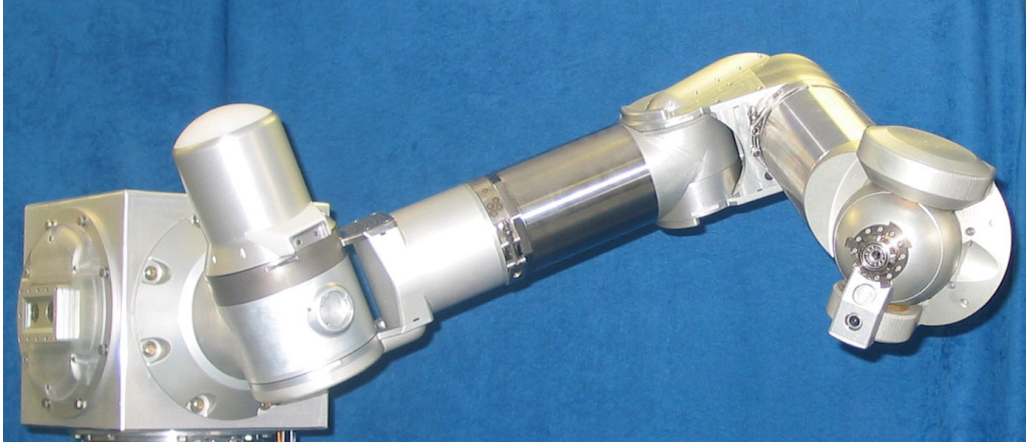


# Ranger Dexterous Manipulator Specifications



## General Description

Maximum reach (mounting plate to IEEM)	135 cm (53 in)
Linkage diameter	13.6 cm (5.375 in)
Mass	
in air	77 kg (170 lbm)
in freshwater	54 kg (120 lbm)
Degrees of freedom	8 revolute joints (R-P-R-P-R-P-Y-R) 2 tool drives (fast/slow)
End-effectors (interchangeable)	4
Bare bolt drive (7/16"-socket) torque	41 N-m (30 ft-lbf)
Right angle drive (7/16"-socket) torque	41 N-m (30 ft-lbf)
Parallel jaw gripper (with interchangeable fingers)	
Nominal grip force	311 N (70 lbf)
Maximum gripper opening	12.7 cm (5 in)
Microconical end-effector torque	41 N-m (30 ft-lbf)
Design ambient temperature range	-40°C to +150°C (mechanical) -40°C to +85°C (electrical)
Primary construction material	Al 6061 (arm); Al 7075, Ti 6AL-4V (wrist)
Operating environment	1-g, underwater, vacuum

## Mechanical Specifications

Speed	
Maximum velocity (at IEEM)	1 m/s (40 in/s)
Tool rotation	10 rpm
Tool rate	10 rpm (slow tool drive) 1500 rpm (fast tool drive)
Force	
Maximum lift at full extension (1-g)	133 N (30 lbf)
Maximum lift in "working" configuration	267 N (60 lbf)
Nominal wrist torque	50 N-m (30 ft-lbf)
Nominal grip force	311 N (70 lbf)

### Joint/Drive Train

	<u>Gear Ratio</u>	<u>Range of Travel</u>	<u>Torque (at output)</u>
Shoulder roll	101:1	576°	163 N-m (120 ft-lbf)
Shoulder pitch	101:1	225°	163 N-m (120 ft-lbf)
Elbow roll	101:1	576°	81 N-m (60 ft-lbf)
Elbow pitch	101:1	180°	81 N-m (60 ft-lbf)
Wrist roll	61:1	576°	54 N-m (40 ft-lbf)
Wrist pitch	120:1	540°	41 N-m (30 ft-lbf)
Wrist yaw	120:1	200°	41 N-m (30 ft-lbf)
Hand (tool) roll	120:1	unlimited	41 N-m (30 ft-lbf)
Slow tool drive	120:1	unlimited	41 N-m (30 ft-lbf)
Fast tool drive	1:1	unlimited	1.4 N-m (1 ft-lbf)

## Electrical/Telemetry Specifications

Control power	20-40 VDC (50W)
nominal	2 amps
maximum	3 amps
Actuator power	20-90 VDC, < 50 amps
1-g, spaceflight	48 V
underwater	32 V
Data Management System (DMS) power	40 W
Connection between local processing units and DMS	MIL-STD-1553B
Connection between DMS and control station communication bus	Ethernet
Communication protocol	TCP/UDP IP

## Pressurization System

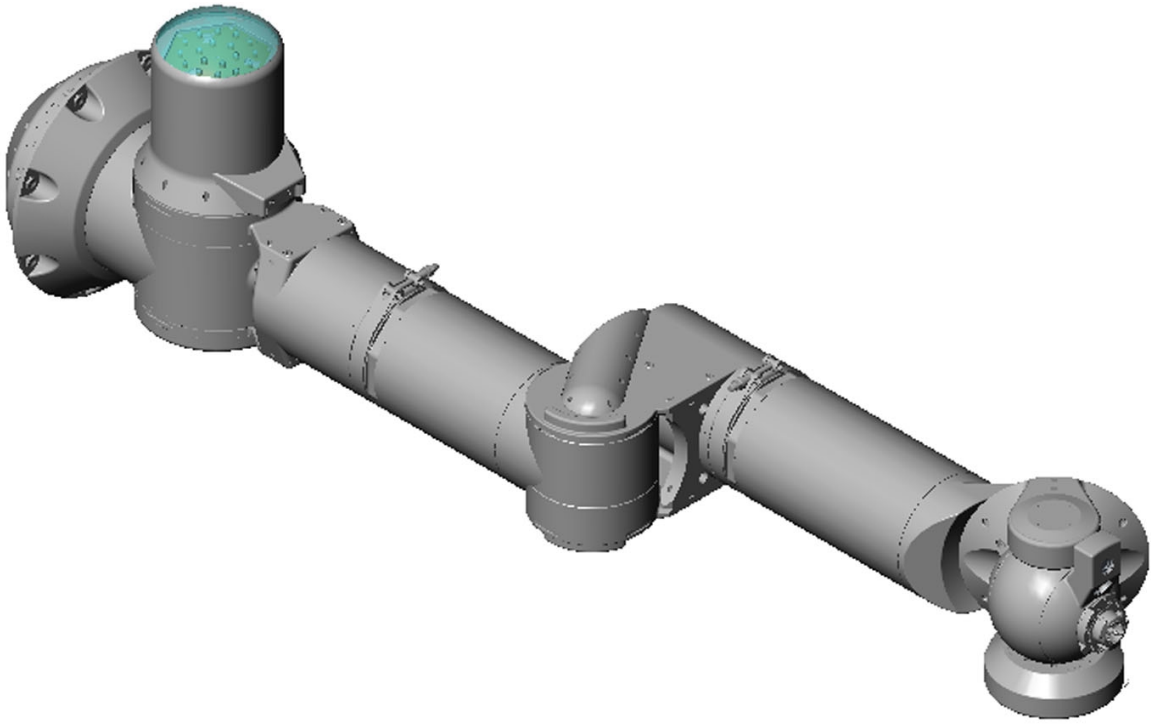
Depth rating	
minimum	vacuum
nominal	7.6-12.2 m (25-40 ft)
maximum	167.6 m (550 ft)
Surface supply pressure	
nominal	862 kPa (125 psi)
maximum	2068 kPa (300 psi)
Internal pressurization	27.5 kPa (4 psig)
Air flow	
nominal	85 lpm (3 cfm)
maximum	283 lpm (10 cfm)

## Sensors

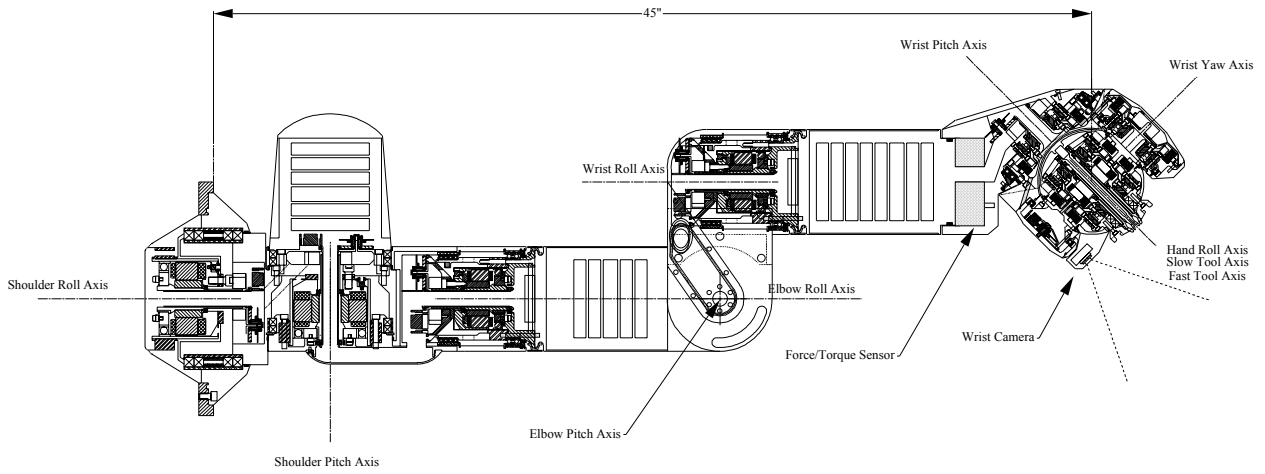
Absolute encoder (first 7 joints; geared 0.5-1.6:1)	1024 lines/rev
Incremental encoder (optical, reflectance)	
shoulder	680 lines/rev
elbow, wrist (roll)	515 lines/rev
wrist (pitch,yaw), hand (roll)	480 lines/rev
Motor Commutation	
wrist (pitch,yaw), hand (roll), tool (slow)	14 poles
shoulder, elbow, wrist (roll), tool (fast)	12 poles
Current (motor and electronics)	0-10 amps
Temperature (motor and electronics)	-40°C to +155°C
Wrist force/torque sensor	
maximum force (radial)	667 N (150 lbf)
maximum force (axial)	1334 N (300 lbf)
maximum torque	75.7 N-m (670 in-lbf)
force resolution	0.44 N (0.1 lbf)
torque resolution	0.056 N-m (0.5 in-lbf)
Wrist camera	
lens	4 mm lens
resolution	250k pixels, 350 lines
view	45° horizontal, 34° vertical
minimum light	5 lux

## Lighting

Laser indicator	670 nm, 3 mW @ 1 m
Wrist LED (white)	3300 mcd

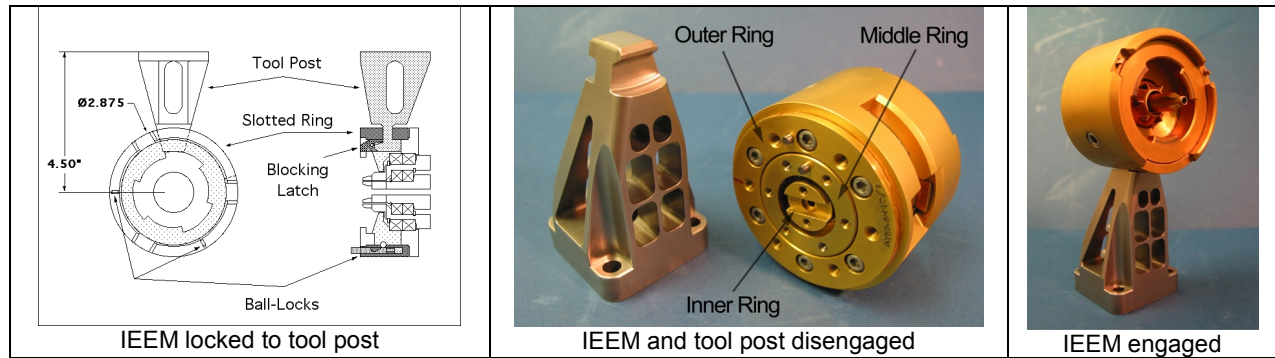


Three-Dimensional View

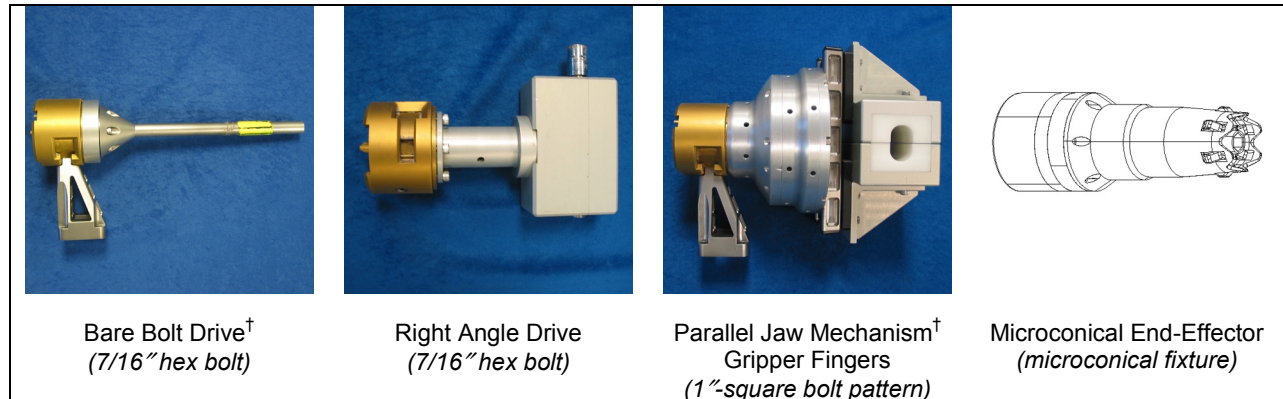


Cross Sectional View

## Interchangeable End-Effector Mechanism (IEEM):

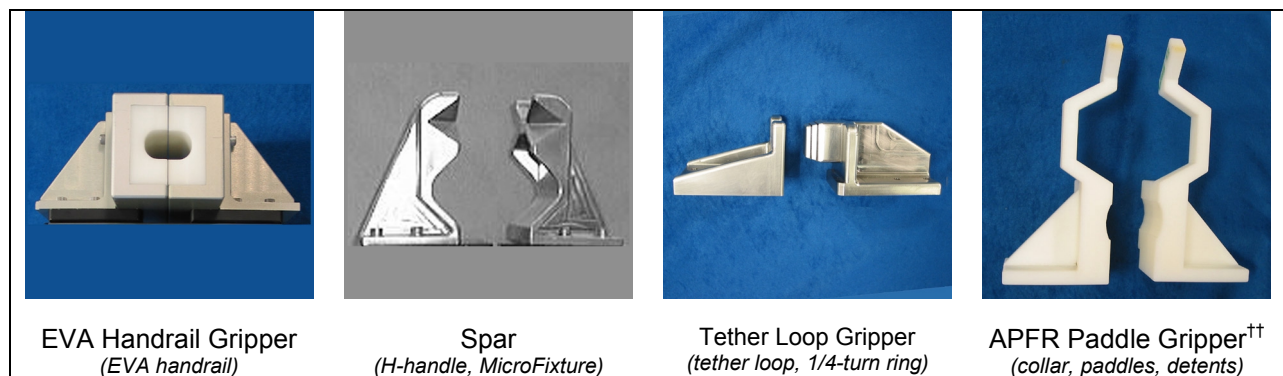


## End Effectors:



<sup>†</sup> shown with tool post attached

## Parallel Jaw Mechanism Gripper Fingers:



<sup>††</sup> rapid-prototyped



For more information, please contact:

Dr. David L. Akin  
 University of Maryland  
 Building 382, NBRF  
 College Park, MD 20742  
 (301) 405-1138 (voice)  
 e-mail: [dakin@ssl.umd.edu](mailto:dakin@ssl.umd.edu)

Space Systems Laboratory  
 University of Maryland  
<http://www.ssl.umd.edu/>