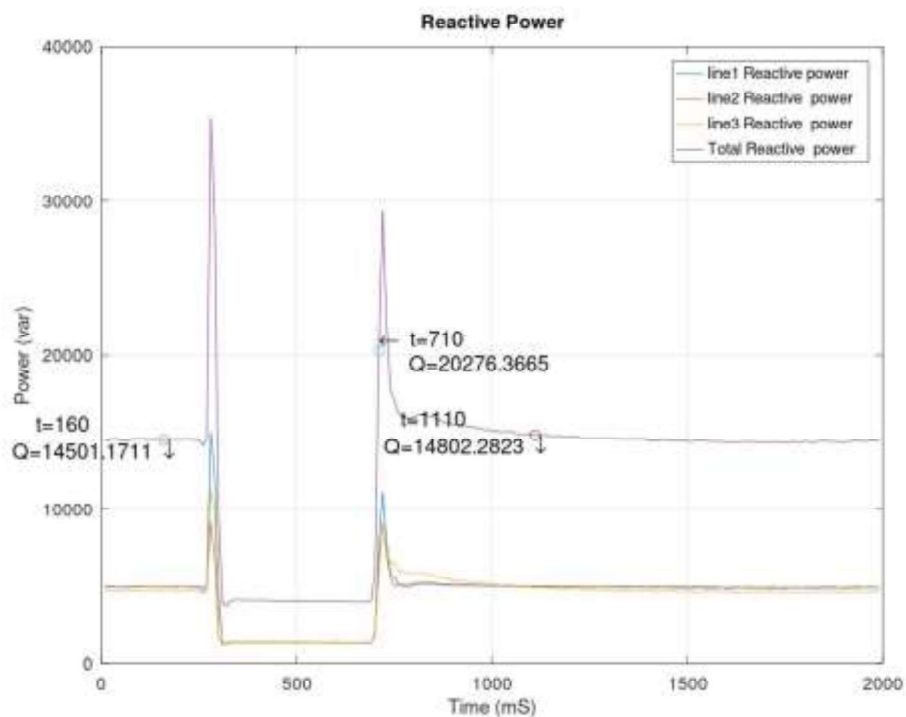
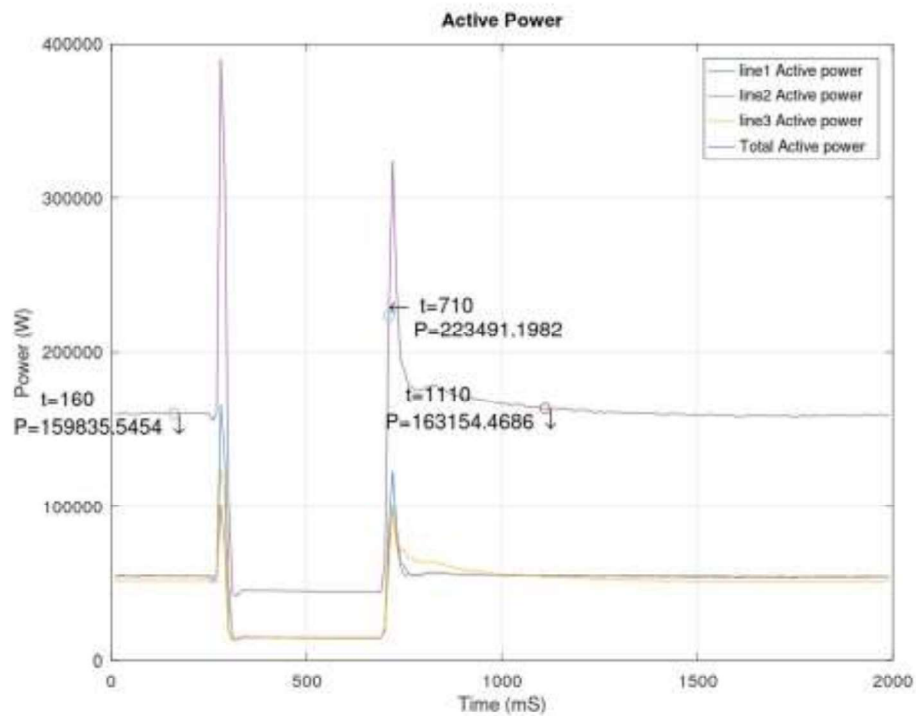




**Test 2s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*



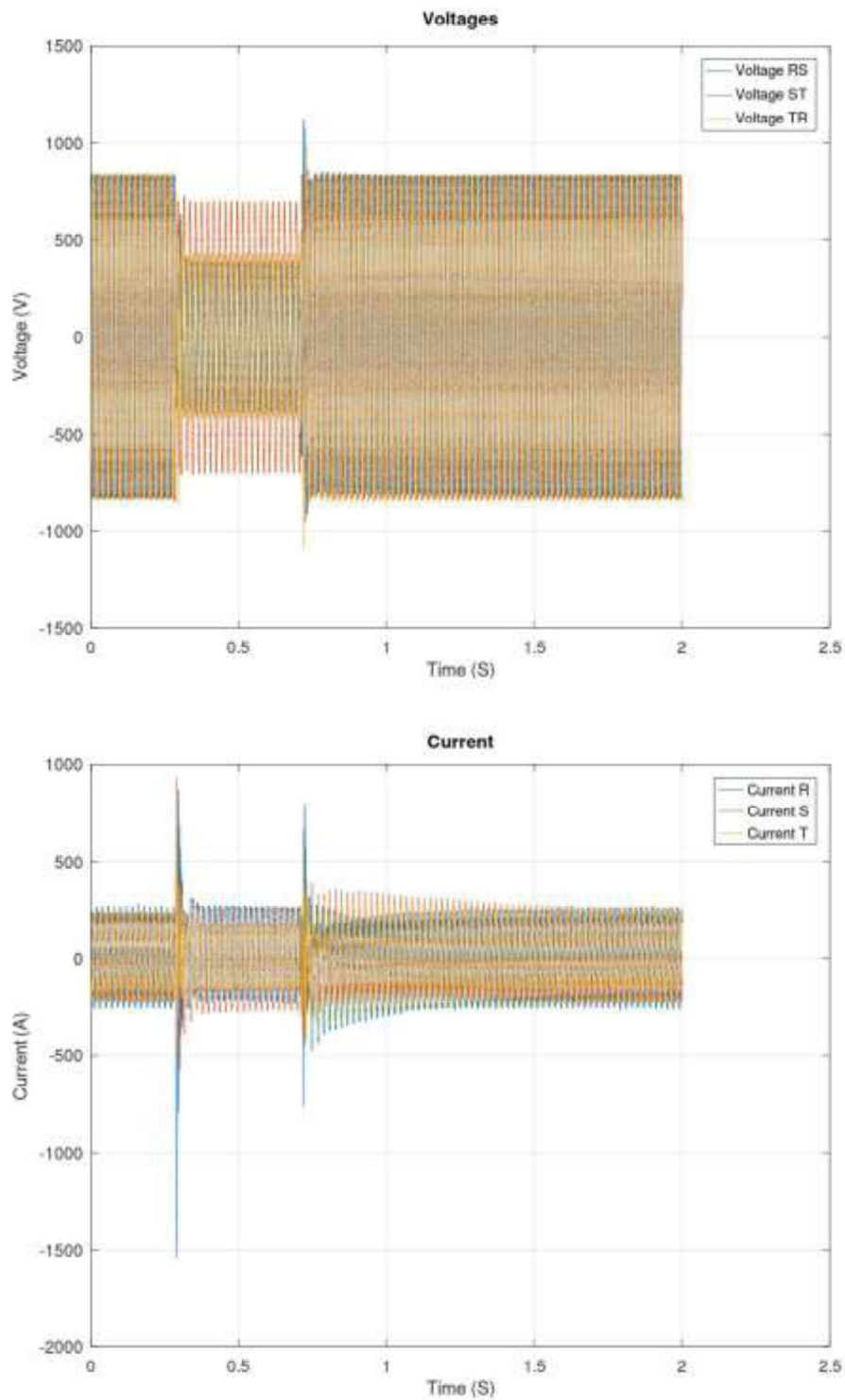




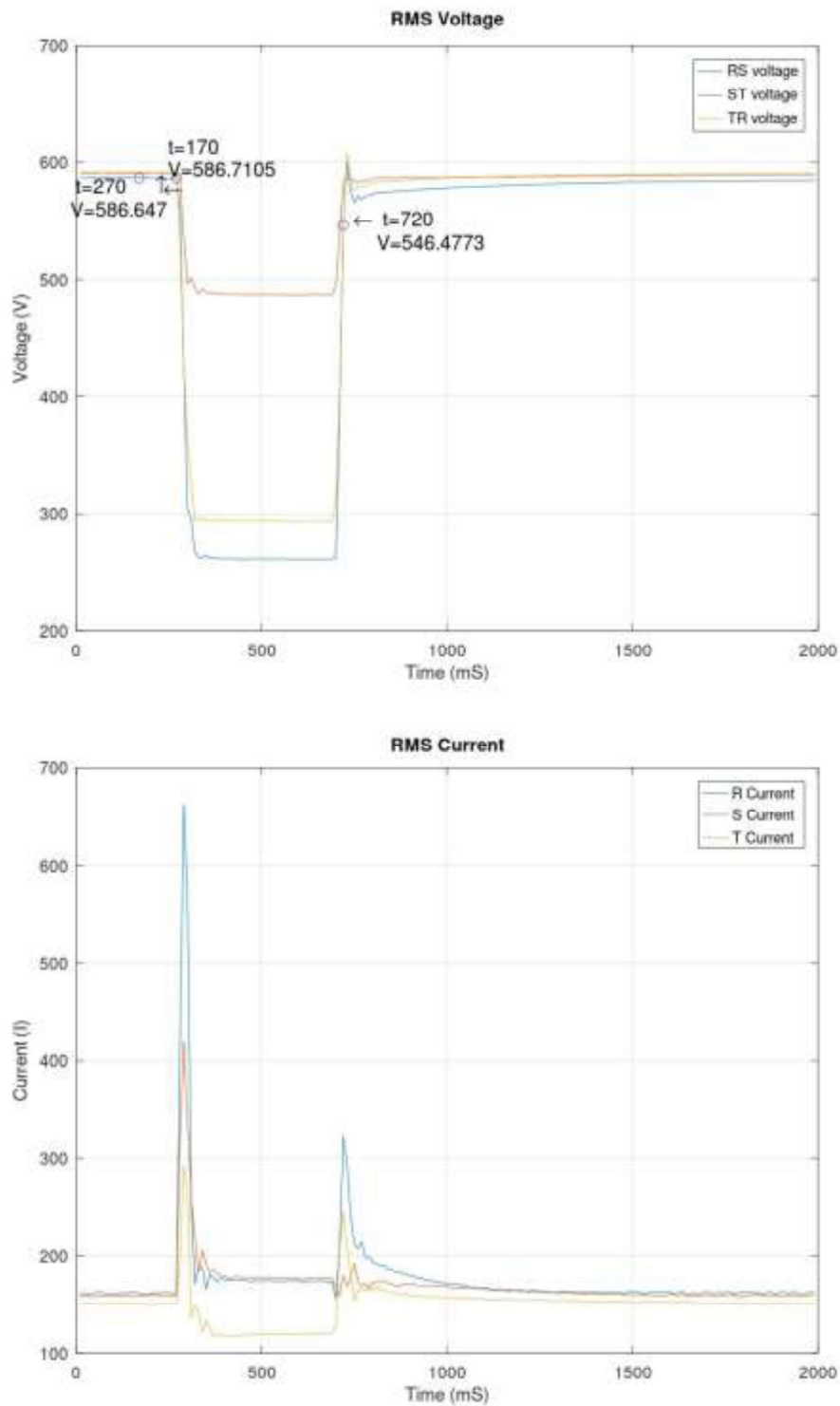


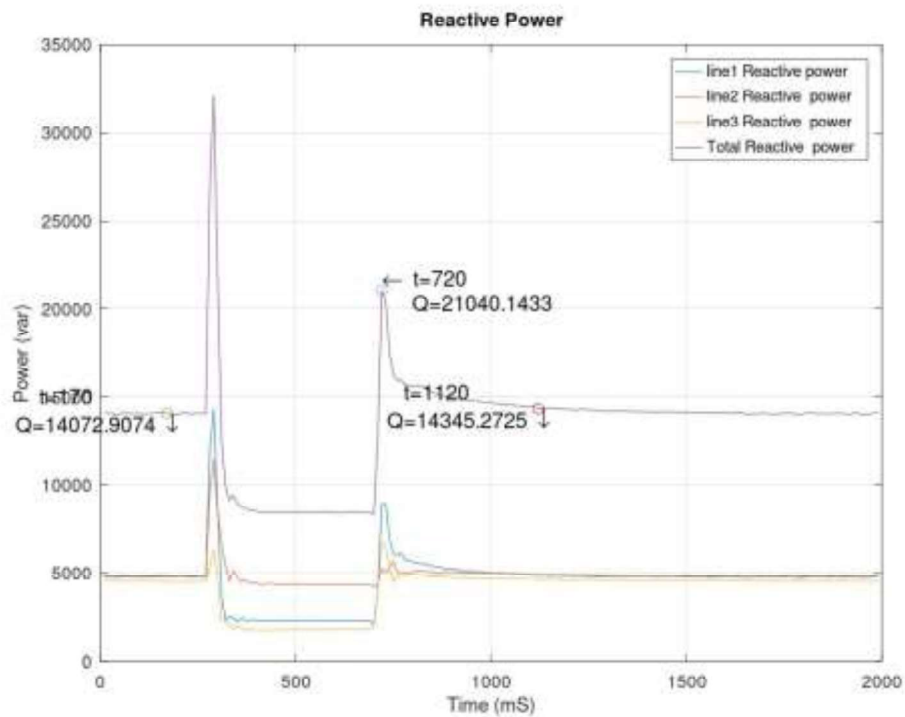
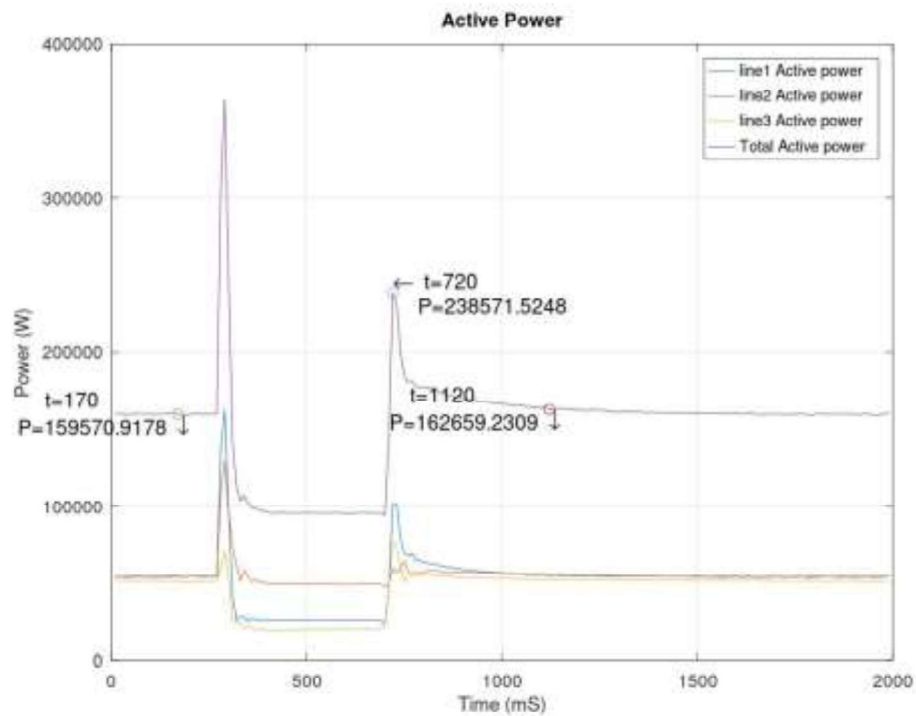


**Test 2a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*



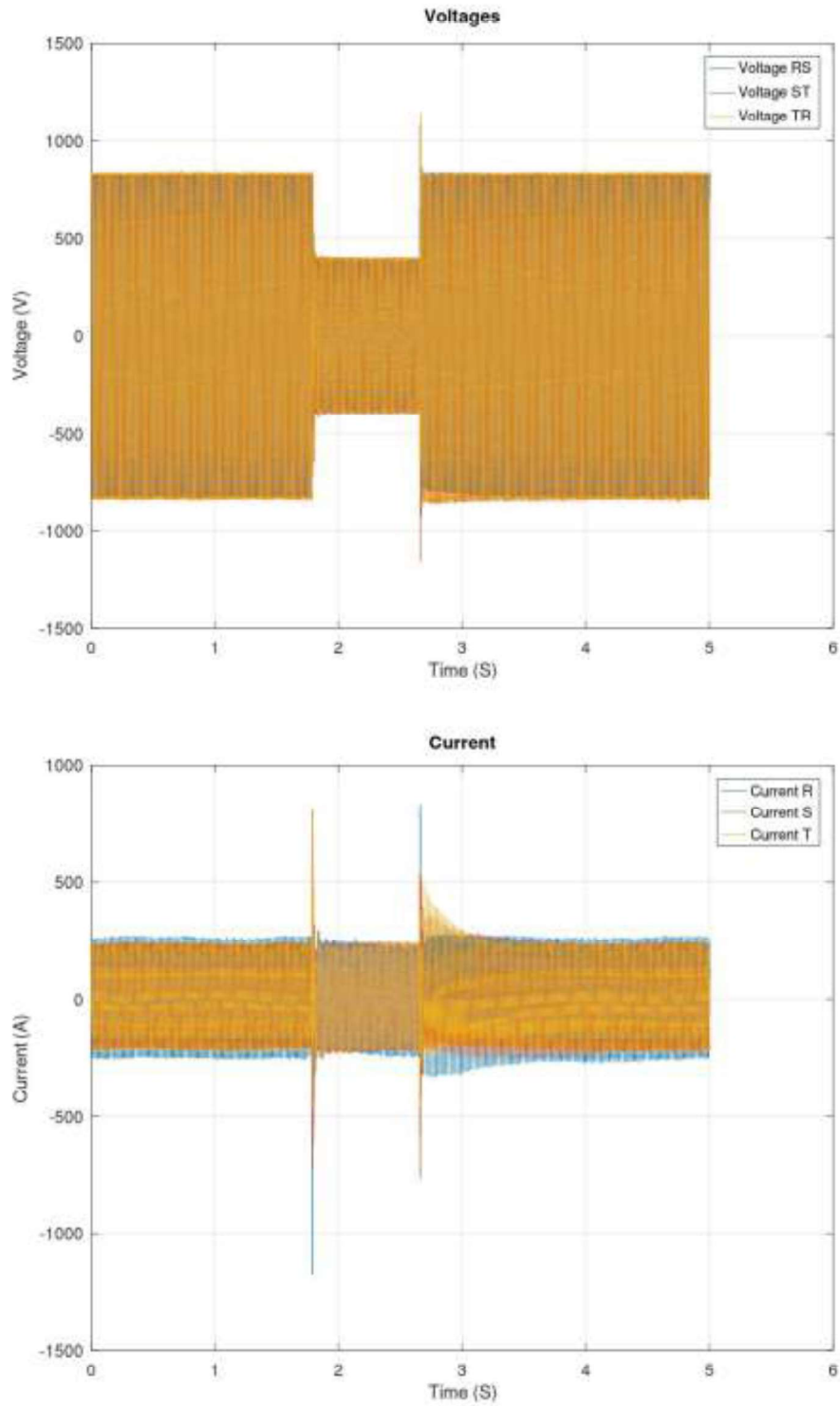


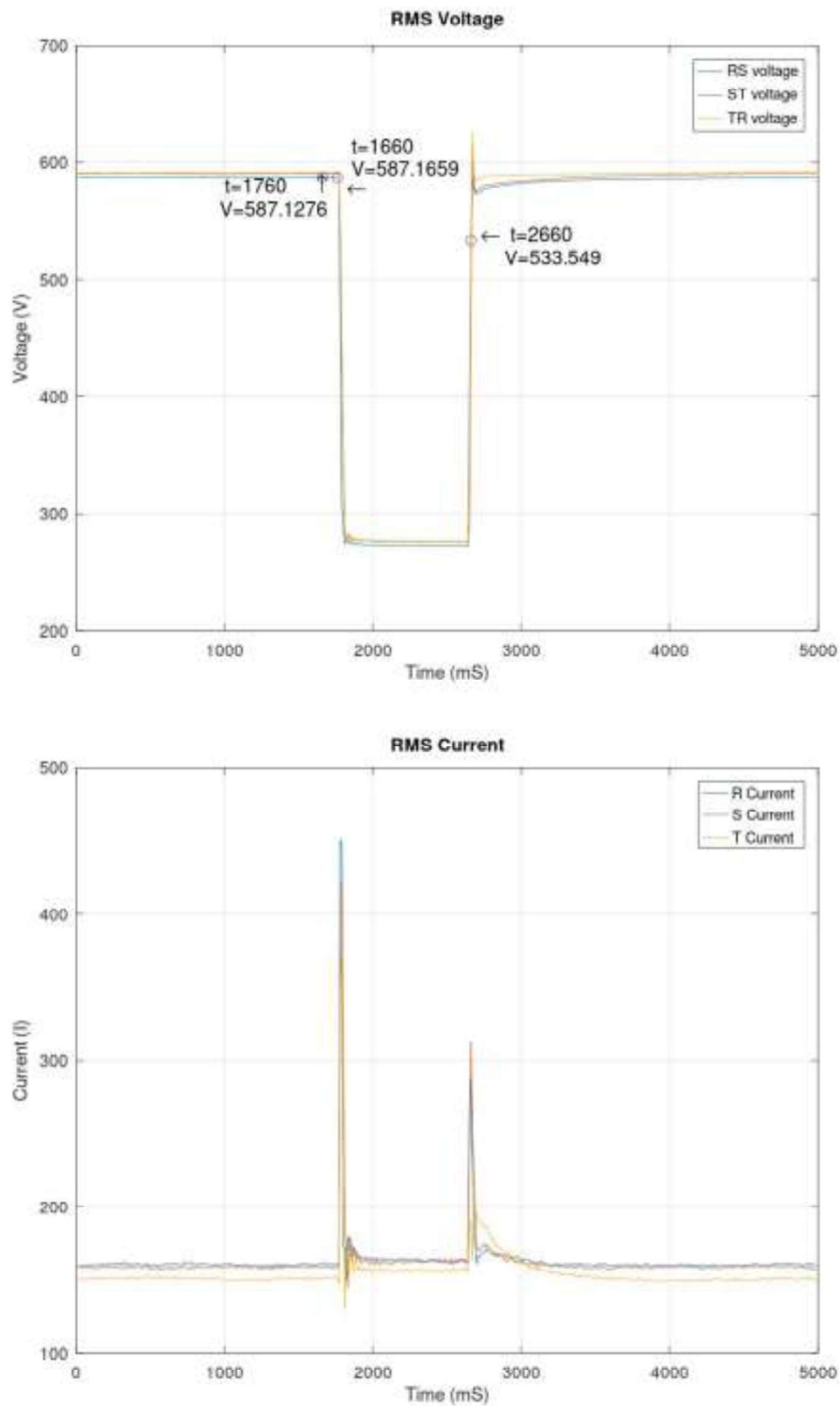


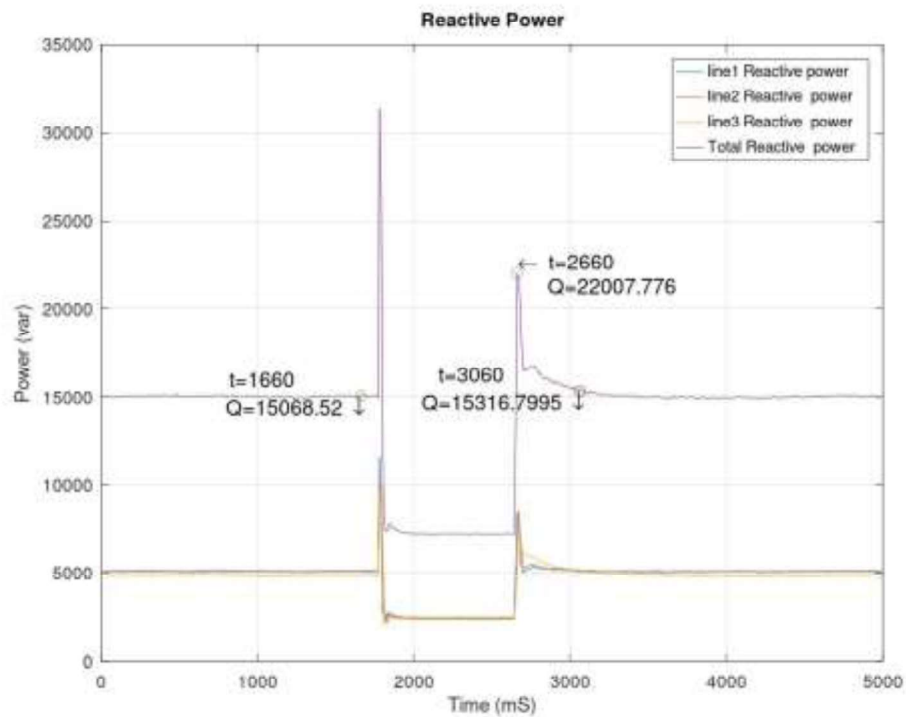
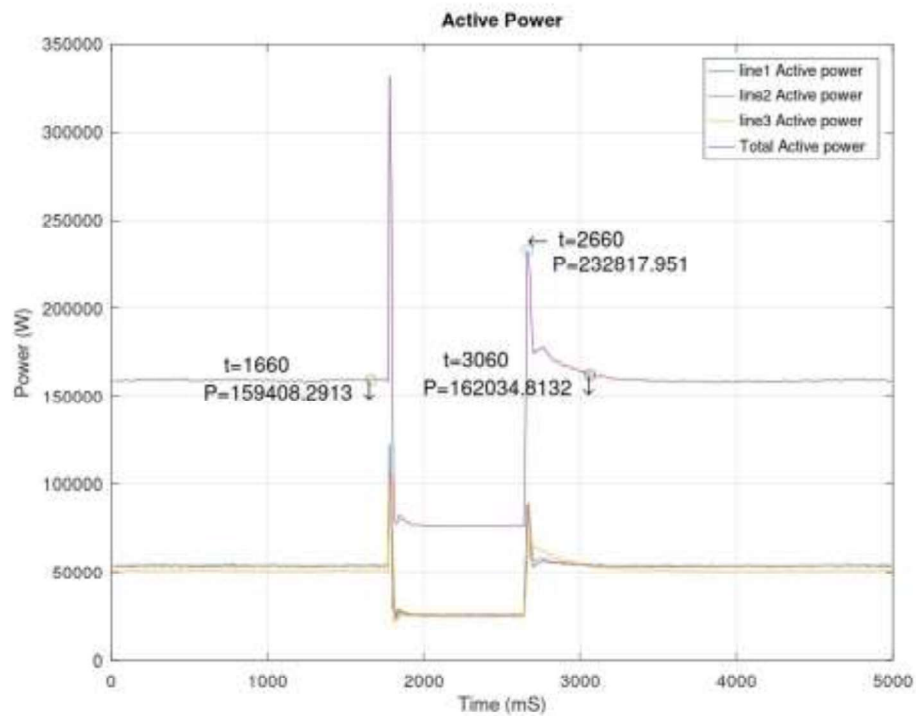




**Test 3s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*

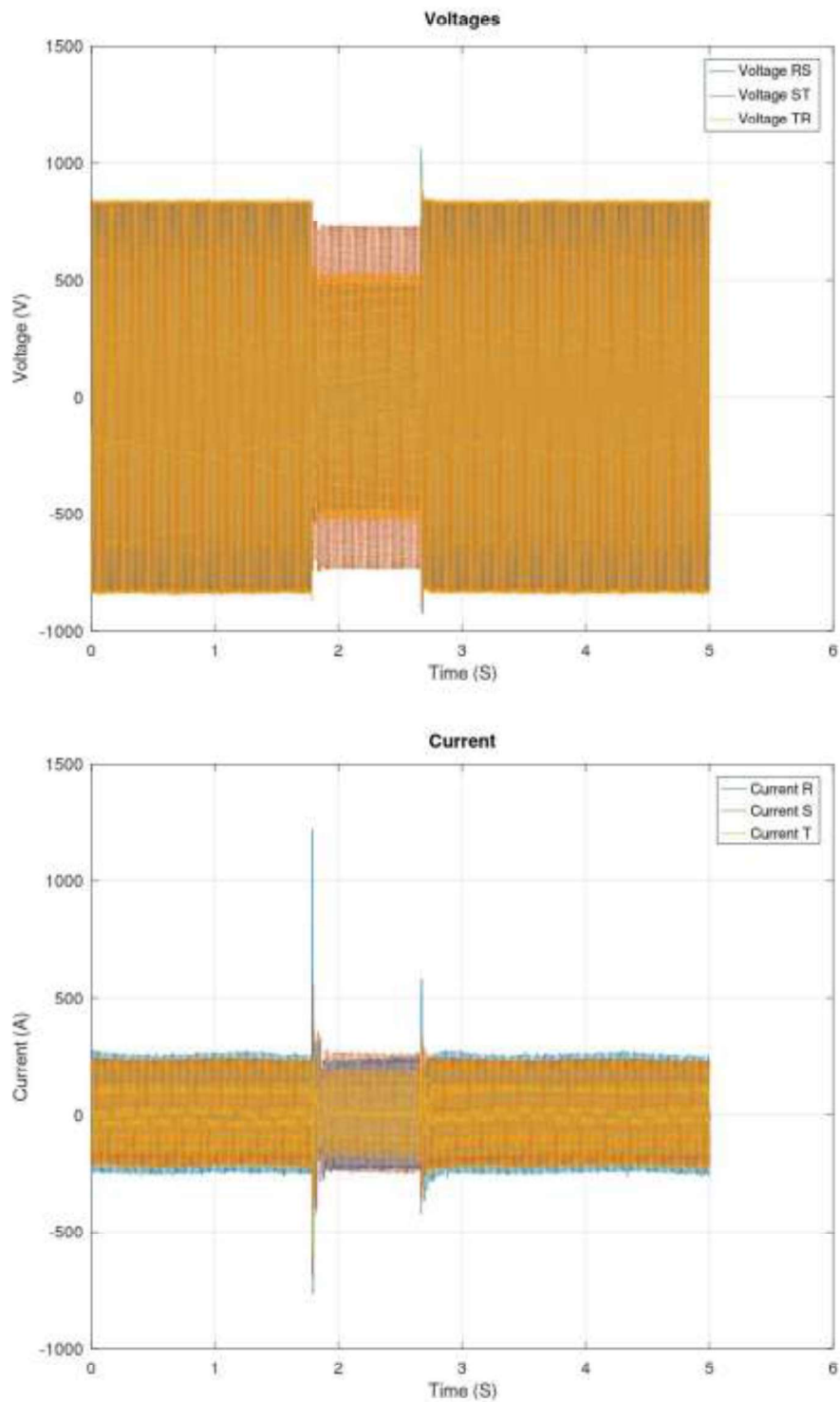


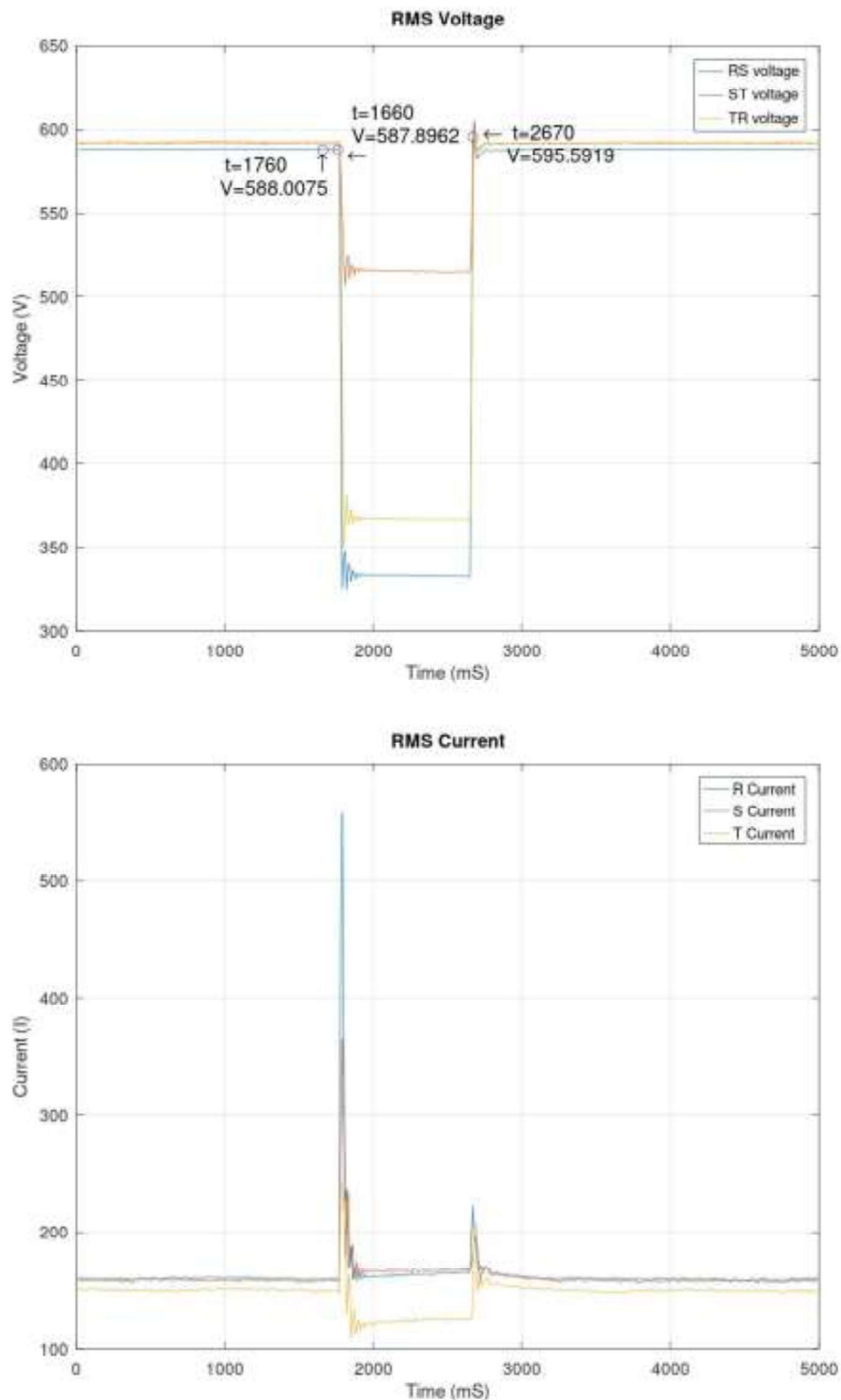




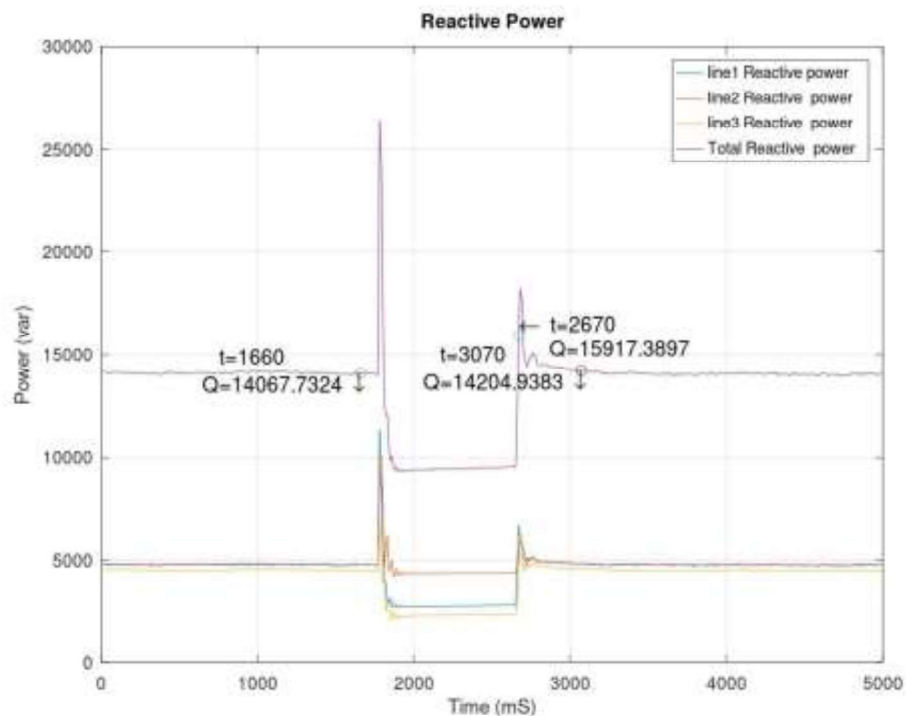
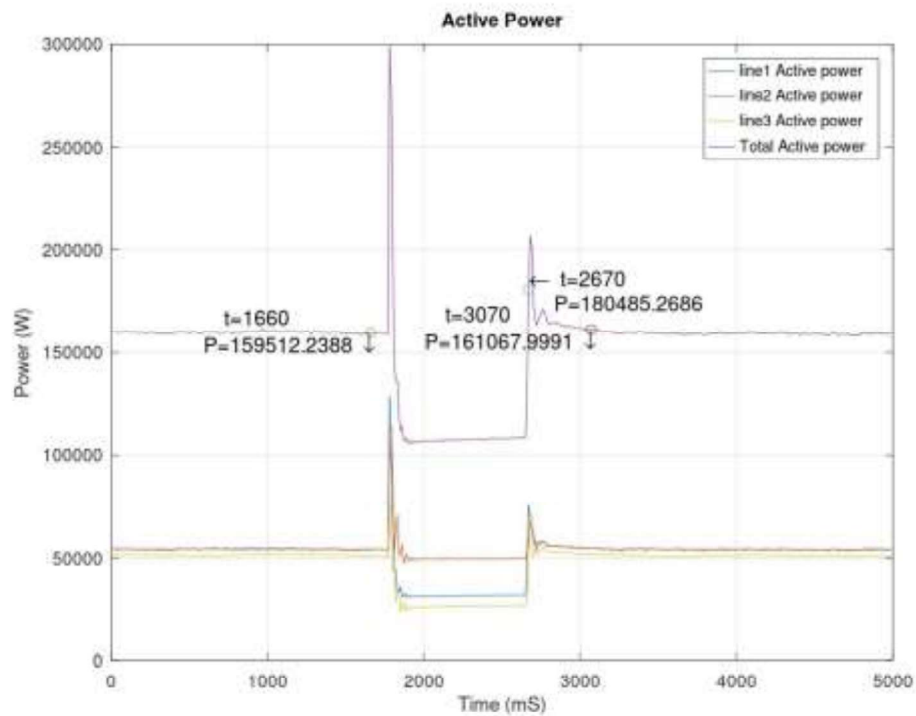


**Test 3a -- guasto asimmetrico bifase**  
*/ two phases asymmetric failure*





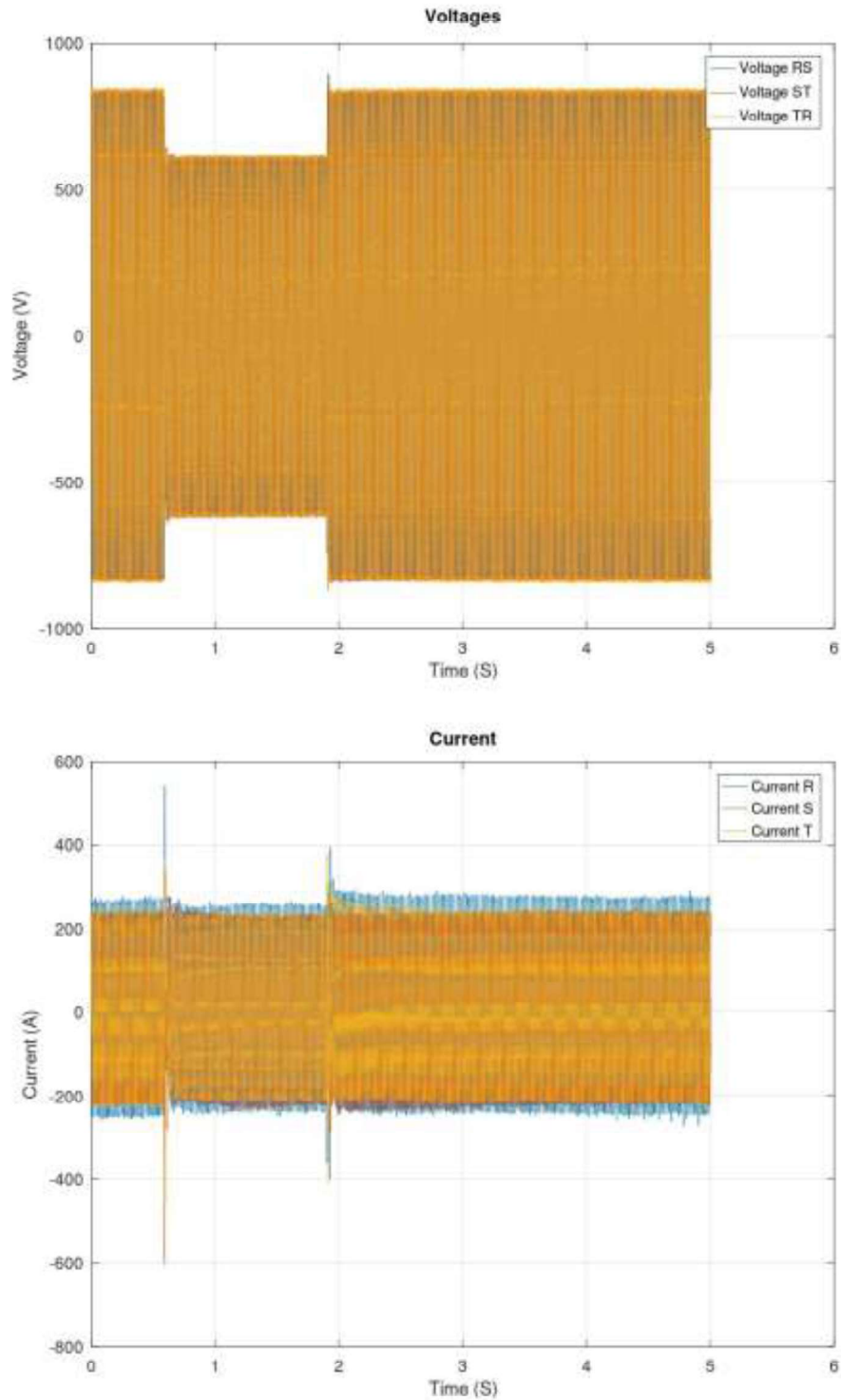


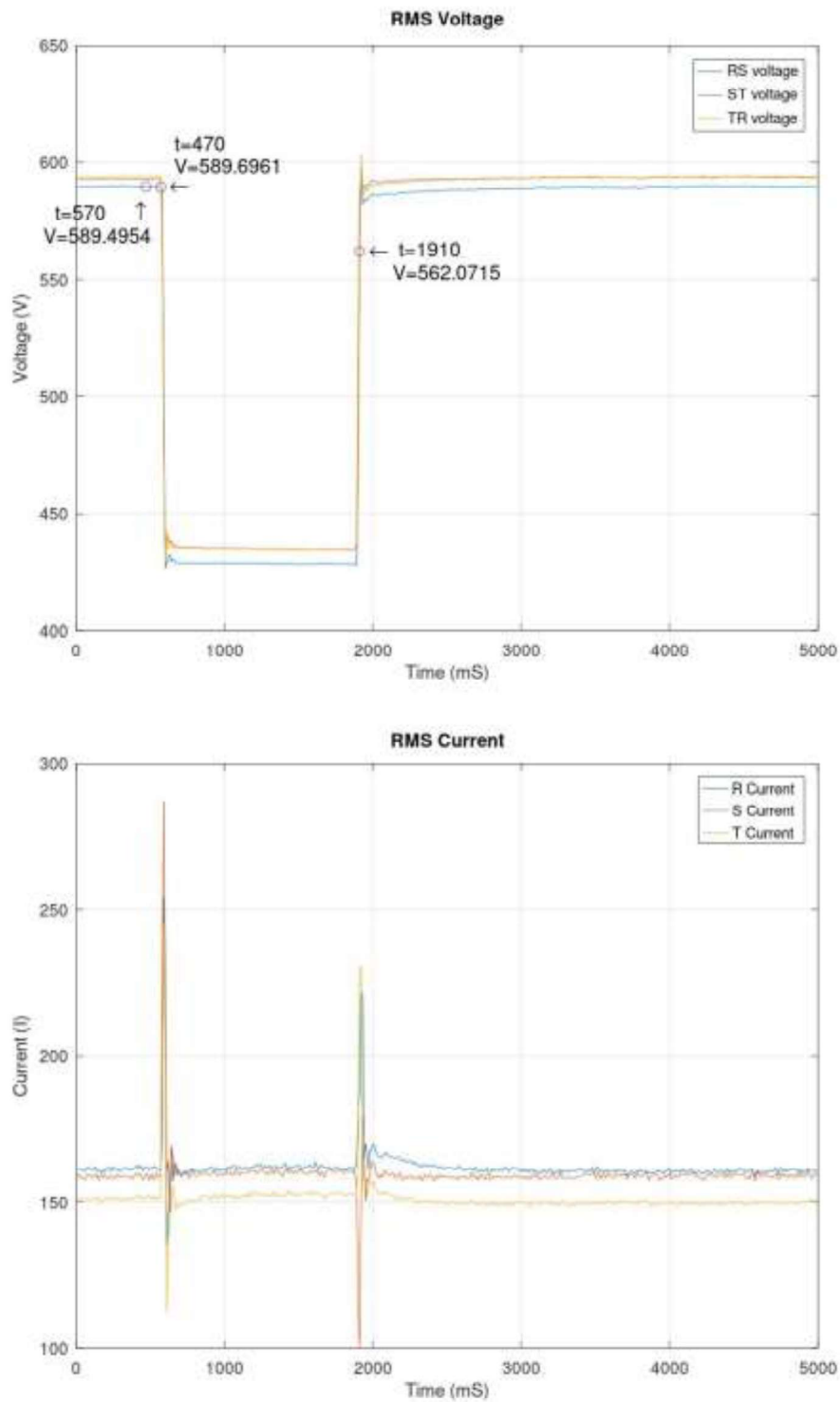


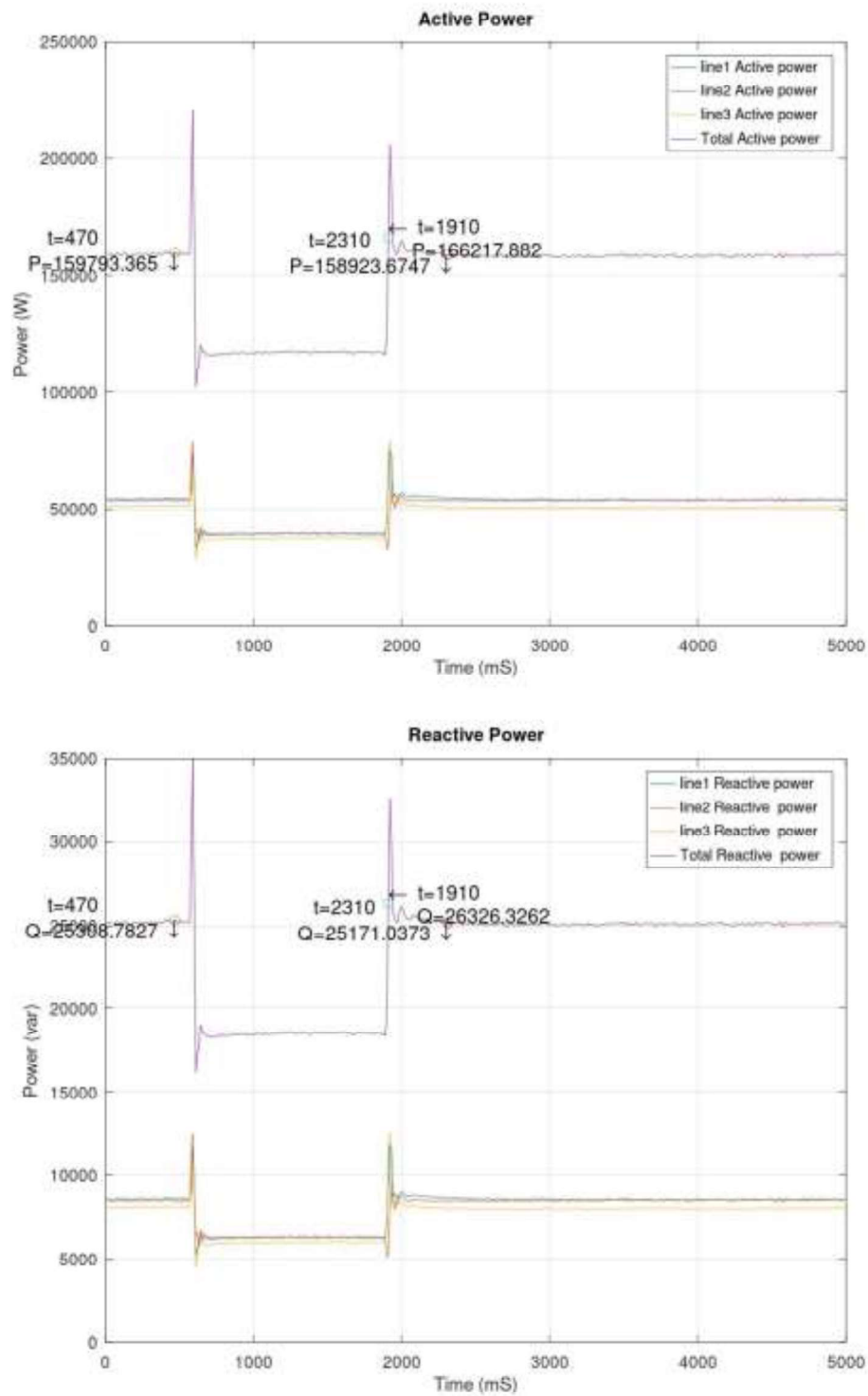




**Test 4s -- guasto simmetrico trifase**  
*/ three phases symmetric failure*

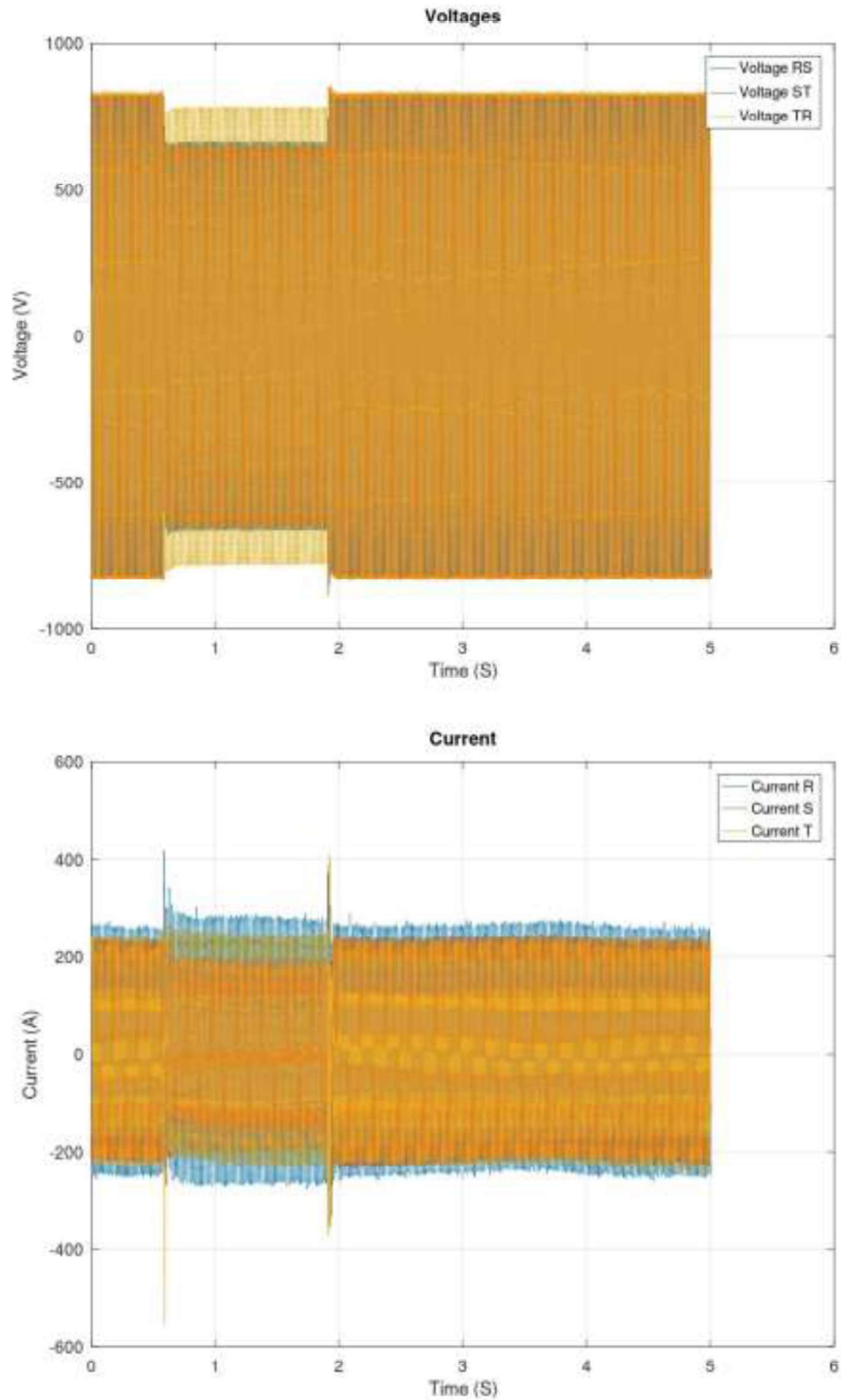


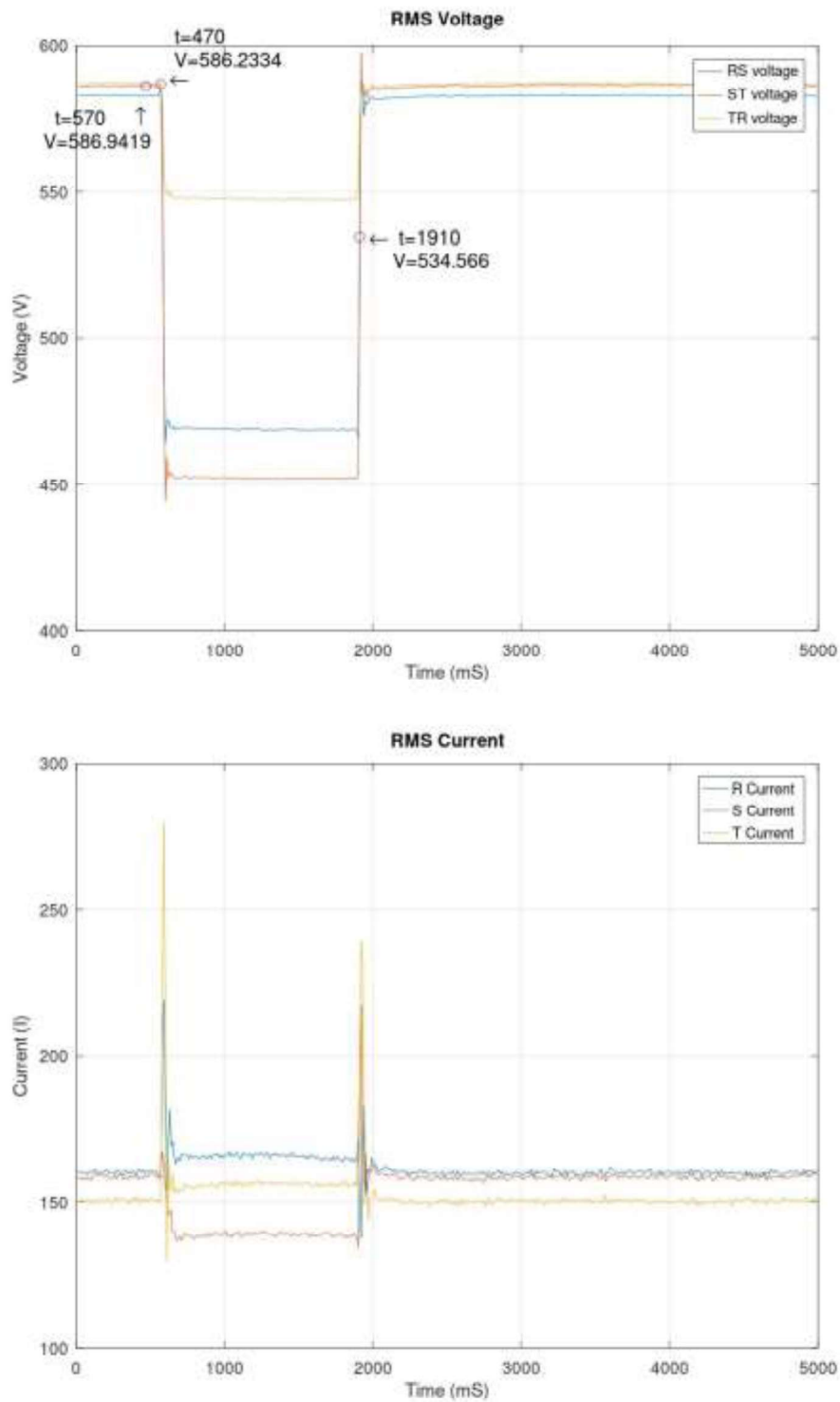


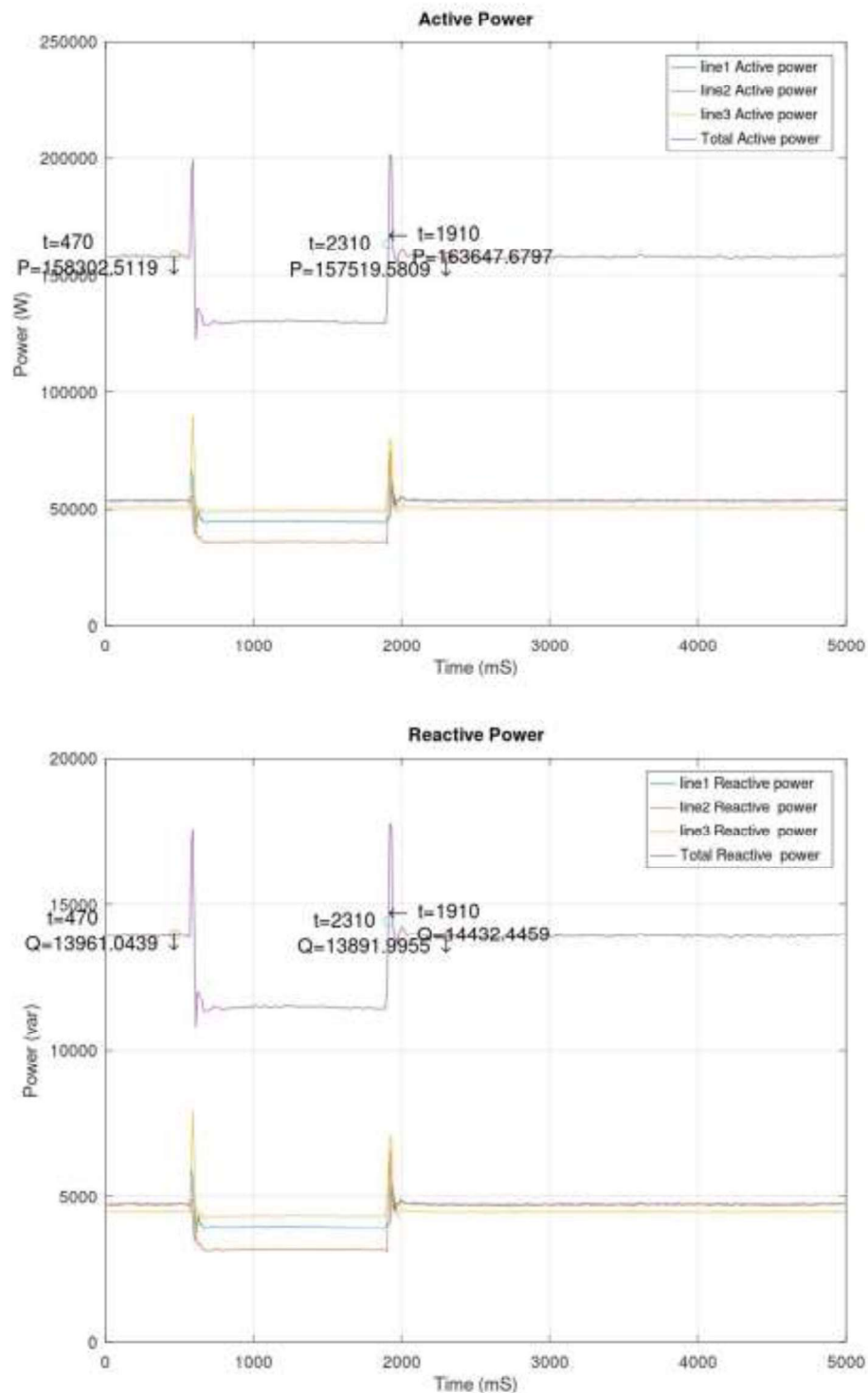




**Test 4a -- guasto simmetrico bifase**  
*/ two phases asymmetric failure*









|                                |   |
|--------------------------------|---|
| <b>N.8.5</b>                   | <b>OVRT Capability</b>                                |
| Ambient temperature (°C) ..... | 20°C ± 2°C  |
| Humidity (RH %) .....          | 65% RH  |
| Instrumentation list.....      | See table "Measurement equipment and instrumentation" |
| Uncertainty .....              | See table   |

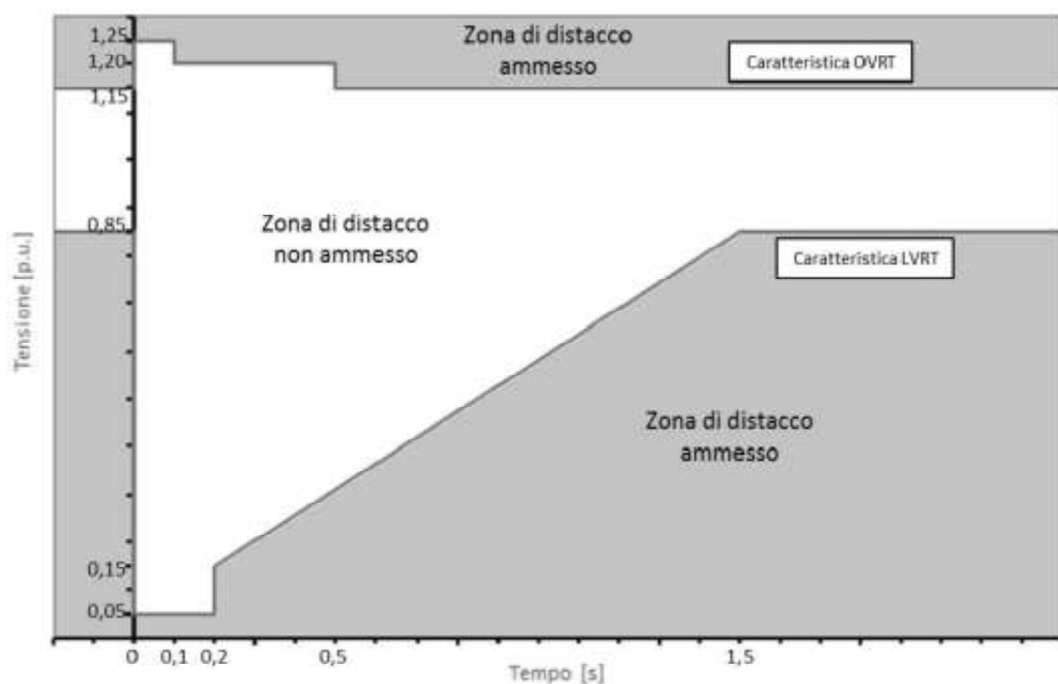


Figura 24 – Caratteristica (V - t): LVRT e OVRT. per i generatori statici

Supplementary information:

Test is performed in the following conditions:

- MPPT Input Voltage: 600Vdc
- Output Voltage: 230Vac p-n @ 50Hz

|                  |                |
|------------------|----------------|
| Operator .....   | Luca Li Vecchi |
| Supervisor ..... | Marco Piva     |
| Test Date .....  | 19/03/2020     |





| Test                                   | Residual magnitude<br>[V/V <sub>n</sub> ] |   |   | phase angle<br>[°] |             |             | Recovery<br>time | Duration     |
|--|---|---|---|--------------------|-------------|-------------|------------------|--------------|
|  | R   | S | T | $\varphi_1$        | $\varphi_2$ | $\varphi_3$ | [ms]             | [ms]         |
| OV1 – sovratensione simmetrica trifase | $1.25 \pm 0.05 (V_{OV1}/V_n)$             |   |   | 0°                 | -120°       | 120°        | 110              | $100 \pm 20$ |
| OV2 – sovratensione simmetrica trifase | $1.20 \pm 0.05 (V_{OV2}/V_n)$             |   |   | 0°                 | -120°       | 120°        | 508              | $500 \pm 20$ |

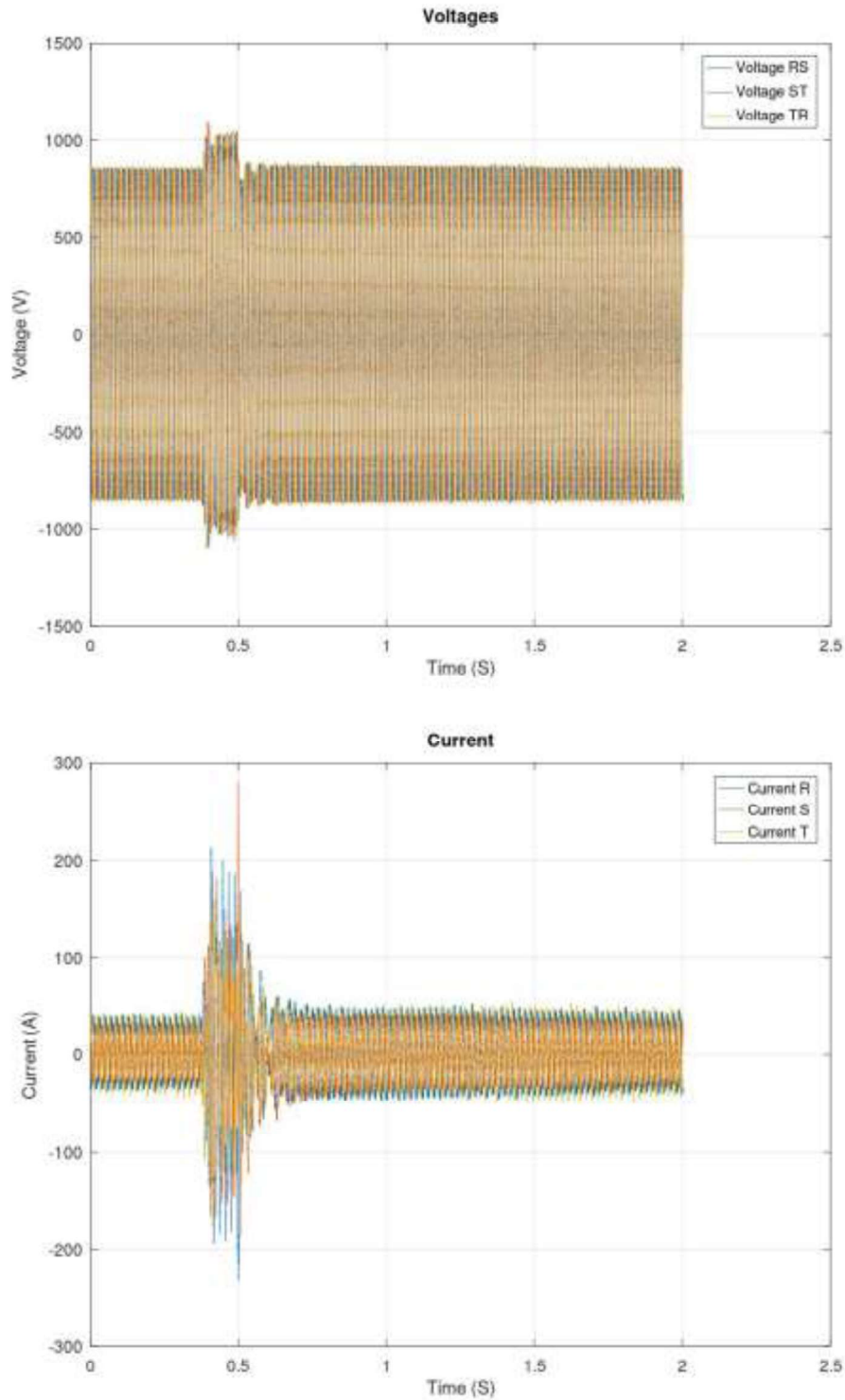


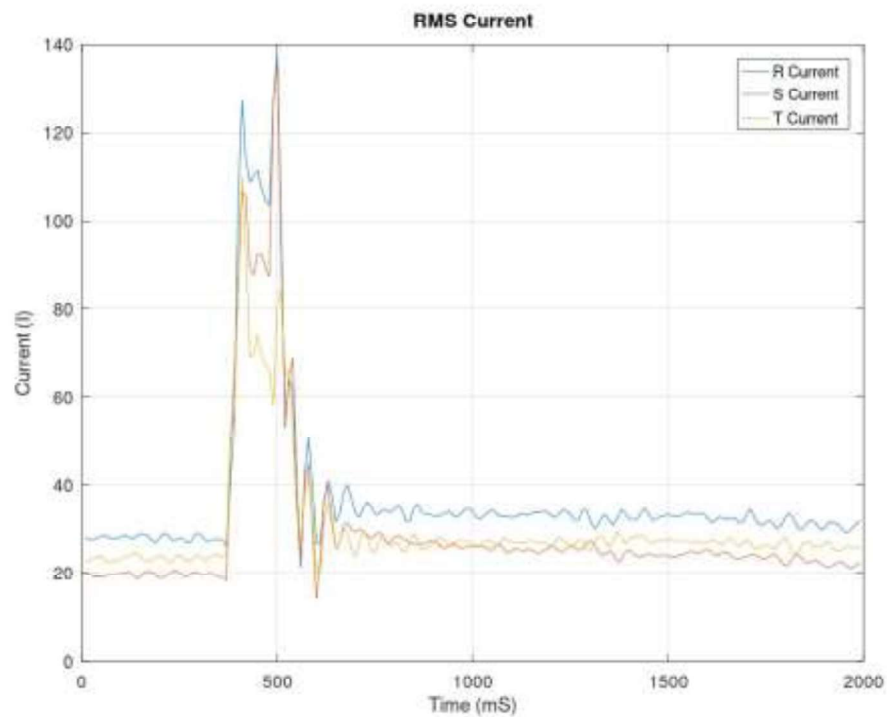
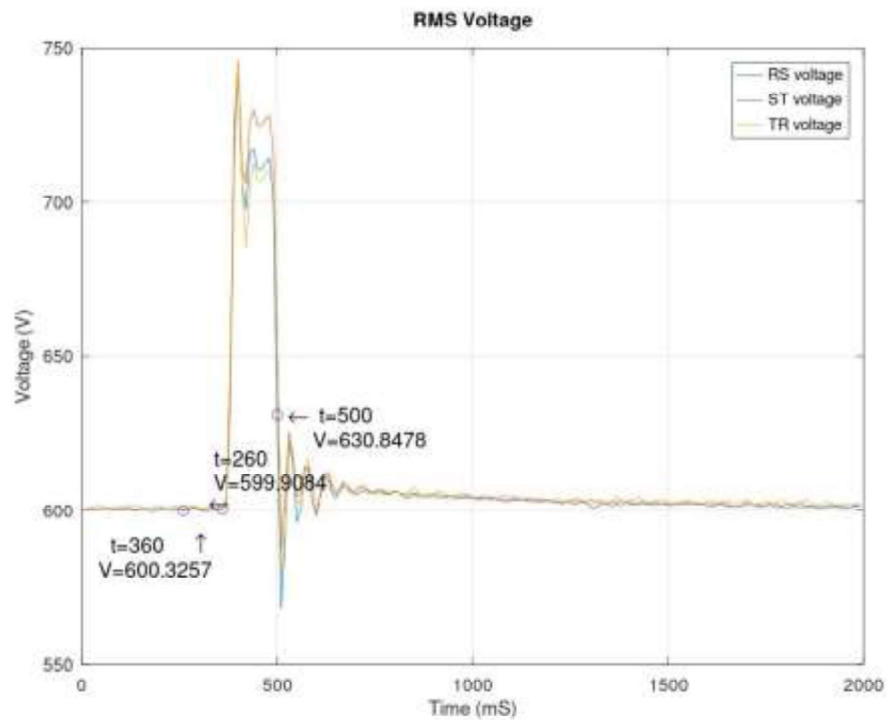
**Grafici: OVFRT**

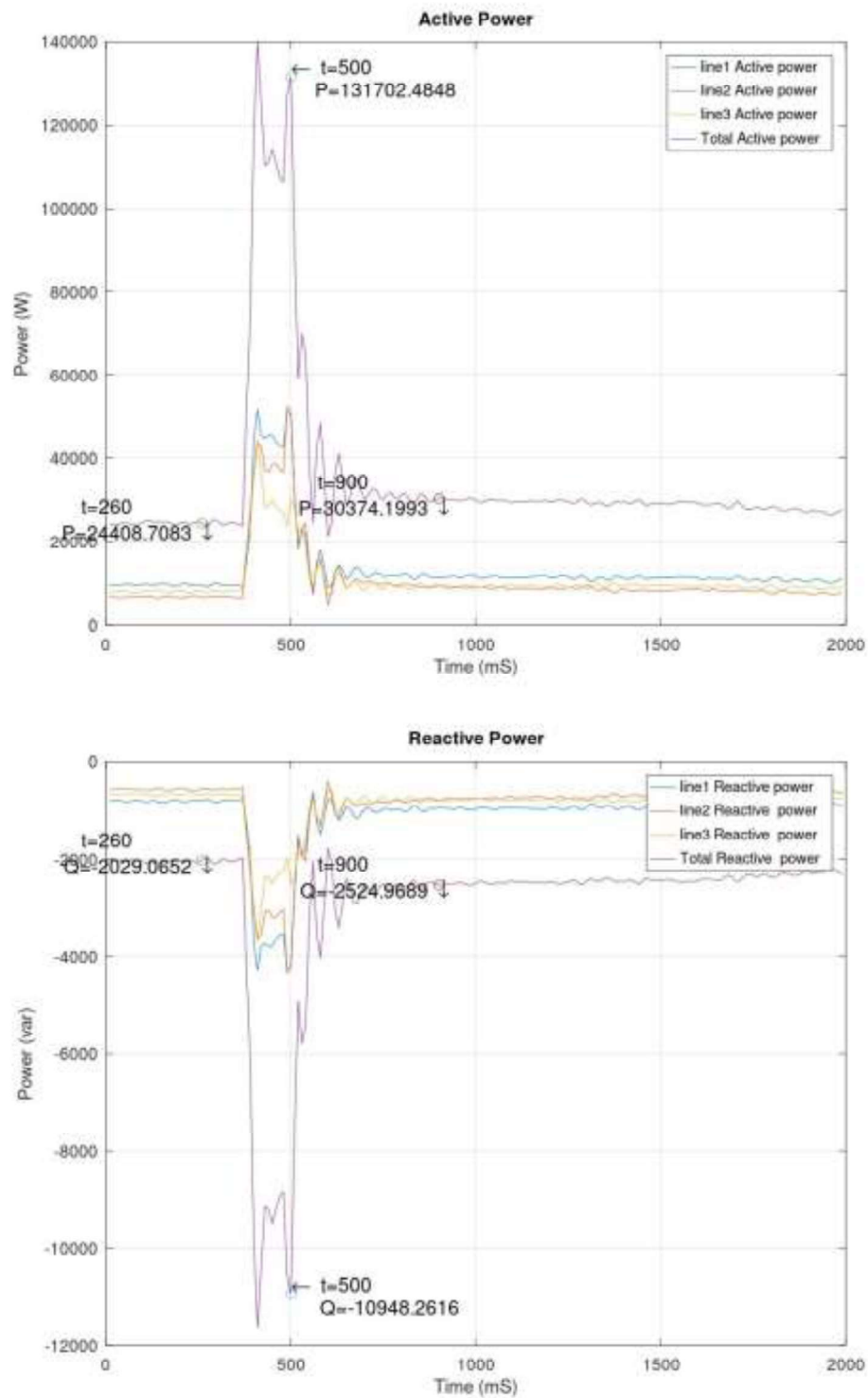
/ Graphs: OVFRT

**OV1 – sovratensione simmetrica trifase**

/ three-phase symmetric overvoltage









**OV2 – sovratensione simmetrica trifase**  
*/ three-phase symmetric overvoltage*

