Next Generation EW Part 15

Upgrades to Acquisition Radars (cont'd)

By Dave Adamy

All of the Russian-made acquisition radars are being upgraded to meet the needs of the continuing upgrades to the missile systems. This month, we will discuss three typical modern Russian acquisition radars among the dozens of upgraded radars.

BIG BIRD

The 64N6E radar, with the NATO designation BIG BIRD (see **Figure 1**), is an S-band acquisition radar that is part of the S-300 surface-to-air missile system. Its antenna is a two-sided reflective phased array fed by two horn antennas with 2,700 phase elements on each side. The antenna rotates with a 12-second period and provides two hits on a target per rotation. It can track airborne targets from 20,000 meters down to 60 meters with target velocities up to 10,000 km/hr.

Figure 1: The BIG BIRD radar provides target acquisition for the Russian S-300 missile systems. This image is from a display at the MAKS 2005 Air Show. ALEXANDER SIGACHOV

Open literature states the BIG BIRD's operating frequency at about 2 GHz and the transmitter power to be 0.7 kW. It has a frequency modulated continuous wave (FMCW) modulation with frequency hopping.

From a graphic analysis of open-source pictures of the BIG BIRD radar, the size of the phased array is about 5.75 meters wide and 4.25 meters high. At 2 GHz, the 3-dB beam for an antenna with these dimensions is 2.5° high by 1.9° wide. Elsewhere in open literature, a beam width of 2° is estimated. These beam widths support a calculation of approximately 38 dBm boresight gain. With a 0.7 dB transmitter power, this would make the effective radiated power (ERP) approximately 97 dBm.

BIG BIRD has auxiliary antenna/receiver channels for side lobe suppression. Open literature states that it can provide direction of arrival information on jamming transmitters and has a moving target indicator (MTI) capability.

The target acquisition range of the radar is reported in open literature to be 149 km or 40 km for smaller targets with a maximum detection range of 200 km and a range accuracy of 1,200 meters.

Figure 2: The VOSTOK radar is claimed to have a 72-km range against the F-117 stealth fighter aircraft. The image above is a Vostok-E variant designed for the export market by Belorussian company, KB Radar. KB RADAR

VOSTOK

The VOSTOK E is a two dimensional radar (no elevation measurement) that is a replacement for the P-18 SPOON REST radar. Open literatures states that its operating frequency is 175 MHz. It operates via random frequency hopping across 50 channels, with the ability to skip jammed frequencies. It has three channels for jamming suppression, and is said to reject chaff by 25 to 30 dB. Its range error is stated at 25 meters, its angle error (this is in azimuth) is 1.1° and its velocity error is 1.8 m/sec. Its ability to determine the direction of arrival of jamming signals is said to be ± 1°.

The Vostok-E's antenna is shown in **Figure 2.** A dimensional analysis of this open-source photograph yields dimensions of 15 meters wide by 1.8 meters high. This radar is very consistent with the Russian "Shoot and Scoot" philosophy in that its stated set up and take down times are 6 minutes.

The acquisition range of this radar (again from open literature) is stated to be 255 km against a B-52, 133 km against an F-16 and 72 km against an F-117.

Figure 3: The Protivnik-GE is a multliband 3D radar. This example was displayed at the MAKS 2011 air show. VITALY KUZMIN

PROTIVNIK-GE

The PROTIVNIK-GE 59N6-E radar is an acquisition radar which is part of the S-400 system. It is designed to track aircraft and cruise missiles flying at all altitudes at ranges up to 200 km. This radar also supports interceptors and tracking of low-orbit satellites. The minimum tracking altitude is a function of range. For a 1.5 m^2 target, at 100 meters altitude, the range (stated in open literature) is 40 km; at 1 km altitude, it is 100 km; at 5 km altitude it is 240 km; and at 12 to 80 km altitude, it is 340 km.

From open literature, the radar's features include pulse compression, 10 redundant receiver channels, IFF and excellent side-lobe suppression. The close-in side lobes are stated as -40 dB and back lobes to -53 dB relative to the main beam boresight gain. The transmitter has 500 kW peak power and 12 kW average power.

The 8.5 x 5.5-meter array (shown in **Figure 3**) is mechanically steered in azimuth and electronically steered in elevation. It can provide up to 20 pencil beams. The tracking accuracy is 0.2° in azimuth, 0.17° in elevation and 50 to 100 meters in range. One variation has an active electronically steered array (AESA) capability to steer and track with agile beams. The system has a 22-meter elevation mast.

WHAT'S NEXT

Next month, we will start a new series to discuss the jamming approaches required to counter the new-generation radars we have been talking about during the last several months. For your comments and suggestions, Dave Adamy can be reached at dave@lynxpub.com.