CHAPTER ⑥

Maintenance & Troubleshooting

The information in this chapter will enable you to:

- ❑ Maintain the system's components to ensure smooth, efficient operation
- ❑ Isolate and resolve system hardware problems

Problem Isolation

If your system does not function as you expect it to operate, you must identify and isolate the problem. When you accomplish this, you can effectively begin to resolve and eradicate the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to use them to replace existing components in your system to help identify the source of the problem.

Determine if the problem is mechanical, electrical, or software-related. Can you repeat or re-create the problem? Do not make quick rationalizations about the problems. Random events may appear to be related, but they may not be contributing factors to your problem. Carefully investigate and decipher the events that occur before the subsequent system problem.

You may be experiencing more than one problem. You must solve one problem at a time. Document all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you have isolated the problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If your system's problem persists, call Compumotor at 800-358-9070.

Motor Maintenance and Inspection

Since this motor does not use wear-prone parts, the following daily inspection is sufficient. Each inspection period varies with the environment and operating conditions. Furthermore, some parts that have been used for 20,000 hours or 5 years may need to be replaced, requiring an overhaul if there are many of them. When an overhaul or motor disassembly is required, call Compumotor (800-358-9068).

Inspection Item	Period	Inspection Details	Evaluation
Sound and Vibration check	Daily	Widen the motor rotating range as much as possible when the motor is checked audibly and by touching.	No change is found under daily inspection.
Insulation Resistance Measurement	Once a year	Separate the coupling from the driver, then measure the insulation resistance between the coil terminal and stator housing with an ohmmeter.	If it is more than 10 , it is OK. If it is less than 10 , consult Compumotor .

Resolving Motor Trouble

If motor trouble occurs, take the appropriate measures in accordance with the information in the following table. If the problem persists after corrective measures have been taken, stop the operation immediately and contact Compumotor. The table shows possible motor problems, their causes, what to inspect, and how to resolve the problem.

Trouble	Possible Cause(s)	Item to Inspect	How to Resolve
No motor torque	• No AC power is applied. • The fuse has burned out. • The servo on (SRVON) terminal is set to **H**. • The CPU reset (RST) terminal. is set to L • The integral capacitor reset (IRST) terminal is set to L • Fc, ILIM, DC gain is small	• Wiring inspection • Fuse inspection • Inspection • Inspection • Inspection • Inspection	• Apply the specified AC power • Fuse replacement • Set to L • Set to H • Set to H • Adjusted to an appropriate value
The motor does not move	• Under overload (error c.) • Incorrect external wiring	• Under no load • Inspect the wiring diagram in this manual).	• Reduce the load or use a larger motor • Rewire unit correctly (use connection
Motor rotation is unstable	• Wrong connection • The motor and driver combination is wrong	• Check Phase A, B, C, and GND connections • Check the numbers on the	• Rewire unit correctly (use connection diagram in this manual). • Match product(s) with appropriate component(s). Consult Compumotor.
The motor overheats	• Ambient temperatire is high • The motor is overloaded	• Check temperature (should be below 45°C) • Run the motor without its load	• Reduce the temperature (below 45°C). • When you start the motor, lighten the load, or replace existing motor with a large motor.
An abnormal sound is produced	• The unit is mounted incorrectly • The bearings are worn or damaged • The mounting base is vibrating	• The set screws are loose • Check for sound and vibration near the bearing • Check the mounting base	• Tighten the screws. • Replace the motor (contact Compumotor). • Reinforce the mounting base.
The position is dislocated rate	• The A/B Phase and U/D pulse jumper selections are wrong • The command pulse rate and width are not specified • Both ends of the feedback pulse transmission cable are not wired to the earth connector	• Inspect the A/B Phase and U/D pulse jumper selections. • Check the feedback pulse rate (3 MHz maximum) and the circuit response • If the ends are not connected, connect the driver to **AGND** and the controller to **SG**.	

Driver Maintenance and Inspection

Although the servo driver does not require daily maintenance and inspection, it is advisable to clean it and check for loose screws periodically. Overhaul the driver in the same way as the motor (i.e., after 20,000 hours or 5 years).

LED Displays

A 7-segment LED is mounted on the front panel of the driver to display the motor and driver's status. Display details are shown below.

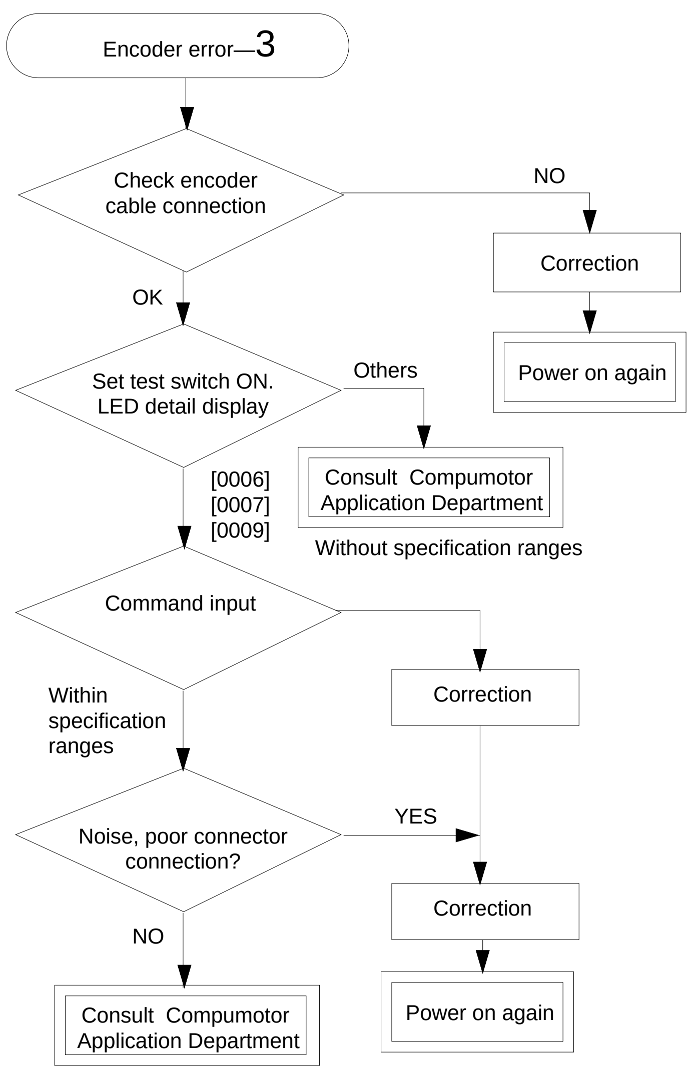
LED Display	Display Details	Cause/Measures
0 0.	• Servo OFF, normal status • Servo ON, normal status	
1 1.	• Servo OFF status after overspeed occurrence • Servo ON status after overspeed occurrence	• Encoder malfunctions • Command input trouble—check command input
2	• RAM error occurrence	• Control board trouble—requires repair
3	• Encoder error occurrence	• Encoder malfunction encoder cable wiring check • Connector trouble—check encoder cable connector • 0000 Open circuit (SIGØ,SIG1 stop) • 0001 Open circuit (SIG1 stop) • 0002 Open circuit (SIGØ stop) • 0006 Abnormal frequency (Smoother error)

		• 0007 Abnormal frequency (Incorrect interruption detected) • 0009 Abnormal frequency (Divided error)
5	• Power supply error	• Control power supply voltage trouble • Connector trouble—requires repair
6	• Counter overflow	• High acceleration/deceleration • High revolution—check command input
7	• ROM error occurrence	• Control board trouble requires repair
8	• Main power supply trouble	• Decrease in main power supply voltage • Fuse burnt out/replace the fuse
8.	• CPU stop	• Control borad trouble/requirement for repair **• Driver reset status**
9	• WDT error, Illegal interrupt, compulation overflow	• Control board trouble/encoder cable wiring check
A	• Power amplifier error	• High main power supply voltage • Bad connector contact—requires repair • Power board trouble—requires repair • 0001 Overvoltage (OOV) signal ON) • 0003 Over current (FAULT) signal ON
c.	• Overload occurrence (Servo ON status)	• Heavy load—review operation procedure • Motor locked status—locked status release
c	• Overload occurrence (Servo OFF status)	• Ambient temperature too high—reduce environmental temperature
OTHER	• Trouble of elements relating to LED output	• Control board trouble—requires repair

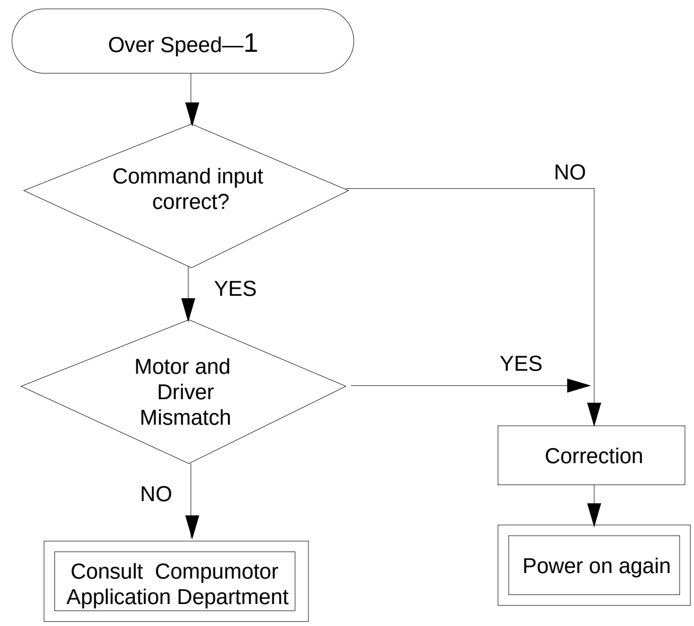
For engineering assistance, call Compumotor at 800-358-9070. For repairs, see below.

Procedure for Error Correction

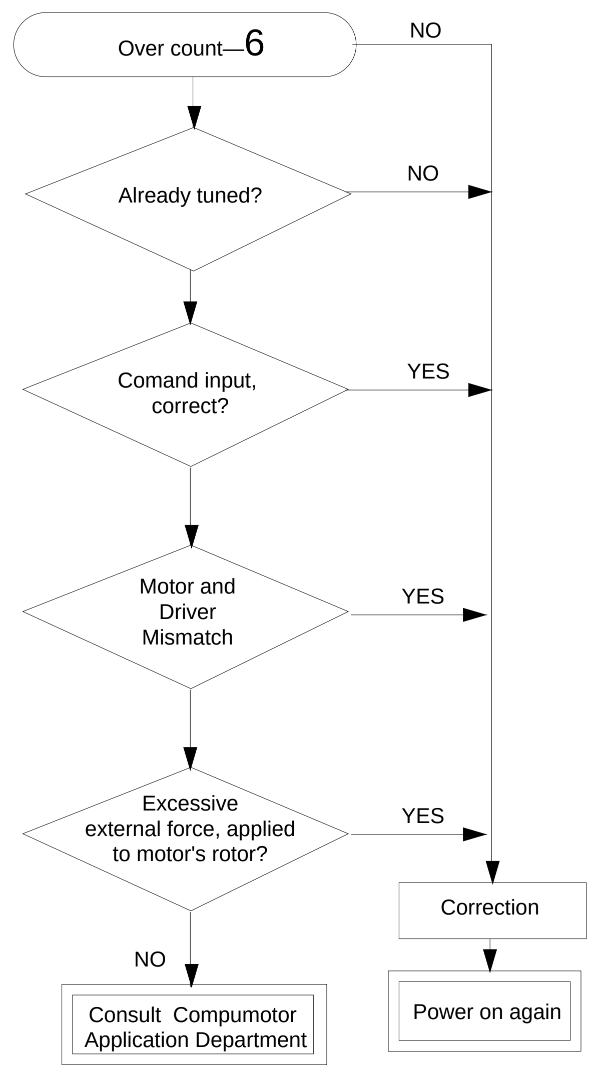
(1) Encoder Error



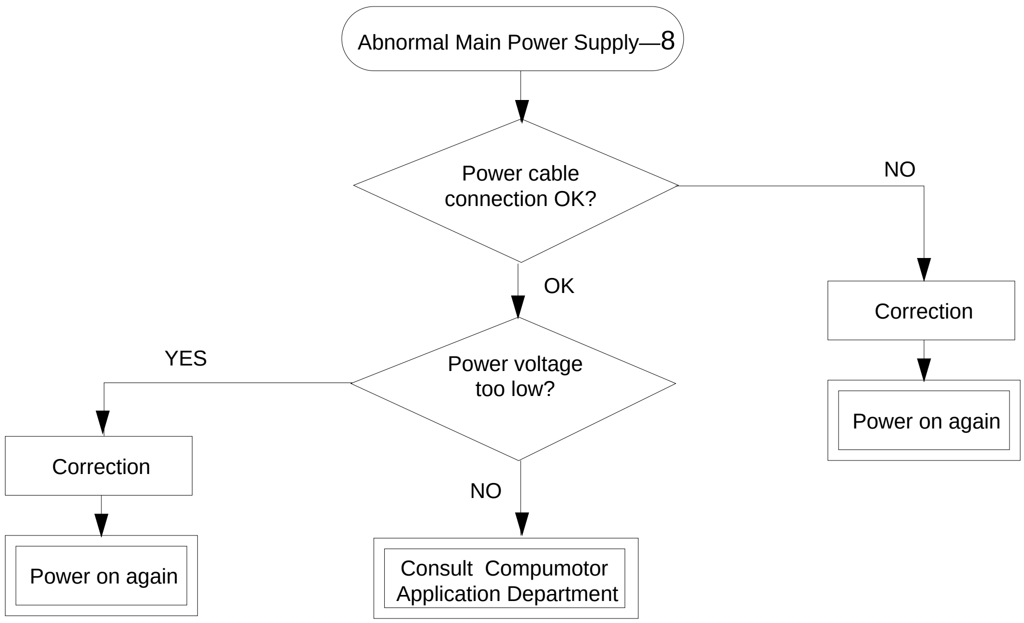
(2) Over Speed



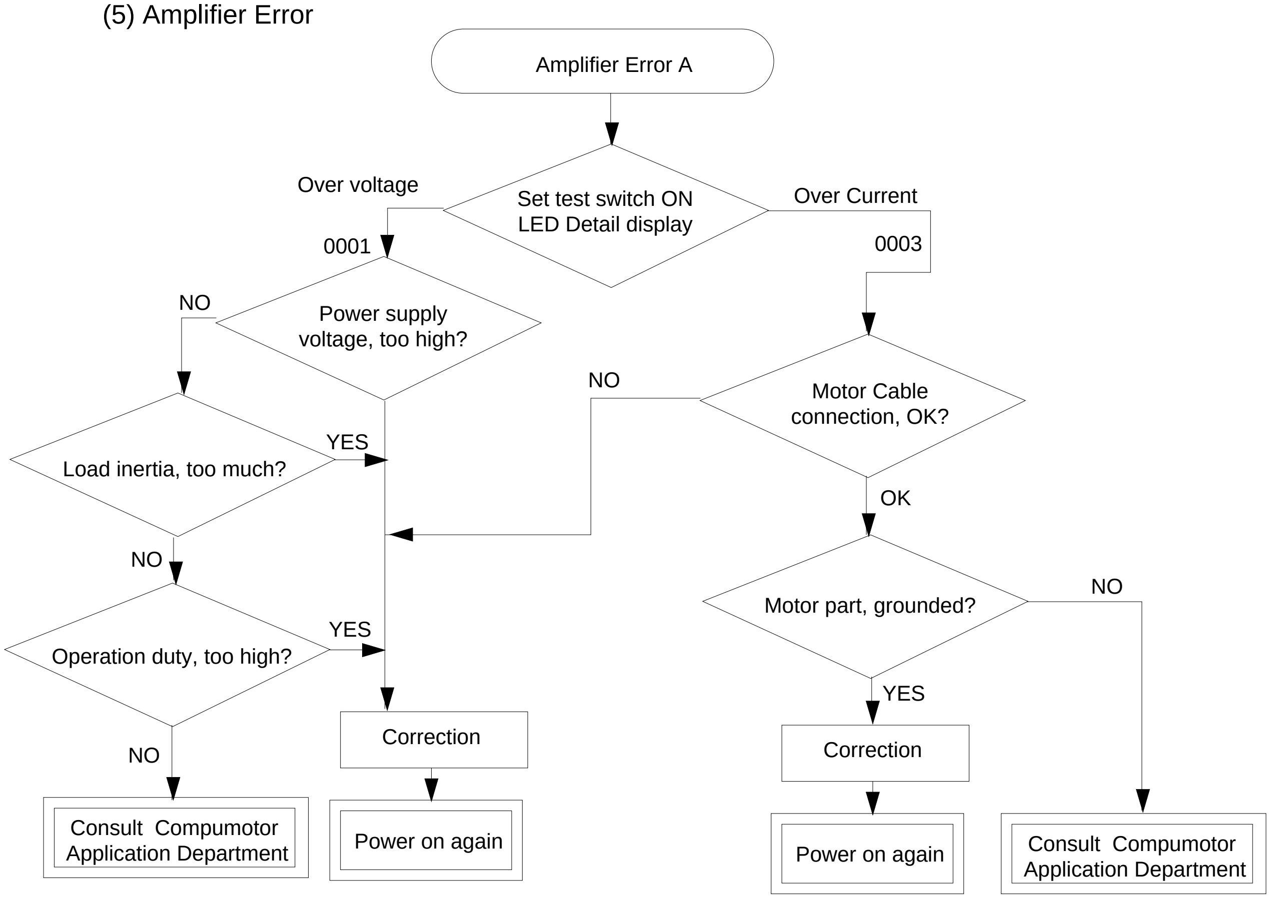
(3) Over Count



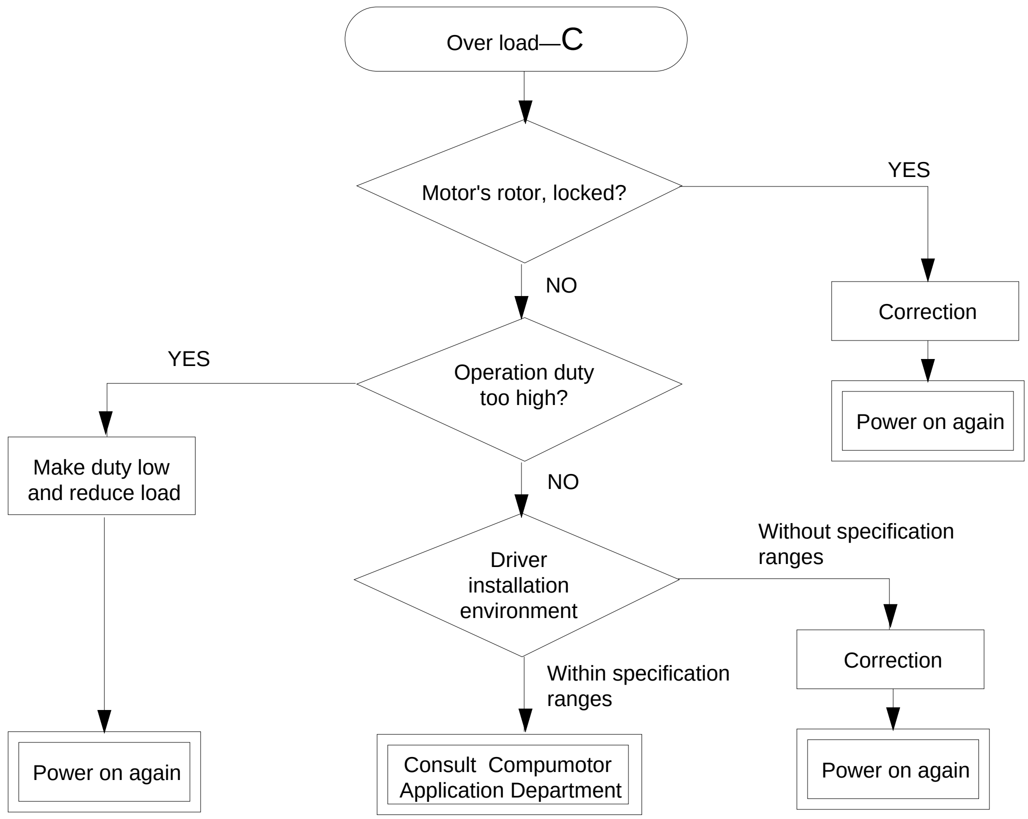
(4) Abnormal Main Power Supply



(5) Amplifier Error



(6) Over load



Returning the System

If your Dynaserv is faulty, you must return the drive and motor for replacement or repair. A failed drive can damage motors. If you must return your Dynaserv to effect repairs or upgrades, use the following steps:

Step ①

Get the serial number and the model number of the defective unit(s), and a purchase order number to cover repair costs in the event the unit is determined by Parker Compumotor to be out of warranty.

Step ②

Before you ship the drive to Parker Compumotor, have someone from your organization with a technical understanding of the Dynaserv and its application include answers to the following questions:

- ❑ What is the extent of the failure/reason for return?
- ❑ How long did it operate?
- ❑ How many units are still working?
- ❑ How many units failed?
- ❑ What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- ❑ How was the product configured (in detail)?
- ❑ What, if any, cables were modified and how?
- ❑ With what equipment is the unit interfaced?
- ❑ What was the application?
- ❑ What was the system sizing (speed, acceleration, duty cycle, inertia, torque, friction, etc.)?
- ❑ What was the system environment (temperature, enclosure, spacing, unit orientation,

contaminants, etc.)?
- ❑ What upgrades, if any, are required (hardware, software, user guide)?

Step ③

Call Parker Compumotor's Applications Engineering Department [(800) 358-9070] for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number.

Step ④

Ship the unit to: Parker Compumotor Corporation
5500 Business Park Drive, Suite D
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

Reducing Electrical Noise

For detailed information on reducing electrical noise in your system, refer to the current Compumotor Catalog.

Direct Drive Motors & Resonance

The major feature of the direct drive motor is its lack of a speed reducer. It therefore is fast, highly precise, and compact. On the other hand, because it is directly coupled to the load, it is easy for the load's mechanical resonance characteristics to find their way into the velocity control loop, causing oscillations in the velocity control system.

These oscillations may consist both of relatively low-frequency (several Hz) hunting and windup phenomena, and relatively high-frequency phase shift oscillations and mechanical resonances.

Although most low-frequency oscillations can be cured by driver adjustments, high-frequency oscillations require countermeasures such as improving mechanical rigidity, adding mechanical damping, and/or inserting compensation filters.

With high-frequency oscillations in particular, it is usual for there to be multiple resonance peaks, and to implement optimal countermeasures requires accurate location of the resonance frequencies by appropriate measurement methods.

The following table is a summary of the characteristics of the low-frequency oscillation phenomena (*referred to as oscillation or resonance*).

Oscillation Symptoms	Oscillation: Reasons/Conditions	Countermeasures
① Hunting	❑ Reason: Poor adjustment ❑ Frequency: Several Hz ❑ Conditions: f*p* fv Where f*p*: Position loop response frequency [Hz] fv: Speed loop response frequency [Hz] fc: Natural oscillation frequency [Hz] J: Load inertia [kg/m2] G: DC gain [multiplier] K: Constant (see attached table)	❑ Make f*p* < 2.5 fv
② Windup	Reason: Poor adjustment procedure). ❑ Frequency: Several Hz ❑ Conditions: May occur when load is great (load inertia <JL> is 10 times or more motor's rotor inertia <JM> and integral limiter <LIM> or <fc> is large, and large deviation is imposed by a step input, etc. *Since windup may sometimes not appear in Test mode, if <JL> is 10 or more times <JM>, you should impose a large deviation —10° or more—by external force or other means to check for it.*	❑ Reduce <LIM > (see adjustment ❑ Load inertia is too great. [Load multiple <K> guidelines] DM: 50 to 150 DR: 70 to 500
③ Phase Shift Oscillation	❑ Reason: Phase shift due to filter insertion. ❑ Conditions: Letting f*p* be the frequency at which the actual motor velocity is 180° phase-shifted relative to velocity command, oscillation occurs at f*p* if f*p* < fv.	❑ Insert compensating shift insertion phase-advancing filter into velocity loop to lower f*p*. *A compensation filter should not be inserted if fv > 40 —instead, lower the DC GAIN.*

② Resonance	❑ Reason: Due to mechanical resonance. ❑ Frequency: 100 Hz to 2 kHz ❑ Conditions: Load mechanical resonance characteristics enter into velocity control loop, and velocity control system oscillates. Multiple resonance points are frequent.	❑ Increase mechanical rigidity to lower resonance peak valueS. ❑ Fit mechanical dampers to lower resonance peak values ❑ Add resonance compensation filters to lower resonance peak values.

Resonance Measurement Methods

Measurements of oscillatory phenomena are performed by measuring the transfer function for speed control in the Velocity P Control mode using a signal analyzer (FFT analyzer). When these measurements are performed, either a random waveform or sine wave signal can be input as the **VIN** signal.

If an FFT analyzer is not available, the resonance points can be found by applying the output of a sine wave generator to the analog velocity input, and monitoring the velocity signal (**VEL**) on an oscilloscope while varying the generator frequency.

Resonance Counter Measures

There are three counter measures for the resonance phenomena generally referred to as *mechanical resonance* (items ③ and ④ in the previous table).

① Increase machine rigidity to reduce resonance peak values.

② Fit dampers in the mechanical systems to reduce resonance peak values.

③ Insert machine resonance compensation filters to reduce resonance peak values.

These measures should be implemented in the order listed.

Mechanical Rigidity

Increasing the mechanical rigidity requires increasing the structural rigidity of the device. You should begin by minimizing play and looseness at all connections to raise the overall rigidity of the machine as a whole. In addition, you should also increase the rigidity of the individual structural components, posts and arms. An arm using a honeycomb or ribbed structure, for example, is more effective from a rigidity standpoint than a hollow construction. Although increasing the rigidity may give rise to new resonances at higher frequencies, such cases can be dealt with by the measures described in the sections that follow.

Dampers

A damper is a mechanical means for absorbing and attenuating resonant energy. Dampers generally consist of a rubber pad and deadweight. A damper's resonance frequency can be varied by changing the thickness and material properties of the rubber pad, and the weight of the deadweight. The following rules should be observed.

Damper resonance frequency = Equipment resonance frequency

Although the heavier the deadweight, the greater the energy absorption, the lowest limit is established by the following condition:

Deadweight weight > 1 kg

The damper mounting location should meet the following specification:

Directly above (or below) the individual axis motor

Resonance Compensation Filters

Generally, the term *compensation filter* refers to a filter of circuit configuration that compensates for resonance characteristics.

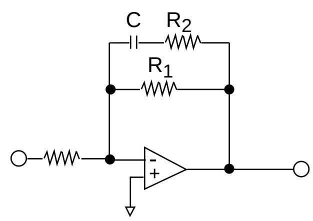
- ❑ First-order lag filter
- ❑ Notch filter

First-Order Lag Filter

This filter can reduce a resonance peak within the velocity band, due to its small phase lag. The transfer function and circuit are shown in the figure below. As can be seen from the characteristics for various values of frequency ratio, increasing n too greatly reduces the phase margin, so fd1 cannot be set very small.

In the actual circuit, n can be set to about 4, and fd1 and fd2, respectively, can be set to 20/80 Hz, 30/120 Hz, or 40/160 Hz by selection with jumpers provided; in addition, separate terminals are provided so that any desired values for C and R2 can be
soldered in.

In general, the first-order lag filter is an effective countermeasure for resonances around 100 Hz; its circuitry is built into the same board as the notch filter.

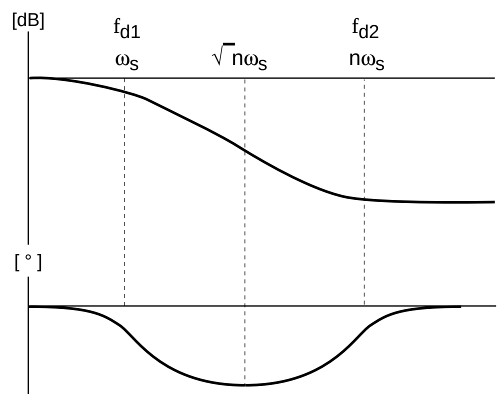


$n = (R_1 + R_2) / R_2$

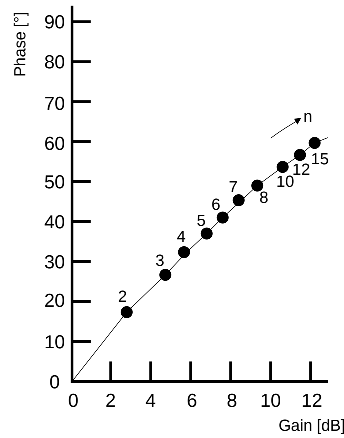
$\omega_S = 1/ (R_1 + R_2)\ C$

$n\omega_S = 1/ R_2\ C$

First Order Lag Filter Circuit



First Order Lag Filter Transfer Function

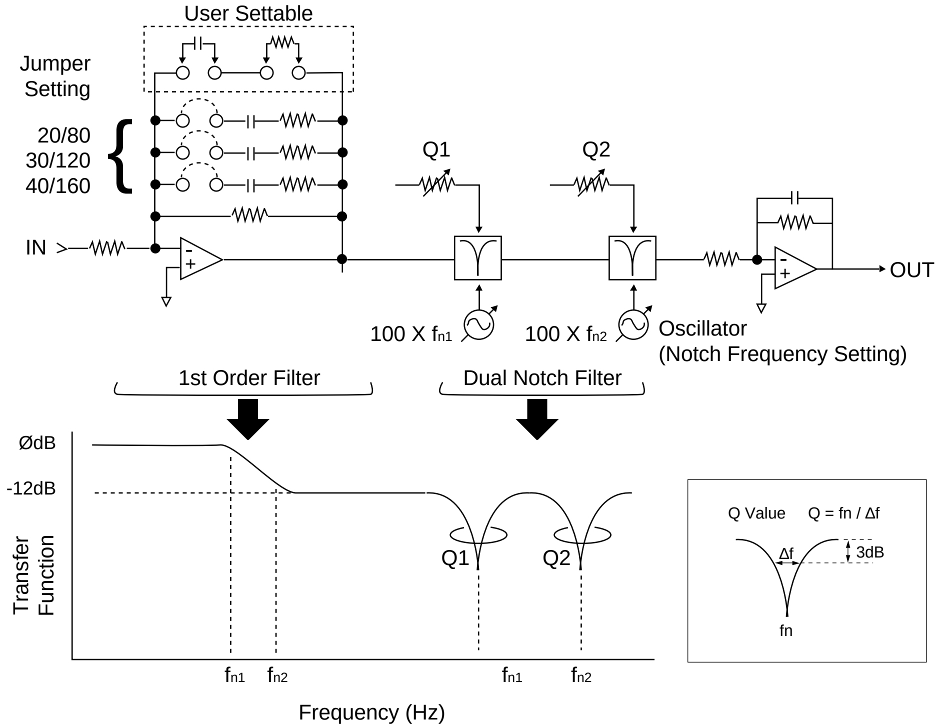


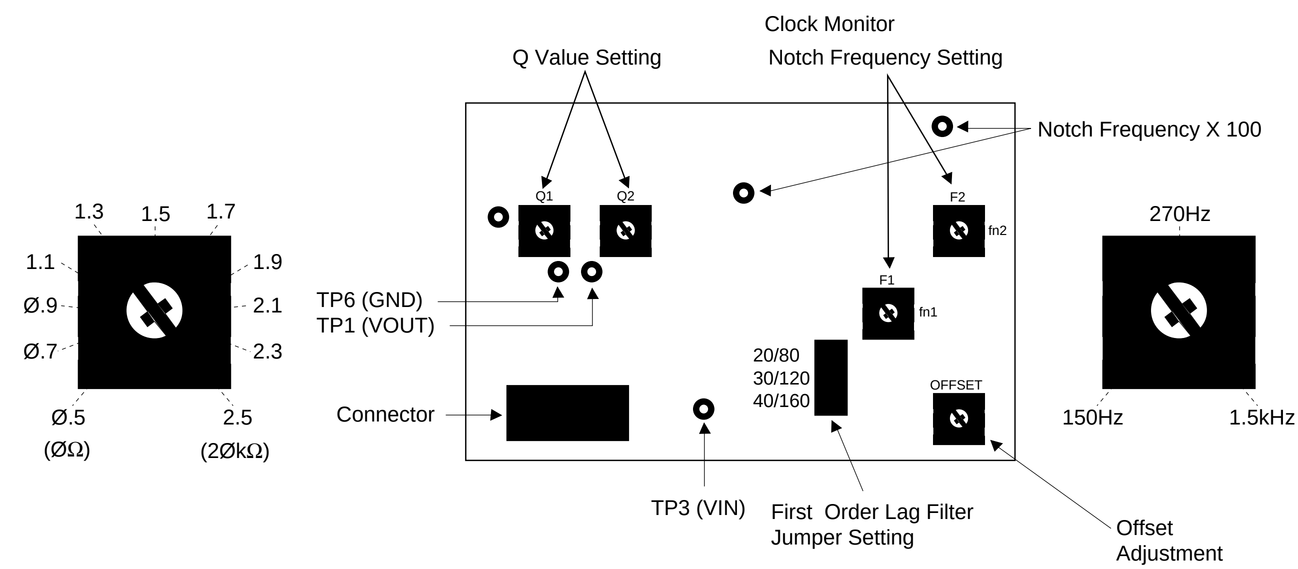
Relationship of Frequency Ratio n, Phase, and Gain

Notch Filter

The notch filter circuit configuration is shown in the next figure. The notch filter board is shown in the subsequent figure. This filter is effective for suppression of high-Q resonances at 100 Hz and above. A switched capacitor filter is used for the circuit, and the notch frequency and Q values can be set within a predetermined range.

From a circuit configuration standpoint, dual types providing two stages for notch frequency are typical, and in this case the first-order lag filter section is built into this construction.





Adjustment Procedures

Since the offset voltage will change when the settings of pots Q1 and Q2 are changed, you should adjust the offset adjustment pot (**VR1**) so that the voltage difference between TP1 (**VOUT**) and TP3 (**VIN**) does not exceed 50mV. When taking signals from
TP1, TP3, and TP6, be careful not to touch any other pins or parts of the pattern.

General Filter Specifications

Item	**Specification**
System	Dual switched-capacitor notch filter+ first-order lag filter
Dimensions(mm)	$75 ~ 40 (board size)
Interface	DM series: Directly installed on control board
	DR series: Connected by 10-pin connector to control board
Power Supply	±15V, 50 mA

Input Voltage Range	±10V
Output Offset Voltage	±100 m max (0 to 50°)

Notch and First-Order Filter Specifications

Notch Filter Section		**First-Order Lag Filter Section**	
Item	**Specifications**	**Item**	**Specifications**
Notch Frequency Setting Range	150 to 1.5 kHz	Jumper Pin Setting	20/80 Hz 30/120 Hz 40/160 Hz
Q Value Setting Range	0.5 to 2.5	Setting via user-added resistor capacitor	Solder in locations: • C (C18) • R (R21)
Notch Frequency Monitoring Terminal	**TP 4:** Stage 1 Frequency X 100 (TTL level) **TP 5:** Stage 2 Frequency X 100 (TTL level)		

Resonance Analysis Example

Oscillation in a servo system may not be due to a resonance peak. Oscillatory limits are also determined by phase margin and gain margin. Therefore, when resonance compensation filters (first-order lag and notch) are used, attention must be given to amplitude *and* phase margin. Particularly in robots, this may vary according to the arm posture. The worst case considered when designing the system.

Eliminating Resonance

The following table summarizes the sources of vibration and the ways that you might eliminate resonance from your system.

Vibration Location	Resonance Frequency	Problem	Counter Measure
Base	39 Hz	Servo rigidity reduction due to absorption	❑ Increase base rigidity ❑ First-order lead filter
Bearings motor)	79 Hz	Has resonance peak (bearing section Moment mode)	❑ Mechanical damper (on ❑ First-order lag filter
Arm filter	134 Hz 276 Hz	Has resonance peak	❑ Increase arm rigidity Notch

Resonance Tuning

The following is a procedure of suppressing resonance (vibration) in a Dynaserv application without the use of FFT Analyzer or Oscilloscope. The purpose is to adjust the Dynaserv for optimum tuning (high gain, stiffness, responsiveness) with no resonance.

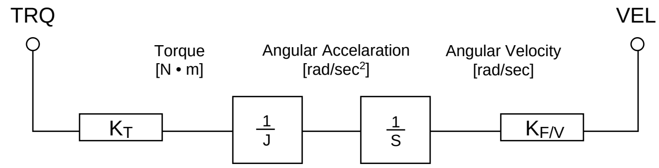
1. This procedure is done in the Position mode.
2. Set the Fc and I.lim to 3.
3. Set Test Switch to ON (up position).
4. On the Notch Filter board set Q1 and Q2 to 1.5 (mid position).
5. Increase the DC Gain until resonance occurs.
6. On the Notch Filter board adjust F1 to null (tune-out) the resonance. If resonance is very close to the same frequency as the first, tune it out with the same pot (F1). If not use F2 pot.
7. Repeat steps 5 and 6 until the DC Gain can no longer be increased without resonance.
8. Repeat steps 5, 6, and 7 adjusting F2 on the Notch Filter board.
9. Depending on the mechanical conditions of the application additional filtering may be necessary. If resonance persists use the 1st Order Lag Filter (20/80, 30/120, 40/160) jumpers. Use one of these jumpers to minimize resonance then repeat steps 5 - 8. (Go to step 11).
10. Increase the DC Gain until resonance occurs, then try nulling it out with the 1st Order

Lag Filters (jimpers 20/80, 30/120. 40/160) on the Notch Filter board. Repeat steps 5 - 8 until

maximum gain is obtained without resonance.

11. Optimize the system tuning by increasing Fc and ILim.

Torque Constant and F/V Gain



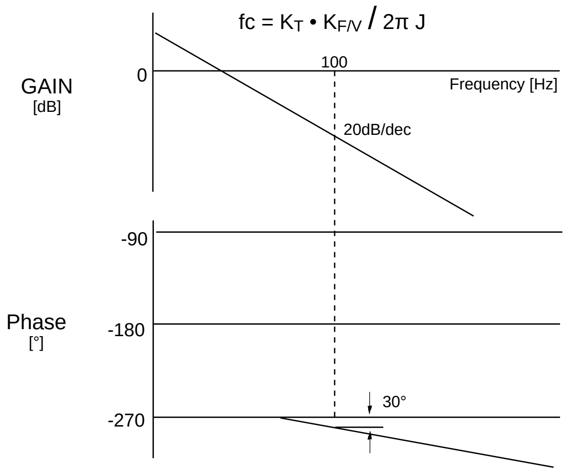
K_T: Torque Constant [N • m/V]

$K_{F/V}$: F/V GAIN [V/rad/sec]

J: Inertia [kg-m^2]

S: Angular Velocity [rad/sec]

The above figure illustrates the transfer function between torque (**TRQ**) and velocity (**VEL**) when no resonance is present.



The following tables contain the $K_{F/V}$ and K_T values for DM and DR Series motors respectively.

Motor Type:	DM Series	KF/V **[V/RAD/S]**	KT **[Nm/V]**
	DM1050A	0.796 (5V/2)	3.92
A Type	DM1100A		7.85
	DM1150A		11.77
	DM1200A		15.7
	DM1015B	0.398 (5V/2 • 2)	1.97
B Type	DM1030B		3.94
	DM1045B		5.91
	DM1060B		7.88

Motor Type:	**DR Series**	**KF/V [V/RAD/S]**	**KT [Nm/V]**A
Type	DR1050A	0.53 (5V/2 • 1.5)	4.86
	DR1100A	0.796 (5V/2)	9.72
	DR1150A		14.58
	DR1200A		19.44
	DR1300A		29.17
	DR1400A		38.89

E Type	DR1070E	0.398 (5V/2 • 2)	4.91
	DR1100E		7.37
	DR1130E	0.796 (5V/2)	9.83
	DR1160E		12.28
	DR1220E		17.19
	DR1250E		19.65
B Type	DR1008N	0.398 (5V/2 • 2)	1.202
	DR1015B		2.04
	DR1030B		4.08
	DR1045B		6.11
	DR1060B		8.15

Motor Type:	**DR Series**	**KF/V [V/RAD/S]**	**KT [Nm/V]**A
Type	DR5030B	.159	3.52
	DR5050B	.159	4.69
	DR5070B	.159	5.87

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