

Feeding Systems of Phased Arrays

Air-borne active radar antenna



Figure 1: Tornado Nose Radar

Active Antenna

Active phased-array antennae are antennae at which the transmit power is produced by many rx/tx- modules of low impact on the antenna directly. E.g.: the airborne Tornado-Nose-Radar, the air defense radar RRP-117 and the naval radar APAR.

Active antennae are usually phased array antennae at which instead of a central high-power oscillator/amplifier, every radiating element got a small power amplifier in the antenna directly. This has the advantage that the necessary phase shifters must only process a small power.

This e.g. antenna shown in the beside picture consists of 428 active radiator elements. Deeper explanation of active antennae you'll find in the recommendation chapter „Transmitter“

Passive Antenna

Passive phased-array antennae are subdivided in:

The constrained feeding is the most applied manner of feeding the passive phased-array antenna. The constrained feeding needs a wave guide wiring or a strip line network for the power supplying. (E.g.: PAR-80).

A method more seldom used represents the space feeding (quasioptical feed). At this the antenna area is illuminated with the transmit power by a feed horn. The power is received by small antennae elements, then modified in the phase and emitted again. (E.g.: FRK - Patriot).

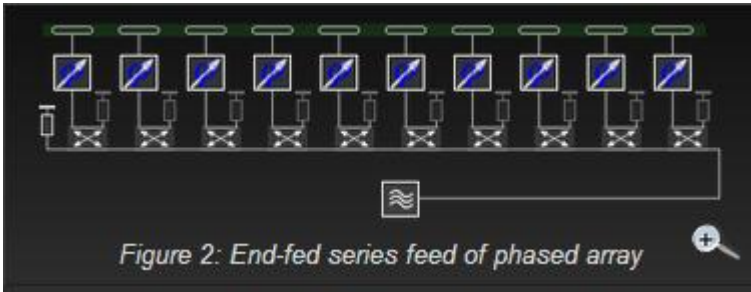


Figure 2: End-fed series feed of phased array

Series Feed

At the series feed of the phased-array antennae the radiator elements are in series and progressively farther and farther removed from the feed point. An end-fed series array is shown in Figure 2. A center-fed array can be considered as two end feeds. Series feed arrays are frequency-sensitive and lead to bandwidth restrictions. When the frequency is changed, the phase at the radiating elements changes proportionately to the length of feed line so that the phase at the aperture tilts in a linear manner and the beam is scanned. This effect can be useful for frequency-scanning arrays, but normally it is undesirable. The increased electrical path length to each radiating element has to be computed as a function of frequency and taken into account when adjusting the phase shifters.

Should a frequency change be carried out anyway the computer also must calculate the phase shifting newly (or most in the practice: it use another phase shift table).

Parallel feed of phased array

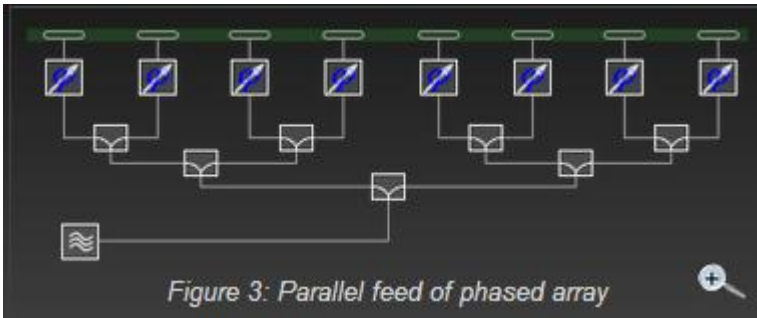


Figure 3: Parallel feed of phased array

Parallel feed of passive antenna

The transmit power is divided up in-phase at every power-divider at the shunt feed of the phased-array antennae. Every radiating element has an equal long feeding line and is provided therefore in-phase exactly.

Changes in frequency don't affect phase differences therefore. This has the advantage that the computer can ignore the length of the feeding lines at the calculation of the phase shifting. This is an advantage for the frequency agility of the radar set and a requirement for frequency diversity and pulse compression.

Transmission Type of Space Fed Phased-Array Antenna

The transmission type of space feeding: the primary radiator illuminates the antenna-field. This one works as a lens for the waves.

run-time difference

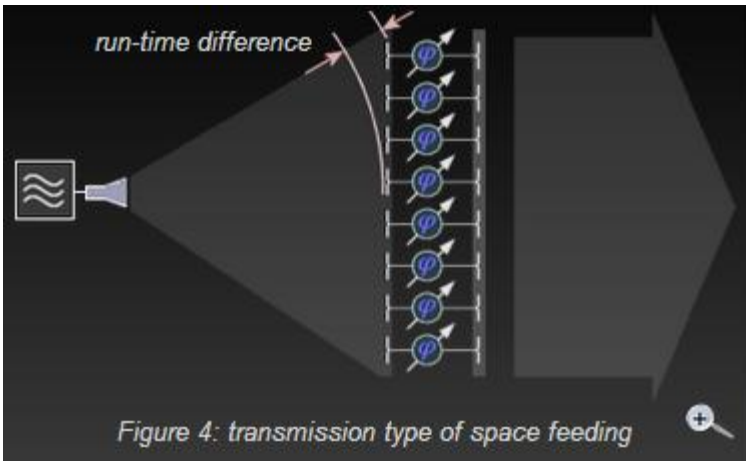


Figure 4: transmission type of space feeding

The space (optical) feed can be considered to be somewhat between a parallel feed and a center-fed series feed. Using a very long focal length, the space feed approximates a parallel feed. With a very short focal length it approximates a center-fed series feed, because there are essential differences in the path length from the feed horn to the individual antenna elements of the lens array. At a transmission type the primary feed is behind the lens array. The place behind the lens array is obstructed by the feeding field. For this the horn radiator doesn't make any shadow in the radiating field in front of the antenna.

The "Patriot" SAM- complex has got a transmission type of space fedded phased-array antenna.

Reflection Type of Space Fedded Phased-Array Antenna

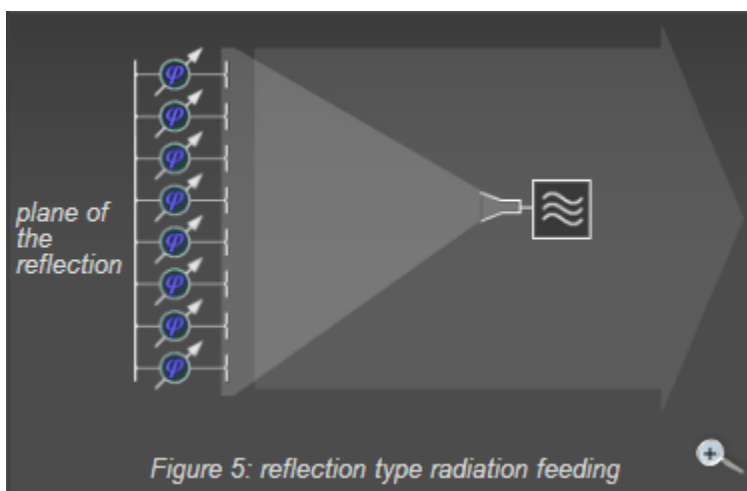


Figure 5: reflection type radiation feeding

At the reflection type behind the antenna is sufficient place to mount modules (E.g.: phase shifter controls and power supplies). Against this the horn radiator disturbs now. Exactly in the best ray direction he forms not only a shadow but he would take the reflected energy again, too. This then produces a standing wave in the feeding system!

But the horn feed already should liking lightly be in the center someplace, if this is not the case different propagation times appear to the radiator elements again.

Source: <http://www.radartutorial.eu/06.antennas/an15.en.html>