BCA2oo2
Axle-Counter System for Railway signalling

DUCATI Energia has designed the Axle-Counter System for railway signalling automatic block system and track circuit, named BCA2oo2, that merges, at design and application level, many recent hardware and software innovations, constituting an indispensable warranty for the plant efficiency and safety. The Axle-Counter System has been designed to fulfil all the requested functions for a Railway control and protection system, having besides a high flexibility to reach elevated performances in railway signalling field.

Project solutions
DUCATI Energia carried out an operative procedure, according to CENELEC railway standard application. BCA2oo2 has been planned with a fault-tolerant and reconfigurable architecture, derived from national and international experiences concerning the optimal project of computerized systems for critical process controlling. This architecture consists of two computers that, beyond parallel-elaborating process data and inputs/outputs, performs cross checks on their intermediate states to check that all the operation phases are rightly performed. BCA2OO2 assures such high selfdiagnosis and operativity that, in case of any fault, guarantees train circulation safety. The Safety level is SIL4.

Axle-Counter System architecture
Different versions of BCA2oo2 can be configured, allowing the easy change from a configuration to another by up-grading software and hardware of single elements in the basic system. The BCA2oo2 DUCATI system is composed by the following elements:

- a) PCA (detector) and CE-PED (electronic box) near the track.
- b) CE-BCA2oo2 Equipment, in the interlocking, for elaborating data coming from CE-PED and for information Reception/Transmission with the corresponding Station.
  - The PCA (Axles Counting Place) is composed by a two electromagnetic sensors installed on the rail, sensible to the crossing of a metallic wheel on the rail. The sensors are electrically connected to the electronic box.
  - The CE-PED (Electronic box) is the unit where the sensors signals are elaborated and afterwards transmitted via optical fibre to the CE-BCA (Axle Counter Elaboration and Automatic Block Information Reception/Transmission system).
  - The CE-BCA (Logic Unit), installed in the interlocking, consists of a single rack whose physical characteristics are properly studied to be installed in any technological room.

Axle-Counter System application scheme (SBA18 e SBA20 by RFI)
The BCA2oo2 system performs its functions by means of:
1) Liberation Keys actionable from both the stations, relevant to the block section managed with BCA (Tl e Tlc);
2) Exchange of Block-signalling information between the stations, relevant to the block section managed with BCA, to realize the safe data transmission (TDS) to send the request of consent and the subsequent consent, from a station to the other one, in order to change the automatic block direction, using only one couple of telecommunication cable.
**Maintenance and Diagnostic**

The system maintenance is very easy because it doesn't need any periodic calibration. The detector is equipped with an online diagnostic that reveals the calibration decay by means of a yellow alarm on the monitor. The diagnostic function is fulfilled by a maintenance Central Post. On the Central Post monitor is displayed the block section status, and the conditions of sensor, TLC and TLI keys, block relations and board faults.

**Trackside Elements**

Wheels detector PCA consists of two independent sensors working with two different magnetic circuits resonant at 47 and 53 kHz, incorporated in dielectric material mounted on a C40 steel support fixed to the rail. The detector is provided with an ulterior steel protection against the hanging objects. The sensors are electrically connected to the electronic box (CE-PED).

**Typical Characteristics of wheels sensors:**
- Quick and precise mounting on the rail, without any drilling
- Complete absence of any other electronic components
- Only one annual check need;
- Wheel sensors in accordance with protection class IP67.

**Trackside electronics**

The trackside electronic box is located in an alluminium container, for environmental extreme conditions - 25°C, + 75°C, protected in stainless steel. The connection to the Head of Automatic Block section CE-BCA, standing in the interlocking, is carried out with two cables, one in optic fibre for data transmission and one in copper for feeding, to obtain high immunity to the troubles, low attenuation and electronic simplification.

**Head of Automatic Block section**

The Head of Automatic Block section CE-BCA consists in two computers, each processes more activities simultaneously and it is continually compared with the other. The System has the capability of managing up to eight active detectors, it performs with sampling frequency of at least 10 kHz, while the DSP section clock is at 20 MHz and the microprocessor elaboration section frequency is 16 MHz. The block information data change between two adjacent Stations is carried out via integrated modem, at 9600 bps. All the Head of Automatic Block electronics and the interfaces with the interlocking are contained in a rack cabinet 19" – 6 units.

**System Characteristics**

- Power consumption for each Head of Block 100 Watt;
- Power consumption for PCA and CE-PED 40 Watt;
- Supervision of track sections with no limit of a maximum number of simultaneous counting;
- Traversing speed of 0 to 360 km/h for open line and 0 to 150 km/h for track circuit inside the station;
- Distances of 10 km between wheel sensor and electronic box.
- Easy project planning of axle counting system;
- Fail safe data trasmission between two CE-BCA Head of Automatic Block in compliance with EN50159-1;
- Compliance with EN50126  EN50128  EN50129  EN50122-1
- Compliance with UIC 790 R;
- Diagnostic on-line with comfortable diagnostics tools.
1.7. Automatic Block Section Typical Layout

The Typical Lay-out of an Automatic Block Section between two station X and Y is arranged like in the following picture:

**Automatic Block Section X-Y**

![Diagram of Automatic Block Section X-Y]
1.8. Axle-counter used as track-circuit typical Layout

<table>
<thead>
<tr>
<th>CDB</th>
<th>CE-PED</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>CE-PED1 – CE-PED3</td>
</tr>
<tr>
<td>02</td>
<td>CE-PED2 – CE-PED4</td>
</tr>
<tr>
<td>03</td>
<td>CE-PED3 – CE-PED4 – CE-PED5 – CE-PED6 – CE-PED7 – CE-PED8</td>
</tr>
<tr>
<td>04</td>
<td>CE-PED5 – CE-PED9</td>
</tr>
</tbody>
</table>
2. System Hardware Architecture

Each unit CE-BCA, Head of Automatic Block section, of a single station consists in 2 computers (A and B) independent between themselves, which note the same signal coming from independent physical inputs, and manage identical controls, with independent physical outputs. All the safety parts are designed with safety technics according to EN 50124 and EN 50129. Generally hardware is functioning by transfer of dynamics signals (frequencies), controlled by filter designed to face accidental auto-oscillation. In the case it is impossible to use these dynamics signals, the system uses logical states, continuously checked by software to verify the correct interpretation. More in general all the outputs “vital” type are fed by a controlled “fail-safe” circuit which consent to deenergize the output in case of fail, with the consequent immediate block occupation. The sub-systems consist in the following physical modules:

- **CE-BCA**
  - System Watch Dog module;
  - Elaboration Section (Back-End e Front-End);
  - Vital Input /Block Relations module;
  - Vital Output module;
  - Power supply module;
  - Modem module;
  - CE-PED interface module;

- **CE-PED**
  - Transducer Optic-electric module to interface PCA to CE-BCA;
  - Power supply module;

- **PCA**
  - Detector S;
  - Detector L;

[Diagram of Detector Track equipment]
In the following picture are represented the “Hardware Architecture Scheme” and “Elaboration Module Composition”.

**Hardware Architecture scheme**

- **Watch Dog Safety Controller-Comparator (CPS/C)**
- **Back-End Computer (2/2) MASTER**
- **Front-End Computer (2/2) SLAVE**
- **Vital Input IN-VIT/VDC**
- **Vital Output OUT-VIT**
- **Modem**
- **CE-PED Interface (Optic–electric transducer)**
- **CE-BCA Power supply**

**CE-BCA** in the interlocking

- From Int.
- To the next station
- To Interl.

**CE-PED** (near to the rail)

- Modem
- Data transmission by fiber-optic connection

**S Detector Station side**
- Bobbin G (Magnetic field generation)
- Bobbin R (Magnetic field measurement)

**L Detector Line side**
- Bobbin G (Magnetic field generation)
- Bobbin R (Magnetic field measurement)

**PCA** (fixed to the rail)
2.1. Elaboration Section- Master and Slave Boards

The actual digital technology doesn’t consent to realize devices functioning with the only hardware “fail-safe”, for this reason the “fail-safe functioning is carried out by a programmable logic architecture, through the elaboration results checks.

CPU-MEM equipment satisfy the following needs:

- Possibility to keep the configuration information also in case of a long lack of feeding (memories type RAM ZeroPower and TimeKeeper);
- Elaboration speed and capacity suitable with the quantity of elaboration to do in time compatible with the process under control;
- Memory capacity suitable both for actual functions and for future implementations;
- Serial communication system full-duplex;
- A local communication system between the boards CPU-MEM which form unit C/P;
- A double couple of frequency output dedicated to the relation with the “supervision” board (CPS/C);
- Generation of the microprocessor clock frequency and of the frequencies necessary to the output functioning.

2.2. CPS/C Board

CPS/C is a fail-safe device, formed by three independent sections, that receives the informations sent by CPU-MEM in form of couples of frequency signals, check thesee signals and, in case of positive check, activates the vital feeders which supply the necessary voltage to the check stage of the computers A and B vital outputs.

In case of negative check the vital feeder is disabled, with the consequent deactivation of the vital outputs connected to such feeder; CPS/C therefore checks in a safe way the correct functioning of the computers of the unit CE-BCA.
WinBCA
System Diagnostci for Axle-Counter System for Railway

This program allows both querying local BCA through RS232 serial port on the front panel that the centralization of information through a modem card with a double MODEM to a central place for maintenance. Using this software you can make a thorough diagnosis of the BCA is that the interface ACEI related apparatus.

a. State CE-PED and Elettromagnetic Sensor
b. State of comunication
c. State of Drive Relay
d. State of Axel Counter
DETAIL TO THE POST OF MAINTENANCE