Testing Procedure

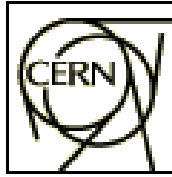## Procedure for Taking a Set of Readings

a. The software will monitor the speed of the rotating shaft by differentiating the positional encoder signal. Proportional control will be used to control motor rotational speed. Note that the shaft is always rotated in one direction.

b. When the desired speed is attained, the software will wait for stabilization. **Stabilization** is achieved when the speed does not vary by more than 3% over some number of consecutive revolutions defined as the rotational speed in RPM divided by 30. If the speed error exceeds 3% of the commanded value at any time during the stabilization period, the system resets the stabilization count and continues to apply speed control until the error is less than or equal to 3% throughout the total number of required stabilization revolutions. The following chart illustrates the specific cases that apply to the system:

Measurement Speed (RPM)	Stable for… (# revolutions)
30	1
60	2
180	6
300	10
500	17
600	20

Table 1: Measurement speeds and the corresponding number of revolutions for which the speed variation must be <=3% for the system to be "stable" at the desired speed.

c. When the speed is stable, readings will be taken at the speeds shown in table 1. A **reading** is defined as 3 revolutions over which the flux is measured as a function of shaft angle through the 3 slip-rings and their integrators. The raw coil voltage will also be measured as a function of shaft angle through the AC4598 slip-ring. Each set of readings will be stored in a text file on the local computer running the LabVIEW software. The text file will also include the total number of elapsed revolutions at the beginning and end of the measurement period, the date, and the time the measurement period began.

d. The initial reading will be taken after stabilization at 600 rpm. Then system will decelerate until stable at 500 rpm, and repeat step 1c. Similarly for the other speeds through 30 rpm.

Test Sequence

1. **Start of test**: Immediately take initial readings according to steps a-d in **Procedure for Taking a Set of Readings**. Shaft starts from rest and is accelerated to 600 rpm in order to perform the first measurement.

2. After the reading at 30 rpm is completed, the system will accelerate back to 600 rpm under proportional speed control. The number of revolutions until the next set of readings will count down beginning with the revolution immediately following the last revolution of the 600 rpm reading. The number of revolutions between sets of readings is as follows:

   0, 1000, 9000, 10000, 10000, 10000… (until the end of the test)

   Note: The total number of revolutions elapsed during periods of acceleration/deceleration and stabilization will be recorded. These will count towards the total number of elapsed revolutions, but will not count towards the number of revolutions between readings. In other words, the number of revolutions until the next reading (typically 10,000) will not count down until after the current set of readings is completed and the system has stabilized at 600 rpm.

3. When the appropriate number of revolutions between readings has elapsed, the system will begin to take the set of readings according to steps a-d in **Procedure for Taking a Set of Readings**.

4. When the 30 rpm reading is completed, return to step 2.

Procedure for Non-Emergency Halting of Test

If the test needs to be halted for any non-emergency reason (maintenance, additional parameter tuning, physical inspection, software changes, hardware changes, etc) the following procedure will be used.

1. If a set of readings is in progress, wait until the set is completed.
2. In software, press button to initiate "manual shutdown".
3. Software zeros the command to the motor, and system will decelerate to a stop.
4. Software detects when speed reaches 0 rpm, and record to a text file labeled "manual shutdown" the total number of elapsed revolutions, the number of revolutions until the next reading, the date, and the time of the shutdown.
5. Software waits in standby mode for resumption of test.
6. Disconnect power to motor.
7. Perform necessary check or maintenance.
8. Reconnect power to motor.
9. Press "resume test" button in software.
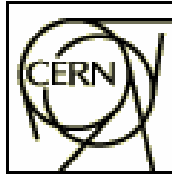
10. Software resumes test and counts revolutions from the values recorded during step 4. If it was necessary to shutdown the LabVIEW software, then pressing the "resume test" button will read from the text file generated during the step 4 to determine from where to resume the test.

**Procedure for Emergency Halting of Test**

If an emergency arises that requires immediate halting of the test, the following procedure will be used.

1. If there is no immediate physical danger to humans near the test rig, then the software "emergency shutdown" button will be pressed.
    a. Software immediately zeros command to motor.
    b. A text file labeled "emergency shutdown" is generated with the total number of elapsed revolutions, the number of revolutions until the next reading, the date, and the time of the shutdown.
    c. Software waits in standby mode for resumption of test.
2. If there is immediate physical danger or the software is inoperable, the emergency stop button will be pressed. The emergency stop button will be large, clearly labeled and visible, and at least 6 feet away from the moving machinery.
    a. When pressed, the circuit providing motor power is opened, cutting all power to the motor.
    b. The software (if operable) is also notified of the event via a connection from the emergency stop button to the DAQ board.
        i. If the software is operable, the motor command is immediately zeroed.
        ii. A text file labeled "emergency shutdown" is generated with the total number of elapsed revolutions, the number of revolutions until the next reading, the date, and the time of the shutdown.
        iii. Software waits in standby mode for resumption of test.
3. If safe to do so, the power supply will be physically unplugged from the wall.

Automatic Emergency Halting of Test Due to Motor Overheating

Motor overheating occurs when the current supplied to the motor exceeds a threshold value of 14.5 amps. The motor controller circuit is designed in such a way that the circuit will be opened when the current exceeds this value, cutting off power to the motor.

If power is cut-off to the motor, the software will detect, via a connection to the DAQ board, that the current supplied to the motor is zero. The software will then follow step 2b in section **Procedure for Emergency Halting of Test**. In this case, the text file will be labeled "automatic shutdown due to motor overheating".
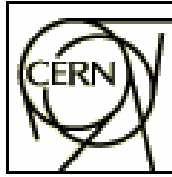
Resumption of Test After Data Loss

If it becomes necessary to resume the test after a power outage, emergency stop in which the software was inoperable, or other event which has caused data loss and/or the lack of generation of a text file describing the shutdown, the following procedure will be used.

1. Assure that system is in proper working order and will not pose a danger to anyone if motion occurs unexpectedly.
2. Reconnect power if necessary.
3. Reset emergency stop button if necessary.
4. Restart computer if necessary.
5. Restart Java data file uploading software (see description below) if necessary.
6. Restart LabVIEW software if necessary.
7. Press software "resume test from last data file" button.
   a. Software locates the data file generated most recently.
   b. Software determines values for total number of elapsed revolutions and number of revolutions until next measurement from this data file.
   c. Software resumes test from the point specified by those values.
   d. Software generates a text file labeled "test resumption after data loss", indicating the re-start values used, the date, and time of the restart.

Automatic Uploading of Data Files to PUB Server

A Java software program has been written to accompany the LabVIEW test program. The Java program will be run separately from the LabVIEW program. It automatically checks the local (test station) computer for a new data file every 5 minutes. If a new one is found, it is automatically uploaded to a server at PUB.