squirrel-cage asynchronous AC motors. But this success has created the need for new measurement capabilities, such as those provided by the Fluke 87V.

The motor

AC motors are designed for use with a rotating magnetic field of constant strength. The magnetic field is generated from the applied voltage and its strength is proportional to the V/Hz ratio. Normally the motor is designed to work with the local supply voltage (230 V/480 V or 120 V/208 V) and supply frequency (50 Hz or 60 Hz). When the motor is connected to an ASD, the drive unit changes the frequency of the output voltage, thereby changing the speed of the rotating magnetic field and thus the speed of the motor.

Lowering only the frequency, however, will generate a higher magnetic field since the V/Hz ratio increases. This will result in magnetic saturation, which causes unstable running and generates higher temperatures in the motor. Conversely, increasing the frequency decreases V/Hz ratio, reducing the magnetic field and resulting in lower torque.

To overcome these problems, the ASD also varies the voltage when the frequency is varied, to maintain a constant V/Hz ratio. Preferably this is done over the complete working range of the ASD. For example, you need 460 V at 60 Hz, or 230 V at 30 Hz, and so on. The control type used in this case is called is V/Hz Control, which in its simplest form takes a speed reference command from an external source and varies the voltage and frequency applied to the motor.

A challenge for older meters

The inaccuracy affecting earlier meters stems from two factors: bandwidth and shielding.

Many of today's digital multimeters have bandwidths out to 20 kHz or more. So in addition to the fundamental frequency component, which the motor really responds to, the meters also read the high frequency
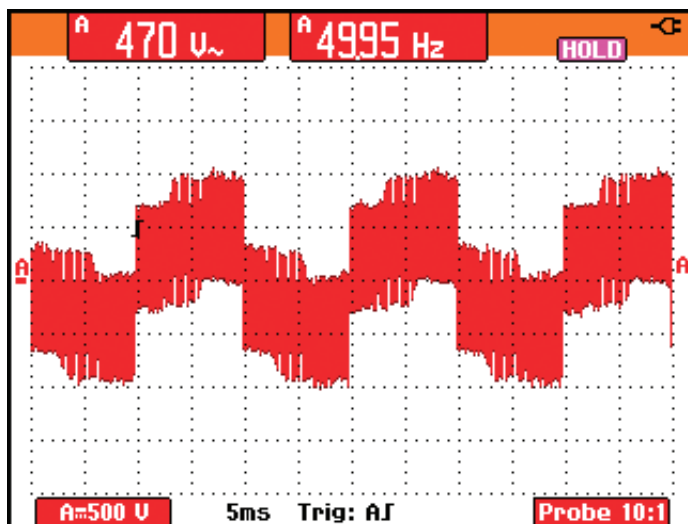
Oscilloscope view of a pwm motor drive signal

components generated by the carrier frequency of the PWM drive. And if the DMM isn't shielded for high frequency noise, the drive controller's high noise levels can make the measurement discrepancies even more extreme.

With the bandwidth and shielding issues combined, many multimeters will display readings as much as 30 percent higher than what the drive controller shows. They may read the carrier frequencies instead of the fundamental frequency on the output side of the ASD. This reading would be in kilohertz, a thousand times higher than the fundamental frequency that matters to the motor.

So in the past, field technicians had few good choices: rely on the readings calculated by the drive itself, return to the office for an oscilloscope, or guess.

"If they didn't have a scope, what they would have to do is take a look on the drive, and just hope that its voltage reading is correct," says Rockwell Automation's Rick Hoadley, technical program manager, engineered drives business. Because the ASD output voltage value is calculated, and not an actual reading, the technician could not rule out problems with the ASD itself. In addition, because the motor can be hundreds of feet distant, the voltage at the motor can differ significantly from the reading at the ASD.

The ASD troubleshooting solution

But the new model 87V digital multimeter from Fluke Corporation, a Rockwell Automation Encompass Program™ partner, delivers accurate drive output measurements with the push of a button. Now troubleshooters don't have to guess whether a drive is operating correctly and delivering the correct voltage, current and frequency for a given control setting.

The Fluke model 87V incorporates a button-selectable low pass filter that enables the 87V to precisely measure voltage and frequency on ASDs.

"Those are two parameters which are critical for operating a motor properly," says Hoadley, who tested a pre-production version of the Fluke 87V at the home of Allen-Bradley drive production in Mequon, Wis. Using a mobile demonstration unit equipped with an Allen-Bradley PowerFlex® 700 AD Drive and two 15-horsepower motors-one used to create a load for the drive-controlled motor-the Rockwell Automation team put the Fluke 87V DMM to the test. They assessed performance at frequencies from 5 Hz to more than 60 Hz, measuring voltage and frequency both with and without a special sine wave filter used on the mobile unit to demonstrate harmonic mitigation and reflected waves with ASDs.