Ranger™ – An Affordable, Advanced, Next-Generation Dual-Pol X-Band Doppler Weather Radar

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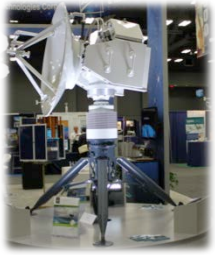
Overview

The Enterprise Electronics Corporation (EEC) Ranger™ radar system is a new generation, X-band (3 cm), lightweight (~200kg), low power Adaptive Polarization Doppler Weather Surveillance Radar that fills the gap between high-cost, high-power traditional C and S-Band radar systems and passive ground station weather sensors. The system uses relatively low power (100W or 500W) solid-state transmitters and pulse compression technology to attain nearly the same performance capabilities of much more expensive traditional radar systems. Ranger™ employs Adaptive Dual Polarization techniques to allow Alternating or Simultaneous Dual Polarization capability with total control over the transmission polarization state using dual independent coherent transmitters.

Ranger™ was developed in partnership with the University of Oklahoma (OU) Advanced Radar Research Center. Ranger™ has been designed using the very latest technology available in the industry, and the technical and manufacturing experience gained through over four decades of successful radar system design and production at EEC.

Ranger™ configurations include the X1 (100W transmitters) and X5 (500W transmitters) with either a 1.0m or 2.44m antenna (radome not required on the 1.0m configuration).

Ranger-X1™ System (100W, 1.0m Antenna)



Ranger-X1™ in Tactical Tripod Configuration

System Specifications

SYSTEM	RANGER X1	RANGER X5
Operating Frequency	9200-9700	9200-9700
Pulse Width	0.4-100.0 usec	0.4-100.0 usec
Pulse Repetition Frequency	100-2500 PRF	100-2500 PRF
Transmitter Output Power	100 Watts	500 Watts
Maximum Velocity (unambiguous)	64 m/s	64 m/s
Sensitivity-reflectivity	18dBz at 50km	18dBz at 120km
Data Output	UZ (NVL), Z (NVL), V, SW, Zdr, Phv, dbdp, KDP, LDR	UZ (NVL), Z (NVL), V, SW, Zdr, Phv, dbdp, KDP, LDR
Max. Sustained Wind Performance	85kts / 120km/hr	85kts / 120km/hr
Max. Wind Gust Performance	78kts /144km/hr	78kts / 144km/hr
Max Wind Survival	130kts / 240km/hr	130kts / 240km/hr
Max Operating Temperature	60° C (140° F)	60° C (140° F)
ANTENNA/PEDESTAL	**1m / 3.44m**	**1m / 3.44m**
Type	Parabolic, Prime Focus Reflector	Parabolic, Prime Focus Reflector	Parabolic, Prime Focus Reflector	Parabolic, Prime Focus Reflector
Gain-Minimum	≥ 37.3 dB	≥ 45.0 dB	≥ 37.3 dB	≥ 45.0 dB
Half Power Beam Width (typical)	≤ 2.3°	≤ 0.95°	≤ 2.3°	≤ 0.95°
Polarization	Dual Polarization Orthogonal Feed (Simultaneous H + V)	Dual Polarization Orthogonal Feed (Simultaneous H + V)	Dual Polarization Orthogonal Feed (Simultaneous H + V)	Dual Polarization Orthogonal Feed (Simultaneous H + V)
Transportability	supports land, sea, and air deployment environments		supports land, sea, and air deployment environments	
Mounting Configurations	guyed pole, tower, vehicle, skid, trailer or conventional fixed installation		guyed pole, tower, vehicle, skid, trailer or conventional fixed installation	
Max Az & El Torque	360 ft-lbs (477 Nm)		360 ft-lbs (477 Nm)	
Continuous Az & El Torque	92 ft-lbs (125 Nm)		92 ft-lbs (125 Nm)	
Antenna/Pedestal System Weight	170kg (375 lbs)		170kg (375 lbs)	
Angle Span (azimuth)	Continuous 360°		Continuous 360°	
Angle Span (elevation)	-12° to +109°		-12° to +109°	
Positioning Accuracy	≤ 0.05°		≤ 0.05°	
Scanning Speed	0 to 8 rpm		0 to 8 rpm	
Drive and Bearing Continuous Service Life	≥ 10 years with no maintenance or lubrication required		≥ 10 years with no maintenance or lubrication required	
TRANSMITTER				
Type	Solid State		Solid State	
Peak Power (per channel/total)	100 Watts/200 Watts 2 Transmitters (H/V)		500 Watts*/1000 Watts 2 Transmitters (H/V)	
RECEIVER				
Type	Frequency Programmable		Frequency Programmable	
Minimum Discernible Signal	-114 dBm typical		-114 dBm typical	
Linear Dynamic Range	≥ 95 dB		≥ 95 dB	

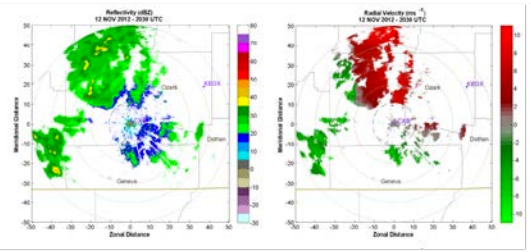
System Applications

Ranger™ is a lightweight, low cost, high performance system designed for tactical grade deployments on a wide variety of fixed and mobile platforms. This densely packed system provides stability, stiffness, position accuracy and raw power directly coupled to the payload, making it ideal for such applications as:

- Gap Filling
- Oil Platforms/Shipboard Operations
- Small Airport/Airfield
- Military Deployments
- Hydrology/Water Resource Management
- Emergency Response
- Outdoor Events/Venues
- Storm Chasing
- Research

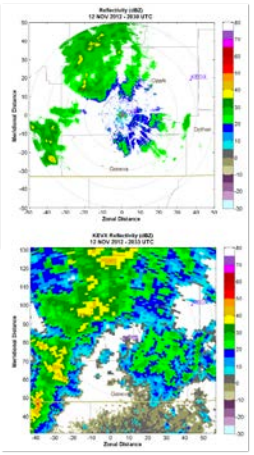
Sample Data Sets

The images displayed below were taken during a rainfall event in Enterprise, AL. Although some beam blockage is seen to the WNW of the radar due to a nearby tower, moderate rain is still visible well beyond 50km from the Ranger™ system (Isom, 2013).



Above Left Two Panels: Calibrated Reflectivity & Radial Velocity data from a rain event near Enterprise, AL. A windowed LFM long pulse was used in conjunction with a 2-μs fill pulse as a TFM waveform. The dashed circle near the center of the display denote the transition between the blind zone and the long pulse region. Subsequent range rings are shown every 10 km. Reflectivity is censored for 3-dB SNR (Isom, 2013).

A comparison between Ranger™ & the nearby KEVX WSR-88D radar shows good agreement between both systems. A portion of the KEVX viewable area is filled with light rain (<15 dBz), which is not detected by the much lower power Ranger™. However, Ranger™ was able to detect moderate rain at ranges exceeding 50 km. (Isom, 2013). The resolution of the Ranger™ data is also far superior to that of the KEVX radar, allowing users to pinpoint embedded areas of more intense rainfall, which are quite pixilated in the KEVX data.



Above, Stacked: Comparison between Ranger™ & a nearby WSR-88D radar (KEVX). Good agreement is observed between the two radars, though much of the light rain (<15 dBZ) is not detected by the X-band system

CASA Project

EEC, in cooperation with OU and the University of Massachusetts, will be delivering two Ranger™ systems to the Collaborative Adaptive Sensing of the Atmosphere (CASA) Project early this year. These units will represent the 4th & 5th operational, low-cost, Doppler X-Band systems to be installed within the CASA network. The units will provide critical data to CASA researchers in their pursuit to study the feasibility of installing and operating a network of X-Band radars as gap-fillers.

A Ranger-X1™ unit for CASA undergoing final testing the the EEC factory

Sources

Isom, B., J. Helvin, M. Jones, and M. Knight (2013). *A New Compact Polarimetric Solid-State X-Band Radar: System Description and Performance Analysis.* Paper Presented at the 93rd American Meteorological Society Annual Meeting: 29th Conference on Environmental Information Processing Technologies, Austin, TX, 9 January (pp. 1-9).