# Wheel Slip Prevention Electronics

Independent UIC541-05's prescribed watchdog board. For Pneumatic Brakes.

Optional GPS-GSM/GPRS board for fleet management and remote diagnostics. With CAN IF.

Advanced diagnostics allows detection of defects in wheels, bearings, tracks, as well as the monitoring of bearings wear

Slot for optional MVB Board

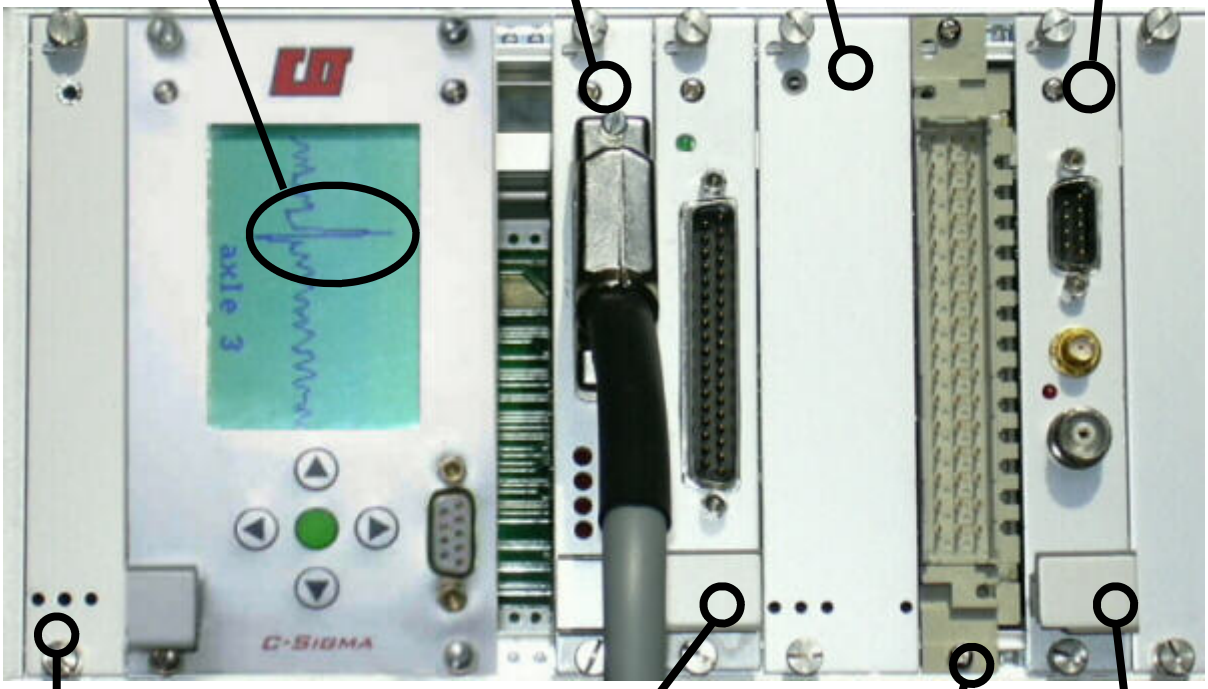
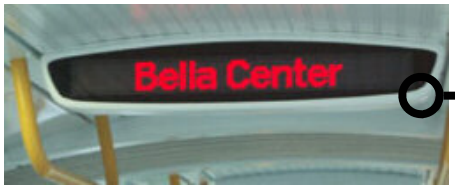



Photo depicts prototype tested to EN50155

Slot for optional supply voltage adapter.

Interface Board with CAN IF

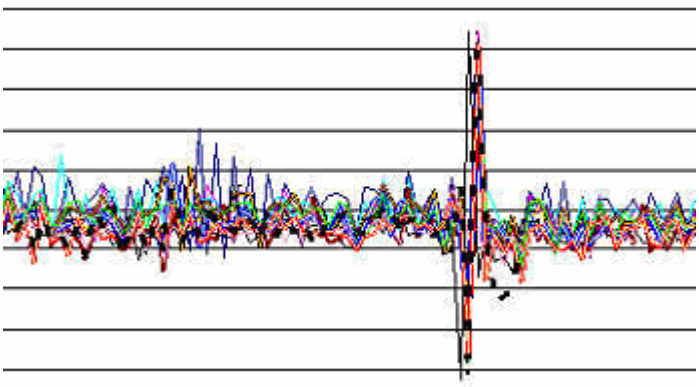
Proportional Valve Amplifier For Electro-Hydraulic Brakes




For automatic next halt messages and local adverts, we can optionally supply LED info panels. Customers could then recover investment by selling time slots for local adverts, contextual to GPS coordinates .

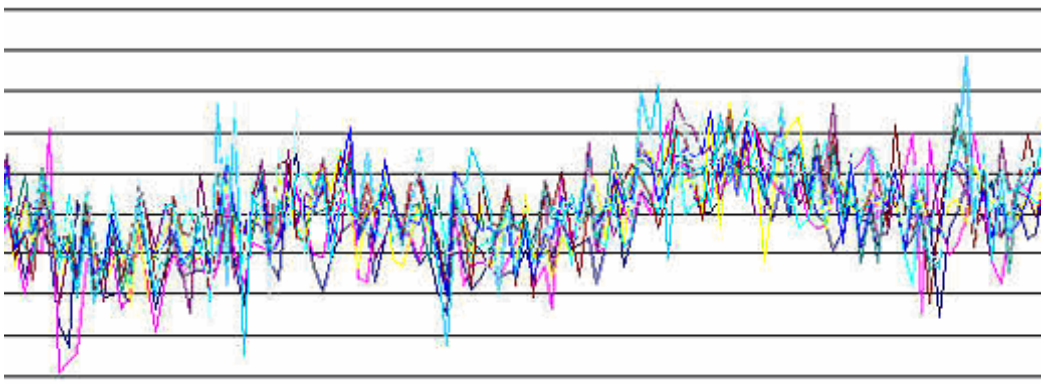
# Innovation

C-Sigma is an independent supplier of Electronic Brake Control solutions for Railway Pneumatic and Electro-Hydraulic Brake Equipments. We strongly believe that constant innovation is the key to successfully meet the most demanding customer expectations with respect to reliability, ease of use and installation, preventive maintenance.
Typical customers are Brake Equipment Manufacturers and System Integrators, for whom System or Sub-System liability is a major issue vis a vis their own customers. To allow customers to minimise the technical support resources required to meet such demands, as well as the associated risk, C-Sigma has developed an innovative double processor architecture with advanced diagnostics capabilities. ***Non Critical*** diagnostic functions are carried out by a ***Diagnostic Microprocessor*** specifically dedicated to this task. Such functions are meant to minimise failure investigation costs by allowing maintenance personnel to immediately restrict the source of a failure to a specific equipment, whose manufacturer can then be contacted for repairs or replacement.
For optimal tuning in the actual field application, the ***Non Critical*** diagnostic software can be easily updated without affecting in any way the ***Critical*** brake control functions, and diagnostics, contained in the ***Brake Control Microprocessor***, and hence without requiring any additional approval from the transport authorities (an expensive and time consuming process).



On our path to innovation, we have recently added a unique feature (patent pending) allowing the detection of defects in wheels, bearings, tracks, as well as the monitoring of bearings wear. By a proprietary processing of jitter on speed signals, suitable plots are generated to highlight such defects. Here on the left is an example of wheel flat detection. The figure shows the overlap of 10 plots corresponding to 10 consecutive complete wheel revolutions. All plots indicate a defect at exactly the same position.

When such spikes occur isolated (i.e.: not correlated by complete wheel revolutions), but on all 4 axles, and with time delays whose correlation is given by the vehicle speed and distance between axles, then the probable cause is a defect of the rail-track (excessive gap or misalignment). The GPS board allows then the recording of the defect's location. When no defects are present, no spike shall appear. However, correlated plots can still be recorded to monitor axle's bearings wear. The figure below shows the same overlapping of plots as above, but for an axle without defects. A pattern, common to all the complete wheels revolutions depicted, is clearly visible. Its shape is determined by the inherent eccentricities and inaccuracies resulting from standard machining and mounting techniques. By comparing similar plots recorded at different times (e.g.: once a year, every 1 million Km, etc.), the evolution of bearings wear can be monitored (standard deviation would increase with wearing).



# Safety

Of course, for railway type brake equipments, Safety is a major concern. This aspect is dealt with differently depending on the type of application.

## *Pneumatic Applications*

For pneumatic applications, the International Union of Railways (UIC) specifies strict requirements to be fulfilled by any Wheel Slip Prevention Equipment (fiche UIC 541-05). In particular, the fiche UIC 541-05 prescribes the use of independent watchdogs, one for each controlled axles, and which shall inhibit any override of the Main Brake Command issued by the driver, would such an override lasts for longer than 10 seconds. This is the purpose of the UIC Watchdog Board, utilised in our controllers configured for Pneumatic Brake Equipments conforming to UIC prescriptions.

## *Electro-Hydraulic Applications*

For electro-hydraulic applications (very common in city trams and light rail vehicles), the overall System Safety is actively pursued at 3 levels:

- At vehicle level, by applying the same level of redundancy for the Electronics as for the Electro-Hydraulic Units. The basic idea is that the overall vehicle Brake Sub-System shall be designed in such a way that the prescribed Emergency Brake Performances (including track brakes) are maintained even with 1 bogie failing to brake. So, the Electro-hydraulic Brake Equipment for any bogie shall be completely independent from the one of any other bogie. Therefore, in this configuration each Brake Control Unit is composed of two identical Electronic Brake Controllers (EBCs), completely independent one from the other. Where signals are exchanged (for diagnostics cross-checks) between the EBC for one bogie and the EBC for the other bogie, then special measures (such as galvanic isolation) are implemented to prevent any possible failure propagation mechanism to take place.
- At brake equipment level, by ensuring that power failure always results in PARK brake applied, as the removal of power from the PARK valve coil allows the spring applied brake to naturally secure the vehicle. Furthermore, also the proportional valve (typically used in this type of equipments for controlling the brake fluid pressure), will discharge pressure from the callipers, and hence ensuring a redundant application of the full spring force.
- At Diagnostics level by making sure that any failure to brake of any bogie is immediately flagged, to inform the driver of the loss of distributed redundancy, and requiring hence to limit the driving speed to a lower value, while driving back to the maintenance workshop. Diagnostic checks are very exhaustive, including: a verification by each EBC of the consistency of pressure telemetry from the controlled bogie while crosschecking also the pressure telemetry from the other bogie, monitoring of all speed sensors, monitoring of the contact status (open or closed) of the PARK relay of the other EBC, monitoring of a ”good health” signal from the other EBC.

# Description

The Electronic Brake Controller ***Ubi_Conf_01*** builds on the successful design of the Brake Controller presently installed on Bombardier's Niederflur Beiwagen, and operating in the towns of Rostock and Leipzig. So far, the 120 Electronic Brake Controllers installed have totalled in excess of 1.500.000 hours of operation.

## *Interface Board*

The function of the interface board is to receive all the system commands and/or signals, via its front panel connector, and to filter and condition them to safeguard against all the specified EMI surges, transients and noise. It also filters and condition the input supply voltage (vehicle's battery). Output commands from the Microcontroller Board are also conditioned on the Interface Board, before being made available on the front panel connector.
For best EMC performances, and to prevent fault propagation, all inputs and outputs, between front panel connector and Microcontroller Board, feature galvanic isolation. It features a CAN bus interface. It can be supplied in two versions: one suitable for typical pneumatic brake equipments, and the other for typical electro-hydraulic brake equipments.

## *Controller Board*

This is the "brain" of the system. It receives input commands and signals, it processes them in order to generate the required brake command. Furthermore, it constantly checks for the occurrence of a slide condition, and, if needed, it issues commands to the Proportional Valve Amplifier as to properly adjust the braking effort.
It features two microcontrollers, one exclusively dedicated to the **Critical Brake Control Functions,** as well as to the processing and digital filtering of the input commands, diagnostic signals, and speed signals. The other microcontroller is instead dedicated to **Not Critical Diagnostic Functions**, and to the control of the front panel display. The front panel 128x64 graphic LCD display provides useful diagnostic information. Diagnostic information can also be downloaded to a PC, via the front panel RS232 serial interface.
On the backplane connector side, it features 4 analog galvanically isolated inputs, 20 digital I/Os (which, depending on the specific application, can be configured either as inputs or as outputs), 5 opto-isolated digital inputs reserved for up to 5 speed signals (the $5^{th}$ speed signal, when required by the application, is usually a 90° phase shifted signal used to determine the direction of movement), one USART serial interface (for RS232 type of serial communication with other cards), one SPI serial interface (for 3-wires serial communication with other cards).
For proper galvanic isolation, and also to prevent fault propagation, the board features its own dc-dc converter.
The Microcontroller Board is very versatile, and it can be used for the control of pneumatic, as well as electro-hydraulic, brake equipments.

## *Optional MVB Board*

When required by customers, we can optionally supply an MVB board to interface with the train data bus. It will be sufficient to simply plug the MVB board into the backplane connector already available for it.

## *Optional Supply Voltage Adapter*

Our Electronic Brake Controller is designed to directly interface to a standard 24V battery supply. However we can also supply a Voltage Adapter Board, for interfacing with other battery voltage levels. It will be sufficient to simply plug the Voltage Adapter Board into the backplane connector already available for it.

## *Optional LED Info Panels*

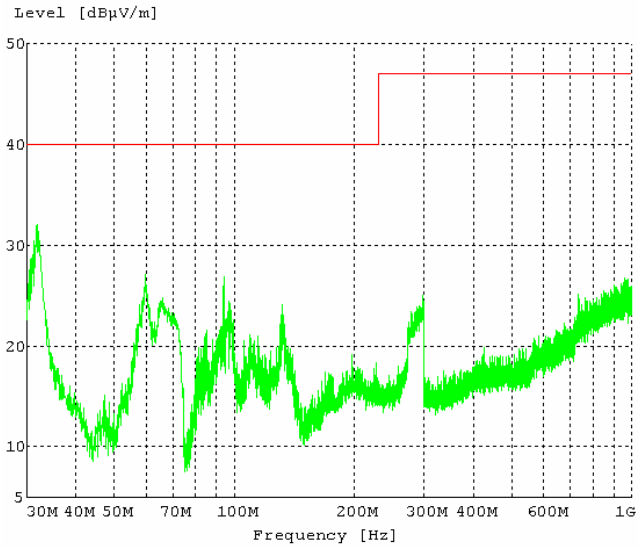
Together with our GPS-GSM/GPRS Board, we can also supply LED info panels for automatic next halt visualisation. Furthermore, the board can store local adverts (sent via SMS, or periodically updated from a central server) to be automatically displayed contextually to the actual vehicle location. Customers can then recover the additional investment by selling time slots for adverts to local shops.

# Physical and Electrical Characteristics

| | |
|---|---|
| Dimensions: | IEC 297-3, 19” 3U subrack |
| Mass: | 3.6 Kg (typ. configuration) |
| Input Voltage range: | 14 to 36 V |
| Current Consumption (at 24 V): | 280 mA (electrovalves not energised) |
| Operating temperature range: | -25°C to +70°C |

# Conformity to Relevant Standards

The Electronic Brake Controller has been designed, and thoroughly tested, according to the EN 50155 (Railway Applications: Electronic Equipment used on rolling stock). For Pneumatic Brake Equipments applications the prescriptions of UIC 541-05 have been thoroughly implemented in the design.




Concerning Electromagnetic Immunity and Electromagnetic Emissions, the unit has been tested to the levels specified by the ENV 50121-3-2 (Railway Applications - Electromagnetic Compatibility: Rolling Stock – Apparatus).
Here on the left is an example of the radiated emissions measurement.

The EN 50155 requires vibration testing to be carried out following the method and levels of IEC 61373.
Here on the right is an example of the random levels applied to the complete unit.