

Application Guidance Notes: Technical Information from Cummins Generator Technologies

AGN024 – AVR Selection

Digital and Analogue Automatic Voltage Regulators are offered by Cummins Generator Technologies. There is a wide selection of AVRs available for STAMFORD and AvK alternators, although the options for AvK alternators are all digital. The choice of AVR will depend on the alternator’s application.

The following Selection Chart shows which AVR’s are the ‘standard’ fit and which AVRs are alternative options on the different STAMFORD and AvK products.

| | SX460 | AS440 | AS480 | AS540 | MX341 | MX342 | MX321 | MX322 | DM110 | DECS100 | DECS150 | DECS250 | UNITROL 1010 | UNITROL 1020 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|---------|---------|-----------------|-----------------|
| P0/P1 | | | • | | | | | | | | | | | |
| S0/S1 | | | | • | | | | | | | | | | |
| UC22 | • | ○ | | | ○ | ○ | ○ | ○ | | | | | | |
| UC27 | • | ○ | | | ○ | ○ | ○ | ○ | | | | | | |
| HC4 | | • | | | ○ | ○ | ○ | ○ | ○ | | ○ | | | |
| S4 | | • | | | ○ | ○ | ○ | ○ | ○ | | ○ | | | |
| HC5 | | • | | | ○ | ○ | ○ | ○ | ○ | | ○ | | ○ | |
| S5 | | • | | | ○ | ○ | ○ | ○ | ○ | | ○ | | ○ | |
| HC6 | | ○ | | | ○ | ○ | • | ○ | ○ | ○ | ○ | | ○ | |
| S6 | | | | | ○ | | • | ○ | | ○ | ○ | | | |
| P7 | | ○ | | | • | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | |
| S7 | | | | | • | | | ○ | | ○ | ○ | | ○ | |
| MV7 | | | | | | | • | | ○ | | | | | |
| P80 | | | | | | | | | • | | ○ | | ○ | |
| S9 | | | | | | | | | • | ○ | ○ | | ○ | |
| DSG62 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DSG74 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DSG86 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DSG99 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DSG114 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DSG125 | | | | | | | | | • | ○ | ○ | ○ | | |
| DSG144 | | | | | | | | | ○ | ○ | ○ | • | | |
| DIG110 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DIG120 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DIG130 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DIG140 | | | | | | | | | • | ○ | ○ | ○ | | |
| DIG142 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DIG150 | | | | | | | | | • | ○ | ○ | ○ | ○ | ○ |
| DIG156 | | | | | | | | | ○ | ○ | ○ | • | ○ | ○ |

| | |
|---|----------|
| • | Standard |
| ○ | Optional |

Analogue AVR's available on STAMFORD alternators: SX460, AS440, AS480, AS540, MX341, MX342, MX321, MX322.

Digital AVR's available on STAMFORD alternators: DM110, DECS100, DECS150, UNITROL 1010.

Digital AVR's available on AvK alternators: DM110, DECS100, DECS150, DECS250, UNITROL 1010, UNITROL 1020.

The AVR's listed above have different specification levels with different features for different operating parameters. The following Features Chart shows the wide variation in operating options, as well as additional accessories that can be added to enhance the AVR's capability.

| | SX460 | AS440 | AS480 | AS540 | MX341 | MX342 | MX321 | MX322 | DM110 | DECS100 | DECS150 | DECS250 | UNITROL 1010 | UNITROL 1020 |
|------------------------------------|-----------------|-----------------|-----------------------|---------------------------|----------------|----------------|----------------|----------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Analogue | • | • | • | • | • | • | • | • | | | | | | |
| Digital | | | | | | | | | • | • | • | • | • | • |
| Excitation System | Self Excitation | Self Excitation | Self Excitation + EBS | Self/Aux. Wdg. Excitation | PMG Excitation | PMG Excitation | PMG Excitation | PMG Excitation | PMG/Aux. Wdg. Excitation | PMG/Aux. Wdg. Excitation | PMG/Aux. Wdg. Excitation | PMG/Aux. Wdg. Excitation | PMG/Aux. Wdg. Excitation | PMG/Aux. Wdg. Excitation |
| Voltage Regulation | +/-1.0% | +/-1.0% | +/-1.0% | +/-1.0% | +/-1.0% | +/-1.0% | +/-0.5% | +/-0.5% | ±0.25% | +/-0.25% | 0.25% | +/-0.25% | +/-0.2% | +/-0.2% |
| Three Phase RMS Sensing | | | | | | | • | • | • | • | • | • | • | • |
| Paralleling Capability | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | • | • | • | • | • | • |
| Sustained Short Circuit | | | □ | | • | • | • | • | • | • | • | • | • | • |
| Stator Current Limiting | | | | | | | ○ | ○ | ○ | | ○ | ○ | ○ | ○ |
| Over Voltage Protection | | | | | | | • | • | • | • | • | • | • | • |
| Under Freq. Protection | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Linear Volts/Hz Slope | | | | | | • | | | ○ | ○ | ○ | ○ | ○ | ○ |
| Voltage Matching | | | | | | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| P.F. & VAR Regulation | | □ | | | □ | □ | □ | □ | ○ | ○ | ○ | ○ | ○ | ○ |
| Over Excitation Protection | | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Under Excitation Protection | | | | | | | | | • | • | • | • | | |
| Soft Start by Excitation Isolation | | ○ | | ○ | ○ | ○ | ○ | ○ | | | | | | |
| Power System Stabilising | | | | | | | | | | | ○ | ○ | ○ | ○ |
| Excitation Circuit Breaker | | □ | | | □ | □ | □ | □ | | | | | | |
| Diode failure Detection | □ | □ | | | □ | □ | □ | □ | ○ | ○ | ○ | ○ | ○ | ○ |
| RFI Suppressor Kit | □ | □ | | | □ | □ | □ | □ | | | | | | |
| External Voltage Adjustment | □ | □ | □ | □ | □ | □ | □ | □ | ○ | ○ | ○ | ○ | ○ | ○ |
| Remote Control Interface | | □ | | | □ | □ | □ | □ | | | | | | |
| Loss of Excitation | □ | □ | | | □ | □ | □ | □ | | | | ○ | ○ | ○ |
| Loss of Voltage Sensing | | | | | | | | | • | • | • | • | | |
| Frequency Detection Module | | | | | | | □ | □ | | | | | | |
| Manual Voltage Regulator | | | | | □ | □ | □ | □ | | | | | | |
| UL Compliant | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| Grid Code Compatible | | | | | | | • | • | ○ | ○ | ○ | ○ | ○ | ○ |

| | |
|---|--------------------|
| • | Standard Feature |
| ○ | Optional Feature |
| □ | Optional Accessory |

There is a range of the above mentioned AVR's that have been UL (Underwriters Laboratories) certified for use on UL certified alternators. For more information on UL, refer to AGN236.

Further details on some features is available in AGN023 – AVR Features. The following table provides brief explanation of various features and the practical use for each of those features:

- 1) Excitation System: Type of excitation method supporting the AVR control.
- 2) Voltage Sensing Regulation: AVR's capability to control the steady state voltage output.
- 3) 3 Phase Sensing: Voltage sensing on all 3 phases. Useful when there are separate 1 phase loads of different magnitudes connected to a 3 phase alternator.
- 4) Paralleling Capability: The AVR has the capability to allow the alternator to synchronise with other alternators, operating in parallel using Droop CTs.

- 5) Sustained Short Circuit: With PMG or Auxiliary Winding Excitation; gives the alternator a current 'forcing' capability to ensure accurate circuit breaker activation in a fault situation.
- 6) Stator Current Limiting: With an additional CT, stator current can be limited during an overload situation, such as starting a large motor, or in a short circuit condition. This helps the prime mover with recovery following load application, or limits fault current contribution, allowing smaller circuit breakers.
- 7) Over Voltage Protection: Prevents alternator damage if the voltage exceeds a pre-set limit, such as with a grid connected application.
- 8) Under Frequency Protection: Prevents alternator damage if the frequency, or speed, drops below a pre-set threshold. A sustained Generating Set engine overload may cause this.
- 9) UFRO: Under Frequency Roll Off is effectively the same as 8), above. However, the roll off "Knee Point" is adjustable and can be set to allow assistance to the prime mover during load acceptance.
- 10) Linear V/Hz Slope: This capability allows the alternator terminal voltage to decrease or increase at a level directly proportional to speed (Hz). Useful for variable speed applications.
- 11) Voltage Matching: Equalises the alternator's terminal voltage with other synchronised alternators, or power grid, connected in parallel. Less sophisticated Generating Set synchronising equipment can be utilised.
- 12) P.F. & VAR Regulation: Suitable for grid connected applications, where the grid voltage cannot be controlled by the alternator and therefore, regulation is achieved by control of Reactive current, i.e. Var. Allows a less sophisticated Generating Set controller to be utilised.
- 13) Over-Exc. Protection: Prevents alternator damage if the pre-set maximum excitation levels of current are exceeded.
- 14) Under-Exc. Protection: Prevents alternator damage, caused by possible pole-slipping, if pre-set minimum excitation levels of current are exceeded.
- 15) Excitation Isolation: By switching the excitation off it is possible to "soft start" loads such as large motors and transformers without high levels of inrush current.
- 16) Power Stabilisation: Improves the stability of the alternator over the highest possible operation range. Particularly useful for grid connect applications requiring Grid Code compliance.
- 17) Excitation CB: MCB for use as a switch when excitation isolation is required.
- 18) Diode Failure Detection: By sensing the level of ripple current in the exciter output it is able to provide an indication of a failed diode, either short or open circuit. Enabling an alarm or shutdown to occur, depending on the Generating Set control methodology.

- 19) RFI Suppression: Provides radio interference protection to the alternator's main output in locations where there is greater sensitivity to RFI.
- 20) External Volts Adjustment: Capable of adjusting the alternator's output voltage from a remote location.
- 21) Remote Control Interface: Provides the means to control generator voltage or power factor from a remote point. Additionally, in grid connect applications, following a Mains failure there is often a requirement to adjust the voltage of several Generating Sets simultaneously with one control signal, to allow voltage matching to the restored Mains supply before paralleling.
- 22) Loss of Excitation: Monitors the alternator's AVR output and signals any sustained interruption to an integral relay to initiate an indication/alarm. A loss of excitation during parallel operation results in circulating currents, pole-slipping, torque/current surges and oscillation.
- 23) Loss of Sensing: If voltage sensing to the AVR is lost the alternator can be shut down or transferred to manual operation.
- 24) Frequency Detection Module: Detects over/under frequency in conjunction with engine control circuits requiring starter motor release and over-speed shutdown.
- 25) Manual Voltage Regulator: An 'emergency' hand-controlled excitation system. Can be useful for the provision of a controlled level of short-circuit current (for drying-out windings or setting protective devices); for the 'frequency' starting of relatively large motors (where an electrically connected Generating Set and motor are run up together from rest); for the 'dynamometer' loading of motors or engines; and for the control of static loads (e.g. variable-intensity lighting).