Auto-Sense Combiners

Setup & Behaviour
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1 Introduction

In order to enable the control of ALDs\(^1\) when deploying standard multi-band combiners in mobile communication networks, such combiners are fitted with integrated DC/AISG bypass circuits. Depending on the application, different bypass configurations are available. The correct bypass combination needs to be selected in order to ensure the proper control and configuration of the ALDs.

Kathrein’s autosense combiners simplify the selection of the correct combiner since there is no need to choose one fixed AISG bypass version. The correct bypass is automatically detected, thereby enabling safe and easy deployment of the autosense combiners in universal applications.

The Kathrein autosense combiner is a multifunctional and multi-scenario product. Autosense combiners can be used in the same way as classic combiners and can either be installed close to the base station (combine mode), or nearby the antenna (split mode). Furthermore, it is possible to use the combiner in a configuration with different ALDs such as DTMAs with AISG, dual-band DTMAs (AISG communication on two feeders), DTMAs with Current Window Alarm (CWA) or RET/RCU only installations.

This manual describes the functionality and behaviour of a triple-band combiner with autosense technology. The described functionality and behaviour can also be transferred to a dual-band or quad-band combiner.

\(^1\) ALD = Antenna Line Device (including where appropriate secondary AISG devices)
2 Operational Description

Depending on where the autosense combiner is mounted, it can operate in two different functional modes. By checking the DC voltage on all connectors, the combiner automatically switches into the corresponding mode.

**Combine Mode**
The combiner is installed close to the base station. DC power is detected at one of the input ports.

**Split Mode**
The combiner is mounted near the antenna. DC power is detected at the common port.

Figure 1: Port description of the autosense combiner
Figure 2: Autosense combiners in a mobile communication network

The autosense combiner is equipped with LEDs to indicate the functional status of the input/output ports. The LEDs are located next to the combiner's input/output ports. The LEDs indicate four different situations:

<table>
<thead>
<tr>
<th>LED state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>No DC/AISG signal detected</td>
</tr>
<tr>
<td>Green</td>
<td>DC/AISG signal bypassed</td>
</tr>
<tr>
<td>Red continuous</td>
<td>DC/AISG signal blocked</td>
</tr>
<tr>
<td>Red flashing</td>
<td>Incorrect setup or configuration → see Troubleshooting, p. 16.</td>
</tr>
</tbody>
</table>

Table 1: LED states
The following symbols are used in this document in order to describe the input of connected AISG/DC signals at the respective connector of the combiner.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🆘</td>
<td>DC/AISG signal ON</td>
</tr>
<tr>
<td>🆖</td>
<td>DC/AISG signal OFF</td>
</tr>
<tr>
<td>🆗</td>
<td>Further DC/AISG signal ON (non-priority)</td>
</tr>
<tr>
<td>🆕</td>
<td>Further DC/AISG signal OFF</td>
</tr>
</tbody>
</table>

Table 2: Symbols used to describe the connected AISG/DC signals at the combiner
3 Combine Mode (Near BTS)

Figure 3: Autosense combiners operating in combine mode

When the combiner operates in combine mode, the unit has the ability to operate in three different functions. These functions define the prioritisation of the DC input signals.

1. First in – first out (factory default setting)
2. Priority controlled
3. Exclusive user

You can choose between these functions according to the required prioritisation. The desired function is preset ex-factory. If any behaviour other than factory default is required, then the attached configuration form in Chapter 7, p. 17 needs to be completed.

3.1 First In – First Out Function (Factory Default Setting)

If the First In – First Out function is set, then the first base station which supplies the combiner with DC voltage at any input port is bypassed to the common port.

If there is an additional base station connected to another input port, then the DC from the second base station will be ignored. The common port will still be supplied with the signal from the first powered-up and connected input.
The port of the second connected base station shows a continuous red light. In this case, it is recommended to shut down the DC signal of the second base station.

### 3.1.1 Switching DC/AISG from One Base Station to Another

In order to switch the DC/AISG signal from one base station to another, it is necessary to shut down the DC power supplies in all base stations. In this case, all LEDs are off. The next step is to power up the DC signal in the BTS, which is intended to communicate with the ALDs. The DC signal on the connected port will be bypassed and the combiner triggers a green LED at the corresponding port. Any other BTS supplying a DC signal afterwards will not be bypassed to the common port.
3.1.2  Behaviour in Case of Power Failure

**Combiner is supplied with DC by one BTS**
If the DC power supply from the active BTS drops below 7 Volt, the combiner automatically shuts down all bypasses. All LEDs are switched off. All DC/AISG functions are shut down until a DC signal with more than 7 Volt is connected to any port. The first valid DC signal will be bypassed to the common port.

**Combiner is supplied with DC from more than one BTS**
If power supply from the first base stations drops below 7 Volt while the combiner is also supplied by DC of a second base station, the common port is shut down. If the DC signal from the first BTS returns, it will automatically be bypassed again.
3.2 **Priority Controlled Function**

If the *Priority Controlled* function is in use, then a corresponding priority table has been stored in the combiner. This priority table defines the prioritisation order of the different input ports. The priority table is set and stored ex-factory and needs to be defined by the customer when ordering; see configuration form in Chapter 7, p. 17. The prioritisation is independent of the connected DC input signals.

An example of a prioritisation table for a triple-band combiner is shown in Table 3. This prioritisation is used here by way of example to describe the behaviour of the combiner if the priority controlled function is set.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Port</th>
<th>BTS 1 - Port 1</th>
<th>BTS 2 - Port 2</th>
<th>BTS 3 - Port 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (highest)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (mid)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>C (lowest)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 3: Example of a possible priority table

If more than one BTS is supplying a DC voltage, the BTS with higher priority will be bypassed to the common port. The bypassed base station will trigger a green LED on the corresponding port. Any DC signal from a lower prioritised input port will not be bypassed.

If the port with the highest priority is not supplied with a DC signal, the DC signal from the BTS with the next lower priority will be connected through to the common port.

![Figure 6: Principle of the priority controlled function](image-url)
3.2.1 Base Station with Higher Priority Connected

If the DC signal is switched on at a BTS connected to a higher prioritised input port, the combiner performs a reset on the common port. This ensures that all ALDs between the combiner and the antenna are reset and are ready to be addressed from the higher prioritised base station.

The new bypassed port is indicated by a green LED. The base station with the lower priority triggers a red LED. The power supply on this base station should be subsequently shut down.

![Diagram of base station connection](image)

Figure 7: Connecting a BTS with higher priority using the priority table function

3.2.2 Behaviour in Case of Power Failure

**Combiner is supplied with DC by one BTS**

If DC power supply from the active BTS drops below 7 Volt, the combiner shuts down all bypasses. All LEDs are switched off. The DC/AISG functionality is shut down until a valid DC signal will be switched on. The combiner then acts according to the prioritisation table as described above.

**Combiner is supplied with DC from more than one BTS**

If the power supply of the higher prioritised base stations drops below 7 Volt and the combiner is supplied with DC by a second base station with a lower priority, the combiner will automatically switch to the next lower prioritised port. When the DC power of the higher prioritised port is switched on again, the combiner will perform a reset and act as described in Section 3.2.1.
3.3 Exclusive User Function

If the *Exclusive User* function is set in the combiner, then the first base station which supplies an appropriate DC voltage at any input port is bypassed to the common port. If a second DC/AISG signal is erroneously fed into the combiner, then none of the DC/AISG signals will be allowed to bypass to the common port. The DC/AISG functionality at the common port will be disabled. All input ports with connected DC power supply will trigger a continuous red LED.

![Figure 8: Principle of the exclusive user function](image)

3.3.1 Behaviour in Case of Power Failure

**Combiner is supplied with DC by one BTS**

If DC power supply from the active BTS drops below 7 Volt, the combiner shuts down all bypasses. All LEDs are switched off. The DC/AISG bypass stays disabled until the DC signal is connected to one port. Subsequently, the combiner acts according to the functional behaviour as described above and bypasses the first active DC signal input.

**Combiner is supplied with DC from more than one BTS**

Not applicable – In case the combiner is supplied with more than one DC/AISG signal, the common port is shut down directly as described above.
4 Split Mode (Near Antenna)

When the combiner operates in split mode, the behaviour is independent of any of the prioritisation functions described in Chapter 3, p. 7ff.

In order to detect the connected ALDs, a short-circuit detection is performed on all output ports. Depending on the connected ALDs between the combiner and the antenna, the combiner bypasses or blocks the DC/AISG signal at the corresponding port. ALDs represent a DC load whereas mobile communication antennas generally represent a DC short circuit or a DC open.

Figure 9: Autosense combiners operating in split mode

Figure 10: Short-circuit detection at the outputs of the autosense combiner
4.1 DC/AISG Bypass

If an output port of the combiner is directly connected to an ALD (*DC load*) or is left open, no short-circuit is detected. The DC/AISG signal is then bypassed to this port and the LED on the corresponding port turns green.

**Notice**
It is highly recommended to terminate unused ports with an adequate protection cap.

4.2 DC/AISG Blocked

If an output port of the combiner is directly connected to an antenna representing a *DC short-circuit*, then a short-circuit is detected on the corresponding port. The DC/AISG signal will be blocked and the LED on this port turns off.

4.3 Auto Bypass Activation

The auto bypass functionality is active in split mode as long as the LEDs are switched on. The LEDs will switch off after a preset period of time. The default time for the LED status indication is 8 hours, starting with the first DC signal detection. The time can be adapted according to the customer's needs (see Chapter 7, p. 17).

While the LEDs are switched on, the combiner monitors the detected short-circuits. If the state of a port changes from *DC short-circuited* to *DC open* or if an ALD is installed (*DC load*), then an auto-recovery is performed, which means the DC/AISG signal will be bypassed automatically. The LED status will change from red to green after a successful link establishment.

4.4 Detection of Unexpected Short Circuits (Auto-Recovery)

This functionality is always active and independent of the LED status. It enables the combiner to react to an unexpected short-circuit on a previously bypassed port. If a bypassed port is suddenly short-circuited, the combiner automatically performs a full reset. Hence, the combiner blocks all ports and restarts to perform a DC short-circuit detection as described in Chapter 4, p. 13. The bypasses are established according to the connected devices on the output ports. The LEDs indicate the new situation after successful completion of auto-recovery.
5 Reset the Autosense Combiner

If the combiner does not react to a DC/AISG input signal for no apparent reason, then a reset of the combiner should be performed.

To reset the combiner, the following steps need to be conducted:

1. Disconnect all connectors from the combiner. All ports need to be open.
2. Connect only one arbitrary connector of the combiner to a power supply which can provide 7 – 30 V DC (Minimum 100 mA).

Notice
- It is only necessary to supply the combiner with power for a short period of time (5 – 10 seconds).
- To supply the combiner with DC voltage, it is suggested to use either a power supply unit, 9 V battery, ALC, PCA or base station with switchable power supply.
- If a DC power supply unit or a 9 V battery is used, then the combiner has to be connected as shown in Figure 11.

3. Disconnect the power supply from the connector. The combiner has now been reset and is ready for reinstallation.

Figure 11: Connecting the autosense combiner with a DC power supply unit or 9 V battery
## Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combiner does not react to any DC/AISG input signal</td>
<td>A relay has been switched by a strong mechanical impact.</td>
<td>Combiner needs to be reset. Please refer to Chapter 5, p. 15.</td>
</tr>
<tr>
<td>BTS does not supply DC/AISG signal.</td>
<td></td>
<td>Check DC/AISG settings in the BTS.</td>
</tr>
<tr>
<td>LEDs are slowly flashing in red (2 seconds interval)</td>
<td>The combiner is supplied from both an input port and the common port at the same time.</td>
<td>Disconnect both power supplies and check the site configuration.</td>
</tr>
<tr>
<td></td>
<td>The combiner is supplied from a power supply or base station on any input port and the common port is short-circuited.</td>
<td>Check the site configuration and eliminate the short-circuit.</td>
</tr>
<tr>
<td>First In – First out function only:</td>
<td>The combiner is powered on by 2 DC power supplies/base stations at exactly the same time.</td>
<td>Disconnect both power supplies and then connect the base station which should communicate with the ALDs first.</td>
</tr>
</tbody>
</table>

Table 4: Troubleshooting
# Configuration Form

## Auto-Sense Configuration Form

### Combiner Type Number

For double units give unit # if separate settings required

<table>
<thead>
<tr>
<th>Base station vendor used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ericsson</td>
</tr>
<tr>
<td>☐</td>
</tr>
</tbody>
</table>

### Required functionality

| First In First Out | ☐ | (default) |
| Priority Controlled | ☐ |
| Exclusive User | ☐ |

### Priority table

(only required if 'Priority Controlled' is chosen)

Indicate highest priority with letter A and further priorities in descending order (e.g. lowest D)

<table>
<thead>
<tr>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>______</td>
<td>______</td>
<td>______</td>
<td>______</td>
</tr>
</tbody>
</table>

### LED Status

**Combine Mode**

| Permanent off | ☐ | (suggested for CWA usage) |
| Permanent on | ☐ | (not recommended due to light pollution) |
| Timer controlled | ______ | (fill in time in minutes here; default 8 h = 480 min) |

**Split Mode**

| Permanent off | ☐ | (suggested for CWA usage) |
| Permanent on | ☐ | (not recommended due to visibility of the LEDs) |
| Timer controlled | ______ | (fill in time in minutes here; default 8 h = 480 min) |