Auto-Sense User Guide

Amphenol
ANTENNA SOLUTIONS

JAYBEAMWireless

Amphenol
ANTENNA SOLUTIONS

Contents

1 Document Information

1.1 Purpose and Target Group

This document explains how the DC and AISG signal is automatically routed between the band selective ports and the common port.

1.2 Definitions and Abbreviations

Expression	Description
DC	Direct Current
AISG	A by 3GPP standardized communication interface for antenna near products.
RF	Radio Frequency
RET	Remote Electrical Tilt
TMA	Tower Mounted Amplifier

2 Introduction

The Amphenol Antenna Solutions Auto-Sense Combiner is a product family with many variants of ports. This manual covers how the DC and AISG signals are routed between the Band selective ports and the common port. All variants but not all combinations are explained in detail.

The Auto-Sense Combiner has two major operating modes: combiner (multiplexer, typically in the lower end of the feeder) and splitter (de-multiplexing, typically in the upper end). Actual operating mode will be automatically selected when the unit is powered up depending on how DC power is provided to the Auto-Sense Combiner.

In combiner mode the Auto-Sense Combiner is used as a multiplexer filter where up to five band selective ports are combined to a common RF port. DC power and data communication from AISG enabled base station(s) are automatically routed to the common port.

In splitter mode, the already multiplexed multiband signal is connected to the common port. This multiband signal is then separated to band specific output ports to allow several antennas to handle different radio frequency bands. DC power and data communication are automatically routed from the common port to those antenna ports that have AISG/3GPP antenna-line devices such as RETs and TMAs attached.

2.1 Features

- Up to five ports for multiplexing (combining) inputs to a single output, or to de- multiplex (split) a single input to several outputs. Actual number of input/output ports depends on product variant.
- All physical ports are equipped with lighting protection.
- Radio-frequency signal path between individual ports and the common port are always active and independent of the switching logic.
- Automatic routing of DC power and AISG/3GPP data communication between the band specific ports and the common port to provide power for AISG/3GPP antenna line devices.
- The operating status of the ports are indicated by red and green status LEDs.
- Several pre-configured multiplexer/combiner types are available: exclusive or (XOR), first power-on (FPO) and priority (PRI). When the unit is working in splitter mode, the functionality is independent of what type it is; XOR, FPO or PRI.
- Supports the full AISG/3GPP voltage range.
- Low power consumption and voltage drop between input and output ports.

2.2 Functional Description

A schematic diagram of an Auto-Sense Combiner variant can be seen in Figure 1 on next page. The radio frequency (RF) paths between port 1-5 and the common port are always enabled. DC blockson all ports prevent unwanted distribution of DC power. Instead DC power and AISG/3GPP on- off keying communication are automatically routed based on the actual operating conditions.

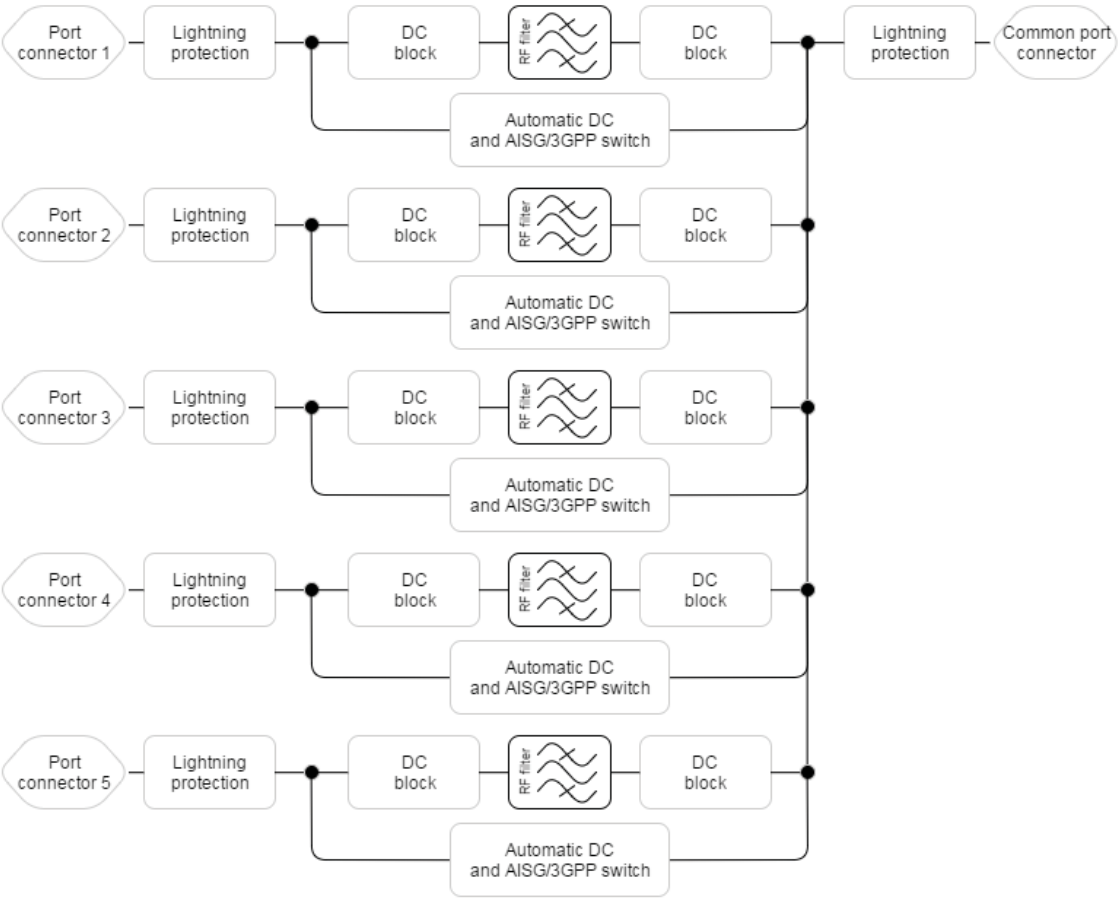

Figure 1 – Auto-Sense combiner diagram. Up to five ports can be connected to the common port. Radio-frequency paths are always active(pass-through). DC and AISG/3GPP communication paths are controlled by the Auto-Sense combiner individually for each port depending on the current operating mode.

While RF paths are always connected, all DC and data communication paths are initially disconnected. The Auto-Sense Combiner will continuously measure and evaluate all input and output ports. When DC power is detected on one or more ports it will change operating mode as illustrated in Figure 2.

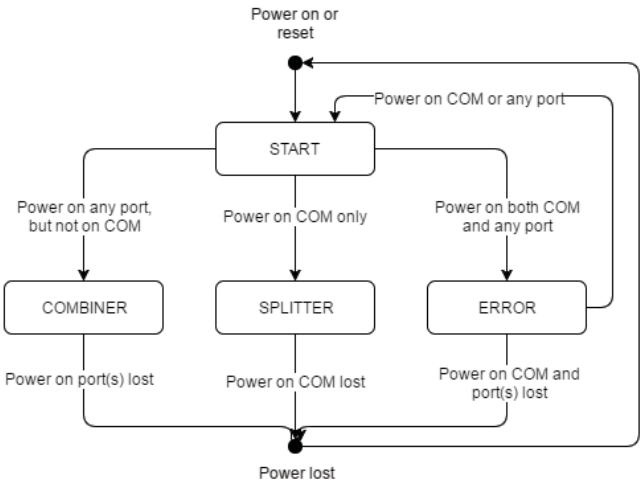

Figure 2 – Start-up behavior of the Auto-Sense Combiner.

If DC power is detected on port 1-5 but not on the common port, the Auto-Sense Combiner will enter the combiner mode and remain there until power is off. Combiner mode is described in detail in section 3, combiner modes.

If DC power is detected on the common port only, splitter mode is entered. See section 4, Splitter mode.

If DC power is simultaneously detected on the common port and any of port 1-5 at start-up, the combiner will enter Error Mode. The error mode will re main active until DC power is removed from either port 1-5 or the common port.

2.3 Operating Status Indication

Port 1-5 each have bi-coloured green/red status LEDs. These LEDs indicate the current status of each port. All LEDs are initially off which means that no DC power has been detected.

When a band specific port is successfully connected to the common port, its corresponding green status LED will be ON.

If a port, successfully connected to the common port, would lose its DC power, the green status LED will be flashing. After restoring DC power to this port, the green LED will change from flashing to steady ON. This is further described in the applicable sections of this document, After a certain time, from last power ON, the LEDs are disabled in order to reduce power consumption. The default time is eight hours (480 minutes).

Combiner modesThe red LED will be ON for ports that are actively blocked because the current operating mode does not allow them to be connected to the common port.

A flashing red LED indicate that the port should be connected to the common port, but an incorrect condition prevents the connection from being executed. The port is therefore temporarily disconnected. This typically occurs in combiner modes when DC power is detected on more than one port.

2.3.1 LED Time-Out and Re-Activation

After a certain time, from last power ON, the LEDs are disabled in order to reduce power consumption. The default time is eight hours (480 minutes).

3 Combiner Modes

When the Auto-Sense Combiner is used near the base stations to multiplex several inputs to a common output, it operates in Combiner mode. The Auto-Sense Combiner continuously measures each port to detect whether DC power is present or not. Depending on the actual combiner mode and the DC status of the ports, the Auto-Sense Combiner will configure the DC and data communication path accordingly.

There are three different combiner modes, XOR, First On and Priority. The mode is pre-set in factory and cannot be reconfigured later on.

3.1 Combiner Mode Exclusive, XOR

In XOR mode, the input port where DC power is first detected, will be routed to the common port. This port remains selected as the active port, until the Auto-Sense Combiner is powered off. The green status LED for this port will be ON, indicating that this port is connected to the common port.

In XOR mode only one input port at a time can have DC applied to have a connection to the common port.

If DC power is detected on more than one input port, the originally selected active port will be actively blocked from the common port. The status LEDs for the ports with unwanted DC present will be solid red as long as the incorrect condition remains. The status LED of the originally selected port will be flashing red during this time, if the port has DC power.

When DC power is no longer detected on the non-selected ports, the status LED of the selected port is once again solid green and the port is connected.

If DC power is removed from the selected port but still present on any other port, the Auto-Sense Combiner will still be powered up waiting for DC power to be restored on the selected port. The status LED for the selected port will be flashing green during this time.

In order to change selected port, the Auto-Sense Combiner must be completely powered off.

LED Indication	Meaning	Action
All Off	No DC power detected.	If a port should be connected to the common port, attach DC power to this port. Otherwise leave as is.
Green On	DC power detected on an input port. Input port is connected to the common port.	If this is not the desired port, power off the Auto-Sense Combiner completely and restart it with DC power applied to the desired port.
Green Flashing	DC power no longer detected on the selected port, but the Auto-Sense Combiner is still powered from another port(s). All ports disconnected from the common port	Re-attach DC power to corresponding port.
Red On	DC power detected but actively blocked – i.e. disconnected from the common port.	If this port should be selected and connected to the common port, power off the Auto-Sense Combiner completely and then reattach DC power to this port. Otherwise remove DC power from this port.
Red Flashing	This is the selected port and should be connected to the common port, but is now temporarily disconnected since unwanted DC power has been detected on other ports as well. All ports disconnected from the common port.	Remove DC power from other ports as indicated by a steady red LED.

Table 1 - LED status indication for Combiner mode exclusive or XOR.

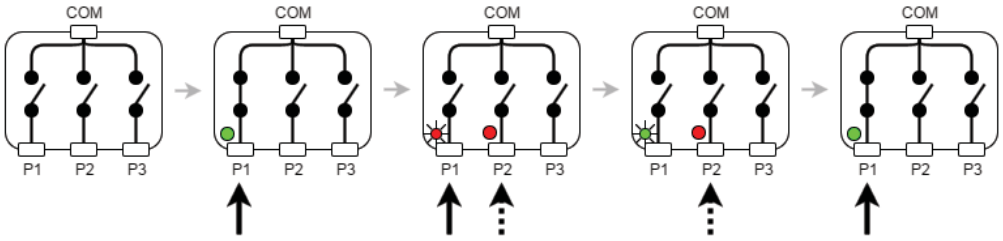

Figure 3 – Examples for a 3 port combiner, XOR mode. Solid arrow represents the desired DC. Dotted arrow represent unwanted DC power. Filled red and green circles indicate LEDs being steady ON. Star marked circles indicate flashing LEDs.

The images above describes the behaviour of the XOR mode Combiner, from left to right:

1) Initially the Auto-Sense combiner is completely powered off.

2) DC power is applied to port 1 and the port is connected to the common port. The green LED is turned solid ON, indicating a successful configuration. This port is now "selected" as the preferred port until the Auto-Sense combiner is completely powered off.

3) DC power is now applied also to a second port, which is not allowed in this combiner mode. Port 1 status LED is flashing red indicating error mod. In error mode all ports are disconnected from Common port. Port 2 status LED is solid red (ON), indicating that this port is incorrectly powered with DC.

4) By mistake, port 1 is disconnected instead of port 2. The Auto-Sense combiner is still receiving power from port 2. The status LED for port 1 is now flashing green to indicate that it is still the selected port, but does not have DC power applied to it.

   Note: If the idea was to have port 2 connected to the common port instead of port 1, the Auto-Sense combiner should have been completely powered off before connecting port 2. This would have made port 2 the new selected port and port 2 status LED would have been solid green (ON).

5) DC power is restored to the originally selected port 1. Unwanted DC power on port 2 is removed and error condition is no longer present. Port 1 is connected to the common port again and the green status LED is ON.

3.2 Combiner Mode First Power-On, FPO

The FPO mode is similar to XOR. Only one input port at the time can be connected to the common port, but detecting DC power on other ports as well is not considered an error.

The port where DC power is first detected will be the selected port and connected to the common port. The corresponding green status LED will be ON. If DC is applied to other ports, they will stay disconnected. But their red status LED will be ON.

Removing DC power from the selected input port while DC is present on any other port will not cause the Auto-Sense Combiner to select another port. Instead the green status LED for the selected port will show flashing green to indicate that DC power should be restored to this port.

In order to select a new port, DC power must be removed from all ports before DC power is applied to the desired port. ***Caution! If power is lost on all ports or the Auto-Sense Combiner is restarted for any other reason, it will at next start-up make a new decision on which port to connect to the common port.*** If DC power should then be available on more than one port the decision can be random and connected to the wrong source. So always avoid having more than one port sourcing DC.

LED Indication	Meaning	Action
All Off	No DC power detected.	No port is selected and the unit is ready for a new selection process.
Green On	DC power detected on an input port. Input port is connected to the common port.	The selected port is indicated by the corresponding status LED being steady ON. If this is the wrong port, power off the Auto-Sense Combiner completely and provide DC power to the intended port.
Green Flashing	DC power no longer detected on the selected port. Other input ports still provide DC power to the Auto-Sense Combiner though. Selected port remains connected to common port but with no DC present.	Re-attach DC power to the selected port.
Red On	DC power detected but actively blocked – i.e. not connected to the common port.	If this port is to be connected to the common port, power off the Auto-Sense Combiner completely and then reattach DC power to this port. Otherwise leave as is.

Table 2 - LED status indication for Combiner mode first power-on, FPO.

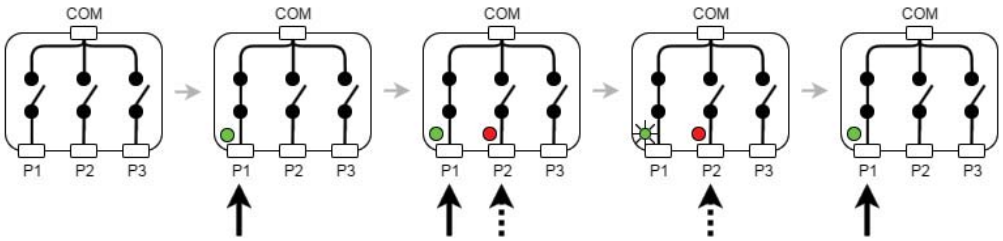

Figure 4 – Combiner in FPO mode. Examples shown for a tree-port Auto-Sense combiner. Solid arrows indicate DC power to the selected port. Dotted arrow indicate unwanted DC power. Filled red and green circles indicate status LEDs in ON state. Star marked circles indicates status LED is flashing.

The images above describe the behaviour of the Combiner in FPO mode, from left to right:

1) Initially the Auto-Sense combiner is completely powered off.

2) DC power is applied to port 1, the port is connected to the common port and the green status LED is ON. This port is now the selected port until the Auto-Sense combiner is completely powered off.

3) DC power is now also applied to a second port, which is allowed in this combiner mode, but not expected. The green status LED for Port 1 is still ON, since port 1 is still connected to the common port. The red status LED for Port 2 is ON, indicating that this port has DC power applied, but it is not connected to the common port. Note that even though the combiner is still giving the desired function, it is an undesired situation. If the power is lost the reconnection may be to the wrong port.

4) By mistake, port 1 is disconnected instead of port 2. The Auto-Sense combiner is still receiving power from port 2. The green status LED for port 1 is now flashing to indicate that it does not have the expected DC power.

   Note: If the idea was to have port 2as the selected port instead of port 1, the Auto-Sense combiner should have been completely powered off before connecting DC power to port 2.

5) DC power is restored to port 1, and DC power is removed from port 2. Port 1 is connected to the common port again and its green status LED ON.

3.3 Combiner Mode Priority, PRI

Only one input port at the time can be connected to the common port. In priority mode the priority of the port will determine which port that will be selected in case DC power is applied on more than one port. In other words, attaching DC power to a port with higher-priority will disconnect a port with lower priority and connect the port with higher priority to the common port. This reconnection is done immediately, without having to completely power off the combiner.

The port connected to the common port is indicated by the green status LED being ON. If DC power is lost for the connected port but DC power is available on other port(s), priority rules will decide which port to connect next.

When ports are changed based on priority rules, DC and AISG/3GPP data communication at the common port is briefly cut. This will allow any AISG/3GPP antenna line devices to restart safely before a device scan sequence is performed.

The port priorities are pre-configured in factory and cannot be changed later on.

LED Indication	Meaning	Action
All Off	No DC power detected.	Apply DC power to the desired port/ports.
Green On	DC power detected on this input port and it is connected to the common port. This is currently the highest prioritised port with DC applied.	If this is not the correct port to be connected to the common port, remove DC power from this port and reconnect DC to the appropriate port. Make sure no port with higher priority also have DC.
Red On	DC power detected but the port is not selected due to low priority. There is at least one other active port with higher priority.	If this port should be connected to the common port, remove DC power from those port(s) having higher priority than the desired port.

Table 3 - LED status indication for Combiner mode Priority, PRI.

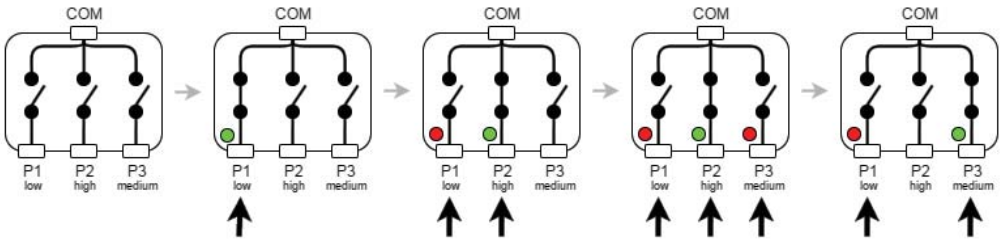

Figure 5. The above series of images describes the behaviour of the Combiner mode PRI.

The images above describe the behaviour of the Combiner in FPO mode, from left to right:

1) Initially the Auto-Sense combiner is completely powered off.

2) DC power is applied only to port 1. Since no other ports has DC, this port is currently the highest prioritised port and therefore connected to the common port. Indicated by the green status LED being ON.

3) DC power is now applied also to the high-priority port 2. This port is now the highest prioritised port. Port 1 is therefore disconnected from the common port and port 2 is connected instead due to its higher priority. Status LED for port 1 is shifted from green to red, indicating that the it is no longer the selected port for the DC path. The green status LED for port 2 is instead set to ON indicating that this port is now the selected port.

4) DC is here applied also to medium-priority port 3. But Port 2 is still the highest prioritised port and will remain connected to the common the port, it's green status LED will be ON. Port 3 will just like port 1 stay disconnected with their red status LEDs ON. Indicating that DC is applied but disconnected due to low priority.

5) DC power from high-priority port 2 is now removed. Out of the remaining two ports with DC applied, the port with highest priority is now the medium-priority port 3. Port 2 is therefore disconnected from the common port and its green status LED is switched from ON to OFF. Instead port 3 is connected to the common port and its green status LED is ON.

4 Splitter Mode

If DC power is detected on the common port at start-up, the unit enters splitter mode. In this mode DC power and AISG/3GPP data communication is routed from the common port to all band selective ports where short circuit is not detected. This mode is always available regardless of factory configuration.

The Auto-Sense Combiner will test the DC load on each port. The ports will be defined as either "electrically short-circuited" or "normal load". See chapter 7 Specifications for definition of short-circuit and load. Short-circuit is expected if an antenna without AISG/3GPP antenna line devices such as RET and/or TMA is connected to the splitter port.

Short-circuit detection is carried out one band selective port at the time. If a port is defined as not short-circuited, it will immediately be connected to the common port. Short circuit detection will then continue for the next port. The Auto-Sense Combiner will periodically, with 10 seconds interval, re-evaluate non-connected ports to see if they are still short-circuited.

Ports that have a load attached and thus have been connected to the common port, are not expected, nor allowed, to become short-circuited. The power supply feeding the combiner must have a short circuit protection. Load detection will be repeated for all ports when the Auto-Sense combiner is restarted.

Note that the Auto-Sense Combiner can only differentiate between short-circuit and load. No load cannot be separated from normal load. No load, however, is normally only a result of an open connector. Open connectors must be weather protected by whether protection caps of high IP class, not only the temporary plastic caps for transport protection. This is to prevent corrosion in the connector that can be accelerated by the DC voltage.

LED Indication	Meaning	Action
All Off	No antenna line device is detected as "load" on any port, only short circuits on all ports. Or no power to the unit.	If antenna line devices are indeed attached to the port, check cables for proper connection.
Green On	Antenna line devices have been detected or "no load". Port is now connected to the common port.	If port should not be connected to the common port, insert a DC block to the port and restart the Auto-Sense Combiner.
Red/Green Flashing	Port is not connected to the common port, because DC power has been detected on it. This is an error state since DC power should flow from the common port, not to it.	Remove DC power from this port, possibly by installing a DC block.

Table 4 - LED status indication for Splitter mode.

5 Error mode

If the Auto-Sense combiner is powered on and DC power is detected on both the common port and one or more of the band specific ports, it cannot decide whether to enter Combiner mode or Splitter mode. The Auto-Sense combiner will instead flash red and green status LEDs for the ports where DC power is detected. It will do so as long as the error condition is present. I.e. until DC power is either removed from the common port or all other ports.

LED Indication	Meaning	Action
Red/Green Flashing	The Auto-Sense combiner has been powered on with DC power from at least one port as well as the common port.	Remove DC power from either the port(s) that have their LEDs flashing, or from the common port.

Table 5 - LED status indication for Error mode.

6 Product Configuration

The following factory configuration options are possible:

- Number of band specific ports: 2 to 5
- Combiner mode: Exclusive or, First power-on or Priority
    - For Combiner Priority mode: priority for each port
- LED activation time: Default value is 8 hours (480 minutes).

7 Specifications

7.1 Environmental

Operating Temperature Range: -40° to +65°C
Environmental: ETSI EN 300 019-1-4 Class 4.1E.

7.2 Electrical

Operating voltage: 8 to 31 V
Non-destructive DC voltage: ±35 V
Continuous current: 2 A
Voltage drop: < 2.4 V at 2 A.
Overcurrent protection: No
Power consumption: <0.3 W

7.2.1 AISG/3GPP On-Off Keying Pass-Through

Frequency band: 2.176 MHz ± 100 kHz
Insertion loss: ≤ 1dB
Return loss: ≥ 14 dB
Attenuation when off: ≥ 21 dB

7.2.2 Load Detection in Splitter Mode

Load with resistance higher than 30 ohms will be defined as “Load” and connected.

Load with resistance lower than 15 ohms will be defined as “short circuit” and not connected.

Load with resistance between 15 and 30 ohms is undefined.

7.2.3 Voltage Detection on Ports

The voltage level on each port is continuously measured and defined as as either active or not active. To be defined as active the voltage must be above the threshold for more than 10 mS. To be defined as not active, the voltage must stay below the threshold for more than 500 mS. Thresholds are described below;

A port is defined as having DC voltage applied if the DC voltage is above 7 volts.

A port is defined as NOT having DC voltage applied if the voltage is below 6 volts.

7.2.4 Lightning Protection

All ports have lightning protection.

7.3 Mechanical

See product specification.