# DYNETIC SYSTEMS COMPANY

# DYNETIC 600 SERIES

# PWM SERVO AMPLIFIER

# OPERATING MANUAL


*DYNETIC SYSTEMS*

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## 1.0 DESCRIPTION:

Dynetic 600 Series Servo Amplifiers are Pulse Width Modulated (PWM) and designed to drive our Dynetic D.C. servo motors.

All models are fully protected against over-voltage, over-current, overheating, and short circuits.

Operating efficiency is over 95%.

The amplifiers can operate in Current (Torque), Velocity or Voltage modes.

A screwdriver slot on the end of the black module is provided for stability adjust.

## 1.a. Terminal Identification: See Section 8.0.

| | | |
|---|---|---|
| P2 | -4 & -5 | ±10V outputs. P2-3 is signal ground. |
| P3, P4, P5 | -5 & -6 | ± COMMAND inputs. |
| P3, P4, P5 | -3 & -4 | ± GENERATOR inputs. |
| P3, P4, P5 | -7 | Inhibit--it turns off all four mosfets of the "H" bridge when activated. Applying +3 to +15 Volts @ 3mA disables the amplifier mode. |
| P3, P4, P5 | -1 & -2 | ± MOTOR connections. |

## 2.0 SPECIFICATIONS:

| | | |
|---|---|---|
| Supply Voltage | : | 24 VDC Standard |
| Peak Current | : | ± 6 Amps |
| Continuous Current | : | ± 3 Amps |
| Min. Load Inductance | : | 200 u Henry |
| Switching Frequency | : | 33 KHZ |
| Max. Generator Voltage | : | ± 60 VDC |
| Max Command Voltage | : | ± 15 VDC |
| Current Monitor | : | ON P1-9; 1V=2A |
| Current Limit | : | Adjustable |
| Max. Speed/Command | : | Adjustable |
| Inhibit | : | +3 to +15 VDC @ 3mA to inhibit drive |
| Voltage Monitor | : | 0.091V/1V across motor terminals |

The data sheets in the appendix also provide technical and descriptive information about the products.

## 3.0 MODE SELECTION:

Dynetic 600 Series Amplifiers operate in the following modes:

- Voltage-to-VOLTAGE Amplifier Mode
- Voltage-to-SPEED Amplifier Mode
- Voltage-to-CURRENT Amplifier Mode (Torque Mode)
- Digital Position Loop Mode.

## 3.a. Voltage-to-Voltage Mode: This is the default mode.

Voltage mode is selected with SW1-3, SW2-3 or SW3-3 ON. IR compensation is selected by setting SW1-4, SW2-4, or SW3-4 ON. Adjust the IR compensation with POT 4, 9, or 14, respectively.

In the voltage-to-voltage mode, the command input determines the motor voltage or speed. However, if there is a load torque variation, the motor current will vary, as torque is proportional to motor current. Since the motor windings have resistance, the actual motor voltage is reduced by the product of motor current and resistance. Thus, motor speed--which is proportional to motor voltage (terminal voltage minus IR drop)--varies with the load torque.

In order to compensate for the internal IR drop, a voltage proportional to motor current must be added to the command input. The amount of compensation is adjusted on the amplifier. Exercise caution when adjusting the IR compensation, if the adjustment is too high it will cause instability. Reduce instability by adjusting pot 4,9,14 when motor armature is at its lowest temperature.

If significant motor torque change is anticipated, the addition of a tachometer to the motor will ensure tight speed regulation throughout the entire torque load spectrum. Then use the voltage–to-speed mode.

## 3.b. Voltage-to-Speed Mode:

The addition of a tachometer fastened to the motor shaft produces a voltage proportional to speed. With this addition, the tachometer output voltage is replaced by the motor terminal voltage as the controlled variable. Since this voltage is proportional to the motor speed, the operating mode is voltage-to-speed.

Note that the speed is dependent on terminal voltage and motor current. The motor current is, in turn, dependent on the load torque, which includes both constant friction torque and the torque required to accelerate or decelerate the load. Thus, the inclusion of these parameters in the control loop may give rise to instability. In general, compensation of a tachometer feedback system is more complex than that of the voltage-to-voltage mode. See "Compensation Adjustments" (Section 5.b) section for procedure.

## 3.c. Voltage-to-Current Mode (Torque Mode):

The voltage-to-current mode produces a torque output from the motor proportional to the reference voltage input. D.C. motor torque is always proportional to the motor current. This mode is particularly important if the servo amplifier is used with a position controller (under this condition, a movement of the motor shaft from the desired position causes a large correcting torque or "stiffness"). This mode can be selected by setting SW1-2, SW2-2 or SW3-2 ON.

## 3.d. Digital Position Loop Mode:

When connecting the amplifier to any position controller, the type of command from the position controller must be known, i.e., velocity command, current command, or voltage command. Select the required mode.

## 4.0 WIRING INSTRUCTIONS: See Section 4.f for CE-EMC Wiring requirements.

### 4.a. Precautions:

Do not install the amplifier without first determining that power has been removed for at least 10 seconds. Never remove an amplifier from an installation with power applied. The following sections must be reviewed before installing it to ensure reliable operation.

### 4.b. Minimum Inductance Requirement:

Dynetic Systems Servo Amplifiers deliver a pulsed output that requires a minimum amount of series inductance to ensure that the D.C. motor current is properly filtered. The minimum inductance value is 200 micro-Henries. All Dynetic Systems motors recommended for use with this amplifier already meet this requirement.

### 4.c. Motor Wiring:

Use of a twisted, shielded pair for the motor power cables is recommended. Ground the shields at both ends to the amplifier's power ground pin P2-3 and the motor frames. The motor itself is connected to the amplifier output pins designated in Section 1.a. (See also connection diagram 8.0). If the motor case is not connected to an earth ground or safety ground, please consider connecting it in order to minimize electrical noise and reduce shock hazards.

### 4.d. Tachometer Wiring:

Use of a twisted, shielded pair for the tachometer wires is recommended. Ground the shield at one end only to the amplifier's signal ground pin P2-3. Connect the tach wires to pins P3, P4, and P5, -3 and -4, respectively.

### 4.e. Reference Input Wiring:

Use of a twisted, shielded pair for the reference input wires is recommended.

### 4.f. CE-EMC Wiring Requirements:

1. Shielded cables must be used for all interconnect cables to the amplifier and the shield of the cable must be grounded at the closest ground point with the least amount of resistance.

2. The amplifier's metal enclosure must be grounded to the closest ground point with the least amount of resistance.

3. The amplifier must be mounted in such a manner that the connectors and exposed printed circuit board are not accessible by personnel when the product is in operation. If this is unavoidable there must be clear instructions that the amplifier is not to be touched during operation.

4. A Fair Rite model 043167251 round suppression core must be fitted to the low level signal interconnect cables to prevent pickup from external RF fields.

5. The AC line filter must be mounted flat against the system enclosure used for chassis ground. Use the

mounting lugs provided on the filter's case. Paint or a non-conductive finish must be removed before installing the filter. This ensures good metal to metal contact across the entire mounting surface of the filter case.

The filter system should be mounted in the enclosure as close as possible to the AC power entry point. Also, any wiring on the load side of the filter should be routed as far as possible from any line side/line power wiring to minimize any RF coupling to the power entry wiring.

## 5.0 AMPLIFIER ADJUSTMENT (TUNING) PROCEDURE:

### 5.a. Initial Power-On Test:

**CAUTION: THESE INITIAL ADJUSTMENTS SHOULD BE PERFORMED WITH THE MOTOR UNCOUPLED FROM THE MACHINE.**

With a zero speed command applied, momentarily apply power to the amplifier. If, upon application of power, the motor rapidly accelerates, a runaway condition exists, due most likely to the reversal of either motor or tachometer wiring.

If the motor and tachometer are properly connected and the amplifier is functioning normally, the motor shaft will remain stationary. The shaft can drift slightly in either direction. Trim the zero speed adjust (P1/P6/P11) potentiometer for minimum amplifier output current by observing motor shaft drift with Command input(s) at zero Volts.

If the motor does not run away but emits a high pitched squeal, turn the stability adjust screw slot (on the end of the module) CCW until it stops.

### 5.b. Compensation Adjustments (Voltage-to-Speed Mode):

Servo system performance can be judged by the following three characteristics:

• Stability • Accuracy • Responsiveness without overshoot

It is a short and straightforward process to meet all three of these criteria. The process involves obtaining a stable servo using the stability adjustment while optimizing the response of the system.

For this purpose, it is necessary to be able to input a small step voltage at the command input and observe the generator signal on an oscilloscope at pins P3-3, P4-3, or P5-3. Set the stability adjustment screw to obtain a properly compensated response. This will be the fastest response without overshoot. If the system is under-compensated (slow response without overshoot), turn the stability adjustment screw (on the end of the module) CW. If it is overcompensated (overshoot and oscillation), turn the stability adjustment screw CCW.

NOTE: In most applications, the compensation can be adjusted by rotating the stability adjustment screw on the module CW until the motor oscillates audibly and then backing off until it stops. This simple procedure also applies to voltage-to-voltage mode.

Contact factory for custom compensation.

## 5.c. Current Limit Adjustments:

If overheating occurs due to extremely harsh operating conditions, the internal analog temperature sensor automatically reduces the current limit to a safe level without interrupting operation or damaging the amplifier.

It is important to set the current limit so that the instantaneous motor current does not exceed the specified motor peak current.

The current limit can be reduced by connecting an external resistor between amplifier pins P1-8 and P1-9 (See Section 11.0).

# 6.0 TROUBLESHOOTING:

## 6.a. Overload Fault:

1. Verify to see if the motor shaft rotates freely with no power applied. The load on the motor must be free of jams.

2. Verify that the minimum inductance requirement is met.

3. Verify motor leads are not shorted to common or chassis. See Section 6.e.

## 6.b. Case Temperature:

Verify that the module case temperature is less than 75°C.

## 6.c. Over-Voltage Shutdown:

1. Check the power input voltage for a value in excess of those listed in data sheets (Section 11.0). If larger than listed, check the A.C. power line connected to the power supply for proper value.

2. Check the regenerative energy absorbed during deceleration. Measure the power supply voltage with a

voltmeter or scope; if the supply voltage increases above 82 Volts, the unit will shut down. Additional power supply capacitance may be necessary. Additional capacitors must be electrolytic type and located as close to the amplifier as possible.

### 6.d. Under-Voltage Shutdown:

Verify power supply voltages for minimum conditions.

### 6.e. Short Circuit Fault:

1. Check each motor lead with respect to motor housing and power ground for shorts.

2. Measure motor armature resistance with the amplifier disconnected between motor leads.

### 6.f. Status:

Check inhibits for proper input.

### 6.g. Causes of Erratic Operation:

1. Improper grounding.
2. Noisy command signal. Check for system ground loops.
3. Mechanical backlash, deadband, slippage, etcetera.
4. Excessive tachometer noise.

## 7.0 CAUTIONARY NOTES:

### 7.a. DO NOT REVERSE THE POWER SUPPLY LEADS!

### 7.b. DO NOT SPIN THE MOTOR WITHOUT POWER!

If the motor shaft is rotated without amplifier power applied, the motor acts as a generator and will charge up the power supply capacitors in the amplifier. A high motor speed may cause over-voltage breakdown in the power transistors. Note: the amplifier has an internal power converter that operates from the high voltage supply and will become operative.

### 7.c. DO NOT SHORT THE MOTOR AT HIGH SPEED!

When the motor is shorted, its own generated voltage may produce a current flow as high as 10 times the amplifier peak current. The short itself should not damage the amplifier but may be bad for the motor. If the connection arcs or opens while the motor is spinning rapidly, this high current flows back into the amplifier due to stored energy in the motor's inductance and may damage the amplifier.

## 8.0 MOUNTING DIMENSIONS:

## 9.0 SWITCH SETTINGS:

| OPERATING MODES | SW1 / SW2 / SW3 | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Current Mode | Off | On | Off | Off |
| Voltage Mode | Off | Off | On | Off |
| IR Compensation | Off | Off | On | On |
| Tachometer Mode | Off | Off | Off | Off |

| | | | | |
|---|---|---|---|---|
| Test Mode | On | Off | On | Off |
| Position Mode | Off | Off | On | Off |

## 10.0 WARRANTY:

Dynetic Systems Company warrants its product to be free from defects under normal use and is limited to replacing or repairing at its factory any of its products which are returned to the factory of origin within one (1) year after shipment, transportation charges prepaid, which are disclosed to Dynetic Systems Company's satisfaction to be defective. This warranty supersedes all other warranties, expressed or implied, including any implied warranty or fitness for a particular purpose, and all other obligations or liabilities on the part of Dynetic Systems Company and it neither assumes nor authorizes any other person to assume for the seller any other liabilities in connection with the sale of the said articles.

The original warranty period is not extended by the above mentioned provisions for any replaced or repaired articles. This warranty shall not apply to any products that have been subjected to misuse, negligence, or accident.

## 11.0 APPENDIX:

See data sheets beginning on Page 10.