

Applying Harmonic Input Filters

Basic Guidelines for Application with Yaskawa AC Drives

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It is well known that PWM drives consume current in a discontinuous manner and therefore, generate harmonics on the input power supply. The Yaskawa iQpump1000/P1000 drive is no different. Current passes through the diode converter rectifier section only when the AC input voltage exceeds the DC bus voltage level. This results in “pulses” of input current rather than continuous current flow. To minimize these harmonics generated by the iQpump1000, DC link chokes are incorporated in models 2A0110 (200V class), 4A0058 (400V class), 5A0041 (600V class) and larger. The link chokes “widen” the current conduction period, resulting in significant reduction in harmonics. Nonetheless, current harmonics continue to exist. Current harmonics on the order of 35% can be expected with drives that incorporate DC link chokes..

In cases where further reduction in harmonics is desired, harmonic filters can be used. Yaskawa drives are compatible with standard off-the-shelf filter solutions manufactured by MTE, TCI, Artech and Mirus International. However, some additional programming may be needed when implementing a filter solution.

Proper steps have already been taken with packaged solutions supplied by Yaskawa. These steps may include optimized programming and testing to ensure compliance with required specifications. Follow these guidelines to minimize the potential for any issues when off-the-shelf filter solutions are integrated with Yaskawa drives.

Passive harmonic filters incorporate inductors, resistors, and capacitors to perform harmonic attenuation. As a result, the filter output voltage level can be expected to change as the load changes. Under light loading, the voltage level may elevate above nominal due to a leading power factor created by the capacitors. Under heavy load, the voltage level may decrease due to the drop across the filter inductors. This voltage change directly influences the drive’s DC bus voltage level. Filter manufacturers take steps to minimize the effect the filter has on the drive’s DC bus voltage and rarely are problems encountered. Nevertheless, the filter manufacturer can often provide direction should any anomalies arise.

Drive programming may be required to accommodate the change in bus voltage. This includes using V/Hz control (A1-02=1) and programming the base and maximum voltage settings (E1-13 and E1-05) to levels that the DC bus can support. This typically involves setting E1-05 and E1-13 to 230V or less for 200V class models, 460V or less for 400V class applications, and 575V or less for 600V class applications. In addition, torque compensation should be reduced or disabled altogether using parameter C4-01. Setting C4-01 to 0.0 will eliminate voltage boost (set to 0.0 when using V/Hz control only, otherwise leave C4-01= 1.0 when using OLV control). The goal is to ensure the drive output voltage does not exceed a level that the DC bus cannot support, thereby avoiding a saturated PWM waveform. If unsure of the voltage settings to use, observe the DC bus voltage using drive monitor U1-07 while operating under worst case load condition at full speed. Set E1-05 and E1-13 no higher than the minimum value observed in U1-07/1.414.

For example, if U1-07 = 625V as minimum, set E1-05 = E1-13 = 440V (625/1.414) as maximum. Furthermore, the maximum voltage settings should be set to accommodate any expected bus voltage decrease due to line voltage sags. A sagging supply voltage will also reduce available drive output voltage. Consult the factory when in doubt.

Next, be sure to observe the input current using a clamp-on ammeter on each of the three input (supply) lines while operating at full speed and full load. The current should be balanced among all three phases. In addition, the current should be stable for a stable operating load condition (steady speed and load condition). Input current imbalance may indicate input voltage imbalance exists. Be sure to confirm the input voltage is balanced at the drive input terminals R, S, and T. Measure both phase to phase and phase to ground voltages to confirm they are as expected. Consult the filter manufacturer should voltage imbalance be encountered.

Fluctuating input current with a stable output load current could indicate resonance exists. If input current fluctuations are observed, first make sure the output voltage as observed using drive monitor U1-06 does not exceed U1-07/1.414 as mentioned previously. Use the previously mentioned parameters to eliminate PWM saturation. In addition, make sure the voltage reading in monitor U1-06 is stable for a stable operating frequency. If the output voltage remains below the calculated level using U1-07 and input current oscillations continue, adjustment to the drive's voltage regulator may be required.

The drive's Automatic Voltage Regulation (AVR) feature adjusts the PWM pulse width in accordance with the DC bus level. The pulse width is slightly adjusted to maintain the desired output voltage as the DC bus level changes. Under some conditions, the AVR feature may interact with the changes in bus level influenced by the filter. Oscillations may result. Here it may be necessary to increase the AVR feature filter time. This requires access to factory level parameters to increase parameter N9-10. Setting parameter N9-10 from 1.0 (factory default setting) to approximately 10.0 may be required. This needs to be set by a Yaskawa authorized service partner. After setting, they can confirm the oscillations no longer exist by making sure the input current is stable.

Associated Parameter List

<u>Parameter</u>	<u>Description</u>	<u>Recommended Setting</u>
A1-02	Control Method	0 (V/F control)
E1-05	Maximum Voltage	230/460/575V or less (depends on minimum bus voltage level)
E1-13	Base Voltage	230/460/575V or less (depends on minimum bus voltage level)
C4-01	Torque Compensation Gain	0.00 (eliminates voltage boost, use for V/F control only)
N9-10	AVR Time	10.0 ms (voltage regulator response time)
U1-06	Output Voltage Reference	Displays drive output voltage (motor voltage)
U1-07	DC Bus voltage	Displays drive DC bus voltage level

Yaskawa drives are successfully being integrated with numerous filtering configurations today, a few of which are mentioned in this document. Understanding the effect the filter may have on the drive and programming the drive accordingly will allow the configuration to operate optimally and provide best-in-class service life.

Consult the factory with any questions.

