for a greener tomorrow

MITSUBISHI ELECTRIC
Changes for the Better

One-Touch Tuning:
Not Your Average Auto-Tuning

WHITE PAPER

Maximizing Machine Performance With One-Touch Tuning

TABLE OF CONTENTS

One-Touch Tuning: Not Your Average Auto-Tuning

One-Touch Tuning takes the pain out of the auto-tuning process by combining the best practices of servo axis tuning and enabling OEMs to automatically set all control parameters at the touch of a button.

Vibration is a fact of machine life. Servo motors and drives especially have to cope with resonant frequencies from many sources, including the load inertia and stiffness characteristics of the machine frame and base. Servo drives with auto-tuning capabilities can go a long way toward reducing or eliminating the troublesome vibrations that arise from any resonances in the system.

Yet even with auto-tuning capabilities built into many modern drives, OEMs don't always have the time or technical know-how to correctly tune their servos for optimal vibration reduction and overall performance. This tuning barrier often delays the commissioning of new machines and interferes with the smooth operation of existing machines.

One-Touch Tuning takes the pain out of this process by combining the best practices of servo axis tuning and enabling OEMs to automatically set all control parameters at the touch of a button.

What Is One-Touch Tuning?

Mitsubishi Electric's One-Touch Tuning sets gains and filters in real-time. The function involves continuous tuning over the lifecycle of the machine, optimizing gains, minimizing setting time and eliminating overshoot. Users begin by simply clicking the start button. Then One-Touch Tuning performs all adjustments automatically to maximize servo machine performance—including estimating the load-to-motor inertia ratio, adjusting gain, suppressing machine resonance and setting responsivity.

The result? Smooth and accurate machine movement that is precisely controlled and free of vibration.

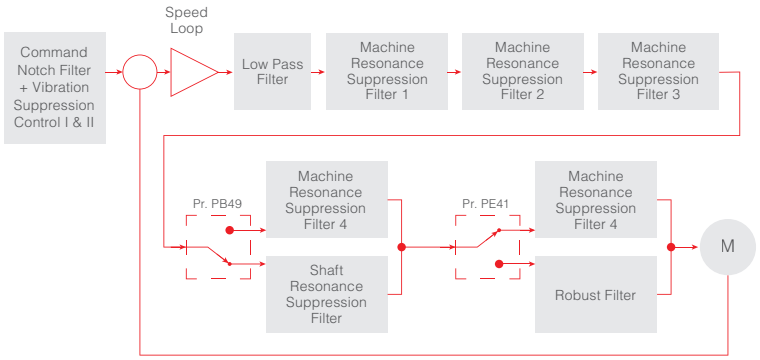
Case Example: The MR-J4

For more complicated tuning requirements, One-Touch Tuning works well when it is used in conjunction with traditional auto-tuning. Only by using the two functions together will users receive the highest performing, most efficient results.

Take, for example, Mitsubishi's MR-J4 drive. First, users initiate One-Touch Tuning to set up simple parameters. Then, they employ auto-tuning capabilities for more complex tuning requirements. Model loops create an ideal motion profile and provide information about the mechanical system. Using a series of highly specialized filters, the auto-tuning function then weeds out unwanted vibration and resonances—enabling smooth, fast and reliable position and speed control.

Again, key to the MR-J4 is its holistic approach to servo axis tuning: One-Touch Tuning automatically and quickly sets control parameters at the push of a button. Auto-tuning then analyzes the machine over a few cycles and filters the signal to eliminate any vibration frequencies from occurring. At the same time, it continuously identifies and compensates for any position and speed errors introduced during each move.

The combined effect of these approaches keeps machine wear and tear to a minimum, delivering the load to its commanded position during each move.



One-Touch Tuning addresses the many sources of machine resonance with highly specialized filters and state-of-the-art digital signal processing.

One-Touch Tuning: Not Your Average Auto-Tuning

How One-Touch Tuning Filters Eliminate Resonance

One-Touch Tuning addresses the many sources of machine resonance with highly specialized filters and state-of-the-art digital signal processing.

The first set of filters takes care of any vibration and resulting resonances stemming from the machine frame, base and static load inertia. These filters include some first-pass vibration suppression filters—perhaps a boost from a command notch filter and a low-pass filter to get rid of any high-frequency screeching due to turning up the gain too high on the drive. These initial vibration suppression filters are critical to taking care of basic system resonances and decreasing settling time.

Beyond these early filters, an additional set of filters seeks to suppress machine resonance resulting from mechanical components, such as couplings, belts, ball screws and drive shafts. These machine resonance filters cover frequency bands of approximately 10 to 4,500 Hz.

Other specialized filters are also available to address machine resonance that crops up from changing work environments. For example, consider a machine build that takes place in a warm factory. Everything is set up perfectly, including the drives. The machine then enters service in a much colder environment where belts shrink and lubricants change viscosity.

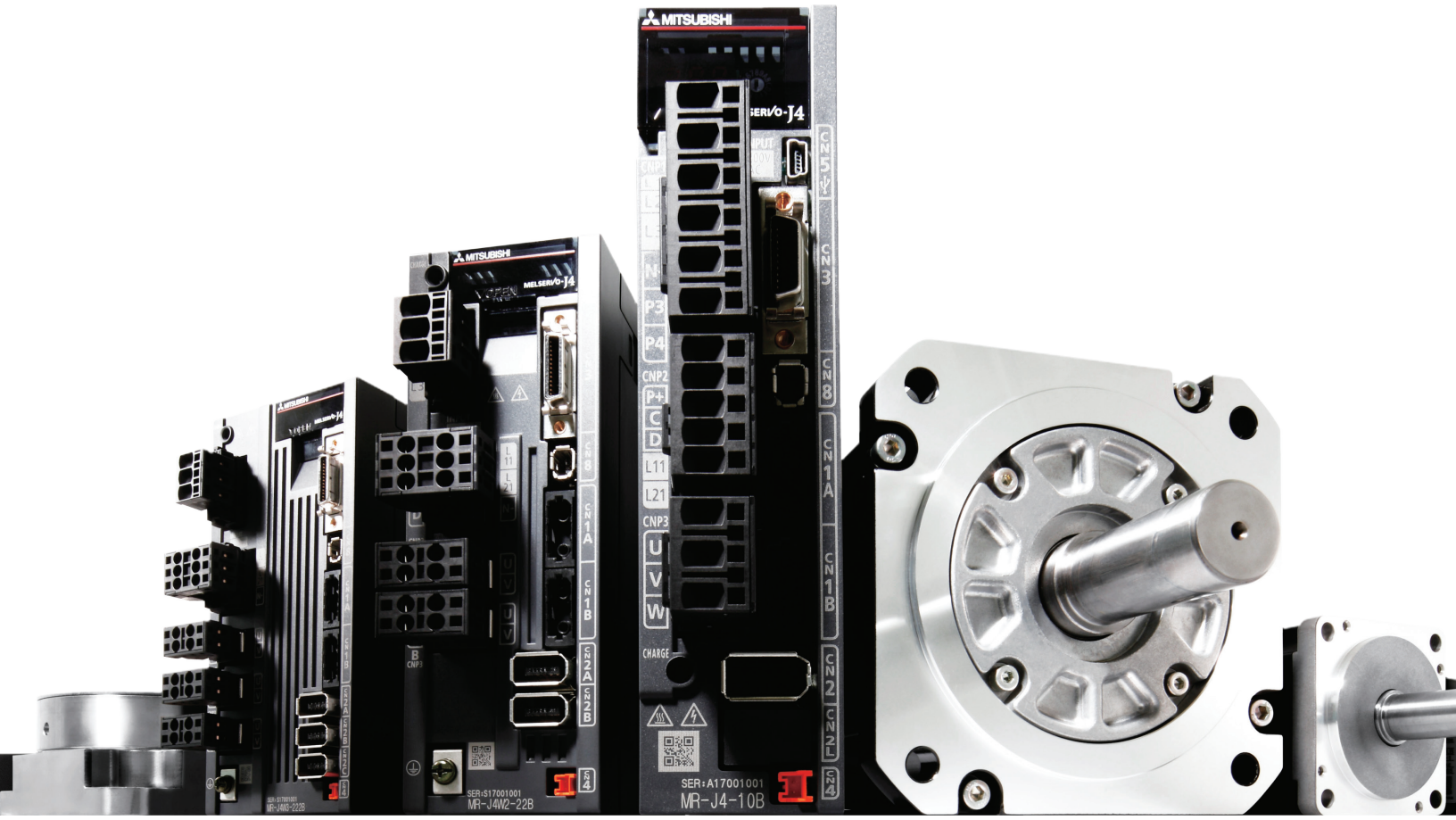
Mitsubishi's MR-J4 drive employs both One-Touch Tuning and traditional auto-tuning, yielding high-performing, efficient results.

Employing Specialized Filters

One-Touch Tuning utilizes comprehensive filter options (see sidebar) that address several areas of the machine and system—from the machine frame and shaft resonance, to static and dynamic load inertia, to resonances induced by mechanical components.

To achieve vibration-free motion, for example, the MR-J4 uses the following combination of special filters:

- ***Vibration Suppression Control I and II*** remove vibration in both the load and machine base to shorten cycle times. Automatic configuration covers 1 to 100 Hz; manual settings cover 1 to 300 Hz.
- ***Command Notch Filter*** deletes resonant frequencies from the command before they cause vibration and acts like a third vibration-suppression control filter. This filter covers a frequency band of 4.5 to 2,250 Hz.
- ***Low Pass Filter*** removes high-frequency singing from systems with high response levels. It also filters out screeching sounds from the motor and works on frequencies of 100 to 18,000 rad/s.
- ***More Machine Resonance Suppression Filters*** remove resonance due to backlash and flex in mechanical components, such as couplings, gearboxes, ball screws, belts and drive shafts. Filters I, II and III are independent, while Filters IV and V can be used interchangeably with a special shaft resonance suppression filter and robust filter. These filters cover frequencies of 10 to 4,500 Hz.
- ***Shaft Resonance Suppression Filter,*** which cannot be used at the same time as Filter IV, removes high-frequency resonance caused by torsional flexing of the motor shaft. It covers frequencies of 290 to 4,500 Hz.
- ***Robust Filter***, which cannot be used at the same time as Filter V, is designed to help with high inertia/low stiffness systems. It introduces a small command delay or phase offset to reduce instability.



With Mitsubishi Electric's One-Touch Tuning, control parameters are adjusted in real time, and the inevitable resonant frequencies experienced by servo systems are automatically identified and filtered.

Summary

With Mitsubishi Electric's One-Touch Tuning, OEMs can minimize the time-consuming auto-tuning process at the touch of a button. Control parameters are adjusted in real time, and the inevitable resonant frequencies experienced by servo systems and drives are automatically identified and filtered. The result is a precise, vibration-free positioning process with just one click. This tuning function leads to significant time savings in commissioning servo drives and getting machines up and running quickly without the need for a control expert or additional measurement devices.

For help with servo drive selection and auto-tuning comparisons, Mitsubishi Electric's engineering team is available for advice and consultation. Contact **Mitsubishi Electric at 847.478.2100** or visit us at **us.MitsubishiElectric.com/fa/en** to learn more.

MITSUBISHI ELECTRIC AUTOMATION, INC.
500 Corporate Woods Parkway, Vernon Hills, IL 60061
Ph 847.478.2100 • Fx 847.478.2253
us.MitsubishiElectric.com/fa/en

L-VH-00108