APPLICATION NOTE #120

Motor Test Systems
No load AC Motor run-up testing

Introduction

AC motor manufacturers are constantly challenged to provide a high quality product. This generally requires some form of testing for each motor or a representative sample of each production run. Many manufacturing defects that may lead to motor failure down the road cannot be tested unless a load is applied to the motor during test. This presents a problem in a high volume production environment, as increased test times reduce throughput.

Many motor test systems in use today require connection of the motor shaft to a dynamometer or some other inertia device to create a mechanical load during motor test. California Instruments has developed a no load run up motor test analysis method using its Motor Test System (MTS) which is capable of detecting several quality or manufacturing defects without the need for a mechanical load.

This application note describes the principles used and uses data based on actual motors - both good and bad - that were tested using this approach.

MTS Architecture

The California Instruments Motor Test System (MTS) consists of a high speed, PC based power analyzer. A 19 inch rack-mount signal interface unit is used to connect the motor input to the output of a programmable AC power source. This unit sends real-time voltage and current signals to a fast data acquisition card located in a nearby PC. All data acquisition is done in the PC using a Digital Signal Processor (DSP) to process the data and stream it to the PC's hard drive.

Since all data is recorded on disk, post acquisition analysis can be done at a later time if needed. The MTS calculates all relevant parameters; i.e. RMS current, RMS voltage and true power, and displays this information on the PC monitor. At the same time, a time domain plot of these parameters is shown on screen.

Due to the high speed data acquisition system, the MTS software is capable of performing voltage, current and power calculations on a half cycle by half cycle basis. This capability is especially important for start-up testing as the current changes rapidly during the first few cycles after applying power to the AC motor.

The MTS system supports up to 16 measurement channels. These channels are used to measure voltage, current, speed and torque.

Characterizing an AC Motor

The ability to detect bad motors in a production run is based on the MTS systems knowledge of what a known good AC motor should look like. This information is collected by running repeated tests on a set of known good motors. This process is largely automated and takes the place of time consuming custom program development.

A special test template creation module is included in the MTS software suite which takes repeated acquisitions on the same AC motors and calculates mean, average, and standard deviation values for all critical operating parameters. The user is presented with a

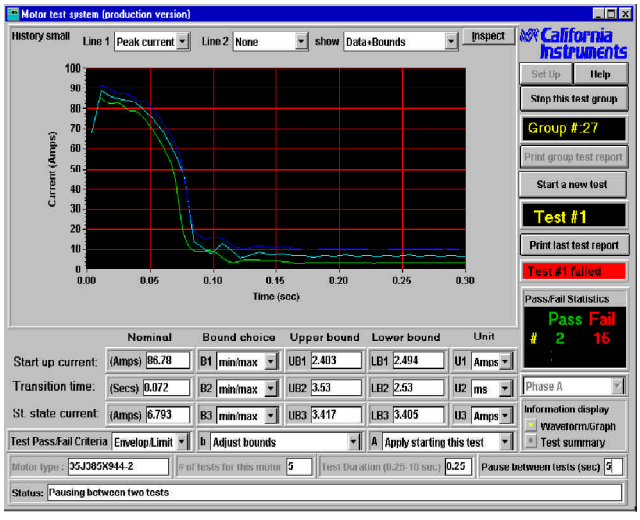

Figure 1: MTS Learn module for test template creation

graphical display of multiple known good motor run-up curves. From the known good data set, the user can enter tolerances in both amplitude (vertical) and time (horizontal) to create a test template for a specific motor type. This template can be saved on disk and will be used during production test as a reference. A library of test templates for all motor types can be created easily using this module.

Figure 1 shows the main user interface screen of the MTS learn module. This module is used for capturing known good motor run-up data. Once the data is captured over a large number of acquisition runs, the template is automatically created from this data. The user can increase or decrease tolerances in both horizontal (time) and vertical (amplitude) directions. Since a motor current run-up curve typically consists of three segments, start up, decay and steady state, individual controls are provided to manipulate each segment of the test template. These controls are shown at the bottom of the screen.

Once a suitable test template has been created, it is saved to disk and is ready to be used on the production line.

Diagnosing Motor Faults

To determine the effectiveness of the test template created with the learn module, common motor faults may be inserted in the AC motor under test to observe the impact on motor run-up. Examples of such faults are wrong start up cap values or rotor winding errors. Since different types of faults will produce different run-up data, the nature of the fault can often be determined by the MTS production test software module. This level of diagnostic information can be used to expedite rework of failed motors.

Repeatable Run-up Testing

Production testing is accomplished by installing the MTS system on the production line. A programmable AC power source is used to provide precise control over amplitude and start-phase angle. The level of amplitude stability provided by the AC source is recommended to ensure repeatable run-up tests and avoid false negatives during testing. The line voltage in most production facilities may not be stable enough and would impact the actual test data. Since each test run is compared against the test template for the motor type selected, the measurement data must be repeatable.

The start phase angle is also carefully controlled to make sure the peak start up current is consistent from motor to motor. The voltage start phase angle has an impact on the start up current and should be repeatable also.

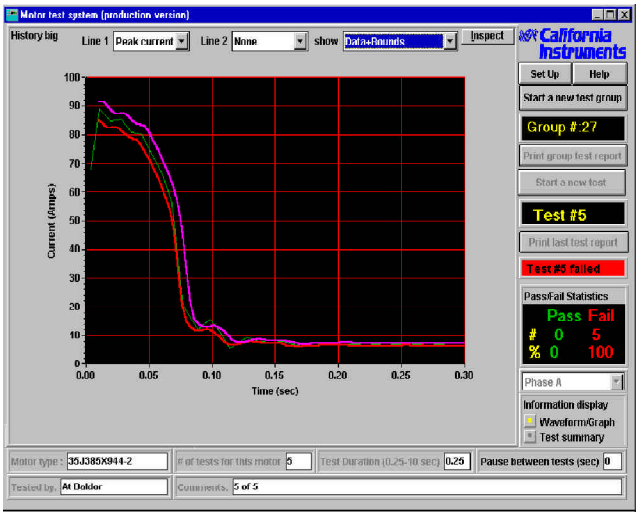

Figure 2: Production run-up PASS/FAIL testing.

Figure 2 shows a typical production test screen for an AC motor with a start up winding feature. The half cycle RMS current as a function of time, shown in the lower graph, clearly illustrates the point at which the start up winding cuts out.

The actual test template is overlaid on top of the measured data for each motor. Any excursion of the measurement data outside the selected template is flagged as a failure. Failures are clearly displayed using a red FAIL indicator.

Reporting and Data Logging

Test data for each motor is collected and saved in tab delimited ASCII test files on disk. These files are easily opened in other programs such as MS Excel® for further processing. The operator can also print a detailed test report for any motor that fails. This information may be used to assist in rework.

The level and amount of detail of the data files produced by the MTS system allows manufacturers to meet ISO 9001 documentation requirements.

Cost Analysis

Using this electrical run up motor test in a production implementation does not decrease throughput. It does however catch a larger number of faulty motors and thus reduces warranty costs significantly. This typically pays for the cost of the test system in a matter of months. Refer to the MTS data sheet for technical specifications.

Contact California Instruments:

TEL: 858 677-9040
FAX: 858-677-0940
Email: sales@calinst.com
Web page: http://www.calinst.com