Interpreting sigma and PE current

- Sigma current and/or PE current flow through the bearings and shaft.
Diagnostic benefits

Avoid damage to bearings from stray current.

Fluting of a bearing race caused by bearing currents.

Photo courtesy of Electro Static Technology.
What are output reflections?

Reflections:
• Occur as a result of impedance mismatch or change in the circuit.
• Have a wide range of waveforms, amplitudes, and durations.
• Show up as spikes on an oscilloscope display.
Measuring output reflections

- Fast output transients and reflections on pulse width modulated waveform can only be measured with an oscilloscope.
- Attach to motor terminals
Interpreting output reflection measurements

- Reflections or transients > 50% of nominal voltage are problematic.
- Fast switching DC voltage from the IGBT (dV/dt).
- Reflections of the PWM signal as a result of a too long cable.
- Make sure the level does not exceed the motor insulation rating.
Diagnostic benefits

- Prolong motor drive and motor life.
- Reduce potential of winding insulation breakdown.
- Avoid tripping overvoltage circuits.
What is a disturbance?

Signal disturbances are signal integrity deviations induced onto low voltage digital network signals.
Measuring disturbances

• Look for disturbances that correlate with other devices on the plant floor.
• Is a big load elsewhere turning on and causing the problem?
Interpreting disturbance measurements
Diagnostic benefits

• Prevent irregular signaling problems.
• Identify wiring and power problems elsewhere in the plant.
What is volt per hertz ratio?

- The ratio of voltage to frequency determines the amount of torque produced by an AC induction motor.
- By keeping this ratio constant the magnetic field inside the motor is kept at a constant level which results in a constant torque.
Measuring volt per hertz ratio

- DMM with Vpwm option or oscilloscope with pwm function.
- Vpwm: Reflects the amplitude of the fundamental frequency
- Use current clamp to measure the frequency
Interpreting volt per hertz ratio measurements

• If V/Hz ratio is correct but the speed is off, check the drive program
• An incorrect volts-per-hertz ratio can create a variety of problems
  • High: motor will overheat
  • Low: Loss of torque
  • Unstable: rough running motor and loss of torque
  • Unstable frequency: Varying speed of the motor.
  • Fluctuating in tandem: potential loss of torque.
Diagnostic benefits

- Reduce excessive heating.
- Prevent a loss of torque.
Diagnostic shutdown

Shutdown systems to solve the problem
Steps in a diagnostic shutdown - when the system stops running

- Isolate motor from drive
  1. Verify Drive proper operation
  2. Check motor cabling, connections
  3. Perform insulation test on motor/cabling
Check motor cabling

- Potential problem: Motor cables or connections between drive and motor
- Check each cable connection for tightness
- Perform insulation resistance test on cables and connections
- Check winding resistance
Motor winding insulation

- Current unbalance can be caused by bad wiring or insulation problems within the motor.
- To check the motor for insulation problems, disconnect the motor and do an insulation resistance test.

We can do a detailed motor insulation test by removing the delta/wye interconnection strips inside the motor terminal box.
Quiz on output side troubleshooting

Q: What can be damaged by excessive sigma current?
A: Bearings and shaft of the motor.

Q: What can excessive PWM waveform reflections cause?
A: Eventual motor winding insulation breakdown

Q: What are the three steps in checking a diagnostic shutdown?
A:
- Verify Drive proper operation
- Check motor cabling, connections
- Perform insulation test on motor/cabling