AlgoRex® CS1140
C-Bus

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1 Basic functions

1.1 Definition

Loop wired (Class A)
The C-Bus is loop-wired. This provides a redundant line. If a line fault arises (short circuit or open line in a cable) the faulty line can be isolated and communication made via the redundant connection.

Stub wired (Class B)
The C-Bus is stub-wired. There is no more communication possible if a line fault arises.

1.2 Loop wired (Class A)

1.2.1 Operating condition

- The logic addresses for the stations in the local network must be different from each other.
- Hardware must function correctly and impedances ratios (cable lengths, cable types, end-of-line resistors) must be provided correctly (see appendix: Impedance modification).
- An open line or short circuit must last continuously for at least 20 s in order that it can be clearly registered and isolated.
- Only one line fault may be present in the network at any time so that total communication can be guaranteed.
- It must be possible for correct impedance rates (lengths of line, cable impedances etc.) to be provided so that the system can function correctly (see appendix: Adjusting impedances).

1.2.2 Behaviour upon short circuit or open line

A short circuit or an open line is circumvented by re-configurating the network. Re-configuration lasts a maximum of 100 s, during which time all communication is interrupted. The line concerned is signalled as faulty. Once the faulty line has been repaired, re-configuration must be manually activated.

1.2.3 Behaviour upon switching station on or off

Reconfiguration of the entire local network is carried out after switching on, switching off, reset, crash, the connection or removal of a station.
1.2.4 Behaviour with several line faults in the network

If line faults occur in several sections, full communication is no longer possible. The network is then divided into various sub-networks. Once repairs to the line have been carried out, the sub-networks can be reconnected by activating reconfiguration at a CT11. Stations in the isolated sub-network are informed about reconfiguration via the C-Bus emergency line. If the emergency line is NOT connected to all stations within the system, the re-establishment of the whole network can only be reached by re-configuring all stations simultaneously. Since the stations are usually not located in the same room this is not possible. The whole system has to be restarted (power down).

1.3 Stub wired (Class B)

If a CS11 C-Bus network must be operated as a stub line, the field "loop mode" must be set to "0: no" in all station records. The disconnecting relays then remain inactive (no flaps). Line ends must be terminated with resistors (see appendix: Impedance modification).
2 Network configuration

2.1 Connection of hardware

Both C-Bus inputs can each be connected to the input or output via a relay, or terminated with a resistor. In this way it is possible to configure a bus with terminated ends from a loop-wired network. In an intact system only one station may activate a relay and so open a connection.

In the event of a line fault, the adjacent stations activate the corresponding relay. This isolates the faulty element.
If both relays are inactive, the end-of-line resistors are isolated and the bus is connected (input and output are connected direct).

The end-of-line resistor must correspond with cable impedance (see appendix: Impedance modification). If the wrong end-of-line resistor has been inserted, with long lines (>100 m) reflections can arise which superimpose themselves on the useful signal whereby bit errors can occur. As a result of collision detection during transmission, erroneous impedance ratios can lead to presumed collisions.

2.2 Normal network configuration

A station (station 1 in the example) opens the loop network and closes both ends. The unused length of line is changed cyclically so that the malfunction of every line can be registered.
2.3 Short circuit or open line on a C-Bus line

Stations 1 and 2 disconnect the faulty line from the local C-Bus.

2.4 One station is switched off

Station 1 is switched off and behaves like a "piece of wire". Following reconfiguration, another station takes over the line termination function (station 2 in the example).
2.5 Defective hardware in a C-Bus station

A relay test is carried out every time the system is started. If a faulty relay is detected it is automatically isolated.

Example 1
Station 1 contains a faulty relay (no contact). The station with the faulty relay can not be the disconnector station. Another station (station 2 in the example) opens the C-Bus loop and closes both ends.

Example 2
One relay in station 1 gets stuck. The faulty relay together with the adjacent line is isolated from the network.

Example 3
The transmitting or receiving hardware for station 2 has malfunctioned. The faulty station is isolated from the network.
3 Basic features

- Communication between all stations of a local C bus network is also guaranteed if short-circuit or open line occurs on a cable.
- Each C bus station can opt to connect their signal transformer to a line A and/or line B via relay contacts, the open ends are terminated with resistors.
- If the C bus is wired as a loop, this results in a redundant connection which can be used in the event of a cable defect. Opening a connection produces a bus from the loop.
- The failure of a connection line is monitored using presence messages. Presence messages are transmitted in cycles at intervals of 3s. Each station monitors the presence of all other stations.
- If several presence messages are missing, an algorithm is started in each station which guarantees to cut off defective elements and correctly terminate the bus.
- If an error occurs on a cable, the connected relay is activated on the defective cable. The rest of the bus is terminated correctly; all stations are connected to one another and can communicate with one another.
- A connection is tested by transmitting and receiving special messages. These messages are transmitted to all stations in the local network and acknowledged by each station equipped with an isolator relay.
- The function of the relay is checked by sending a message with the relay open. If an acknowledgement message can be received by a neighboring station, a relay must be defective. Relays are tested by manually activating the reconfiguration process and switching on a station.
- A station only closes both relays if both connections are tested and found to be good and if another station is known to have a reliable and open connection at the same time.
- A relay to a defective connection is kept open until the reconfiguration process is activated manually.
Appendix: Modifying the impedance of the various C-Bus cables

This modification is only necessary if the length of the whole C-Bus exceeds approx. 100 meter.

C-Bus standard cables have a characteristic impedance of 110 Ω. The driver and end-of-line resistors are soldered to solder lugs and can be adapted accordingly with other characteristic impedances (see diagram below).

1. Explanation
A cable must be terminated with resistors. The resistance value must correspond to the impedance of the cable. Each C-Bus user has four end-of-line resistors ($R_i$). In addition two driver resistors ($R_d$) are integrated on the p.c.b. In order that the resistors can be exchanged easily they are all soldered to solder lugs.

<table>
<thead>
<tr>
<th>C-Bus-Karte</th>
<th>$R_i$</th>
<th>$R_d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>E3X10x</td>
<td>R196, R197, R198, R199</td>
<td>R178, R179</td>
</tr>
<tr>
<td>E3X120</td>
<td>BR1, BR2, BR3, BR4</td>
<td>BR5, BR6</td>
</tr>
<tr>
<td>B3Qxxx</td>
<td>R31, R32, R33, R34</td>
<td>R49, R50</td>
</tr>
<tr>
<td>E3H020/021</td>
<td>R173, R174, R177, R178</td>
<td>R180, R183</td>
</tr>
</tbody>
</table>

The driver resistors specify the current on the C-Bus. In order that the signal on the C-Bus always has the same amplitude (1.35Vpp), the following correlation is valid:

$$R_d = R_i \times 3.65$$

(45 Ω < $R_i$ < 200 Ω)
Appendix: Modifying the impedance of the various C-Bus cables

2. Procedure

- Request characteristic impedance of the cable from manufacturer (45 Ω ... 200 Ω)
- Select the value of the $R_i$ the same as the value of the cable characteristic impedance and insert the four end-of-line resistors on the p.c.b.
- Insert two driver resistors $R_d = R_i \times 3.65$ on the p.c.b.
- Each C-Bus user must be adapted

If only the inductance and the capacitance are known for a cable, the impedance can be calculated with the aid of the following formula:

\[
Z_c = \sqrt{\frac{L_c}{C_c}}
\]

- $Z_c$: Cable impedance [Ω]
- $L_c$: Cable inductance [μH]
- $C_c$: Cable capacitance [μF]

3. Mixing of different types of cable

In a C-Bus loop (or stub line) only one type of cable may be used.

4. Operation as a stub line

If the C-Bus is operated as a stub line, two end-of-line resistors (values as for $R_i$) must be inserted externally at both ends of the line (default 110 Ω). In the choice of other cables the above rules apply (the $R_i$ are in this case the external end-of-line resistors).