# Attachment 2

**Array Description**
The CISS Antenna Module consists of the Antenna Array, Switched Beam Forming Network (SBFN), matching network, self test network, and interface. The vertically polarized directional/omnidirectional Antenna Array consists of four folded monopoles with capacitive hats, feeding posts, shorting posts arranged in a circular pattern every 90 degrees. The SBFN includes 4 x 4 hybrid matrix with four 90-degree hybrids, four invertors, and 180-degree switched-line phase shifter. The matching network provides matching between the antenna monopoles and SBFN inputs/outputs. The self test network includes the shunt grounded resistors electrically coupled to input/output SBFN terminals and used to control right connection of four cables to four input/output terminals. The directional mode is provided by the alternate activation of one input port J1, J2, J3 or J4 of the SBFN with phase shifter at 0 deg and identical amplitudes of the four antenna monopoles. Each of the four antenna module SBFN input corresponds to a beam in one of the four cardinal directions: front, right, aft,left. The omnidirectional mode is provided by activation of the one port (J2 or J4) with phase shifter at 180 deg, progressive 90 deg phase shift (0 – 90 – 180 – 270 deg) at antenna monopoles, and identical amplitudes of the four monopoles.

**1030 MHz Directional Gain TCAS Transmit**
Antenna gain at each sector center at 1030 MHz shall be +1.0 dB minimum, and +3.0 dB maximum, at elevation angles from -15 to +20 degrees. At elevations greater than +20 degrees through to +30 degrees, the antenna gain shall be 0 dB minimum.

**1030 MHz Directional Beamwidth TCAS Transmit**
The 3 dB beamwidth of each sector beam shall be greater-than-or-equal to 90 degrees and less-than-or-equal to 100 degrees at elevation angles from -15 to +30 degrees. Supplier will use best endeavors within the contract timescale to achieve the above at elevations from +21 to +30 degrees and to achieve 3 dB beamwidths >= 90 deg and <= 100 deg for elevations from -15 to +30 degrees. Supplier will, however, guarantee: At the sector center +/- 50 degrees, the antenna gain shall be <= -3 dB with respect to the gain at the peak of the beam. At the sector center +/- 45 degrees the antenna gain shall be >= -4 dB with respect to the gain at the peak of the beam at any elevation from -15 to +20 degrees.

**1030 MHz Directional Side/Back Lobe Gain TCAS Transmit**
The difference between peak beam gain and gain of the strongest side/back lobe shall be greater-than-or-equal-to 8 dB for each of the 4 beam sectors at elevation angles from -15 to +20 degrees.

**1090 MHz Directional Gain TCAS Receive**
Antenna gain at each sector center at 1087, 1090, and 1093 MHz shall be +1 dB minimum at elevation angles from -15 to +20 degrees. For the 1090 MHz directional beam pattern, the gain measured at azimuths +/- 90 degrees from

sector center shall be no more than 16 dB down from the gain measured at sector center for elevation angles of -15 to +20 degrees. Variation between sector gains shall not differ by more than +/- 0.4 dB.

**1090 MHz Directional Side/Back Lobe Gain TCAS Receive**
The difference between peak beam gain and gain of the strongest side/back lobe shall be greater-than-or-equal-to TBA (to be agreed) dB for each of the 4 beam sectors at elevation angles from -15 to +20 degrees.

**1090 MHz Directional Beamwidth TCAS Receive**
The gain at the crossover points (where adjacent beams overlap) shall not be less than the adjacent peak-of-beam gain minus 4 dB from -15 to +20 degrees. The difference between the antenna gain at sector center and the antenna gain at +/- 45 degrees from sector center shall be less-than-or-equal-to 4 dB at elevation angles from -15 to +20 degrees. The 1090 MHz directional beam pattern shall be monotonic over +/- 90 degrees from sector center over -15 to +20 degrees elevation.

**1030 MHz Omnidirectional Gain TCAS Transmit**
Omni signal gain at 1030 MHz +/- 10 kHz shall be no less than 2.01 dB below a matched quarter wave monopole over 90% of a coverage volume from 0 to 360 deg in azimuth and from -15 to +20 deg in elevation. Supplier will use best endeavors within the contract timescale to achieve 1.0 dB. Ripples in the gain pattern shall be no greater than 2.0 dB (+/-1.0 dB).