# AVRs for SHUNT excitation

<table>
<thead>
<tr>
<th>Type of AVR</th>
<th>LSA alternator type range</th>
</tr>
</thead>
<tbody>
<tr>
<td>R220</td>
<td>40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54</td>
</tr>
<tr>
<td>R250</td>
<td>40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54</td>
</tr>
<tr>
<td>R438</td>
<td>option option option option option option option option option option option option option</td>
</tr>
<tr>
<td>R449</td>
<td>option option option option option option option option option option option option option</td>
</tr>
<tr>
<td>Digital</td>
<td>DE59/10** option option option option option option option option option option option option option</td>
</tr>
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</table>

AVRs for PMG excitation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>R220</td>
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<td>R438</td>
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</tr>
<tr>
<td>R449</td>
<td>option option option option option option option option option option option option option</td>
</tr>
<tr>
<td>Digital</td>
<td>DE59/10** option option option option option option option option option option option option option</td>
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</table>

AVRs for AREP excitation

<table>
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</thead>
<tbody>
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<td>R438</td>
<td>option option option option option option option option option option option option option</td>
</tr>
<tr>
<td>R449</td>
<td>option option option option option option option option option option option option option</td>
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<tr>
<td>Digital</td>
<td>DE59/10** option option option option option option option option option option option option option</td>
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Excitation and regulation systems

- **SHUNT**
- **PMG**
- **AREP**

AVRs for SHUNT excitation

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AVRs for PMG excitation

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<td>R438</td>
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<tr>
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<td>option option option option option option option option option option option option option</td>
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<td>Digital</td>
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AVRs for AREP excitation

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</tr>
<tr>
<td>Digital</td>
<td>DE59/10** option option option option option option option option option option option option option</td>
</tr>
</tbody>
</table>

Excitation and Regulation matched for optimised performance

- **Mounted externally**
- **** A/D/D optional for three-phase sensing
- *** Parallel operation with mains included

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Low Voltage Alternators - Excitation and regulation systems

**SHUNT excitation for basic applications**

- The AVR power supply voltage is shared on the alternator output terminals.
- The voltage reference is shared on the same output terminals.
- The AVR generates and regulates the excitation current as a function of the alternator output voltage.

The SHUNT system is extremely simple in its design and is ideal for basic applications. It cannot tolerate high overloads and does not offer a short-circuit capability.

**PMG excitation for demanding applications**

The main alternator is the same design as that used with SHUNT excitation.

- The AVR power supply voltage is generated by a permanent magnet generator (PMG) which is mounted on the shaft extension behind the alternator. The PMG delivers constant voltage which is independent of the main alternator winding.
- The voltage reference is shared on the alternator output terminals. Whatever the load, the AVR therefore delivers an excitation current that is proportional to the current drawn by the alternator.
- The PMG system therefore has a high overload capacity (load changes).

The PMG delivers constant voltage which is independent of the main alternator winding. The PMG system improves the performance of a SHUNT system.

**AREP excitation for demanding applications/Patented by Leroy-Somer**

The AVR power supply voltage comes from 3 independent auxiliary windings located in the main stator:

- The voltage delivered by the first auxiliary winding is proportional to the current drawn by the alternator.
- The voltage delivered by the second auxiliary winding is proportional to the current drawn by the alternator and is a function of the applied load (compound characteristic – booster effect).

This power supply to the AVR power circuit is independent of the main alternator winding. The exciter is independent of any voltage distortions (harmonics) due to the load.

The AREP system gives the alternator a high overload capacity (load changes), a short-circuit capability (300% - 10 s) in order to provide discriminating protection: the AREP system is particularly suitable for demanding applications. The PMG system therefore has a high overload capacity (load changes).

**Excitation system selection chart**

<table>
<thead>
<tr>
<th>Type of alternator</th>
<th>SHUNT</th>
<th>AREP</th>
<th>SHUNT + PMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor starting capacity</td>
<td>Basic</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Short-circuit capability</td>
<td>N/A</td>
<td>300%/10 s</td>
<td>300%/10 s</td>
</tr>
<tr>
<td>Susceptibility to non-linear loads</td>
<td>Maximum</td>
<td>Minimum</td>
<td>Minimum</td>
</tr>
<tr>
<td>Number of components</td>
<td>Minimum</td>
<td>Minimum</td>
<td>Minimum</td>
</tr>
<tr>
<td>Possibility of conversion</td>
<td>Yes</td>
<td>PMG</td>
<td>Yes (PMG)</td>
</tr>
<tr>
<td>Possibility of conversion</td>
<td>Yes</td>
<td>(Shunt)</td>
<td></td>
</tr>
<tr>
<td>Alternator length</td>
<td>Minimum</td>
<td>Maximum</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>€</td>
<td>€€</td>
<td>€€€</td>
</tr>
<tr>
<td>Starter design</td>
<td>Standard</td>
<td>Special</td>
<td>Standard</td>
</tr>
<tr>
<td>Voltage build-up</td>
<td>Residual magnetism</td>
<td>Residual magnetism</td>
<td>Permanent magnets</td>
</tr>
<tr>
<td>Applications</td>
<td>Basic backup</td>
<td>Marine, industry, construction, hospitals, barracks, standard production</td>
<td>Marine, industry, construction, hospitals, barracks, standard production</td>
</tr>
<tr>
<td>Lifetime</td>
<td>Optimale</td>
<td>Optimale</td>
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</tr>
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</table>

**Excitation system varies depending on the type of alternator**

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<thead>
<tr>
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<tbody>
<tr>
<td>SHUNT</td>
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</tr>
<tr>
<td>AREP</td>
<td>-</td>
</tr>
<tr>
<td>PMG</td>
<td>-</td>
</tr>
</tbody>
</table>

**Analog or digital voltage AVRs depending on customer requirements**

Leroy-Somer AVRs benefit from all Leroy-Somer’s experience in the electronics field. They have been designed to comply with market requirements in terms of characteristics, performance, conformity with standards and reliability.

Their main characteristics are as follows:

- Simple, user-friendly user interface
- Power switching transistor offer an optimum response to interference generated by disturbing loads
- Voltage regulation with a steady state with rapid response time (9 ms)
- Optimized mechanical design for resistance to vibration and harsh environments, with coated electronic circuits

- Conformity with IEC 60034-1 and UL 508.

**Analog AVRs with digital regulation function**

- R250 range for SHUNT excitation: simplicity itself
  - Single-phase voltage sensing
  - Underspeed protection by U/f (R250) or U/f and LAM (R251) function

- B400 range for SHUNT, PMG and AREP excitation types: performance
  - Single-phase voltage sensing
  - Underspeed protection by U/f (R400) or U/f and LAM function
  - Underspeed protection by U/f and flux function (R450) or U/f and LAM function
  - Parallel operation with the mains with CT and R726 module
  - Three-phase version (R731 version or with R711 module)
  - Overload protection by R452 module

**Digital AVRs**

- D500 range for SHUNT, PMG and AREP excitation types: performance – communication
  - EASYDRIVE "parameter setting and supervision program with user-friendly interface
  - Parallel operation without additional voltage regulation (U/f)
  - Digital excitation current
  - Underspeed protection by U/f and LAM function
  - Underspeed protection by U/f and flux function
  - Built-in parallel operation between alternators and with the mains
  - Communication: USB serial, proprietary CAN (V193 CAN)
  - Redundant detection

**Systems that help take account of load impact/load shedding**

- Load shedding due to LAM
- Load impacts taken into account
- Instant response from the AVR below the underspeed threshold
- Gradual voltage variation into stalled voltage

**Digital LAM function**

- Load impact Adaptive
- Reduction in voltage drop and duration of speed variations of the Diesel engine
- Possible increase in the applied load for the same speed variation
- Adaptive tuning LAM for load impacts • 50%
**Low Voltage Alternators - Excitation and regulation systems**

**SHUNT excitation for basic applications**
- The AVR power supply voltage is shunted on the alternator output terminals.
- The voltage reference is shunted on the same output terminals.
- The AVR generates and regulates the excitation current as a function of the alternator output voltage.
- The SHUNT system is extremely simple in its design and is ideal for applications. It cannot tolerate high overloads and does not offer a short-circuit capability.

**PMG excitation for demanding applications**
- The main alternator is the same design as that used with SHUNT excitation.
- The AVR power supply voltage is generated by a permanent magnet generator (PMG) which is mounted on the shaft extension behind the alternator. The PMG delivers constant voltage which is independent of the main alternator winding.
- The voltage reference is shunted on the alternator output terminals. Wherever the load, the AVR therefore delivers an excitation current proportional to the load, depending on how the voltage reference changes.
- The PMG system therefore has a high overload capacity (load impact or starting electric motors) and a short-circuit capability.

**AREP excitation for demanding applications/Patented by Leroy-Somer**
- The AVR power supply voltage comes from 2 independent auxiliary windings located in the main stator:
  - The AVR generates and regulates the excitation current as a function of the alternator output voltage.
- The voltage reference is shunted on the same output terminals.
- The AVR generates and regulates the excitation current as a function of the alternator output voltage.
- The SHUNT system is extremely simple in its design and is ideal for applications. It cannot tolerate high overloads and does not offer a short-circuit capability.

**Excitation system selection chart**

**Analog or digital voltage AVRs depending on customer requirements**

Leroy-Somer AVRs benefit from all Leroy-Somer’s experience in the electronics field. They have been designed to comply with market requirements in terms of characteristics, performance, conformity with standards and reliability. Their main characteristics are as follows:
- Simple, user-friendly user interface
- Power switching transistor offers an optimum response to interference generated by distorting loads.
- Voltage regulation of ±0.5% steady state with rapid response time (≤ 50 ms)
- Optimized mechanical design for resistance to vibration and harsh environments, with coated electronics circuits
- Conformity with NEC (UL) 48-1 and CSA 22.2

**Digital AVRs**
- D500 range for SHUNT, PMG and AREP excitation types: performance communication
  - EASYREG parameter-setting and supervision program with user-friendly interface
  - Single-phase or three-phase voltage sensing
  - Load Acceptance Module
  - Gradual voltage return to rated voltage
  - Instant response from the AVR below the underspeed threshold
  - Adaptive tuning for load impacts > 60%

- **Comparison of U/f and LAM system performance**

- **Systems that help take account of load impact/load shedding are built into Leroy-Somer AVRs**
  - Load function
    - Load impact is taken into account
    - Instant response from the AVR below the underspeed threshold
    - Gradual voltage return to rated voltage
  - **LAM function**
    - Load Acceptance Module
    - Reduction in voltage drop and duration of speed variations of the diesel engine
    - Possible increase in the applied load for the same speed variation
    - Adaptive tuning for similar load impacts × 60%
SHUNT excitation for basic applications

- The AVR power supply voltage is shunted on the alternator output terminals.
- The voltage reference is shunted on the same output terminals.
- The AVR generates and regulates the excitation current as a function of the alternator output voltage.

The SHUNT system is extremely simple in its design and is ideal for basic applications. It cannot tolerate high overload and does not offer a short-circuit capability.

PMG excitation for demanding applications

The main alternator is the same design as that used with SHUNT excitation.

- The AVR power supply voltage is generated by a permanent magnet generator (PMG), which is mounted on the shaft extension behind the alternator. The PMG delivers constant voltage which is independent of the main alternator winding.
- The voltage reference is shunted on the alternator output terminals. Whatever the load, the AVR therefore delivers an excitation current that is independent of the load, leading to a voltage reference change.

The PMG system therefore has a high overload capability (load impact or starting electric motor) which can shunt-current (300% - 10 s) in order to provide discriminating protection: the exciter is independent of any voltage distortions (harmonics) due to the load.

This power supply to the AVR power circuit is independent of the alternator output terminals, behind the alternator. The PMG delivers constant voltage which is independent of the excitation. The PMG system improves the performance of a SHUNT system.

AREP excitation for demanding applications/Patented by Leroy-Somer

The AVR power supply voltage comes from 3 independent auxiliary windings located in the main stator:
- The voltage delivered by the first auxiliary winding is proportional to the alternator output voltage (Shunt characteristic).
- The voltage delivered by the second auxiliary winding H3 is proportional to the current delivered by the permanent magnets (PMG).
- The voltage delivered by the first auxiliary winding H1 is proportional to the phase-to-phase voltage supplies power to the AVR.

The resulting phase-to-phase voltage supplies power to the AVR. This power supply to the AVR power circuit is independent of the alternator output terminals, behind the alternator. The PMG delivers constant voltage which is independent of the excitation. The PMG system improves the performance of a SHUNT system.

Excitation system selection chart

<table>
<thead>
<tr>
<th>Type of excitation</th>
<th>SHUNT</th>
<th>AREP</th>
<th>SHUNT + PMG</th>
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<tbody>
<tr>
<td>Motor starting capacity</td>
<td>Basic</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Short-circuit capability</td>
<td>Yes</td>
<td>300% (10 s)</td>
<td>300% (10 s)</td>
</tr>
<tr>
<td>Susceptibility to non-linear loads</td>
<td>Maximum</td>
<td>Minimum</td>
<td>Minimum</td>
</tr>
<tr>
<td>Number of components</td>
<td>Minimum</td>
<td>Maximum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Possibility of conversion</td>
<td>Yes (PMG)</td>
<td>Yes (PMG)</td>
<td>Yes (Shunt)</td>
</tr>
<tr>
<td>Alternator length</td>
<td>Minimum</td>
<td>Maximum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Price</td>
<td>E</td>
<td>6K</td>
<td>60K</td>
</tr>
<tr>
<td>Starter design</td>
<td>Standard</td>
<td>Special</td>
<td>Standard</td>
</tr>
<tr>
<td>Voltage build-up</td>
<td>Residual magnetism (permanent)</td>
<td>Residual magnetism (permanent)</td>
<td>Permanent magnets</td>
</tr>
<tr>
<td>Applications</td>
<td>Basic backup</td>
<td>Telecommunication</td>
<td>Marine, industry, construction, hospitals, banks, standard production</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Marine, industry, construction, hospitals, banks, standard production</td>
</tr>
<tr>
<td>Lifetime</td>
<td>Optimal</td>
<td>Optimal</td>
<td>Reduced Additional winding part</td>
</tr>
</tbody>
</table>

For better voltage build-up, permanent magnets are inserted in the exciter poles (standard in 53.2, 52.1 and 54).

Analog or digital voltage AVRs depending on customer requirements

Leroy-Somer AVRs benefit from all Leroy-Somer’s experience in the electronics field. They have been designed to comply with market requirements in terms of characteristics, performance, conformity with standards and reliability.

Their main characteristics are as follows:
- Simple, user-friendly user interface
- Power switching transistor offers an optimum response to interference generated by disturbing loads
- Voltage regulation is in 1% steady state with rapid response time (~ 500 ms)
- Optimized mechanical design for resistance to vibration and harsh environments, with coated electronic circuits
- Conformity with IEC 60335-1 and 1123 standards

Analog AVRs with digital regulation function

R250 range for SHUNT excitation: simplicity itself

- Single-phase voltage sensing
- Undervoltage protection by U/f (R212) or U/f and LAM (R215) function
- R450 range for SHUNT, PMG and AREP excitation types: performance
- Single-phase voltage sensing
- Undervoltage protection by U/f (R250) or U/f and LAM function
- Parallel operation with the mains with CT and R726 module
- Three-phase versions in R715 version with R726 module
- Overload protection with R450 version

Digital AVRs

D350 range for SHUNT, PMG and AREP excitation types: performance – communication

- EASYDIN™ parameter-setting and supervision program with user-friendly interface
- Single-phase or three-phase voltage sensing
- Adjustable U/f function and adjustable U/f and LAM function
- Starter overvoltage protection
- Built-in parallel operation between alternator and with the mains
- Communication: USB serial, proprietary CAN, J1939 CAN
- Chicken detection built

Systems that help take account of load impact/load shedding are built into Leroy-Somer AVRs

LAM function

- Load impact taken into account
- Instant response from the AVR below the underspeed threshold
- Gradual voltage return to rated voltage

LAM function

- Load Acceptance Module
- Reduction in voltage drop and duration of speed variations of the diesel engine
- Possible increase in the applied load for the same speed variations
- Adaptive tuning of LAM for load impacts < 60%
**Excitation and Regulation matched for optimised performance**

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<tr>
<td></td>
<td>48</td>
</tr>
<tr>
<td>R216</td>
<td>*</td>
</tr>
<tr>
<td>R235</td>
<td>*</td>
</tr>
<tr>
<td>R438**</td>
<td>option</td>
</tr>
<tr>
<td>Digital D510C***</td>
<td>option</td>
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### AVRs for PMG excitation

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<td>option</td>
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<tr>
<td>R450**</td>
<td>option</td>
</tr>
<tr>
<td>Digital</td>
<td>D510C***</td>
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</table>

*mounted externally
** AVDIT optional for three-phase sensing
*** parallel operation with main included

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**Excitation and Regulation matched for optimised performance**

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<tr>
<td></td>
<td>40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54</td>
<td>-</td>
<td>-</td>
<td>-</td>
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**Digital** (D510C)**

- option
- option
- option
- option
- option

### AVRs for PMG excitation

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**Digital** (D510C)**

- option
- option
- option
- option
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**Digital** (D510C)**

- option
- option
- option
- option
- option
- option

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**Low Voltage Alternators**

Excitation and regulation systems

- **SHUNT**
- **PMG**
- **AREP**

---

**AVRs for SHUNT excitation**

- LSA alternator type range
- 40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54

**Digital** (D510C)**

- option
- option
- option
- option
- option
- option

**Excitation and Regulation matched for optimised performance**

- Mounted externally
- **A** R450T optional for three-phase sensing
- **P** Parallel operation with mains included

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**Low Voltage Alternators**

Excitation and regulation systems

- **SHUNT**
- **PMG**
- **AREP**

---

**AVRs for PMG excitation**

- LSA alternator type range
- 40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54

**Digital** (D510C)**

- option
- option
- option
- option
- option
- option

**Excitation and Regulation matched for optimised performance**

- Mounted externally
- **A** R450T optional for three-phase sensing
- **P** Parallel operation with mains included

---

**AVRs for AREP excitation**

- LSA alternator type range
- 40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54

**Digital** (D510C)**

- option
- option
- option
- option
- option
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**Low Voltage Alternators**

Excitation and regulation systems

- **SHUNT**
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---

**AVRs for SHUNT excitation**

- LSA alternator type range
- 40 42.3 44.3 46.3 47.2 49.3 50.2 52.3 53.1 54

**Digital** (D510C)**

- option
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Excitation and regulation systems

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**Digital** (D510C)**

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