CURTISS WRIGHT
Flow Control Company
INDAL Technologies

AIRCRAFT HANDLER TYPE

MANTIS

TECHNICAL SPECIFICATION

INDAL Technologies
3570 Hawkestone Road
Mississauga, Ontario
L5C 2V8
Canada

Phone: 905-275-5300
Toll free US/Canada: 800-263-7340
Fax: 905-273-7004
Email: sales@indaltech.com

Aircraft Handler Type MANTIS

Dimensions:

Length overall	1780 mm
Width	2560 mm
Height (over drive wheels)	350 mm
Height (over central portion)	215 mm
Wheelbase	1362 mm
Track (Drive)	1718 mm
Ground clearance	70 mm

Weight:	1950 kg
Weight (less batteries)	1650 kg

Performance:

Tractive effort		max – 6 KN - Optional 14 KN
Speed		0 to 5.5 km/hr
Turning circle		2.4 m
Centre Point Steer		0 m about the CL of matrix
Duration of batteries	Examples:	Moving an aircraft of 18,000 kg at least 7,000 metres including nose wheel pick-ups and set-downs **OR** 5 hours continuous movement with a 11,000kg aircraft

Traction motors:	x2 1.2 KW Separately Excited D.C. Motor

Batteries:

24 off 2V Lead Acid Full Traction battery packs giving total 210Ah (C_5)

Type	6 EPzB or approved equivalent
Size (Each 2 V Cell)	110 mm x 158 mm x 289.5 mm
Weight (Each 2 V Cell)	12 kg

Charging Unit	High Frequency Transformer, Primary 96 to 260 VAC input.

Hydraulic System:

Tank capacity	4.5 l
Hydraulic pump displacement	4.5 l per rev/min
Pump/motor unit	Bosch 0541 300 032
Hydraulic Pressure (Main system and lift pressure)	175 bar
Pin Clamp pressure: Normal	125 bar
Clamp Release Pressure	100 bar
Aircraft to Handler Interface	**M**ulti **A**ircraft **M**atrix **A**cquisition **S**ystem MANTIS (patents pending)

Wheels & Tyres:

Driving,
x 2 - Solid Polyurethane – Special high traction 'deck friendly' – 'designed for purpose' low shore hardness compound - 270 mm ϕ x 185mm Wide

x 2 - Solid Polyurethane – Special high traction 'deck friendly' – 'designed for purpose' low shore hardness compound - 210 mm ϕ x 70mm Wide

Illumination

x4 High intensity red LEDs for night illumination
x3 Emergency stop switches illuminated whilst the vehicle is in run mode
Operators controls are backlit for night operations.

Optional upgrade to night vision compatible lights (NVG)

The equipment discussed covers a tractive device for manoeuvring aircraft, including helicopters, in or out of hangars, on board ship, on the apron or any location having a hard standing.

equipment to be utilised on decks above the water line in modern Naval vessels where equipment mass has become an increasingly significant consideration. Equally essential is the advantage gained when the equipment is air transported.

Although the equipment is lightweight it is also specifically designed to be extremely tough and with a wide envelope of survivability in the harsh maritime condition in which it is to operate.

The Universal Handler utilises a range of proven technology brought together in an innovative (patent pending) combination to achieve a genuine tri-force - multi-role Aircraft Handler for today's multi-platform vessels.

GENERAL DESCRIPTION ~ MECHANICAL HANDLER RAM UNIVERSAL

This is a battery powered pedestrian controlled vehicle capable of moving a wide range of aircraft types, extending from lightweight very low ground clearance helicopters such as the Lynx Mk8 fitted with its chin-mounted radome right through to F16 , F22 and Sikorsky MH60-R.

The design incorporates clearance and lifting capacity for all current and envisaged aircraft within its payload range.

The listing shown on page 17 indicates the total compatibility of the Universal Handler system with widely differing aircraft types from a wide range of manufacturers in a wide range of countries from lightweight fixed wing trainers and helicopters to the new generation heavy fighter aircraft.

The Handler is steered by a remote console connected to the Handler via a coiled steel wired armoured cable of 6 meters length (extended). This enables the operator to view the aircraft and handler from the safest position whilst giving the best visibility. The Handler can be positioned, engaged and disengaged from the aircraft by the operator remotely.

Operating Procedures

1.0 The operator identifies the aircraft type to be moved, and selects the aircraft type on the remote chest pack console. (This sets the maximum tractive effort within strict parameters laid down by the aircraft manufacturer for the particular aircraft)

2.0 Select an appropriate set of tow pin adaptors from their stowage location on the handler and insert into the towing attachment points on the aircraft.

3.0 With the lift arms fully lowered move the handler to approximately encompass the aircraft nose wheel or tail wheel. Then using the chest pack controls, clamp the arms until they capture the tow pin adaptors.

4.0 Raise the arms until the aircraft tyres are approximately 50mm clear of the ground (If the nose weight is < 3500Kg). As the lift pressure increases a locking mechanism automatically stops the arms being opened in a loaded condition.

The aircraft is now secured to the handler and can be moved as required

Please note it is a design feature of the unit to utilise the aircraft mass to maximise the tractive effort available. Up to a maximum 3500 KGs strut download.

Where aircraft strut weight is >3500Kg it will not be lifted clear of the deck and the aircraft will be moved with the wheel in rolling contact with the deck as it would with a conventional tow bar.

NB: All tractive effort and deck stability/slide calculations have utilised 0.6 Mu for the deck coefficient of friction – this is considered to be a conservative figure, and therefore inherently safe.

The INDAL Technologies Universal has many other advantages making it especially suitable for manoeuvring aircraft in confined spaces such as aircraft hangars, onboard ship and aircraft parking aprons.

The Universal is extremely manoeuvrable, utilising it's power steer computers (patents pending) linked to the speed and traction controllers; these carefully control the torque proportionally to each of the drive wheels, and simultaneously calculates the steering angles to give true Ackermann steering to the steer wheels. Universal can also automatically readjust its steering geometry to enable it to rotate on its own axis (centre point steering).

The Universals intuitive controls ensure that each step of the process is logical and ergonomic via the chest pack console. Computerised inter-actions and internal protocols ensure that operators carry out actions in logical progression, and most importantly safely.

Aircraft types and consequently traction/airframe loadings are all pre predefined and

require only operator selection. Consequently very limited operator training is required.

Logical, drive and steer joysticks allow the aircraft to be moved with absolute precision even under the most arduous deck condition and ships motions in confined spaces and to the extremities of hangars or deck edges. With most current and proposed fleet aircraft designs the Handler will actually be within the footprint of the aircraft which when coupled to its 'turn on the spot' capability means that aircraft can be parked at very high densities and very close to bulkheads.

Where space is at a premium the unit can utilise simple, optional, ramps to actually park itself on top of another (When stowed the ramp sizes allow it to be stowed within the Handler's footprint).

Since Handler has been designed for marine embarked operation it has virtually no emissions, which makes it particularly suitable for indoor and below deck use.

Hangars and equipment are kept cleaner and the relatively silent operation means that reflected noise in enclosed metallic hangars is virtually eliminated.

MANTIS utilises the latest technology and sophisticated digitally controlled computerised battery management computers to ensure the shortest charge times and maximum on deck endurance whilst maximising battery life in a completely maintenance free environment.

The in built battery charging and management system automatically controls charge and battery condition, whilst the traction system provides digitally controlled regenerative braking feeding the over-run power back into the batteries further increasing on deck endurance.

The Handler is charged by local mains power supply, which can be between 96 to 260V AC.

Typical Clamping of Undercarriage Wheel

SAFETY FEATURES

The Handler incorporates many integrated and automated safety features, designed to safeguard both personnel and aircraft and prevent misuse as follows:

Static Conditions

The Handler cannot be moved if:

The battery isolating switch is in either the OFF or in Battery Charge position, (Can be pad locked OFF)

The Remote console is unplugged.

The charging lead is connected.

The 'Dead-Mans' grip is not activated correctly.

The Emergency Brake Release system is activated.

Operating Conditions

The fail-safe electromagnetic brakes are applied automatically when the power is OFF. The brakes can only be released when forward or reverse motion is requested via the remote console. An emergency system is incorporated to release the brakes for servicing or manual movement of the Handler.

The Handler will electronically 'stall' if the draw bar pull (or equivalent) exceeds the design figure selected by the operator.

Lift 'Arms' cannot be opened until the weight of the aircraft is released. This ensures that the aircraft cannot be released with the undercarriage wheel still raised from the deck or ground.

KEY FEATURES

Listed below are a few advantages in using the Universal Aircraft Handler as opposed to a conventional aircraft tractor for aircraft movement:-

'Cost'- cheaper running costs, no fuel bills - long life expectancy, minimal maintenance expenditure - self contained, no ancillary equipment required - saving in manpower, only one pedestrian operator required.

'Operational Advantage' - superior manoeuvrability plus ultra low chassis enables the aircraft to be stowed more compactly - precise steering and stopping capability minimise risk of accidental damage to aircraft - time saving achieved by accurate aircraft "spotting" - simplicity of control renders the Handler 'foolproof', minimising the level of operator skill required.

Aircraft can be parked right up to bulkheads or other aircraft without the need to leave manoeuvring space to remove the handling system or tractor

'Lightweight' - the Handler utilises the weight of the aircraft over the driving wheels to give tractive grip - its weight, compared with conventional tractors, renders it particularly suitable for embarked aviation operations by minimising mass above the waterline in embarked roles.

As a rule of thumb 'dead mass' deck tractor with an equivalent pull to the unit would have a mass of 5,259 Kgs/unit against the unit at 1,950 Kgs/unit.

On a typical ten unit deck fleet this would add over 33,000 Kgs to the 'mass above the water line'.

'Environmental Advantages' - pollution from exhaust fumes with attendant health hazards are avoided - can be used safely within enclosed areas - quiet operation enables commands to be heard distinctly and avoids distraction of operators engaged in other work in the vicinity, thereby reducing annoyance which may lead to fatigue errors.

'General Advantages' - Up to 2,000 kg of stores can be carried on the Handler's robust flat top deck; making it a fast and stable transit platform. The Handler can also be used to haul cables or heavy wheeled ground support equipment. Two Universal handlers can also be stacked for storage. Is is also fitted with low intensity red lights for enhanced load area lighting and optional NVG lighting.

CONSTRUCTION DETAILS

Chassis

The chassis is a computer designed welded carbon steel-plate box monocoque structure. Strengthening steel plates welded inside the box structure and preformed structural shaping form an equipment bay with separate compartments into which the batteries, hydraulic pump/motor, fluid tank, and the electrical control unit are housed. Each compartment is designed to contribute to the chassis strength and rigidity by virtue of shape rather than thickness. Extreme attention to anti-corrosion processes adds to the overall 'design for application' approach.

Lifting and Lashing Points

Lugs are fitted into each of four strong points. Two are located at the front of the handler and two the rear. These points are for use with a four-legged sling or deck/floor lashing when the Handler is being hoisted or air transported.

Steering

Two powered steer wheels are mounted at the front end of the Handler. A signal input from the remote console powers the wheel to the required steering angle. The same signal input also varies the power output to the main drive wheels located at the rear of the Handler giving differential steering effect. On full lock the outer drive wheel will travel in the forward direction whilst the inner drive wheel would travel in the reverse direction. This results in a very manoeuvrable Aircraft Handler.

Traction Drive System

The main drive is from the two 'motor in hub' wheel units located at the rear of the Handler each fitted with a unique integrated 1.2 KW Separately Excited D.C. Motor. The motors are mounted directly inside the steel wheel section which in turn carries a 270 mm diameter x 185 mm wide purpose designed 'deck friendly' polyurethane tyre. Each motor is fitted with an Electromagnetic brake with a rating of 32 Nm torque, to act as an ultimate 'Fail Safe'.

Brakes are only released under computer control when forward or reverse motion is selected. Under fully loaded conditions and travelling at manoeuvring speed these brakes will stop the Handler within 300 mm.

Controls and Indicators

All controls and indicators associated with the control and operation of the Handler are located on the remote console. The console is connected to the Handler by a coiled Steel Wired Armour cable of 6m length (extended). The console houses the following functions:-

Horn Button. Used for warning purposes.

Night Loading Area Lights. Used to illuminate the lift area in low level ambient lighting conditions.

Forward/Reverse Stick. Fitted with integrated 'Dead Man' switch.

Left/Right Stick. - Speed variable, centre bias.

Hydraulic - Raise Button. Operation of this button will raise the arms.

Hydraulic - Lower Button. Operation of this button will lower the arms.

Hydraulic - Open Button. Operation of this button will open the arms.

Hydraulic - Close Button. Operation of this button will close the arms.

Note: for safety reasons the open/close functions will not work when the arms have been lifted. This is to prevent accidental opening of the arms when an aircraft has been lifted.

Hydraulic - Close Button. Operation of this button will close the arms.

Note: for safety reasons the open/close functions will not work when the arms have been lifted. This is to prevent accidental opening of the arms when an aircraft has been lifted.

Digital Display. This indicator displays all operational and steering information and battery status.

Emergency Isolating Pushbutton. This isolates the main battery voltage from the system and can be used in emergency situations. Actuating this push button will immediately remove the power to the drive circuit and apply the electromagnetic brakes. There are 3 of these buttons on the vehicle. left/right and front, there is also an additional button located on the remote chest pack.

OPERATION OF THE HYDRAULIC SYSTEM

Closing the Arms

Pressing the CLOSE button on the remote console closes the solenoid-operated valve.

Current through the solenoid causes a relay to be energised, which routes the 48V D.C. supply to the pump motor. The motor runs and hydraulic fluid flows through the control valve and relief valve where it is regulated to a pressure of 125bar to the annulus side of the hydraulic ram piston. The piston rod is retracted and the arms close around the nose or tail wheel. Pressure within the system is shown on the gauge.

Releasing the CLOSE button, switches off the pump. Pressure is retained within the system by the Pilot Operated Check Valve which forms an integral part of the control valve.

Opening the Arms

Pressing the OPEN button on the remote console, opens the solenoid valve and the internal ports in the valve route the hydraulic fluid to the output port then through a pressure relief valve to the main bore side of the hydraulic cylinder. The piston extends and opens the jaw mechanism. Pressure in the system is regulated at 100bar by a pressure relief valve separate from that in the 'Close' hydraulic circuit.

Close/Open Valve Safety Interlock

The 'Close/Open' control valve cannot be operated when there is pressure present in the lift cylinder hydraulic line controlled by the Arms Raise/Lower valve. Pressure in the line locks the arms Open/Closed valve in the closed position throughout the arms Raise/Lower sequence until the pressure in the line is released. The interlock ensures that the jaws can only be opened when there is no additional load on the lift arms.

Raising the matrix arms

Pressing the RAISE button on the remote console opens the solenoid valve.
Current through the solenoid causes a relay to be energised which routes the 48V D.C. supply to the pump motor.
The motor runs and hydraulic fluid flows through the control valve and relief valve where it is regulated to a pressure of 175bar.

Lowering the matrix arms

Pressing the LOWER button on the remote console opens the solenoid valve.
Current through the solenoid causes a relay to be energised which routes the 48V D.C. supply to the pump motor. The internal ports in the valve route the hydraulic fluid to the output port then through a pressure relief valve to the 'annulus' side of the hydraulic cylinder. The piston retracts and lowers the arm mechanism.

ELECTRICAL SYSTEM

General

Electrical power is derived from 24 x 2 volt lead acid batteries connected in series. (Option of GEL type batteries).

Five electric motors are fitted; two supply the traction power, two supply the steering and fifth is the hydraulic pump motor. The control system of the traction motor is composite in nature in that it utilises the dominant features of both electro-mechanical and solid state devices using MOSFET technology and CANBUS communications. Control of the pump motor is through a switched relay and contactor.
(Option to increase the DBP from 6KN to 14KN)

Four High Intensity LED work lights are fitted. These permit the Handler to be attached to the aircraft and used without recourse to auxiliary lighting in situations of low light intensity.
(Option of NVG compatible lighting)

Provision is made to re-charge the batteries from a suitably rated AC supply through a built-in charging unit. A battery discharging indicator unit is provided on the remote console. This gives visual indication when the batteries need to be recharged and serves as a continuous state-of-charge indicating device.

Speed Controller

The speed control unit is housed on an aluminium base plate that is bolted to the chassis main frame.

The main features are:-

- High frequency MOSFET switching technology.
- Real-time control over the internal and external factors that influence the behaviour and performance characteristics of the Handler with self-diagnosis of the checking circuits themselves.
- Stored programme machine configuration (SPC) where the hardware is completely separate from the configuration functions. The programme is parametric and can be modified by the factory I.E. acceleration/deceleration ramp.
- Various draw bar maximums can be selected by the user, without the need for hardware modifications.
- Logic and power units are fitted in sealed enclosures (IP54).

Battery Isolating Switch

The battery isolating switch is the main current carrying switch. It is a heavy-duty four position rotary switch each position identified in accordance with its particular functions as follows:

In the 'RUN' position the battery's 48 V DC positive output terminal is connected through the 450 amp fuse - to the central computers systems.

The 'OFF' position disconnects the battery from all the motors, control, indicator and lighting circuits.

In the 'Charge' position the battery is connected to the battery charger output.

In the EBR position (Emergency brake release) all brakes on the unit are released to enable recovery of a disabled vehicle. (Manual brake release is also fitted as standard)

CURRENT LIST OF COMPATIBLE AIRCRAFT

Aircraft
A10 Thunderbolt
A109
AMX (Italy)
Apache
AW159 Lynx Wildcat
Buccaneer
CH53 Sea Stallion
Chinook
Denel Oryx
EH101 (and EH101 variants)
F104 (Grumman)
F15
F16
F18
F22
F5E Northrop
Harrier GR7/9
Hunter
Jaguar
Kaman HH2
Lightening
Lynx Mk8 & Mk9 (all current variants including chin radome variants)
MASC *
Merlin
MH60-R
MH60-S
Mirage 111C
Mirage 111S
MRH90
NH 90 NFH
Puma
Sea King Mk7
Sea-King
SH60 Seahawk
Shorts Highlander
MH60-M and variants
MH60-R
MH60-S
Tornado
V22 Osprey *
Wessex

* note Simulations from current data availability

Note this list is by no means exhaustive, this list refers to the most popular current uses; refer to INDAL Technologies if the aircraft you require is not listed.