MICAS-S2 distributed traction control for motive power units

Practically all of the rail tractive units with three-phase propulsion that ABB Transportation Systems has developed in recent years are equipped with MICAS®-S2 traction control electronics. A distributed structure, powerful data bus systems and user-friendly programming give MICAS-S2 a flexibility that enables it to be used with all types of motive power unit.

The emergence in the 1980s of powerful GTO thyristors gave an impetus to three-phase propulsion that was soon to create demand for a modular converter design. The first result was the 'Lok 2000' design concept for main-line rail tractive units with the following characteristic features:

1. Modular design of the traction converters, with standard function units for universal application and minimized costs.
2. Microprocessor-based traction control with MICAS-S2, featuring distributed bus stations. The MICAS vehicle bus (MVB) is fiber-optic based; fiber-optic cables are also used to transmit control signals to the GTO thyristors.
3. Enhanced operational availability. A diagnostics facility incorporating an expert system keeps maintenance downtimes short.

This article complements an earlier one in ABB Review 4/95 that described the traction converters installed in ABB motive power units [1]. ABB Transportation Systems first installed MICAS-S2 in vehicles operated by Swiss railways in 1992. In the meantime, it has become a standard feature of all the rail tractive units delivered by the company, in Switzerland and elsewhere. MICAS-S2 is equally well-suited for local, regional and main-line vehicles (*Table 1*) 1.

Tasks for traction control electronics

The driver of a rail tractive unit operates the entire train with the help of just a few controls, a single manipulation often initiating a whole series of operations. The role of the control electronics is to give meaning to the interplay between the different functions. Subsystems, such as the propulsion system, safety equipment, power supply, heating system, etc, can be linked together and integrated via MICAS-S2. Besides controlling all the operations involved in driving a train, MICAS-S2 ensures that no dangerous situations arise that could put passengers or the train's operation at risk. A diagnostics processor integrated in the control electronics signals disturbances to the drive or stores them for later evaluation by the depot staff.

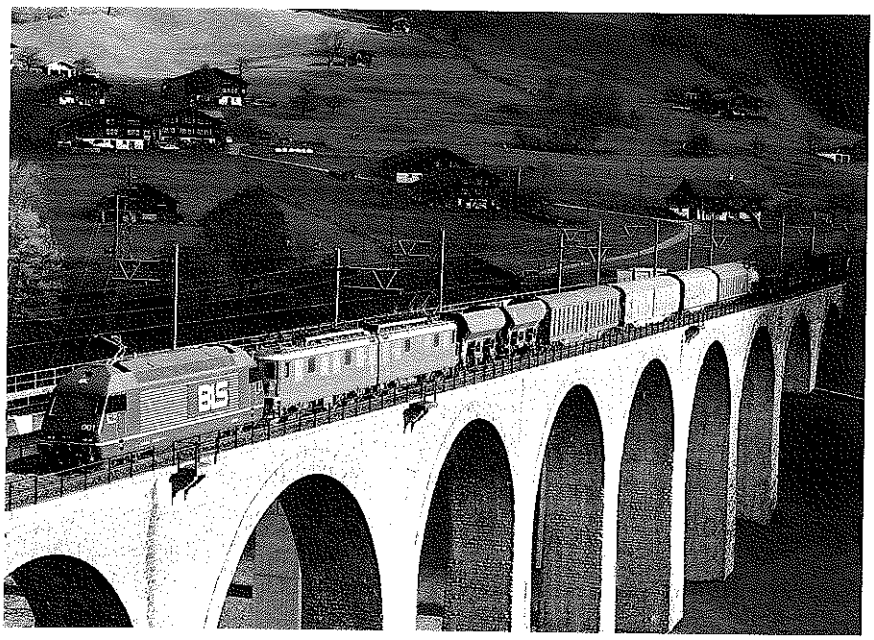
The distributed control electronics was a cornerstone of the modular 'Lok 2000' concept. Every one of the assembly units (eg, the auxiliary services unit, onboard converter unit, drive converter unit, and driver's console) has a control unit with bus station which controls its function. Thus, the converter control unit is responsible for the way the traction motor and converter system function together, while the drive control unit is responsible for controlling the GTO thyristors in the drive inverter. The driver's console in the cab also has its own bus station, to which all the pushbuttons, signal lamps, operating levers and displays are linked. By installing the control electronics in these distributed assembly units, it is possible to fully assemble and test the equipment outside of the motive power unit, before it is installed in the vehicle.

The control electronics in the individual modules is not only responsible for their functioning but also for the way they perform together with other modules in the vehicle. The 'driver's cab' module, for example, tells the 'converter system' module when the train driver requires tractive power. And the central train and vehicle controller signals to the driver's cab the actual train speed, which is recorded and processed by a special measuring unit.

MICAS-S2 distributed control system

The traction control electronics performs all the train vehicles' control and diagnostics functions 2. The 'Lok 2000'

Heinz Schneider
Dr. Janis Vitins
ABB Transportation Systems



Multiple control of a class Re 465 multipurpose locomotive of the Berne-Lötschberg-Simplon Railway (BLS) and a class Ae 485 two-unit locomotive hauling a transit goods train over the Kander viaduct near Frutigen, Switzerland 1

Re 465: Wheelset arrangement Bo'Bo', operated with single-phase AC at 15 kV, 16⅔ Hz, wheelsets powered by dedicated GTO three-phase propulsion

concept, for example, takes advantage of all the possibilities that MICAS-S2 offers. Its control electronics functions are divided among three levels [2], namely the:

- Drive control level
- Vehicle control level
- Train control level

3 shows the different control levels with their respective data transmission systems. As an example, 4 gives the range of control electronics modules installed on the class Re 460 locomotive of *Swiss Federal Railways* (SBB).

The traction converter's control and protection functions are incorporated in the *drive control level*. The main task of the *drive control unit* (ALG) (5a, 5b) is to provide the torque demanded by the *vehicle control unit* (FLG). Using the inputs from the *vehicle control level* and the signals from the monitor sensors, the drive and mains supply converter controllers (ASC and NSC) integrated in the ALG form turn-on and turn-off commands for the GTO thyristors of the traction converters. These control commands are transmitted from the ALG to the gate units over fiber-optic cables, as are the acknowledgements from the gate units to the ALG.

Also implemented at the drive control level is the antislip/antislide protection. When adhesion conditions are poor, this prevents wheelset slip during motoring and wheelset blocking during braking.

The *vehicle control level* is where the higher-order vehicle control operations initiated by the train driver take place. An example is the power-dependent control of auxiliaries, such as the blowers for the traction motors and oil/air heat-exchangers [3]. The central FLG (6a, 6b) also carries interfaces that link it to the electronic modules supplied by subcontractors. These include the:

- Speed indicator
- CPU of the train's radio communication system
- Automatic train control unit
- Automatic train protection unit
- Braking processor

Because of the distributed configuration of the MICAS-S2 control electronics, the FLG can be mounted either in the driver's cab, where it performs the tasks of the local bus station (eg, in tractive units for local train services) [3], or in the vehicle's middle (eg, in main-line locomotives) [4].

The vehicle's availability has to be easy to check, as it plays an important role in ensuring reliable operation and keeping maintenance downtimes short. MICAS-S2 meets this need with a diagnostics system for detecting faults and statuses, integrated at the vehicle control level. A display in the driver's cab 7 shows data and other information concerning the vehicle status. The emergence of an unusual event or simply an operating error is signalled on the monitor. A built-in expert system suggests corrective measures that the driver can take to secure operation of the vehicle in such situations 8. The diagnostics also features the following capabilities for enhancing operating efficiency when extraordinary demands are made by the train's composition:

- Diagnosis and correction of disturbances involving remote-controlled motive power units, eg, in the case of multiple-unit control or reversible train services.
- A diagnosis covering the entire train, originating from the occupied driver's cab.
- Braking tests showing the braking status of each individual vehicle fitted with a brake test recording unit, plus a check at the rear of the train.
- Information about the instantaneous fault/disturbance status of the train every time one driver takes over from another or when the driver's cab is changed.

In addition to the operating diagnostics there is also a service diagnostics facility which improves the efficiency of mainten-

ance. A special diagnostics processor is responsible for managing and storing the diagnostics data.

The information exchange between the vehicles making up the train takes place at the *train control level*. Data is transmitted at this level for, eg, the passenger information system, control and monitoring of the side doors, control of the lighting, and control and supervision of the pneumatic brakes. Drive control functions are transmitted with the help of frequency shift keying over the *MICAS-S2 train bus*. If required, the train bus can be duplicated to provide redundancy, this being the case on the class Re 460/465 multipurpose locomotives of the SBB and the *Berne-Lötschberg-Simplon Railway* (BLS). Multiple control of up to four tractive units is possible with the train bus.

MICAS-S2 modular system

MICAS-S2 provides, in addition to the primary hardware and software, the tools that are needed for project engineering, commissioning and maintenance of the system.

In terms of hardware, MICAS-S2 offers some 50 modules for input/output and for processing digital and analogue signals. The circuit boards are mounted in subracks which provide the necessary infrastructure 9:

- Power supply units, connected to the vehicle battery
- A bus separation unit for the link to the fiber-optic based data transmission system (MICAS vehicle bus)
- Digital I/O units for peripherals
- Analogue I/O units
- Processor hardware
- EMC capabilities

The hardware components of MICAS-S2 are selected for their ability to meet the demands of traction applications, and are put through comprehensive works tests. They satisfy special requirements, eg, an extended temperature range of –25 to +70 °C, and in most cases also facilitate self-diagnostics.

A special feature of MICAS-S2 is that all the cables from apparatus fitted with front-panel connectors are led direct to the I/O circuit boards of the respective bus stations. All of the plug-in modules and boards are of a standard design, allowing the widest range of applications. The processors comprise single modules designed to be plugged into subrack tiers sized at 6U and 3U. Depending on the application, these are configured either as normal processors (for deriving output signals from process values), bus servers, diagnostics processors, display

Table 1:
Main-line tractive units with the MICAS-S2 distributed traction control system

Customer	Country	Locomotive type [power car/trainset type]	No. of locomotives [power cars, trainsets]	Max. speed km/h	Power rating MW	MICAS train bus + installed – conventional multiple control
Berne-Lötschberg-Simplon Railway (BLS)	Switzerland	Re 465	8	230	7	+, –
Swiss Federal Railways (SBB)	Switzerland	Re 460	119	230	6.1	+
Finnish State Railways (VR)	Finland	Sr2	20	230	6	
British Rail (BR)	United Kingdom	Class 92	37	140	AC 5 DC 4	
French National Railways (SNCF)	France	Class 92	9	140	AC 5 DC 4	
Indian Railway Board (IR)	India	WAP-5	11	160	4	
		WAG 9	22	100	4.5	
Norwegian State Railways (NSB)	Norway	[BFM/IC 70]	16	160	1.7	+
Eurotunnel (ET)	UK/France	ESL 9000	38	160	5.8	+
Queensland Rail (QR)	Australia	[SMU+IMU]	12+4	100/140	1.6	+
Rhaetian Railway (RhB)	Switzerland	Ge 4/4 III	9	100	3.2	+
Norwegian State Railways (NSB)	Norway	El 18	22	200	5.8	
Ente Ferrovie dello Stato (FS)	Italy	E 412	20	200	6.0	
Regionalverkehr Berne–Solothurn (RBS)	Switzerland	[ABe 4/12]	8	100	0.6	–
		[Be 4/8]	3	100	0.6	
Generalitat de Catalunya (FFCC) Barcelona	Spain	[Bo'Bo' + Bo'Bo' + 2'2' + Bo'Bo']	16	90	2.2	+
Consorcio de Transportes de Vizcaya, Bilbao	Spain	[Bo'Bo' + Bo'Bo' + Bo'Bo' + Bo'Bo']	24	90	2.9	+

processors or train bus couplers. Bus servers are not part of the FLG. Instead, they belong to the bus system and can be mounted locally, ie, outside of the FLG subrack. The power supply and drive inverter controllers take the form of special processor modules.

Fiber-optic cables link the bus stations of the modules to the MICAS vehicle bus. The design of the MICAS-S2 hardware depends on the application, resulting in three basic designs 4:

- 6U subrack tiers, for the vehicle/train control hardware (FLG), converter and drive control modules (SLG, ALG)
- 3U subrack tiers, for the peripheral bus stations
- 6U compact tiers, for the onboard power supply converters

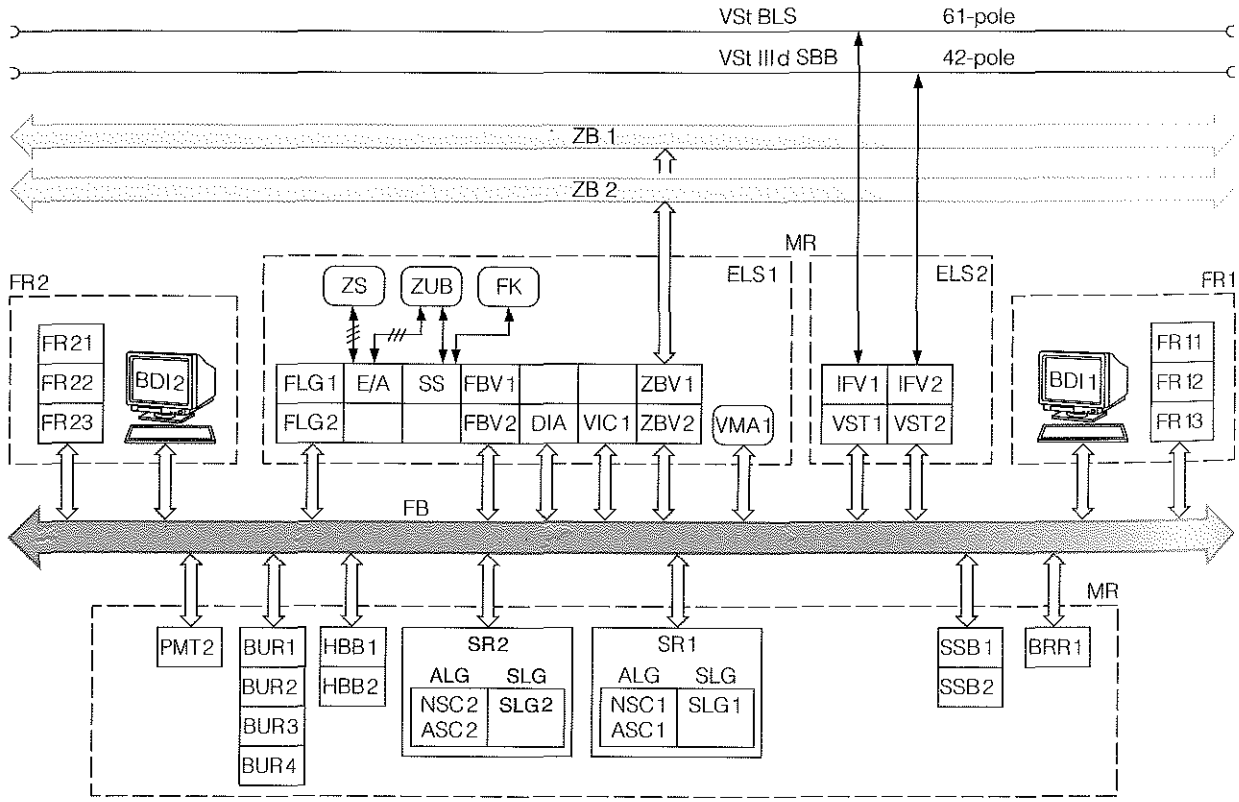
The MICAS-S2/F hardware for passenger car services, eg, door control and monitoring and the heating and ventilation control, etc, is of an extra flat design.

Most of the MICAS-S2 hardware is designed to be multipurpose. Through the implementation of programs, this hardware can be dedicated to specific tasks. The function of the cable connected to a subrack is specified solely by the program running on one of the processors. This programmability allows modifications to be carried out later without having to replace components, which is both costly and time-consuming.

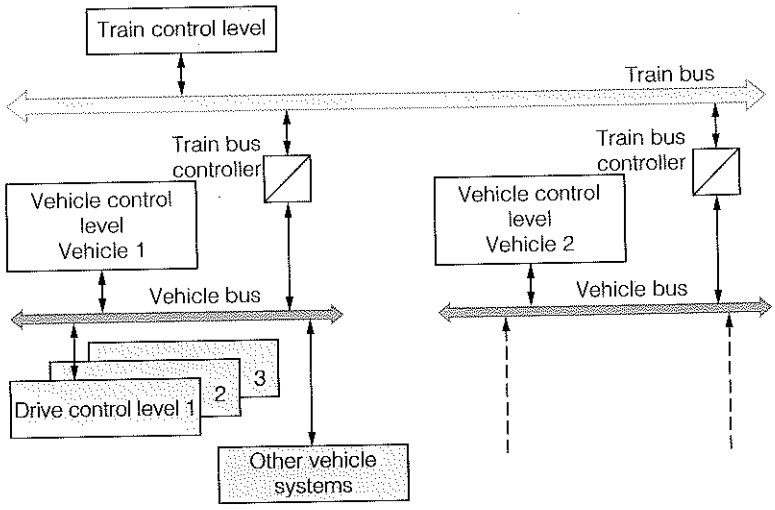
Programs can be written with the help of *MicTools* – a set of programs, all of

Schematic showing the MICAS-S2 control system, in this case for the class Re 465 multipurpose locomotives of the Berne-Lötschberg-Simplon Railway 2

ALG *Drive control unit*
ASC *Drive converter controller*
BDI *Diagnostics terminal (display)*
BRR *Braking processor*
BUR *Onboard converter control unit (bus station)*
DIA *Diagnostics processor*
E/A *Input/output interface*
ELS *Electronics rack (bus station)*
FB *MICAS vehicle control bus (multifunction vehicle bus)*
FBV *Bus server*
FK *Ground-train radio system (ZFK 88 SBB)*
FLG *Vehicle control unit*
FR *Driver's cab (bus station)*
HBB *Auxiliary unit (bus station)*
IFV *Interface for multiple unit control*
MR *Machine room*
NSC *Supply converter controller*
PMT *Pneumatic panel (bus station)*
SLG *Converter control unit*
SR *Traction converter (bus station)*
SS *Interface circuit board*
SSB *Control system supply cubicle (bus station)*
VIC *Visualization controller*
VMA *Speed recording equipment*
VSt *Multiple control line*
VST *Multiple unit control*
ZB *MICAS train control bus*
ZBV *Train bus controller*
ZS *Train safety system*
ZUB *Automatic train stopping control, ZUB 121 SBB/BLS*



which can be run on personal computers. The project engineer uses these programs to specify the function a module has to perform, determining at the same time how the vehicle will behave in the event of disturbances and how these are to be signalled to the operator/user. Another program from the MicTools series can be used to specify the data exchange over the MICAS vehicle bus. As soon as they are ready, the programs are loaded in the traction control electronics via the vehicle bus, a routine which does away with the complicated replacement of EPROMs and allows the commissioning engineer to check a vehicle for correct functioning. Troubleshooting is also facilitated by this.



Data transmission throughout a train 3

Vehicle bus — *Data transmission between modules installed in motive power unit, based on fiber-optic links with RS 485 serial interfaces*

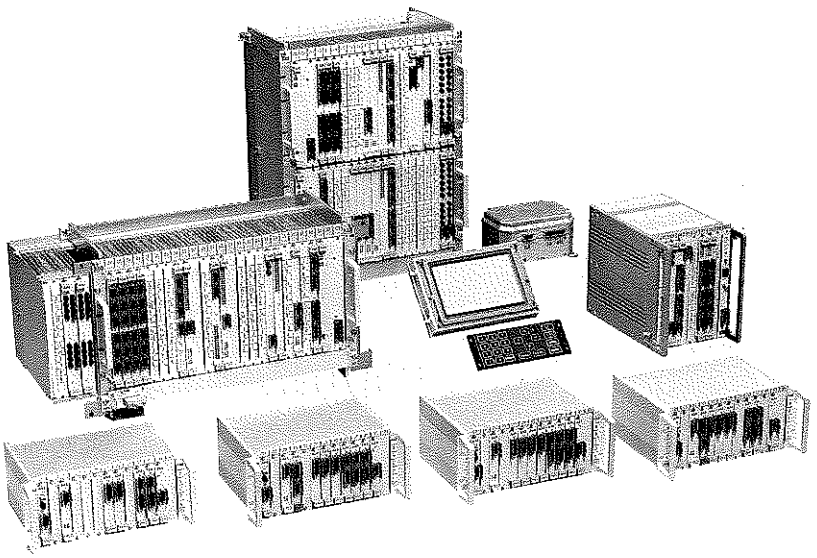
Train bus — *Data transmission between multiple-controlled motive power units as well as between motive power unit and wagon, based on wired links employing frequency shift keyed multiplexing*

Selection of distributed traction control modules belonging to MICAS-S2 and used in the class Re 460 multipurpose locomotive of Swiss Federal Railways 4

Front row: controllers for the onboard power supply converter unit, auxiliary unit, pneumatic panel, control current unit and other peripherals

Middle row, left: drive/converter controller for traction inverter; center: display with keyboard for driver's console; right: master computer for onboard power supply converter

Back row: train/vehicle controller with bus manager and diagnostics computer, plus train bus controller (in electronics rack)



MICAS vehicle bus and MICAS train bus

The *MICAS vehicle bus* is the internal highway over which all information travels between the control electronics in the modules and subassemblies 10. The data traffic between the control hardware of the assembly units runs over a single link, although this is duplicated if redundant data transmission is required. Conventional wiring is restricted to 'internal links' within the apparatus racks. The MICAS vehicle bus has been specially optimized for fast transmission of commands and measured values. The data exchange between the drive and vehicle control levels is secured in MICAS-S2 by the standardized, serial multifunction vehicle bus (MVB). Data and signals are transmitted between physically separated apparatus over fiber-optic links, as these are immune to electromagnetic interference and allow complete electrical isolation of the modules.

The *MICAS train bus* for transmitting commands and signals between the train vehicles (tractive units, passenger cars and control trailers) makes use of two-core wire links. In the case of multi-sectional trainsets which only have to be separated in the workshop, the train bus

is not necessary providing the fiber-optic vehicle bus extends over several cars. Transmission of information on the train bus is based on frequency shift keying (FSK). On the one hand, the electrical connections allow the use of internationally standardized UIC couplings (especially the 9-pole, so-called EP line for controlling the electropneumatic train braking equipment, and the 18-pole UIC multiple control line), while on the other they permit use of pneumatically operated cable autocouplers.

Application areas

ABB Transportation Systems employs MICAS-S2 for all of its projects with modular propulsion equipment, in particular for the locomotives of type 'Lok 2000'. The following examples illustrate several areas in which it is used.

Trainsets for suburban and regional services

Multi-sectional trainsets for use at peak traffic times need to be adaptable to different transportation requirements. As a rule, mass transit trains run without a crew, except for the driver, who is responsible for coupling and uncoupling. During operations of this kind, absolute passenger safety has to be ensured (operation of the side-doors), as has proper braking of the trains, whether already at standstill or arriving or leaving (eg, via an automatic braking test after a change in the train's composition, or spring-loaded braking of the vehicle when it is at standstill).

After successful trial runs with the Swiss railway *Regionalverkehr Berne-Solothurn* (RBS), the above configuration with MICAS-S2 was put into service with the class ABe 4/12 power trainsets and class Be 4/8 two-unit power cars now being operated by RBS as well as two other Swiss railways, *Bremgarten-Dietikon-Bahn* and *Wynental-Suhrental-Bahn* **11** [3].

These low-floor vehicles with three-phase GTO propulsion are operated with 1200 or 650 VDC, depending on the railway company. Due to the possible need for multiple-unit control with trainsets dating from 1972, the MICAS train bus was not installed. The vehicle control unit (FLG) in the occupied driver's cab assumes the duties of the so-called train master and converts vehicle setpoints as well as control commands and acknowledgement signals into 'conventional' signals for the existing multiple control line. This is done via peripheral I/Os. Every FLG in the train evaluates the signals, using them to generate new control signals for the vehicle bus to which they are assigned.

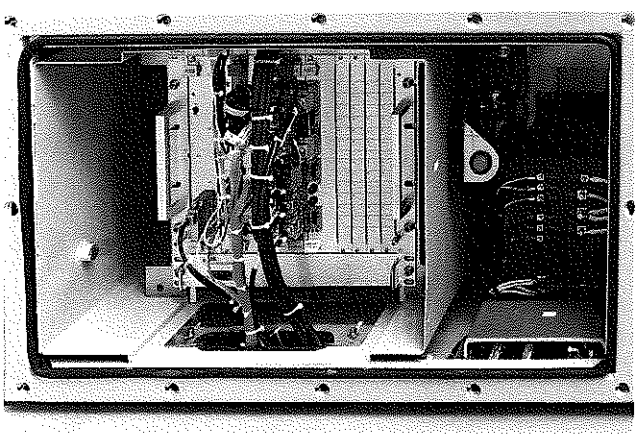
Class Re 460 multipurpose locomotives of Swiss Federal Railways

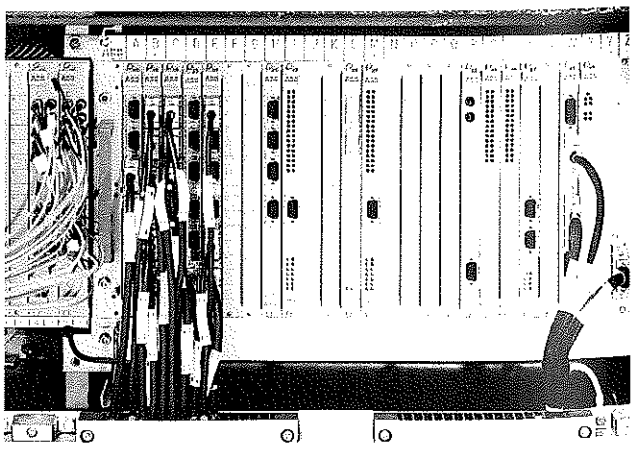
January 1996 will see the SBB operating 119 units of the class Re 460 6-MW locomotives with the wheelset arrangement Bo'Bo'. They will be used mainly on Intercity and Eurocity routes within Switzerland's 'Bahn 2000' rail network, in particular for piggyback and large-container services on the transalpine lines. The flexibility that enables the Re 460 to be used on these routes is due to a large extent to the benefits that come with the MICAS-S2 control electronics and the train bus.

Converter/drive controller in the traction control unit (drive control level) **5**

LHS: *Installed in drive inverter unit for mounting on roof of class A(B)e 4/6 low-floor articulated light-rail vehicle of Ferrovie ed Autolinee Regionali Ticinesi*

RHS: *Installed in underfloor converter unit of class BFM 70 reversible train power car of Norwegian State Railways' IC 70. The example shows the advantage of a distributed arrangement in which the controllers are immediately next to the standard valve set modules: only short fiber-optic links to the gate units are required.*





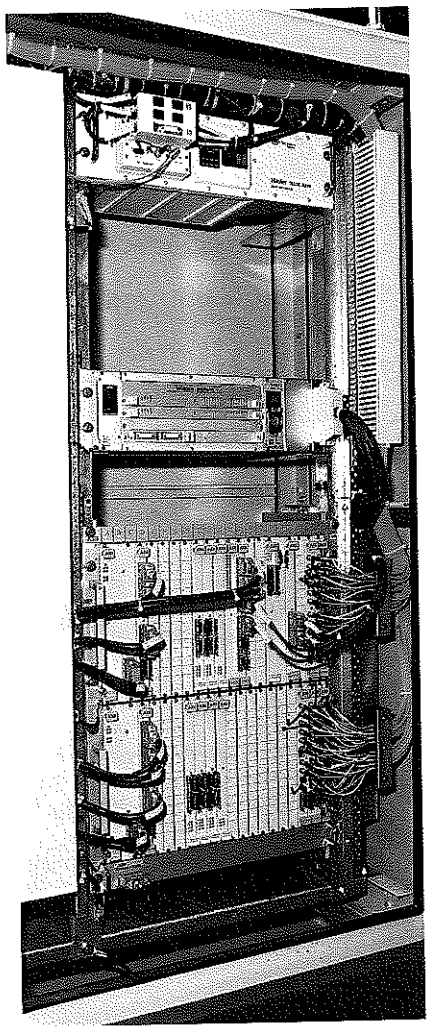
To deploy the vehicles more efficiently on the 'Bahn 2000' Intercity routes, where trains travel at speeds of up to 200 km/h, and at the same time reduce the number of times the trains have to reverse directions in the stations, the Re 460 makes use of MICAS train bus features that support shuttle service. Nine class Btm control trailers will be available in the near future for intercity services with IC 2000 double-deck cars. These will allow shuttle trains comprising 7, and in exceptional cases 10 cars per train. Also, 60 class Bt control trailers have been ordered to enable shuttle trains with a maximum of 12 cars per train to be formed with existing EW IV passenger cars (at high speeds with two Re 460 units due to the power that is required). The 9-pole, UIC-compatible EP control line, which employs two cores of the electropneumatic brake control cable, transmits the train bus signals in the IC 2000 double-deck cars and EW IV passenger cars (the latter need to be equipped for this). The control signals for the passenger cars (eg, for remote control and monitoring of the side doors, remote control of the lighting, supervision of braking) and the signals for the passenger information system are transmitted via the 18-pole UIC control line.

The MICAS train bus is also able to integrate three class Re 460 units at different locations in a 'piggyback' train into the multiple unit control system. By equipping piggyback trains for maximum loads of 1950 t with the 9-pole EP control line, Re 460 units that are in the middle of the train and at its end can be remotely controlled from the head of the train on inclines of 2.7% as follows:

- On uphill climbs, the tractive effort that the third locomotive has to provide is limited to max. 240 kN, compared with 300 kN each for the leading and second locomotive.
- During regenerative braking (on downhill journeys), however, the third locomotive provides the full braking effort of max. 300 kN, the second and leading units providing only 240 kN each in order to prevent 'compression' of the train.
- Insulated sections of the overhead contact line can be run through by the three locomotives of a piggyback train. The distance of the second and third locomotive from the head of the train have to be entered in the program in order for each drive control unit to receive, via the train bus, properly timed commands to first reduce the tractive effort, then operate the main circuit-breaker and finally restore the tractive effort.

The driver enters the positions of the locomotives in the train as well as the data giving the train length on the keyboard belonging to the diagnostics monitor in the occupied cab.

Arrangement in driver's cab of class A(B)e 4/6 low-floor articulated light-rail vehicle of Ferrovie ed Autolinee Regionali Ticinesi; example of arrangement of an FLG in each driver's cab without separate bus station; master function in occupied driver's cab overrides all drive control units during multiple control.

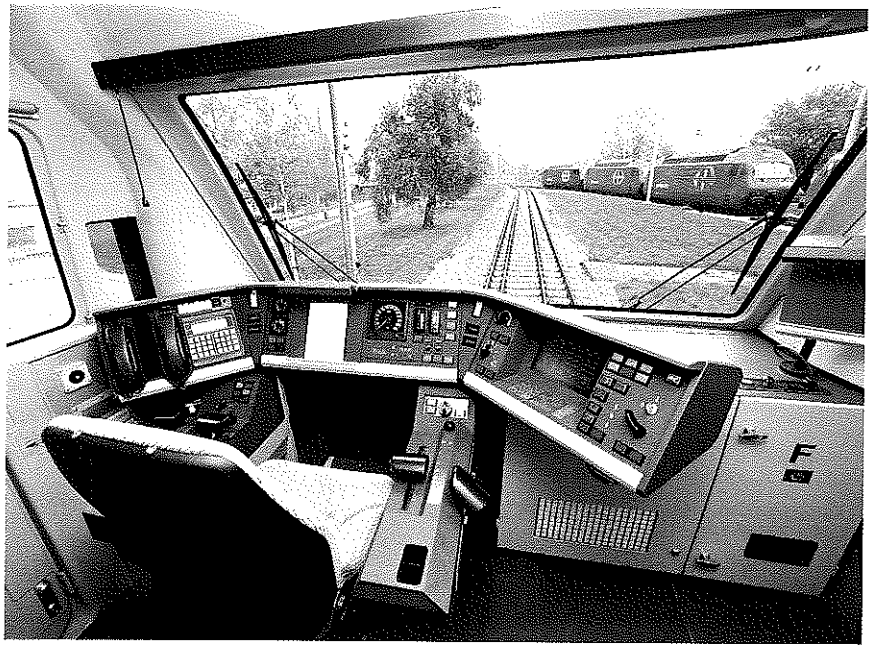


Arrangement in electronics rack (right) on class Ge 4/4 III meter-gauge multipurpose locomotives of Rhaetian Railway, Switzerland; lower section contains central control electronics with FLG, bus server, diagnostics processor, train bus coupler, etc; immediately above are other suppliers' electronic units working directly with the FLG, eg, for train supervision and speed recording.

Vehicle control units (FLG) for the vehicle and train control levels 6

Re 465 multipurpose locomotives of the Berne-Lötschberg-Simplon Railway (BLS)

Since the spring of 1995, BLS has been operating eight 7-MW multipurpose locomotives of class Re 465 on Intercity and Eurocity passenger routes and for heavy goods and piggyback services on the Lötschberg route between Thun and Brig as well as on international through-routes for heavy traffic. In addition, the units, with dedicated three-phase propulsion and Bo'Bo' wheelset arrangements, are used with car shuttle trains in the Lötschberg tunnel, with plans also afoot to use



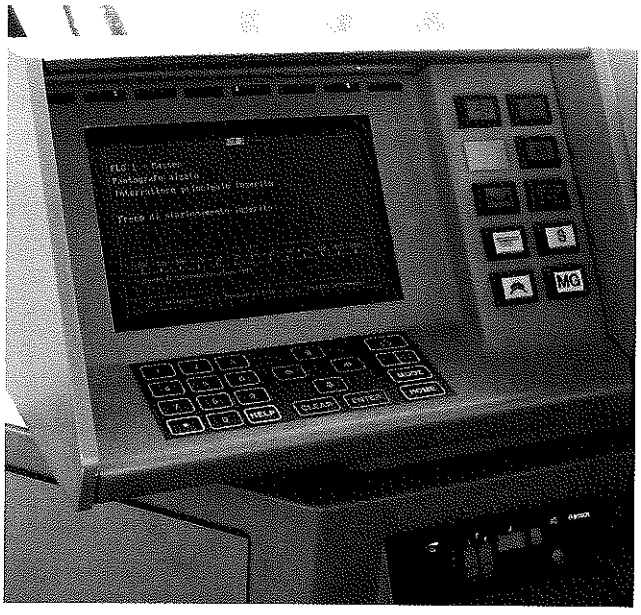
Driver's console with diagnostics display and keyboard **7**

The display in the upper right part of the console of the class Re 460 multipurpose locomotives of Swiss Federal Railways and Re 465 units of the Berne-Lötschberg-Simplon Railway shows disturbances and suggestions for corrective action.
The driver can enter the traction data and train's composition for multiple control on his keyboard.

them in the future with single- and double-deck intercity shuttle trains [5].

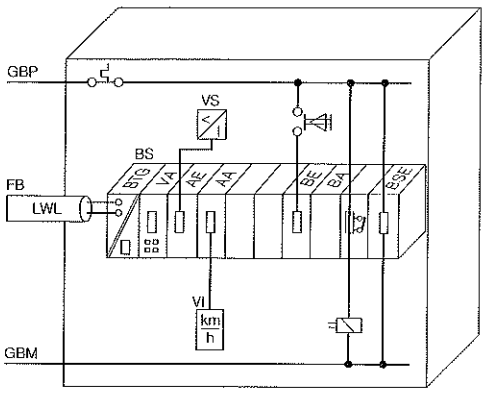
Besides the similar kinds of service involving multiple and remote control – as in the case of the class Re 460 locomotives of the SBB – BLS applications concentrate on flexible dual traction with the existing locomotive types, using on-load tapchanger or converter phase angle control for large hauled loads on the sections of line with steep inclines **1**. The programming of MICAS-S2 therefore allows multiple control at the train control level not only for the classes Re 460 and Re 465 units with three-phase propulsion (via the wired FSK train bus incorporated in the 9-pole EP control line) but also for motive power units featuring commutator motor drives and use of existing multipole, multiple control lines (61 poles for BLS, 42 poles for the SBB). The concept adopted for the vehicle control electronics of the class Re 465, based on the principle of combined multiple control, can be seen in **2** and **12a**, **12b**. A special interface sub-

Display showing information for the driver of a class A(B)e 4/6 low-floor articulated light-rail vehicle of Ferrovie ed Autolinee Regionali Ticinesi **8**

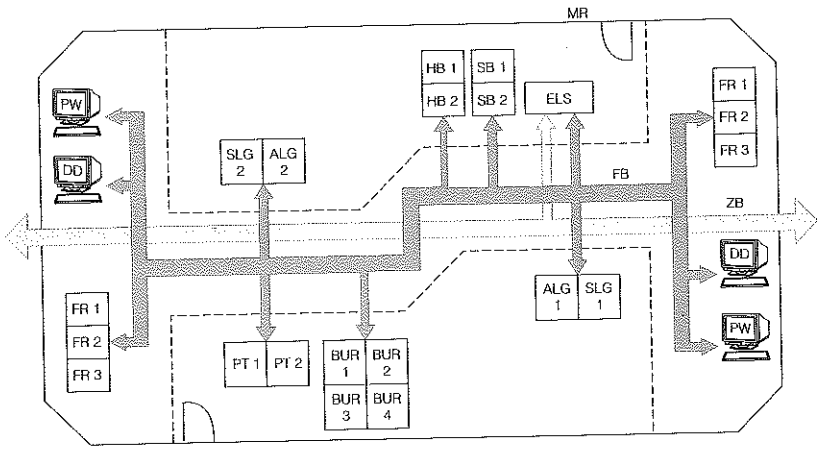


Schematic of a subrack in an assembly unit (vehicle control) **9**

AE/AA	*Analogue input/output*	GBP/ GBM	*Onboard DC power supply, pos/neg pole*
BE/BA	*Binary input/output*	LWL	*Fiber-optic link*
BS	*Bus station*	VA	*Processor*
BSE	*Power supply*	VI	*Actual speed*
BTG	*Bus separation unit*	VS	*Reference speed*
FB	*Vehicle bus*		



rack tier is provided for the conversion of the signals transmitted between the 'conventional' multiple control units and the vehicle control unit (FLG) of the Re 465 unit. Based on the programmed characteristics of the commutator motor drives, the FLG software calculates for every operating state either the tap-changer position or the phase-angle value for the converter. Combined multiple control is possible between all three types of propulsion with up to three tractive units.



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Distributed organization of the MICAS-S2 control electronics and bus links. The configuration of the 35 independent processors in the vehicle bus stations corresponds to the arrangement used in the class Ge 4/4 III meter-gauge multipurpose locomotives of Rhaetian Railway [4].

ALG *Drive control unit*
BUR *Bus station, onboard power supply converter*
DD *Diagnostics display*
ELS *Electronics rack with vehicle control unit, bus server, train bus coupler, diagnostics processor and tachometer*
FB *Vehicle bus*
FR *Bus station, driver's cab*
HB *Bus station, auxiliary unit*
MR *Machine compartment*
PT *Bus station, pneumatic panel*
PW *Process value display*
SB *Bus station, control system supply*
SLG *Converter controller*
ZB *Train bus*

Class ESL 9000 'Le Shuttle' locomotives of Eurotunnel Ltd

38 class ESL 9000 locomotives with a Bo'Bo'Bo' wheelset arrangement power the road vehicle shuttle trains that run on the Channel Tunnel route between Calais in France and Folkstone in the UK [6]. Each of the trains comprises two rakes, or half-trains, each with an ESL 9000 locomotive at one end. Two types of train were designed especially for the Channel Tunnel route:

- *Shuttle trains for tourist traffic*, carrying cars, motor bikes, caravans and coaches. They consist of 26 double-deck and single-deck wagons. The trains have a length of about 730 m without locomotives.
- *Shuttle trains for trucks and semi-trailers*, comprising a total of 28 passenger, partially enclosed and loading wagons. These trains have a length of about 690 m without locomotives.

Whereas the structure of the distributed MICAS-S2 used in the locomotives corresponds to that employed for the SBB's class Re 460, the data transmission within a train is divided between two train bus systems. Data is exchanged between the locomotives over the 'loco-loco bus', an integral part of the the MICAS-S2 system based on frequency shift keyed multiplexing. The data that the train captain requires to control the wagon functions

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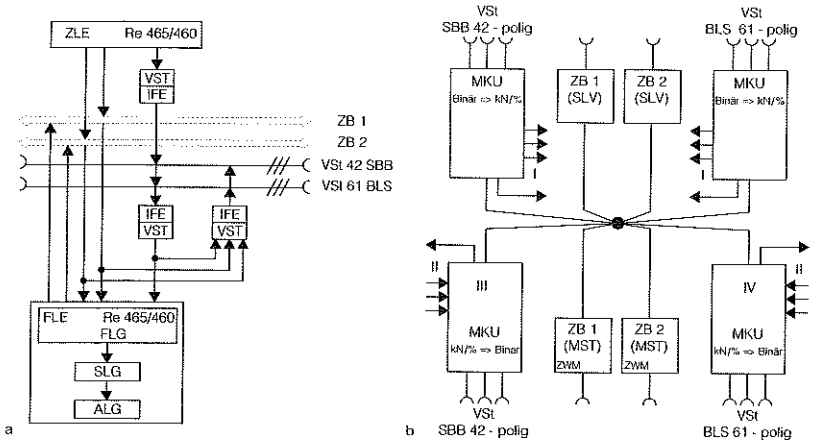
Class ABe 4/8 low-floor two-unit power car (today the class ABe 4/12 trainset) of Regionalverkehr Berne-Solothurn (RBS)

Wheelset arrangement (today) Bo'2'+2'2'+2'Bo'; GTO three-phase propulsion; operated with direct current at 1200 V; multiple control for maximum 3 trainsets (total 6 traction converter controllers) from locomotive control unit in occupied driver's cab (master) via multicore multiple control line of a forerunner trainset type



Combined multiple control of the class Re 465 multipurpose locomotive of the Berne-Lötschberg-Simplon Railway, Switzerland 12

The control electronics, based on the MICAS-S2 concept, demonstrates the adaptability of the system to operating requirements: Unlike the system installed on the Re 460 locomotives of Swiss Federal Railways, additional train bus controllers and interfaces allow a free choice of multiple control of the Re 465 units alone, in combination with the Re 460 units of the SBB and/or with older standard multipurpose locomotives (SBB and BLS), as well as remote control from the control trailer (conventional multiple control).

a *Communication concept*
b *Principle of vehicle control*

I *Master provided*
II *Slave provided*
III *Not active when Master VSt 42 SBB provided*
IV *Not active when Master VSt 61 BLS provided*

ALG *Drive control unit*
FLE *Vehicle control level*
FLG *Vehicle control unit*
IFE *Interface, multiple control*
MKU *Motor characteristics conversion*
MST *Master (controlling tractive unit)*
SLG *Converter control unit*
SLV *Slave (controlled tractive unit)*
VST *Multiple control*
VSt *Multiple control line*
ZB *Train bus*
ZLE *Train control level*

(air-conditioning, passenger information system, etc) and for the train-level diagnostics (fire protection, monitoring of the pneumatic equipment, etc) is channelled through the 'wagon bus'. The interface linking the bus systems – allowing input of important information from the train and vehicle control levels – is located in the driver's cab of each half-train.

MICAS-S2 is compatible with the submitted IEC standard drafted on behalf of the European organization responsible for standards, CEN/CENELEC. Work on the international standardization of the MICAS vehicle bus (Multifunction Vehicle Bus, MVB) is also well-advanced, giving extra weight to the future-oriented concept of the MICAS-S2 traction control system.

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Authors' address

Heinz Schneider
Dr. Janis Vitins
ABB Transportation Systems Ltd
P.O. box 8384
CH-8050 Zurich
Switzerland
Telefax: +41 1 318 1080