

PREDATOR

Force Feedback Manipulator



Features

- Strong – Rugged heavy duty construction
- Large operating envelope – Over 79 inches of reach
- Powerful – 500 lbs of maximum lift, 200 lbs at full extension
- High Dexterity – 200 degrees of wrist pitch & yaw motion
- Integral control valves – No separate valve package and hose bundle
- Intuitive master/slave control with high fidelity force feedback



Kraft TeleRobotics

Performance in Motion™

Technology to Extend Your Reach

Predator is a 7-function, hydraulically powered manipulator for use in both deep ocean and hazardous inland environments. Widely regarded as a leading example of state-of-the-art manipulator technology, Predator delivers unparalleled controllability and responsiveness to operator commands. With over 79 inches of reach and a lift capacity of 500 lbs, Predator delivers powerful manipulator performance in a streamlined, integrated package.

Intuitive master/slave control allows even an inexperienced operator to perform work tasks with human like motion and speed. Force feedback dramatically improves operator awareness and allows the operator to perform tasks more quickly and perform tasks of much greater complexity. In addition to improved telepresence, the compliant nature of a force feedback system greatly reduces the risk of accidental damage to both the work site and the manipulator arm.

Predator is the beneficiary of over 25 years of manipulator system development and manufacturing experience. Predator is a mature product combining field proven technology with simplicity of design. With an emphasis on overall system reliability and field serviceability, the Predator manipulator arm incorporates fewer components and is less complicated than any other manipulator in its class. By design Kraft manipulator arms minimize overall cost of ownership.

Kraft force feedback manipulator arms have achieved a remarkable track record by demonstrating exceptional performance and reliability in demanding undersea, nuclear, aerospace, electric utility, and military applications worldwide. When ease of operation and productivity at the work site are important, Predator offers outstanding performance.



Predator is capable of completing a wide variety of complex tasks in unstructured environments.

Meeting The Challenge

Predator force feedback manipulator arms are used to perform a wide variety of tasks in undersea and terrestrial environments. In applications where reach and physical strength are important Predator excels. When work must be completed in a timely manner, and with little risk of damage to the work site, the advantages provided by a high dexterity force feedback manipulator are significant.

Dual Predator force feedback manipulator arms on an undersea ROV used for maintenance and burial of subsea telecommunication cables.

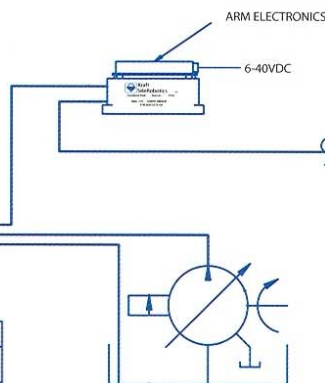
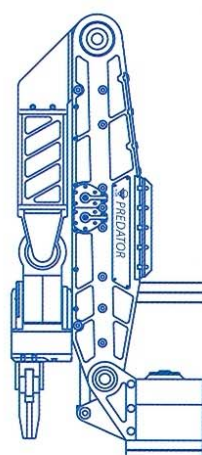


Predator's close-coupled wrist with 200 degrees of pitch and yaw motion provides high dexterity where its needed most. A high efficiency piston motor delivers "smooth" wrist roll torque, even at fractional RPM. Kraft's unique method of controlling the gripper allows the operator to proportionally vary the rate of jaw closure, and the amount of grip force.

Predator is available with either parallel acting, or four fingered intermeshing jaws. Both jaw configurations can grip 3/4" diameter T-handles.

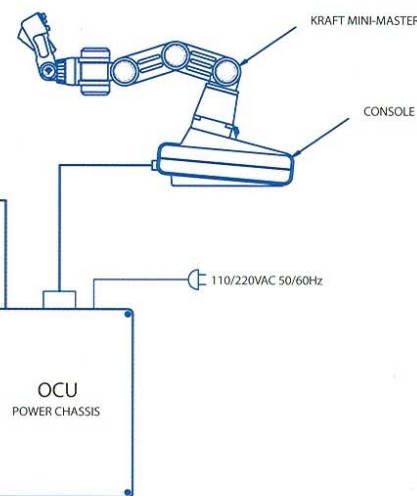
REMOTE MANIPULATOR ARM

Predator requires only one electrical connection and a pressure & return hydraulic connection. All valves are packaged as an integral part of the manipulator arm, eliminating the cumbersome hydraulic lines that would be necessary with a remote valve package. A square, four-bolt flange makes mounting the arm simple.

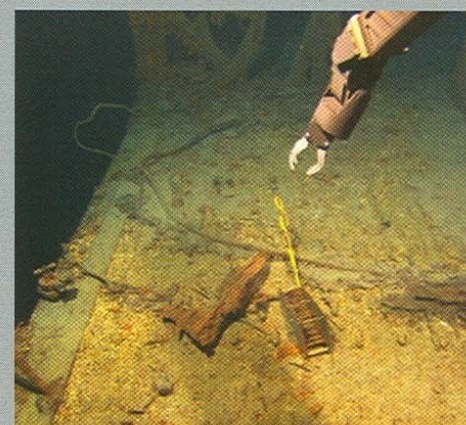


HYDRAULIC POWER UNIT
(CUSTOMER FURNISHED)

OPERATOR CONTROL UNIT



Predator on the Institute For Exploration (IFE) deep diving ROV "Hercules". During Bob Ballard's "Return to Titanic" expedition, the Predator arm on Hercules recovered a steel test sample from the port side bow section of the RMS Titanic in 12,000 FSW. The test sample was placed on the bow as part of an experiment to determine rusticle growth rate.



Innovation In Control Technology



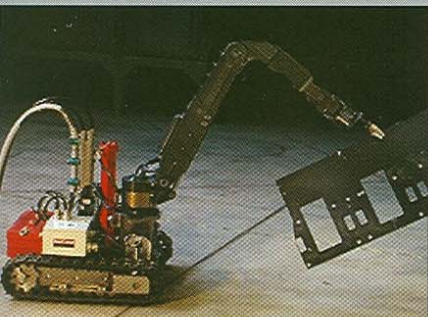
As the vital link between the remote manipulator and the human operator, the Kraft force feedback mini-master® allows the operator to control complex manipulator motions in a comfortable and intuitive manner. Electric actuators on the individual joints of the master respond to the forces acting upon the manipulator arm, providing force feedback to the operator. Conveniently located switches on the master provide the operator with direct access to core manipulator functions for faster arm operation. The mini-master® is designed for comfortable left-hand or right-hand operation.

In its standard configuration the mini-master® is mounted to a compact, portable, operator control unit that can be placed on nearly any surface for operation. A color liquid crystal display allows the operator to view system information and menus. Pushbutton keys surrounding the display allow the operator to select various operating options.

KMC 770 Advanced Operating System

The KMC 770 control system offers many standard features which enhance system performance and ease of operation. **These features include:**

- **One button indexing** – the ability to offset master position relative to the manipulator for operator comfort.
- **Power alignment** – allows the operator to realign the master with the manipulator after indexing. When initiated, the master controller will move into alignment with the manipulator under its own power.
- **Joint lock** – used to selectively lock one or more axes of the manipulator so that motion at the master has no effect on the locked axis.
- **Joint scaling** – the ability to alter the ratio of master arm movement to manipulator arm movement. Scaling can be established for each joint individually.
- **Joint limits** – the ability to establish individual joint motion limits to prevent arm impact with peripheral equipment.
- **Proportional control of grip force** – greatly enhances manipulator performance and is far superior to conventional rate or position control.
- **Auto stow/deploy** – allows the operator to automatically stow or deploy the manipulator using a previously programmed routine.
- **Robotic operation** – provides the ability to teach the manipulator a routine or sequence and permanently save it for execution at a later time.
- **System diagnostics** – provides comprehensive tools for evaluating and troubleshooting the system.

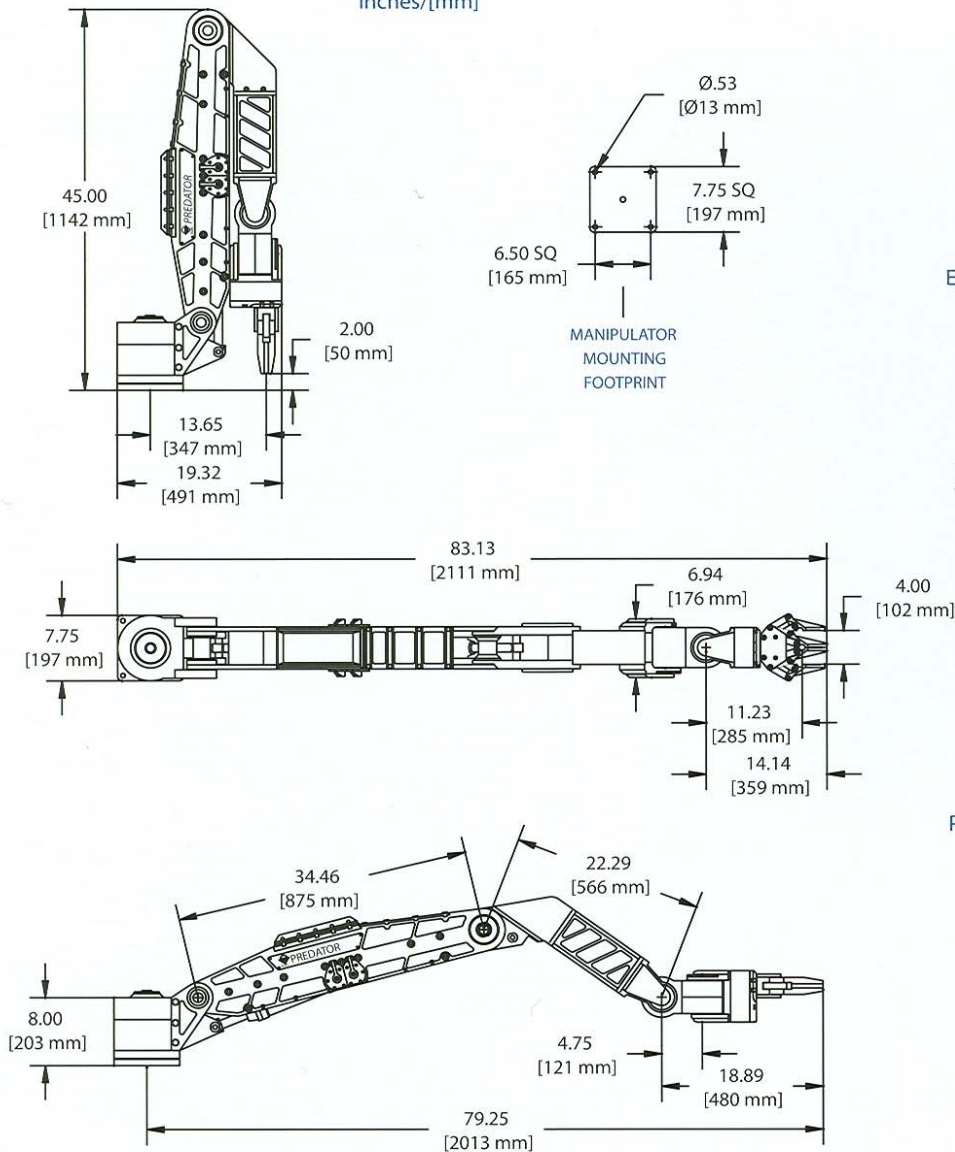


Predator manipulator arms are used in the decommissioning of nuclear facilities world wide. A Predator arm on the RedZone vehicle "Houdini", is used to perform a wide variety of decommissioning tasks in hot cells.

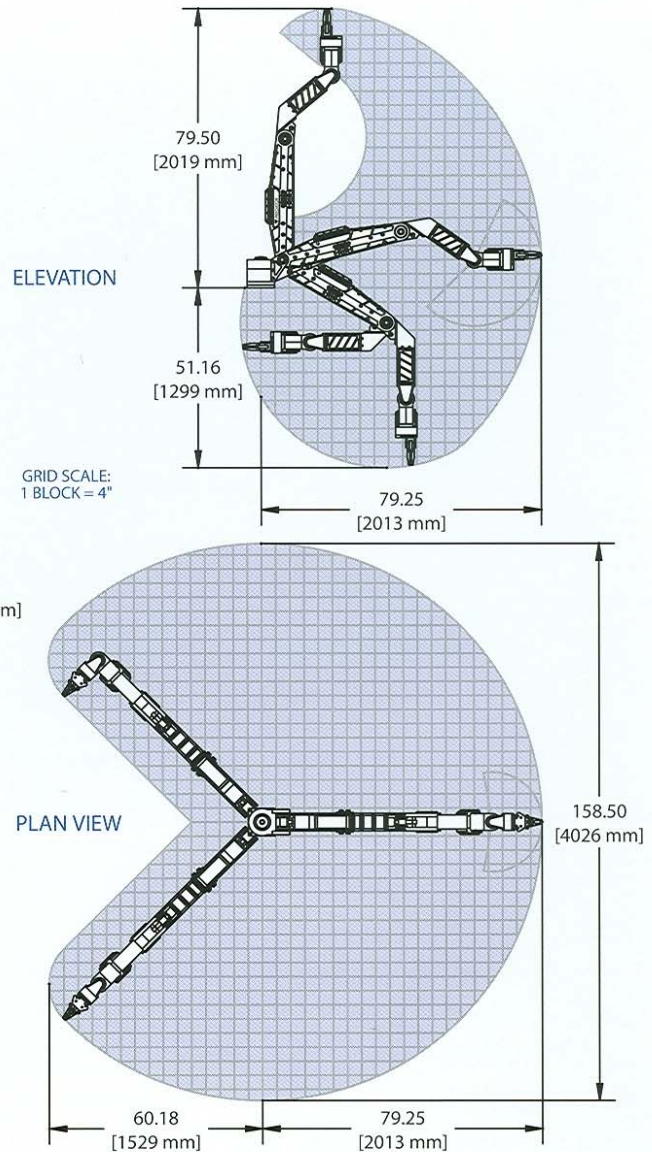
US Air Force "ARTS" vehicle, equipped with both a Kraft Grips and Predator force feedback manipulator arm for the remote handling of unexploded ordnance.



OUTLINE DRAWING
Inches/[mm]



PERFORMANCE ENVELOPE



Predator Arm Specifications

Manipulator Type	Hydraulically powered 7-function
Construction	Anodized aluminum & stainless steel
Horizontal Reach	79.25" (2013 mm)
Vertical Reach	79.50" (2019 mm)
Stowed Height	45" (1142 mm)
Maximum Lift Capacity	500 lbs (227 kg)
Lift Capacity at Full Extension	200 lbs (91 kg)
Wrist Rotate Torque	1200 in-lbs (135 Nm)
Grip Closure Force (controllable)	0-300 lbf (1334 N)
Degrees Freedom-Of-Motion	6 plus gripper
Maximum	Shoulder Azimuth 270 degrees
	Shoulder Elevation 120 degrees
	Elbow Pivot 125 degrees
Range	Wrist Pitch 200 degrees
	Wrist Yaw 200 degrees
Of	Wrist Rotate (slaved mode) 340 degrees
	Wrist Rotate (continuous) 0-40 rpm
Motion	Jaw Opening (parallel acting) 4" (100 mm)
	Jaw Opening (intermeshing) 8.75" (220 mm)
Weight In Air	175 lbs (80 kg)
Weight In Seawater	112 lbs (51 kg)
Operating Depth, Standard	10,000 fsw (3000 msw)
Operating Depth, Extended	21,000 fsw (6500 msw)
Hydraulic Power Requirements:	
Operating Pressure	1500-3000 psi (104-207 bar)
Flow Rate	5 gpm (19 lpm)
Filtration	25 micron absolute
Hydraulic Fluid Type	Petroleum / Mineral based oils Shell Tellus® 32 (or equivalent) MIL-H-5606 NATO Code H-515 Fire resistant Quaker Quintolubric® 822

KMC 770 Control System Specifications

Mode of Operation	Position control with force feedback
Operator Control Unit (OCU)	Portable console with color display, multi-function keys, and mini-master®
Dimensions (LxWxH)	15.75"x 8"x3.75" (400x203x95 mm)
Weight	11.5 lbs (5.2 kg)
Power Requirements	Powered by OCU power chassis
Ambient Temperature	Operating 0°C to +55°C Storage -25°C to +70°C
Humidity	95%RH max (non condensing)
OCU Power Chassis	Aluminum enclosure with On/Off switch and LED power indicator
Dimensions (LxWxH)	15.87"x12.25"x5.62" (403x311x143 mm)
Weight	35 lbs (16 kg)
Power Requirements	Auto select 110/220VAC 50/60Hz 375W max, 180W typical
Optional	24VDC 265W max, 130W typical
Ambient Temperature	Operating -20°C to +55°C Storage -40°C to +85°C
Humidity	95%RH max (non condensing)
KMC 770 Servo Driver	Module, provides all necessary power, command and telemetry for the arm
Dimensions (LxWxH)	5"x4.25"x2.46" (127x108x62 mm)
Weight	1.4 lbs (0.64 kg)
Power Requirements	6-40VDC 30 Watts
Ambient Temperature	Operating -20°C to +70°C Storage -20°C to +85°C
Humidity	95%RH max (non condensing)
Telemetry	
Standard	RS-232, RS-422/485, Ethernet
Optional	Fiber Optic, (single mode / multimode) RF (digital spread spectrum)



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