Eaton’s Aerospace Group is a recognized leader in the design and manufacture of advanced power and motion control equipment. Over recent years, Eaton has achieved a growing reputation in the field of emergency and supplementary electrical power generation.

The increased system demands of new and extended range operations (EROPS) aircraft have led to additional electrical requirements under certain operating and emergency conditions. Eaton has met these demands with a range of highly integrated, compact, efficient hydraulically driven electric generators.

The expertise gained by Eaton in electrical power generation and its monitoring and control has led to this core technology development and a growing family of designs.

From Eaton’s original Vickers® 5kVA hydraulic electrical generating system developed for the Airbus A320, there are now systems with rated power outputs up to 10kVA.

System Profile
Each hydraulically driven electrical generating system consists of two products,
- Constant Speed Motor/Generator (CSM/G)
- Generator Control Unit (GCU)

The latest GCU’s use state-of-the-art Eaton designed Application Specific Integrated Circuit (ASIC) technology.

To date aircraft fitted with this equipment include:
- British Aerospace CAT III 146
- Boeing B757 and B767 EROPS aircraft
- Airbus A320, A321, A330 and A340 aircraft

Control Design Concept
Constant Speed Motor/Generator
The CSM/G consists of a servo controlled, variable displacement, inline axial piston hydraulic motor integrated with a three stage, brushless generator. The CSM/G and associated control systems are designed to maintain a steady state generator output frequency of 400 +/- 5Hz and an average steady state AC phase voltage of 115 +/- 2V (at the point of regulation) over their output specific power range.

The speed/frequency of the CSM/G is maintained constant by a closed loop, electro-hydraulic servo control system. The output speed/frequency of the CSM/G Permanent Magnet Generator stage is compared with a quartz crystal reference frequency. The resultant frequency error is converted via a Proportional-Integral-Derivative controller into current. This current is proportional to servo valve flow rate.

A servo valve is hydraulically connected to the motor yoke actuation system and controls the output torque of the hydraulic motor by changing the angle of the pivoting yoke in response to the torque demands of the generator.

Under steady state conditions the output torque of the motor is matched to the input torque of the generator. Under these conditions the subsequent frequency error approaches zero.

The output voltage of the CSM/G is also controlled by a closed loop servo system. In this case, output voltage of the main generator is compared with a precision voltage reference source.

Any resultant errors are converted into a signal which drives the CSM/G exciter stage until an equilibrium between actual and reference is established.
Generator Control Unit

The GCU consists of a compact, cast aluminium housing containing a series of printed circuit boards. The unit is of a functional modular design consisting of the following principle sub-systems.

- Constant speed control
- Constant voltage control
- System functional protection
- EMI / Lightning strike protection
- Power supply
- Aircraft BITE interface

The Eaton GCU has evolved significantly with respect to technological advancement. Today’s unit uses dedicated digital hardware, which has been packaged into ASICs, performing the fundamental functions of speed/voltage control and system protection. The digital voltage control operates on the Root Mean Square of the generator output wave form, thus eliminating the effects of harmonic distortion. This is not possible using traditional analog design techniques.

In addition to the enhancements in performance obtained from using dedicated digital hardware, an overall increase in product reliability is also achieved.

OEM / Operator Benefit

The Eaton philosophy is to provide emergency electrical power generation systems that give quality, reliable, performance products resulting in a low cost of ownership that benefits OEMs and operators worldwide.

### Applications and equipment designations

<table>
<thead>
<tr>
<th>Application</th>
<th>Rated Electrical Output</th>
<th>Model Code CSM/G</th>
<th>Model Code GCU</th>
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<tr>
<td><strong>Airbus</strong></td>
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<td>A320</td>
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<td></td>
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