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Off-Highway Edition

ALL SYSTEMS GO

Apart from all components operating at their maximum capacity, OEMs seeking total system integration will also benefit from better-performing vehicles and savings in labor costs

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Imagine an ideally synchronized electrical universe; one where all components work in perfect harmony, each empowering the other to perform at its absolute best. That was the result envisioned by the SEV Group when it set out to create a fully integrated system for its new generation of electric trucks.

Formed in 1927 as Smiths Electric Vehicles, the SEV Group is one of the leading European manufacturers of a wide variety of electric-powered vehicles, including pedestrian controlled vehicles (PCV), road vehicles (RV), access platforms and tow tractors.

Seeking improvements in vehicle performance, SEV wanted to create an electrical system that would be 'future perfect' – one that would readily accept advances in technology without major overhauls to the manufacturing process. There was also a requirement to build in better speed control, to pre-empt the potential for motor damage. Above all, SEV wanted to create a system wherein each component would optimize the other, for overall superior performance. Exploring the possibilities of system integration was therefore part of a strategic initiative to maintain its leadership in the marketplace.

David Smith, managing director, and Jan Coulter, operations manager, spearheaded the initiative at SEV. They invited Curtis Instruments UK – a trusted vendor with a history of leadership in battery management, motor control, power conversion and vehicle instrumentation – to submit a proposal as lead supplier.

Setting the stage for system integration

Clearly, choosing a supplier with a comprehensive product line is one of the first criteria for successful system integration. The more parts that come from one manufacturer, the greater the potential for system optimization, as they can be microcalibrated to work in harmony. The Curtis line includes battery monitors, motor controllers and power-conversion products for electric vehicles; electronic gages, panels and modules for battery- and engine-powered vehicles and equipment; and timing and counting devices. And while Curtis does not manufacture motors or connectors, it has strong relationships with partner companies and was able to purchase components that suited the requirements of the SEV project.

"We considered several factors in our choice of lead supplier, in addition to

The enGage IV system being installed onto the T150 – all components work in perfect harmony, empowering the others to perform at their absolute best

product performance," says Coulter. "We wanted a reliable global service network so that no matter where we send our vehicles, they can be serviced by the vendor's own agents. We also looked for high quality in the technical documentation, and attractive extended warranty terms."

Establishing project parameters

SEV asked Curtis to tender a proposal for the supply of a control system for its T150 RV, a 7.5-ton electric truck to be used by municipal authorities for maintenance and curb-side recycling. The re-design would be based on the desire for modernization, improved vehicle performance and dual sourcing of critical components.

Design requirements called for an 80V 22kW control system that would provide high torque and speed in addition to regenerative braking, 'overspeed' protection and instrumentation to show battery state-of-charge and vehicle speed.

Enhancing the T150 was in part a response to growing demand, particularly in UK municipalities. "There has been a trend," observes Smith, "towards replacing fuel-consuming vehicles with environmentally friendly ones. Electric vehicles offer a highly cost-effective solution to problems of refuse collection and considerable advantages over conventional internal combustion (IC) engine vehicles. Not only are they more environmentally friendly, but they also produce real savings in terms of reduced running and service costs and longer life spans per vehicle.

"Fuel costs, traffic congestion and environmental pressures will continue to mount, making IC vehicles increasingly unsuitable for urban environments," he continues. "The technology inside electric vehicles, however, is constantly developing with new batteries, drivetrains and body configurations making them a more attractive alternative, both in economic and environmental terms."

Initiating the integrated solution

Defining the needs: Kerry Green, a technical sales representative at Curtis UK, acted as project liaison. Working closely with the SEV team, he gathered extensive background on the T150 RV applications and requirements. "We started from scratch to determine the performance criteria," says Green. "How fast should it go; what range; what instrumentation; what did they want displayed to the customer? We didn't take anything for granted."

Choosing the power system: Rather than opt for a conventional DC system, a new AC controller system was recommended, with the advantage of better electrical efficiency. As a closed-loop system it offered superior speed control, which resolved the issue of motor damage occurring should operators accelerate vehicles beyond their recommended performance specification. AC motors are also extremely robust and have fewer moving parts with a solid rotor construction.

Coulter supported the choice: "The biggest issue with conventional controllers is the number of contactors, which are all points of maintenance. Switching to AC eliminates all the contactors except for the line contactor."

Selecting the components: Kerry Green identified the parts that would deliver the desired results and modeled the performance achieved from the system. Curtis's proposed design incorporated AC induction motor, model 1238 traction controller, model 1254 hydraulic controller, enGage IV instrumentation, contactor panel, electrical harness, battery condition data logger, linear throttle and battery charger (see sidebar for details).

Reaching the agreement: The vendor submitted a proposal, itemizing the

Bringing it all together – the components of T150 RV system integration

- AC inductor motor: model C.F.R AM270 4 pole with integral encoder bearing;
- Curtis 1238 traction controller: a high-powered AC induction motor-speed controller. Combines power and smoothness with Programmable Logic Controller for full flexibility. Compact, fully sealed housings offer advanced thermal management. Appropriate for a wide range of industrial and material handling vehicles, including single/dual drive and pump control.
- Curtis 1254-6401 hydraulic system controller: offers smooth, silent, cost-effective control of motor speed and torque, which can also be factory-configured to be compatible with CANbus communication systems. Sophisticated microprocessor provides high efficiency and flexibility.
- Curtis enGage IV instrumentation: provides advanced functionality and full programmability for wide-ranging customization in a smaller package. Dot-matrix display allows the OEM to select each display element and location, along with end user's logo or other graphics. Accommodates up to four gage functions (needle or bar graph) plus additional on/off indicators, all custom-configured.
- Motor controllers are supplied on a custom aluminum baseplate that incorporates safety power fuses, Curtis/Albright line contactors and high-power links to enable a simple four-bolt installation.
- A low-power control harness mounted to the panel creates a one-point connection to the rest of the vehicle, allowing fast assembly for the OEM;
- Battery condition data logger: SmartIC battery management system provides detailed battery discharge and recharge information. The SmartIC is integrated into the European Standard DIN 160 or 320 connectors with handles. Programming the SmartIC is simple and can be carried out by using the Smart-Hand programmer or with a computer that has SmartView installed.
- Linear throttle: The Curtis/Balkan OKL.00 accelerators are designed to provide better environmental protection, reliability and safety at work. Features include:
  - Potentiometer ranging from 0-5,000 ohms;
  - Linear displacement of 13mm;
  - Available with or without microswitch;
  - Durability with over one million work cycles;
  - Environmental protection provided to IP55;
  - Operating temperature: -25 to +55°C;
  - Humidity up to 90%;
  - Weight is 0.8kg.
- Power conversion: The Curtis 1400 series DC-DC converter is designed to provide a reduced voltage supply to power auxiliary electrical systems with high levels of efficiency and safety. Regulated outputs preclude lights from dimming and other effects of voltage-drop caused by battery loading. It also prevents battery damage and unsafe installations caused by battery tappings. Efficient performance generates less heat, which, together with transient protection, improves reliability.

RIGHT: **Curtis Instruments' enGage IV on SEV Group's T150 is integrated to show battery energy, speed and distance traveled**
BELOW AND BELOW RIGHT: **T150 meeting systems integration head-on; the T150 AC road vehicle includes 20kW three-phase induction drivetrain**
BELOW FAR RIGHT: **Systems integration begins with the concept – how can 'x' be achieved?**

components to be used and the identified performance criteria. It was agreed the integrated system prototype would be supplied to SEV for evaluation and could be returned for full credit within 60 days of installation.

SEV accepted the proposal and supplied a sample vehicle to enable development of a prototype. The vehicle was subsequently returned to SEV complete with the new, fully integrated control system for approval.

Creating the integration

The prototype team engineers utilized VCL (the Curtis Vehicle Control Language) and CAN to create system intelligence. VCL is a software programming language that allows OEMs to develop software specifically suited to the vehicle application. By implementing ideas directly into the motor controller, VCL affords higher levels of flexibility and performance at lower costs.

Combined with CAN, VCL allows design engineers to develop highly integrated and customized vehicles. The CANbus physically connects the system and allows a virtual network of I/O, while reducing the expenses associated with wiring and maintenance. Distributed logic and I/O unify the vehicle resource, making it available to the entire system.

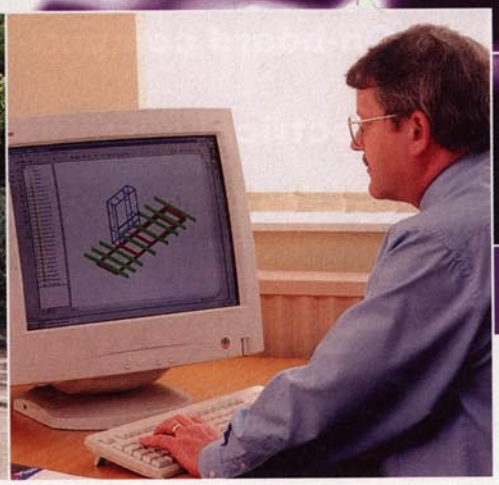
Because VCL works with Flash programmable memory, it allows instant modifications to be made to systems in development. This supports ease of prototyping, field testing and upgrades.

The Curtis 1238 controller represented a major advance. It is one of a new generation of controllers that can accept direct custom software downloads. The flexibility is significant as the controller is no longer a predefined unit with preset specs that OEMs must build around. The I/Os are programmable so the controller can be totally customized via VCL. "We found it a great advantage," confirms Coulter, "to be able to program the controller to suit our particular application."

Model 1238 processes the enGage IV instrumentation data within the controller. It also provides a boost function for the vehicle: when the T150 RV pulls away it automatically receives maximum power. Then the boost shuts down to lengthen endurance. In Green's words, "it's a performance advantage but the customer gets it virtually for free because it's built into the new controller".

The system being future-proof is another advantage. As model 1238 comes fully enabled with CAN for enhancements that might need to be made in the future, it is essentially non-aging. Using VCL, OEMs can change a vehicle's capabilities without changing its entire control system. Instead, they can recustomize their software to get the desired vehicle response.

Because VCL uses more of each unit's capabilities, it provides the ideal environment for true system integration. Maximum performance per part enhances the system as a whole.



Built-in system-integration benefits

In addition to performance enhancements, SEV attained other advantages from its system integration initiative. One of the most meaningful was the elimination of kitting the parts on-site. The entire group of components became one part number, so that SEV could receive the entire kit as a complete set.

The new control system arrives pre-assembled on an aluminum baseplate, incorporating Curtis's 1238 traction controller and model 1254 hydraulic controller, contactor panel with power fuses and electrical harness. SEV simply fits it onto the T150 truck with four bolts, and plugs into a connector. "By creating a turnkey solution for our electrical control system, we sped up assembly, with labor savings of up to 50%," says Smith.

Like the best of outsourcing, this approach makes optimum use of both the vendor's and the OEM's strengths. "We're the experts in panel assembly," affirms Green, "while SEV personnel are the experts on their vehicle assembly. An integrated system approach lets us each do what we do best – add value and simplify the process for SEV."

The advantages continue to add up. With its one-part inventory, this system integration solution can save on order-placement costs, administrative time, shipping costs and will deliver long-term savings on support and maintenance. "Having one lead supplier for an entire system eliminates finger pointing," says Coulter. "If a problem arises, you don't have one vendor blaming another – it simplifies the resolution process."

Regarding the vendor commitment, Green adds: "If SEV experiences a problem it can't resolve, we will take it up directly with its customer – we'll share the responsibility for getting it solved."

Expanding the potential

This was not SEV's first system integration project. "We're exploring the potential with other vendors and have already modernized a PCV using Curtis as the sole supplier on the controller side," says Coulter. "The system just bolts right in. This is now out in the field and performing very well. If all goes as anticipated, we'll roll out the T150 with the same success."

The message for OEMs is to look to system integration for multiple benefits. This enables all components to operate to their maximum capacity, creating a higher performance vehicle. It also achieves savings in labor and may allow for additional volume discounts from the key supplier.

System integration also builds closer ties with the key vendor, setting the stage for the best possible product mix. In this example, the vendor became a one-stop shop for SEV that supplied and supported a complete solution.

"By creating a turnkey solution for our electrical control system, we sped up assembly, with savings on labor of up to 50%," concludes Smith. ***iVT***

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