Doosan Corporation Mottrol / Defense Systems
Excellence in Motion & Control

Doosan Corporation Mottrol has contributed to national defense through developing and supplying hydraulic systems and electro-hydraulic systems to the army, navy and air force.
The Brief History of Defense Systems Division

1974-
1974 Foundation
1976 Started to produce hydraulic products for industrial use and hydraulic press
1977 Established Changwon plant Designated as defense contractor
1989 Started to produce track devices for excavators

1990-
1990 Started to produce hydraulic pumps and swing motors for excavators
1992 Started to produce hydraulic pumps for aircraft
1999 Received “Outstanding company in R&D” (The Minister of Defense)

2000-
2001 Received “Outstanding Technology development award” (Hydraulic Industrial Institute, Japan)
2005 Received award in Precision Technology promotion competition
(Ministry of commerce award, Precision bent-axis type Hydraulic motors, electro-hydraulic servo device)
2007 Track device for excavators was designated as “World best product” from Korean government (Ministry of commerce)

2010-
2010 Received “New quality global system excellence award”
2011 Exceeded millionth hydraulic unit production
2012 Established China factory at Jiaxing, Jiangsu - Doosan Mottrol Jiangxin Co., Ltd.

Established in 1974, Doosan Corporation Mottrol advanced into the unexplored hydraulic industry first time in Korea. We have built the foundation for full line-up hydraulic components by overcoming many difficulties. Since 1989, we have produced hydraulic parts for construction equipment and grown up as hydraulic specialist. Now, based on the accumulated hydraulic technology, we supply high-quality hydraulic component reflected electric-electro technology. In 2011, we exceeded millionth hydraulic unit production first time in Korea. Doosan Corporation Mottrol will step forward to global comprehensive hydraulic supplier by keeping the basic and challenge to Creative R&D and Quality Innovation.
Doosan Corporation Mottrol has developed and supplied hydraulic systems and components for Mobility & Fire

- GTDSS and EM-GTDSS for MBT
- Hydraulic Drive System for AVLB
- Hydraulic Winch System for ARV
- GTDS and Suspension System for SPH
- In-arm Suspension Unit for IFV
Main Battle Tank (MBT)
Armoured Recovery Vehicle (ARV)
Armoured Vehicle-Launched Bridge (AVLB)

K1/K1A1 and K2 are up-to-date Main Battle Tank that have outstanding fire powers, superior mobility and high accuracy rate.

Gun/Turret Drive and Stabilization System (GTDSS) for K1/K1A1 Main Battle Tank (MBT)

GTDSS for K1/K1A1 MBT measures and compensates yawing and pitching which occur on uneven and curved roads for gun turret to be capable of the precise fire while running.

Production:
- K1A1: 1999 –

Key Features:
- Electric-hydraulic servo system
- Feed back control by servo valve and velocity sensor
- Noise/vibration minimization
- Hydraulic control technology for heavy load system

Customer:
- Korea Army

1. Elevation Servo System
   - Controls hydraulic fluid flow according to the signal from the electronic unit to control the speed of the elevation drive system.

2. Elevation Drive System
   - Converts hydraulic power into mechanical linear motion to move gun up and down.

3. Feed-Forward Gyro
   - Detects and converts the angular speed of gun and turret into electric signals and sends them to the electronic unit.

4. Reference Gyro
   - Detects and converts the angular speed of gun and turret into electric signals and sends them to the electronic unit.

5. Traverse Drive System
   - Rotates turret by converting hydraulic power to mechanical force.

6. Electronic Unit for Gun and Turret Drive
   - Supply power to the components of gun and turret drive stabilization system and processes sensor feedback signals and commands.

7. Steering Handle for Artillery Man
   - Converts the angle change caused by steering handle operation to electric signals and sends the signals to the electronic unit.
Electro-Mechanical Gun/Turret Drive System (EM-GTDS) for K2 Main Battle Tank (MBT)

This system steps up the 28VDC power supply to 260VDC to drive gun and turret by precise control of elevation/traverse servo amplifiers. Doosan Corporation Mottrol has realized highly efficient and precise current control, minimized the noise and vibration of the drive system and improved the stability of gun and turret.

**Production**
- 2013

**Key Features**
- Precise gear design with high rigidity and minimum backlash
- Noise/vibration minimization
- High efficiency Power transformation
- Motion control technology for heavy load system

**Customer**
- Korea Army
Hydraulic Drive System for K1 Armoured Vehicle-Launched Bridge (AVLB)

This system provides hydraulic power to armoured vehicle launched bridge which provides way to tanks or other vehicles by rapid installation and withdrawal of bridges.

- **Production**: 1995 - 2019
- **Key Features**
  - Load sensing hydraulic system
  - Integrated reservoir with valves
  - Counterbalance valve block for preventing overload
  - Constant power operation

Customer: Korea Army

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Hydraulic Winch System for K1 Armoured Recovery Vehicle (ARV)

This system provides hydraulic power to armoured Vehicle launched bridge and facilitates rapid installation and withdrawal of bridge.

- **Production**: 2006
- **Key Features**
  - Constant type winch
  - Load sensing hydraulic system
  - Constant pulling force: 350 kN

Customer: Korea Army
Self-Propelled Howitzer (SPH)

Self-Propelled Howitzers support infantry and armoured units with fire power. They are equipped with superior maneuverability, survivability, and auto-fire direction abilities for modern wars. Doosan Corporation Mottrol has been producing the hydraulic and suspension systems for the K9 and K55A1.

Hydraulic Drive System and Suspension System for K55A1 Self-Propelled Howitzer (SPH)

The hydraulic drive system for gun provides hydraulic power to elevation/balancing system of gun, turret traverse system and automatic loading system. Also, the hydro-pneumatic suspension system improves the travel performance and comfort.

Production:
- K55A1: 2010 ~

Key Features:
- R.P. Ramming System
- Energetic swing through discontinuous drive

Customer:
- Korea Army

![Hydraulic Drive System and Suspension System for K55A1 Self-Propelled Howitzer (SPH)](image)

1. Elevation Balancing Cylinder
   - Drives gun up/down with the hydraulic power from gun control system and prevents the gun by absorbing the firing shock.

2. Elevation Limit Valve
   - High angle is limited to prevent loading device collision with the floor.

3. Ramming Driver
   - Piston rod pushes or pulls push rod assembly for automatic loading.

4. Swivel Valve Block
   - This block controls hydraulic oil flow direction to raise or lower loading device assembly.

5. Strut Suspension
   - This telescopic hydraulic system minimizes the shock and vibration from the ground. Using the attenuation characteristics of damper and the non-linear spring of fluid type.

6. Hydraulic Power Pack
   - Converts the electric power from power supply system to hydraulic power (pressure/flow rate) to supply to elevation, traverse and loading systems.

7. Ramming Valve Block
   - This block is activated by loading device switch to move the push rod assembly of the loading device assembly forward/bakward.

8. Manual Elevation Pump
   - Replaces or lowers gun manually in case of main power line failure.

9. Balancer Pressure Accumulator
   - Compensates the unbalanced moment caused by the high angle of gun using compressed nitrogen gas.

10. Main Pressure Accumulator
    - The electric power from power supply is converted into hydraulic power. The accumulator stores hydraulic oil from the hydraulic pump into the power pack for a short time and prevent pressure pulsation.
Gun/Turret Drive System (GTDS) and Suspension System for K9 Self-Propelled Howitzer (SPH)

GTDS for K9 SPH drives gun up and down, rotates turret by hydraulic power.

**Production**
- 1999

**Key Features**
- Biclick Ramming System
- Compactly integrated MPRIDC motor, hydraulic pump and reservoir
- Hydro-Pneumatic Suspension

**Customer**
- Korean Army
- Turkish Army (Exported to Turkey)

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**Traverse Gear Box**
- Converts hydraulic power into mechanical rotational motion to traverse turret.

**Motor Pump Oil Reservoir Assembly**
- Controls hydraulic fluid flow according to the signal from the electronic unit to control the speed of the elevation drive system.

**Filter Manifold Assembly**
- Removes impurities from the hydraulic oil in supply and return lines. A pressure switch triggers an alarm when closed.

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**Hydraulic System Control Panel**
- Supplies power to the hydraulic system components of turret, and drive electric motor and pump to generate the hydraulic power for turret driving.

**Elevation Manual Pump**
- Raises or lowers gun manually in case of the main line failure.

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**Swivel Valve Block**
- The block elevates the loading device assembly.

**Balancer Manifold Assembly**
- Uses if ball nut pressure is excessive, or needs to be released for service or maintenance work.

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**Ramming Valve Block**
- This block is activated by locking device switch to move the push rod assembly of the loading device assembly forward/backward.

**Ramming Driver**
- Piston rod reciprocates by ramming valve to move push rod assembly forward/backward.

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**Cooling Device Assembly**
- Keeps steady state of hydraulic fluid temperature by oiling internal air into turret system.

**Elevation Balancer Cylinder**
- Drive gun up/down with the hydraulic oil led from the elevation valve assembly, and supports self-weight of the gun.

**Hydro-Pneumatic Suspension**
- The hydro-pneumatic suspension system of K9 Self-Propelled Gun minimizes the shock and vibration from the ground, using the simulation characteristics of damper and the nonlinear spring characteristics of fluids. This system improves field traversing performance, ride comfort, and enables continuous and accurate firing.
In-arm Suspension Unit for K21 Infantry Fighting Vehicle (IFV)

In-arm Suspension Unit (ISU) for K21 armoured vehicle developed by Doosan Corporation Mottrol has been applied in armoured vehicles for the first time in the world, and its performance has been proven in the field test.

Production: K21 - 2009

Key Features:
- In-arm design configuration, integrating the hydraulic and the pneumatic suspension within the housing, is the most effective means to package such a high-performance system with minimal space claim and weight.
- Static load per wheel: 2.5 to 3.0 ton
- Arm length: 400 mm
- Vertical travel: up to 480 mm
- Max. pressure: 1800 bar
- Weight: 120 kgf

Customer: Korea Army

Infantry Fighting Vehicles which transport soldiers require high maneuverability and operability. Doosan Corporation Mottrol has been producing the hydraulic and suspension systems which enable infantry fighting vehicles to travel on field and water.

In-arm Suspension Unit

- The In-arm Suspension Unit minimizes the shock and vibration from the ground, using the attenuation characteristics of damper and the nonlinear spring characteristics of the arm. The system improves field travelling performance, ride comfort, and maneuverability of armoured vehicles.
Defense Weapon

Doosan Corporation Mottrol has been developing hydraulic systems for defense weapons such as KM-SAM Multi-Function Radar and KM-SAM Launcher that will be the core equipment in future wars.

Hydraulic Drive System for KM-SAM Launcher

Hydraulic Drive System and Controller for KM-SAM Launcher is capable of combining and separating vehicle from launcher, supporting launcher, driving launcher up/down and controlling attitude.

Production: 2012

Key Features:
- Low power consumption of below 9 KW
- Mechanical auto self-locking type Jack cylinder
- Operating temp: -32 ~ 50 °C
- Max operating slope: 5°

Customer: Korea Army

1. Elevation Driver
   - When connected with the lower and upper frames, the driver extends to move the projectile to the position.

2. Elevation Drive Distributor
   - Controls the pressure and low to return from elevation drive according to the control signal of the launching ramp.

3. Jack Cylinder
   - Extends Jack to fit, support the launching ramp and lifts the ramp up for separation, combination with vehicle.

4. Main Pump
   - Composed of a hydraulic pressure generator with electric motor and hydraulic oil reservoir.

5. Lock Cylinder
   - Locks high angle driver and outrigger during travel.

6. Extension Cylinder
   - Extends outrigger and rear rotating beam for vehicle separation.

7. Extension Drive Distributor
   - Controls the pressure and low return from extension cylinder according to the control signal of the launching ramp.
Hydraulic Drive System for Multiple Launch Rocket System (MLRS)

Hydraulic Drive System for MLRS drives the pod up/down and turns it to the right and left.

- **Production**: 2012
- **Key Features**:
  - The electro-hydraulic servo motor was applied in this MLRS
  - Feed back control by servo valve and yoke position sensor
  - Optimization of hydraulic system and energy saving
- **Customer**: Korea Army

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Hydraulic Drive System and Controller for KM-SAM Multi-Function Radar (MFR)

Hydraulic Drive System and Controller for KM-SAM MFR is capable of combining and separating vehicle from radar, supporting radar, driving radar up/down and controlling altitude.

- **Production**: 2012
- **Key Features**:
  - Low power consumption of below 90W
  - Mechanical auto self-locking type jack cylinder
  - Operating temp: -32 ~ 100°C
  - Max operating slope: 5°
- **Customer**: Korea Army

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**Diagram Descriptions**

**1. Traverse/Elevation Servo Motor**
- Drives the launching drum to precise position and angle with the hydraulic power from the main pump.

**2. Hydraulic Pressure System**
- Provides hydraulic power to hydraulic system during engine stop for remote firing.

**3. Oil Reservoir**
- The reservoir of the hydraulic oil which cools down the oil from the hydraulic surface.

**4. Main Pump**
- Operates hydraulic power from the energy of engine, and supply the power to hydraulic system.

**5. Jack Cylinder**
- Supports vehicle horizontally for accurate firing control using the hydraulic power from the main pump.

**6. Swivel Joint**
- This device provides hydraulic oilpaths from the hydraulic pressure system towards the service to the hydraulic motor for rotation up/down and left/right.

**7. Jack Drive Distributor**
- Controls the pressure and flow tests, returned from actuator according to the control signal.

**8. Hydraulic Power Pack**
- Using electric motor, generates hydraulic power and supply the power to hydraulic devices.

**9. Hydraulic Jack**
- Extends hydraulic jack for stable support of antenna base, or rotates antenna base for separation, combination with vehicle.

**10. Antenna Up-Down Cylinder**
- Extends/retracts cylinder to raise/lower antenna.

**11. Antenna Lock Device**
- At launching position and antenna up-down, locks or releases antenna locking device.

**12. Hydraulic Unit**
- Controls antenna up-down cylinder and locking device.

**13. Oil Reservoir**
- Stores hydraulic oil.

**14. Extension Cylinder, Extension Drive Distributor**
- Extends/retracts extension cylinder to extend/retract antenna. The extension drive distributor controls extension/retraction of extension cylinder.

**15. Integrated Controller, Inclination Indicator/Controller**
- Integrated controller controls hydraulic system electronically according to the built-in software program. Inclination indicators/controller indicates vehicle inclination.
Naval Weapon

Doosan Corporation Mottrol has been developing and producing the servo system for short range tracking radar and terminal antenna pedestal for naval weapon system.

Stabilization System for Terminal Antenna Pedestal

Precise, stabilized pedestal for surface ship antenna to enable accurate satellite tracking automatically or manually. Ship’s roll, pitch, yaw are automatically compensated for uninterrupted military satellite communication.

**Key Features**
- 3-Axis Pedestal
- Coverage
  - Azimuth: 360° continuous
  - Elevation: -30° ~ 120°
  - Cross: -55° ~ 55°
  - Velocity: 120°/sec
  - Acceleration: 25 g/acc

**Production**
- 2007

**Customer**
- Korea Navy
Hydraulic Winch System for Sonar System (TASS/TACM/ULTASS)

Active sonar system detects enemy submarines or mines in the sea with the sound wave transmitted from a surface ship and reflected by the target.

- Production: 2010
- Key Features:
  - Self-activated cable spooling system
  - Compact winch system using a hydraulic servo driving unit
- Customer: Korea Navy

Electro-Mechanical Servo System for Short Range Tracking Radar

Being linked with various equipments and systems on board, improves survivability of ship.

- Production: 2010
- Key Features:
  - 2-Axis Pedestal
  - Coverage
    - Azimuth: 360° continuous
    - Elevation: -20° ~ 85°
  - Velocity: 2 rad/sec
  - Acceleration: 7 rad/sec²
- Customer: Korea Navy

1. Power Supply Unit
   - Supplies power to towing winch, using a hydraulic system

2. Towing Winch
   - Deploys, tremonts, lifts, and stores the sensor and towing cable for detecting sound wave

3. Towing Device
   - Guides the sound wave detector sensor and cable into the sea

1. Servo Amplifier
   - The device is for the operation of the high voltage, high precision BDC motor for precise control of servo driver

2. Servo Controller
   - Compensates the external disturbance, such as waves, to the ship by utilizing high level PID. An algorithm for precise tracking is built-in

3. Servo Driver
   - A device for low backlash and high speed precision control of antenna direction based on 2 axis electric precision drive control

4. Emulator
   - The emulator tests and analyzes servo system performance by creating drive commands
Aerospace Weapon

Hydraulic Main Pump (HMP) for Korean Utility Helicopter (KUH)

Hydraulic Main Pump for KUH supplies the hydraulic flow for attitude control of Helicopter.

Production: 2010

Key Features:
- Variable displacement axial piston pump
- Rated speed: 4723 RPM
- Rated temp.: 110.2°C
- Rated flow: 21 l/min
- Rated outlet pressure: 20.7 MPa (3,000 psi)

Customer: Korea Army

Doosan Corporation Mottrol has been contributing to development of national aerospace industry by developing the hydraulic pump for helicopters.

Hydraulic Main Pump (HMP)

- Hydraulic Main Pump for KUH is an in-line variable displacement pump.
- This pump meets SAE AS19699 specification and generates hydraulic pressure of 20.7 MPa (3,000 psi)
Future Weapon

Doosan Corporation Mottrol has been participating in the development project of the Robot Vehicle and has been developing a variable suspension and wheel drive system.

Rotatable Suspension Arms for Robot Vehicle

Rotatable Suspension Arms using the nonlinear spring characteristics of Nq gas and MR fluid damper minimizes shock and vibration to increase rough ground driving performance and protect mounted equipments of a vehicle.

Key Features
- Rotatable Suspension Arm is a kind of semi-active type suspension which gives better riding performance and helps the robot to keep the desired attitudes and positions.
- Electric power of motor with gear box provides power to Rotatable Suspension Arms to rotate the arm 360 degrees.
- Either leading arm or trailing arm position is possible to conduct the same performance in a Rotatable Suspension Arm.

Electric Direct Drive System for Gun/Turret Drive System

EDDS, Advanced electric driving system by applying direct driving servo motor, achieves more accurate, effective, rigid Gun/Turret Drive System than existing gear reduction based drive system.

Key Features
- The pancake type Direct Drive motor(Die 2.0kw) was applied in this system
- Enhanced tracking accuracy with EDDS hardware and an algorithm
- Improvement of tracking position performance
- Advanced boosting the voltage technology
- Efficiency up to 63.4%(1:38 converting ratio)
R&D Overview

Doosan Corporation Mottrol has been contributing to national defense for more than 30 years by developing and supplying various hydraulic devices, electro-hydraulic systems, and electric drive gears used in various weapon systems.

Development Field

Doosan Corporation Mottrol has developed hydro-pneumatic suspensions for the K9, KSS, K21 and other combat vehicles, gun/turret stabilizer for K1 and K1A1, electric gun/turret drive for K2, satellite antenna for ships, and stabilizer for short range tracking radar. The servo valve developed jointly with academy-industry-research circles has become a core part for guns and turret stabilizer and fuel controller.

Core Technology

With the advanced technology that is accumulated more than 30 years, Doosan Corporation Mottrol has positioned itself as a leader in hydraulic-electric system. Doosan Corporation Mottrol has been contributing to national defense by developing hydro-pneumatic suspension, gun and turret stabilizer for K1, K2, K1A1 tanks, ship antenna stabilizer and servo valve.

Development Performance

Beginning with the development of the K95 self-propelled howitzer and Korean type K1 tank, Doosan Corporation Mottrol have developed hydraulic pump for UH-60 helicopter, TASS/TACCM winch, onboard naval ships, K9 self-propelled howitzer, hydro pneumatic suspension and a number of other Electro-Hydraulic systems for the national defense.

Description

- 1986 Developed gun/turret drive system for 155mm self-propelled For K55
- 1991 Developed GTDSS for K1
- 1992 Developed large capacity Electric Drive System (EDS)
- 1995 Developed Hydraulic Pump for UH-60
- 1996 Developed TASS/TACCM
- 1996 Developed ISU Suspension
- 1997 Developed gun/turret stabilizer for K1A1
- 1997 Developed Fire Control Simulator System (FCS)
- 1998 Developed Gun/Turret Drive System for 155mm self-propelled gun (GTDS)
- 1999 Developed ISU 155mm self-propelled gun for K9
- 2002 Developed high performance hydraulic servo valve
- 2007 Developed hydro pneumatic suspension for K21
- 2008 Developed terminal antenna drive stabilizer for ships
- 2008 Developed electric gun/turret drive for K2

With continuous investment in R&D, Doosan Corporation Mottrol has been developing total solution for servo valves, hydro-pneumatic suspension, hydraulic/electric stabilized driving system and the core parts in guided weapons and aerospace systems.