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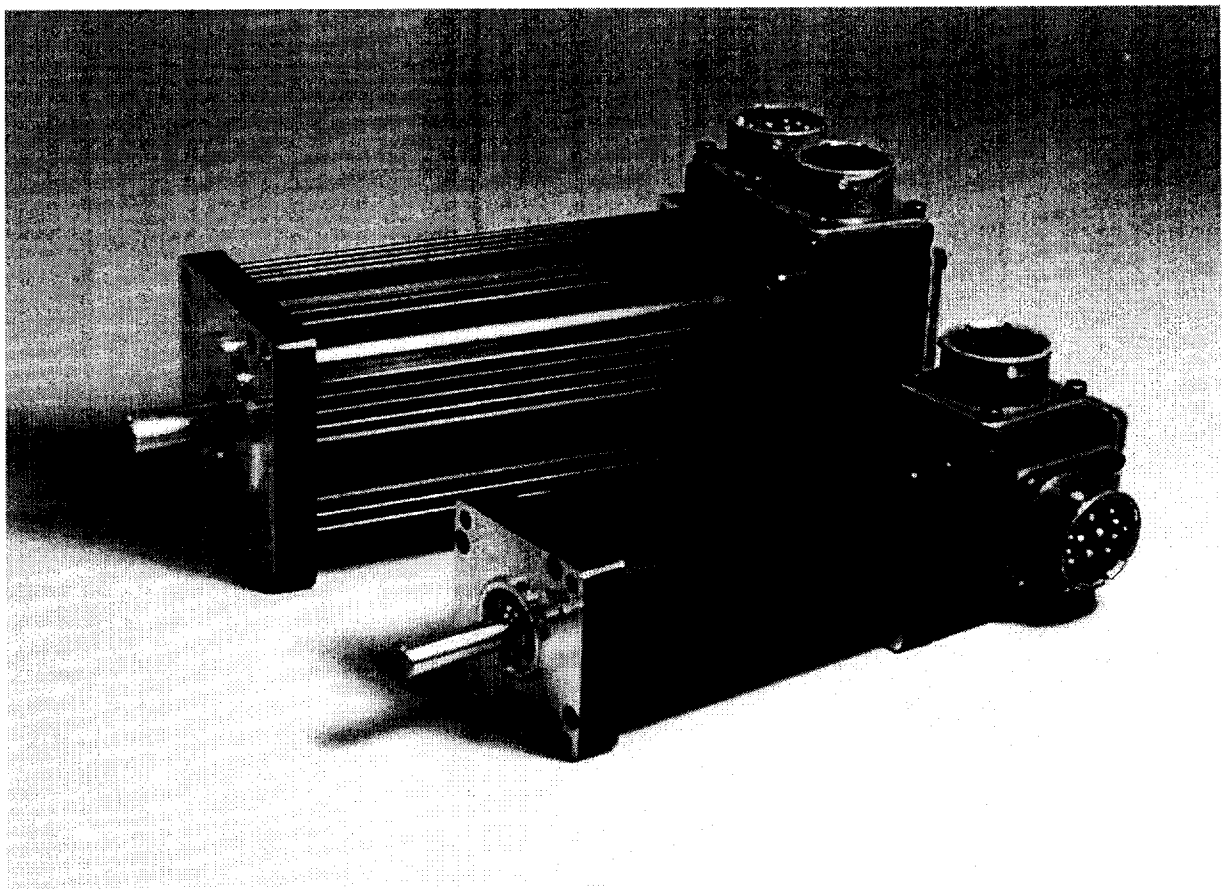
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p/n 88-016303-01 D

SM, BE, SE and N0 Servo Motors Technical File

Effective: October 2001



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IMPORTANT

User Information

Prepared by: Jack Bacott

Checked by: Steve Nolan

WARNING

Compumotor servo motor products are used to control mechanical components of motion control systems. You should test your motion system for safety under all potential conditions. Failure to do so can result in damage to equipment and/or serious injury to personnel.

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Equipment:

Neometric 92mm series Servo Motors
Neometric 70mm series Servo Motors
BE34 series Servo Motors
BE23 series Servo Motors
BE16 series Servo Motors
SM16 series Servo Motors
SM23 series Servo Motors
SE16 series Servo Motors
SE23 series Servo Motors

Description of Equipment:

Brushless servo motors
See the appropriate brochure for full specifications.

Year in which CE mark affixed 1998, 2000, 2001

The above equipment conforms with the requirements of Council Directive 73/23/EEC (Low Voltage Directive) as amended by Directive 93/68/EEC (CE Marking Directive), when installed, operated and maintained as intended. The installation requirements are detailed in the User Guide supplied with the equipment.

This has been demonstrated by the application of the following standards:

EN60204-1	1993: Safety Of Machinery - Electrical Equipment of machines Part 1: General Requirements
EN61010-1	1993/A2: 1995 (includes 1995 AMD 8961) Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General Requirements
EN60950	1992: (AMD M48: 1993, A~ 8083: 1993) Specification for Safety of information technology equipment, including electrical business equipment
IEC 34-1	Rotating electrical Equipment

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SECTION 1 - INTRODUCTION

1.1 SCOPE

This document is the Technical File (TF) for the Parker Hannifin, Compumotor Division (henceforth referred to as Compumotor) SM, SE, BE and NeoMetric Series brushless motors. It will list the directives and standards, give details of the testing process and provide information on the quality systems used to demonstrate continued compliance to the Low Voltage Directive (LVD), 72/73/EEC for the SM, SE, BE and NeoMetric series servo motors. For the purpose of simplification in this document, the SM, SE, BE and NeoMetric series motors will be collectively referred to as Compumotor servo motors; this simplification does not include servomotor series other than the four specifically mentioned in the previous sentence. Compumotor servomotor amplifiers for brushless motors will be discussed under separate Technical Files. Compumotor servomotors are privately labeled for other manufactures. These products are the same as Compumotor Servo motors except for manufacture name and model numbers. For the purpose of this Technical File all motors will be discussed as Compumotor servo motors.

1.2 PURPOSE

The purpose for the Technical File is to obtain CE Certification. This is a self-certifying process. This document will demonstrate compliance to the LVD for CE Certification.

The argument for conformity is presented for these Compumotor servomotors in any or all of their variant forms. This is based upon three chief criteria:

(1) A series of tests carried out upon one or more identified configurations per the applicable directive or specification.
(2) An analysis of the technical design that demonstrates the incorporation of components or other measures which are beneficial in terms of safety.
(3) Evidence of a quality system which fully describes the product in its design and manufacture and has procedures which can demonstrate an adequate engineering control over the build at any stage in the product life cycle.

1.3 DOCUMENT OVERVIEW

This document is divided into four sections. Section 1 (this section) provides the scope and purpose of the Technical File and a general overview of the Technical File.

Section 2 gives an overview of the functional design, a description of the equipment and options, and an overview of safety and EMI/EMC considerations.

Section 3 lists the applicable standards and documents used for reference. There is a summary of each test completed to demonstrate compliance with LVD. This section also gives detailed descriptions of the tests performed and equipment used.

Section 4 describes the quality system in place to assure continued compliance with the requirements of the Low Voltage Directive.

1.4 REQUIREMENT FOR COMPLIANCE

Most European countries now have legislation in place that requires electrical equipment to comply with the Low Voltage Directive before it can be marketed in those countries. The objective of the LVD is only to permit electrical material to be put on the market if it does not jeopardize the safety of persons, domestic animals and goods. The freedom of movement of safe electrical material within the Community must be safeguarded. However, products, which do comply with the Directive, may be marketed in all EC states without restriction.

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1.5 ELECTROMAGNETIC ENVIRONMENT

The Compumotor servomotors are designed to operate in industrial production plants that require controlled motion. Such an environment typically contains other industrial production equipment that can create a noisy electromagnetic environment containing RF emissions, switching transients, motor noise and similar electromagnetic disturbances. Therefore, the Compumotor servomotors have been designed to operate as intended in a working environment where the electric and magnetic fields can exist.

Additionally, the Compumotor servomotors must operate reliably in the presence of electrical transients in the form of ESD, power surges and electrically fast transients generated from other sources and/or induced on interconnecting cables.

Compumotor servomotors have been defined as a component of a system. As such, it is the ultimate responsibility of the system builder to conform to electromagnetic standards. Parker Compumotor has addressed these issues with specially designed cables and an EMC/EMI Installation Guide.

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SECTION 2 - TECHNICAL EQUIPMENT DESCRIPTION

2.1 GENERAL CONSTRUCTION

2.2 FUNCTIONAL DESIGN

2.2.1 Principal Considerations

Compumotor is not responsible for knowing what type of application a Compumotor servomotor will be a part of, nor is this important. The motors are sized for each specific application and may be part of Large Industrial Process Control Systems.

For the sake of this TF, we are only concerned with the Compumotor servomotors.

2.2.2 Functional Overview

The motor operates in response to load conditions, programmed outputs from a motor controller, and servo feedback signals fed back into the motor driver or controller. Brushless motors are able to operate with a fine degree of control under different loading conditions

2.2.3 Mechanical Arrangement

Typically, the mechanical arrangement has the motor or motors in their required configuration (welder, food pump, process control, etc.) with the motor power and control cabling running to a Motor Amplifier. The Motor Amplifier and Power Supply may to be mounted on a panel within an enclosure. Raw AC voltage is connected to the Power Supply and it converts the AC input to a DC bus voltage. This DC voltage is delivered to the motors through the connecting cables.

2.2.4 Power Input

Compumotor servomotors are brushless motor that have been designed to operate from an PWM or linear Servo Amplifier.

2.2.5 Feedback

Position control for the Compumotor servomotors is either through a resolver or an incremental encoder. The signal from the feedback device is fed back to a motor controller device that uses the signals to control the position and movement of the servomotors.

2.3 EQUIPMENT OPTIONS

2.3.1 General

Compumotor servomotors are very flexible and can be used to support a diverse array of motor operating conditions. Through the use of a Servo Amplifier and Controller, the user can set up advanced motion control. The user or the vendor also configures the control strategy, since each industrial process is different.

2.3.2 Product Variant

Product variants are basically different in power rating, packaging, and motor type. When these variations affect the specifications or test, a table, list or specific conditions for the product variants are given in the test document.

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2.3.3 Equipment Description

Applications of the Compumotor servo motors are extensively used as part of industrial, commercial, and aeronautical applications. Typical applications of the Compumotor servomotors include food processing, machine assisted/operated factory production lines, material handling, process control, machine tool, and robotics. These motors have not been designed for hazardous applications.

Compumotor servomotors are used in conjunction with the Compumotor Servo Motor Amplifiers and other manufacturer's brushless Servo Motor Amplifiers.

The Compumotor SE and SM series motors are four pole (two pole pair), slotless designs. Among their characteristics are negligible cogging torque, minimal torque ripple and large rotor inertia.

The Compumotor 70mm and 92mm NeoMetric design is also a four pole design but feature a "bridged" stator construction. This reduces audible noise emanating from the motor. The Neometric Series design provides high torque-to-inertia ratios.

The Compumotor BE series motors feature a bridged eight pole design. This series of motors features higher torque per package relative to the other motor series.

2.4 SAFETY AND EMI/EMC FEATURES

2.4.1 General

The primary consideration for the design of the Compumotor servomotors was safety. The insulating materials were selected on the basis of providing the most protection against harmful voltages.

2.4.2 Mechanical Construction

It is intended that the units be mounted on a metal frame that can provide adequate cooling and heat dissipation. The Compumotor servomotors are not intended to operate in a stand-alone environment unless they are de-rated sufficiently to prevent over-heating.

2.4.3 Electrical Construction

2.4.3.1 General

The electrical design of the Compumotor servomotors are in keeping with good design practices for safety. Safety guidelines normally include adequate insulation, temperature ratings and recommended wiring practices for protection from electrical shock.

2.4.3.2 Grounding and Bonding

Grounding or bonding practices for the Compumotor servomotors are covered in the Servo Motor Amplifier Installation Manual. The green/yellow wire is required for earth and any local enclosure grounding scheme to meet the requirements of the National Electric Code and IEC 34-1. This wire is provided on all Compumotor servomotors.

2.4.3.3 Power Requirements

The power delivered to Compumotor servomotors is provided by a Servo Motor Amplifier, and is dependent on the commanded move profile and the load on the motor.

2.5 INSTALLATION

The installation details for the motors are given in the appropriate Servo Motor Amplifier Installation Guide.

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SECTION 3 - TECHNICAL INFORMATION

3.1 GENERAL

This section describes the basis for compliance with the Low Voltage Directive. Information on the following items is provided:

1. Environmental considerations for the proper operation of the Compumotor servo motors.
2. Overview of safety standards, specifications, and test used to demonstrate compliance with the Low Voltage Directive.
3. Detailed Reference to the test performed to confirm compliance to the Low Voltage Directive.
4. Mechanical Integrity
5. Marking Requirements
6. Compliance with the EMC Directive

3.2 ENVIRONMENTAL CONSIDERATIONS

Compumotor servomotors are designed for use in an industrial or commercial environment. The operating temperature and humidity are specified as follows:

- Temperature: 0° C to 40° C (32° F to 104° F)
- Relative Humidity: 10% to 90% (non-condensing)

Unless otherwise stated the test environment shall conform to the Compumotor's specified climatic conditions for the motors. Specifically, the maximum continuous and peak currents are de-rated for operation in ambient temperature above 25 degrees celsius.

Under some conditions, a more restricted range of ambient conditions is required during some tests to give predictable and repeatable results. The equipment shall therefore be tested within the environmental range specified in the appropriate test procedure.

3.3 OVERVIEW OF THE SAFETY STANDARDS USED FOR REFERENCE

- EN 60204-1: 1993 (Safety of machinery - Electrical equipment of machines Part 1: General requirements)
- EN 61010-1: 1993 (Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements)
- EN 60950: 1992 (AMD M48 :1993, A~ 8083: 1993) (Specification for Safety of information technology equipment, including electrical business equipment)
- IEC 34-1 (Rotating electrical machines)
- IEC 445 (Identification of equipment terminals and of termination of certain designated conductors, including general rules for an alphanumeric system)
- UL 1004 (Safety standard Electric Motors)
- NEC (National electrical code - 1996)

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- IEC 721-3-2 (first edition with amendment 1 and 2)
- IEC 721-3-3 (second edition with amendment 1)
- NEMA MG7

3.4 SUMMARY OF THE SAFETY SPECIFICATIONS AND TEST REQUIREMENT

Compumotor servomotors have been evaluated as a component of a machine using the standards listed in the Safety Standards Section.

The motors were observed throughout the test for any signs of malfunction or degradation in performance.

All of the Test equipment used during the tests had a valid calibration certificate. All motors used for the test were current production model motors.

The following is a summary of the test performed to demonstrate compliance to the Low Voltage Directive. For a detailed description of the test conducted, see section 3.5

3.4.1 Dielectric Withstand Test

- Winding high-potential
  A specified high-potential voltage was applied between the 3 phases and case ground for a specified time, in order to determine the adequacy of the insulating materials and spacing against a breakdown under normal conditions. The voltage and duration of the test is dependent on the motor voltage rating. See Table in the detailed test description section.

- Thermal Switch high-potential
  A specified high-potential voltage was applied between the thermal switch and the winding to determine the adequacy of the insulating materials and spacing against a breakdown under normal conditions. See the table in the detailed test description section for the specific requirements.

3.4.2 Thermal Test

- Winding Temperature (IEC 34-1)
  The winding temperature was measured while running the motor at the maximum continuous load without causing the protector to open the circuit and the temperature of the windings to exceed the predetermined limits.

- Bearing Temperature (IEC 34-1 section 7.9)
  The motor was run under various conditions and the front and rear bearing temperature was measured. See the detailed test for the temperature values.

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3.4.3 Overload Protection Testing

- Running Overload Test (EN 60950 Annex B)
  The motor was run at continuous load conditions until the temperature is stable. The load is then increased in small increments, allowing the motor to stabilize between each change, until the thermal protection activates.

- Locked Rotor Overload Test / Thermal Switch Test (EN 60950 Annex B)
  The motor was operated in a locked rotor condition until the winding reaches a constant temperature, provided the temperature does not exceed the windings specification, or the protective device operates. The motor is considered to have a manually reset protection switch so a 60 cycle test is required.

- Overspeed (IEC 34-1 section 8.5)
  The motors was run at 1.2 times the maximum velocity for 2 minutes.

3.4.4 Mechanical Integrity

- Finger Test
  The purpose of this test is to determine if the EUT has any parts that may cause harm to the user in the form of a voltage or mechanical movement.

- Vibration Test
  A vibration test was run to verify the mechanical strength of the motor and any components mounted to it.

- IP Rating
  The IP Rating must be a minimum of IP23 for motor enclosure and IP44 for junction boxes.

- Shaft and Keyways
  The applicable key is provided with motors that have keyways cut in their shaft.

- Connections
  The motors have included in the plug connectors, a pin designed for the earth connection, and the ground wire is green with a yellow stripe.

- Creepage and Clearance Distance
  EN 60950 section 2.9 specifies the minimum spacing requirements between the stator windings, or bare lead wires to other conducting parts. Each Compumotor servomotors has its winding completely encapsulated in an insulating epoxy; therefore windings are not exposed to air. All motor lead wire interconnects are insulted with a heat shrink insulator so that the minimum creepage requirements are met.

- Wiring Practices
  EN 60204 section 15 specifies the wire colors allowed for color-coding. The specification also requires that the green and yellow combination is only allowed for a ground wire. Compumotor servomotors meet these requirements.

3.5 DETAILED DESCRIPTION OF TEST PERFORMED

The Compumotor servomotors will be operated in accordance with the motor specification. Testing will follow the procedures and methods of the relevant standard(s) given below unless otherwise stated by the test plan document.

3.5.1 Dielectric Withstand Test

A high-potential voltage (higher than the rated voltage) is applied for a specified time to determine the adequacy of the insulating materials and spacing against a breakdown under normal

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conditions. The conditions of the high-pot test are in accordance with NEMA MG 1 section 3, NEMA MG 7 section 2.6.1.2, EC 34-1 section 17, and UL 1004 section 28.

A motor-protector combination shall withstand for 1 minute without breakdown a test potential, applied between live parts of opposite polarity, and between live parts and dead metal parts that are grounded or that are exposed to contact. The high-pot test will be performed between the motor windings and chassis ground (motor case). The dielectric test voltage (r.m.s) shall be 1000 + 2 times the rated voltage (r.m.s) of the motor and shall be applied for 60 seconds. A variant of this test may be used within a manufacturing and production environment, which allows the application of voltage to be 1 second as opposed to 60 seconds. This one-second test shall be limited to applied voltages of less than 2500 VAC and its purpose is to expedite production while still providing an acceptable dielectric test. For the one second production test, the applied voltage shall be 1200 RMS + 2.4 times the rated voltage.

Dielectric failure in high-pot testing shall be a measure of the leakage current. The total leakage current from the motor windings to ground or frame is made up of capacitive and resistive current. Resistive leakage current is a measurement of the level of insulation resistance and is an effective evaluation of the insulation system. Any capacitive current should be determined and included when evaluating resistive leakage current. The resistive leakage current for test potentials up to and including 1920 volts (r.m.s) shall not exceed 2 milliamps and the resistive leakage current for test voltages between 1920 and 2640 (r.m.s) shall not exceed 3 milliamps. The production test unto which a higher voltage is applied for 1 second will tolerate a leakage current not higher than 10 milliamps. Both leakage current limits are taken from NEMA standards.

3.5.1.1 Winding to Protective Earth High-Potential Test

The Compumotor servomotors were tested to the voltage according the table below.

Motor Rating	Condition A Potential, Volts r.m.s	Time, seconds	Condition B Potential, Volts r.m.s	Time, Seconds
Less than 100 volts and less than 1kW	500 + 2V*	60	500 + 2.4V*	1
250 volts or less and 1/2 horsepower	1000	60	1200	1
More than 250 volts or more than 1/2 horsepower	1000 + 2V*	60	1200 + 2.4V*	1

**Maximum rated voltage r.m.s.*

In addition to the High-Potential test required from the winding to ground, there is an additional requirement for a High-Potential test from the thermal switch to the winding (EN 60950 section 5.3 table 18 for Basic and Supplemental insulation and section 2.3 SELV). **See Annex C: Technical File Test Data - Dielectric Test for the actual test data.**

3.5.1.2 Thermal Switch to Winding High-Potential Test

The isolation of the thermostat to the winding was tested according to the table below.
See Annex C: Technical File Test Data - Dielectric Test for the actual test data.

Motor Rating (U = working volts)	Test Voltage
U <= 130 volts r.m.s	1000 volts
130 < U <= 250 Volts r.m.s	1500 volts
250 < U <= 1000 Volts r.m.s	1787 volts

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3.5.2 Thermal Testing

3.5.2.1 Winding Temperature

When a motor is thermally protected and is running at the maximum continuous load, which it can carry, without causing the protector to open the circuit, the temperature of the windings shall not exceed the predetermined limits. The method for measuring the temperature of the windings is best accomplished by three methods. The first acceptable method is the resistance method, the second is the ETD (embedded temperature detector) method, and the third method is the thermometer method.

Resistance Method - (IEC 34-1 section 7.5.1) The temperature rise is determined from the increase of the resistance of the windings. The temperature rise may be obtained from the ratio of the resistance cold and resistance hot by the formula:
For copper:

$$T_h = 254.5\left[\frac{R_h}{R_c} - 1\right] + T_c$$

Where:

R_h = Hot Resistance

R_c = Cold Resistance

T_h = Winding temperature @ hot Resistance measurement

T_c = Winding temperature @ cold Resistance measurement

This formula is equivalent to the formula given IEC 34-1 section 7.6.

Embedded Temperature Detector Method – (IEC section 7.5.2) The temperature is determined by means of temperature detectors (e.g. resistance thermometers, thermocouples, or semi-conductor negative coefficient detectors) built into the machine during construction, at points which are inaccessible after the machine is complete.

Thermometer Method (Modified) – (IEC section 7.5.3) The temperature is determined by thermometers applied to accessible surfaces of the completed machine. The term 'thermometer' includes not only bulb-thermometers, but also non-embedded thermocouples and resistance thermometers provided they are applied to points accessible to the usual bulb-thermometers. When bulb-thermometers are used in places where there is a strong varying magnetic field, alcohol thermometers shall be used in preference to mercury thermometers.

When Compumotor uses the thermometer method, a variation in the test is implemented. Since the thermal resistance of the case to ambient, R_{ca}, and the thermal resistance from winding to case, R_{wc}, are measured during the normal rating process of the motor, these values are known for each of the motors. Therefore, these two parameters can be utilized to more accurately estimate the winding temperature from accessible parts of the motor, namely, the case temperature. The equation given below is used to estimate the winding temperature from the case temperature and the known thermal resistances.

$$T_{winding} = \frac{R_{wc}}{R_{ca}}\left(T_{case} - T_{ambient}\right) + T_{case}$$

Compumotor will use the Winding Resistance, Embedded Thermal Detector (ETD) method, or the Modified Thermometer Method for all winding temperature measurements.

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The ***maximum temperature limits*** for a particular class of insulation is given in the table below. This temperature limit is identified for normal operating conditions of the motor and does not reflect any temperatures that may occur due to overload testing etc. Also, there is no ambient reference identified. The **maximum temperature rise** will depend on the ambient temperature during the test.

Maximum Temperature (C°)				
Class A	**Class E**	**Class B**	**Class F**	**Class H**
105	120	130	155	180

This test was done using a combination of the winding resistance method with the thermometer method. The winding temperatures were recorded during the test. While the motors were running at their maximum continuous current, all winding temperatures were below the maximum specified temperature as listed in the table above. See Annex C: Technical File Test Data - Motor Winding Temperature Test for the actual test data.

3.5.2.2 Bearing Temperature

For measuring the temperature of bearings, the thermometer method and the embedded temperature detector method are recognized; however, no limits or test conditions were specified in IEC 34-1 (Reference EC 34-1 section 15.8).

Compumotor used the embedded temperature method for this test. The bearing temperature was measured and recorded. See Annex C: Technical File Test Data - Bearing Temperature Test for the actual test data.

3.5.3 Overload Protection Testing

For motors rated at or above 0.5KW, a requirement exists for thermostats/overload protection. Motors below this rating are not required to have thermostats; however, it is highly recommended as listed in EN60204-1 section 7.3. EN 60950 sections B.4 and B.5 discuss thermal tests for overload protection. The tests are Running Overload Test and Locked Rotor Overload Test. It is the purpose of these tests to ensure the internal thermostat will protect the motor.

Compumotor motors are equipped with a thermal switch to protect the motor against excessive winding temperatures. The rating of the thermal switch depends on the power rating of the motor and the location of the switch. The windings are insulated with class H insulation. The internal epoxy is rated to 155° C.

3.5.3.1 Running Overload Test - (EN 60950 section B.4)

This test is not performed on Compumotor motors that are not equipped with a thermostat. All Compumotor motors that are rated above 0.5KW are built with thermostats to comply with the directive. A running overload protection test is carried out by operating the motor under normal load (continuous rated current). The load is then increased so that the current is increased in appropriate gradual steps (increments of 5% of continuous current rating), the motor supply voltage being maintained at its original value. When steady conditions are established, the load is again increased. The load is then progressively increased in appropriate steps, but without reaching the locked-rotor condition, until the overload protection device operates. The motor winding temperatures are determined during each steady period and the maximum temperature recorded shall not exceed the values specified below.

Maximum Temperature (C°)				
Class A	**Class E**	**Class B**	**Class F**	**Class H**
140	155	165	180	200

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Compumotor motors use Class H insulation however, the epoxy limits the temperature to 155° C.

The above chart indicates the maximum allowable temperature for the windings, for the running overload test. For example, the Compumotor servo motors have class H insulation; therefore, the winding temperature for these motors cannot exceed 200°C at any point during the test.

The load was increased in 5% increments from the maximum continuous current until the thermal switch operates. The temperature was recorded after it stabilizes for each increment. The temperature did not exceed the maximum temperature allowed as specified in the table above. See Annex C: Technical File Test Data - Overload Protection Test for the actual test data.

3.5.3.2 Locked Rotor Overload/Thermal Switch Test - (EN60950 section B.5)
This test is not performed on Compumotor motors that are not equipped with a thermostat. All Compumotor motors that are rated above 0.5KW are built with thermostats to comply with the directive. A locked rotor test is carried out starting at room temperature. The duration of the test is as follows: a motor protected by inherent or external impedance is operated on a locked rotor for 15 days. Except that testing is discontinued when the windings of the motor reach a constant temperature, provided that the constant temperature is not more than that specified for the insulation system used according to the following table (EN 60950 section 5.1 table 16 part 1).

Maximum Temperature (C°)				
Class A	**Class E**	**Class B**	**Class F**	**Class H**
115	130	135	155	180

Compumotor motors use Class H insulation however, the epoxy limits the temperature to 155° C.

A motor with an automatic reset protection device is cycled on a locked motor for 18 days. A motor with a manual reset protection device is cycled on a locked rotor for 60 cycles, the protection device being reset after each operation as soon as possible for it to remain closed, but after not less than 30 seconds. A motor with a non-resetting protection device is operated until the protective device is activated.

Temperatures are recorded at regular intervals during the first ten cycles for a motor with a manual reset protection device, or at the time of operation of a non-resetting protection device. The temperature shall not exceed the values specified in the following table (EN60950 section B.3):

Maximum Temperature (C°)				
Class A	**Class E**	**Class B**	**Class F**	**Class H**
150	165	175	190	210

Compumotor motors use Class H insulation however, the epoxy limits the temperature to 155° C.

During the test, the protective devices shall operate without insulation fault to the motor frame or permanent damage to the motor, including excessive deterioration of the insulation. Severe damage includes the following:

- Severe or prolonged smoking or flaking
- Electrical or mechanical breakdown of any component
- Flaking, embrittlement or charring of insulation (discoloration is permitted)

NOTE: ***The over-temperature protection switch in Compumotor servo motors is considered to be a manually protective device. When it is used properly, a manual***

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reset is required on the Amplifier before the motor will run after the switch is activated. Parker Compumotor does not recommend by-passing or using the thermal switch in any configuration that would not shut down the Servo Amplifier.

The Locked Rotor Overload Test was done as specified for a manually resetting thermal protector. The thermal switch was cycled 60 times. A thermal couple and data acquisition system recorded the motor temperature during the test. See Annex C: Technical File Test Data - Locked Rotor Test Part A and Part B for the actual test data.

3.5.3.3 Over-speed
The Overspeed requirement specified by EC 34-1, section 8.5 is 1.2 times the maximum rated speed (from nameplate) for 2 minutes. An over-speed test is not normally considered necessary but can be performed when this is specified and has been agreed between manufacturer and purchaser. An over-speed test shall be considered as satisfactory if no permanent abnormal deformation is apparent subsequently, and no other weakness is detected which would prevent the machine from operating normally, and provided the rotor windings after the test comply with the required dielectric tests. The maximum rated speed is derived from restrictions which can include mechanical/rotor integrity, bearing speed ratings, applied voltage, insulation restrictions etc.

The Compumotor servo motors were run at 1.2 times their maximum rated speed for 2 minutes. **See Annex C: Technical File Test Data - Overspeed Test for the actual test data.**

3.6 MECHANICAL INTEGRITY

3.6.1 General
The products designed and produced by Compumotor must be in accordance with the schedule of tolerances on quantities involved in the rating of electrical machines (IEC 34-1 part 26).

3.6.2 Finger Test (EN61010-1 section 6.2).
The purpose of this test is to determine the EUT has no accessible parts that may cause harm to the user. The danger could be in the form of a voltage or a mechanical movement. **Unless obvious, determination of whether a part is accessible shall be made using test fingers.** Parts touched by a test finger are considered to be accessible. The jointed test finger shall be applied in every possible position. Where a part could become accessible by applying a force, the rigid test finger shall be applied with a force of 10N. The force shall be exerted by the tip of the test finger so as to avoid wedge and lever action. The test shall be applied to all outer surfaces, including the bottom.

Compumotor servo motors are rotating devices and by design, the shaft preset an obvious danger when running. The motor winding is completely enclosed and provides no access to dangerous voltages.

3.6.3 Vibration Test (EN 61010-1 section 8.3 and EC 68-2-6)
To verify mechanical strength, vibration testing shall be carried out according to the following profiles. Parts that are intended to be loose during normal use are removed for this test The equipment is fastened in its position of normal use to the vibration generator, using any specified shock absorbers. Straps around the enclosure may be used in the absence of other fastening means. The equipment is subjected to vibration over a range of frequencies as specified in EC 68-2-6. The vibration conditions we tested to are:

The motor was clamped in the Vibration Chamber & run through a profile of 70 minutes in duration from zero to 21Grms with a 10 minute dwell at each stress-step. Each step

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consisted of a increase in vibration of 3 Grms. The motor was not operated or electrically connected to anything. An HP spec analyzer monitored the vibration levels on the DUT (device under test) & the shake table. An accelerometer was glued to the rear of the DUT near the encoder.Ambient temperature was allowed to vary from 20C to 36C.

The vibration test was conducted to verify the mechanical strength of the motors and the components attached to it. The test was done with a QualMark Test Chamber. It has a 6-Axis vibration table capable of producing random vibration of up to 50 Grms from 10 Hz to 5 KHz. The Compumotor servo motors were tested to those limits. There was no damage or degradation from the vibration test.

3.6.4 IP Rating (NEMA4 MG 7 section 2.3, EN 60204-1 sections 15.5.8, 15.5.9, and 16.2)

This IP code represents the degree of protection provided by the enclosure of the motor and the enclosure of the junction box. The junction box and the motor are essentially one and the same, so the IP codes for each are the same. The minimum recommended IP rating for the motor enclosure is IP23. The minimum IP rating for junction boxes is IP44. Also, the motor connection boxes enclose only motor connections and associated equipment connections (i.e., resolver, encoder, etc.).

The standard Compumotor SM and NeoMetric Series motors are designed for a minimum rating of IP44 up to a rating of IP65 depending on the connectorization option the customer uses. The standard Compumotor BE series motors are designed for a rating of between IP44 and IP64 rating. The standard Compumotor SE series motor is designed for a rating of IP44 only.

3.6.5 Shaft and Keyway (EC 34-1 section 3.1)

The shaft of the motor to which a keyway has been machined, should have with it upon delivery to the customer a proper key, ensuring proper coupling during application of the motor. The key provided should be of normal shape and length.

Compumotor provides the applicable key for the motors shipped with keyways in the shaft.

3.6.6 Connections (EN 60204-1 section 15.2.2 & section 15.4.5, EC 34-1 section 12)

The motors have included in the plug connectors a pin designed for the earth connection. The motor cable will contain at least 4 conductors of equal cross sectional area, thus providing a ground wire of equal size to the 3 phase motor wires feeding the windings of the motor. The pin representing the earth should be marked by an appropriate symbol or legend. The ground wire should be green and yellow bicolor. The standard requires the ground pin of a connector be the first to make on hookup of the connector and the last to break when disconnecting the connector **unless the plug/socket is only used to facilitate assembly and disassembly**.

Conductors shall be limited by temperature under normal and short-circuit conditions to the following table. The motor supply wire size are in accordance with the National Electric Code.

Table 4 (EN 60204-1 section 14.4)

Types of insulation	Maximum conductor temperature under normal conditions (°C)	Ultimate short-time conductor temperature under short circuit conditions (°C) (*see note*)
Polyvinyl chloride (PVC)	70	160
Rubber	60	200
Cross-linked polyethylene (XLPE)	90	250
Silicone rubber (SiR)	180	350

Note: Assuming adiabatic behavior for a period of not more than 5 sec.

Compumotor uses wire with PVC type of insulation.

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The plug/socket assembly on Compumotor servo motors are designed specifically to facilitate assembly and disassembly of the motor/amplifier system. Compumotor considers it an unsafe practice to use the plug/socket on our motors for any other purpose. Therefore, it isn't necessary that the ground pin be the first to make or the last to break. The ground wire is a bicolor green/yellow wire.

3.6.7 Creepage and Clearance Distances (EN 60950 section 2.9.4)

The minimum required insulation thickness of 0.4 mm is not applicable because it meets the requirement that the insulation is used within the equipment's protective enclosure and it is not subject to handling or abrasion during operator servicing. However, we do meet the criteria for dielectric strength test.

The connectors used on the motor conform to the above creepage/clearance requirements also. The motors will not create either a shock, fire, or other hazards which may endanger either persons or domestic animals.

3.6.8 Wiring Practices (EN 60204 section 15)

Where color coding is used for identification of conductors, the following colors may be used:

Black, Brown, Red, Orange, Yellow, Green, Blue (including light blue), Violet, Gray, White, Pink, and Turquoise.

It is recommended that, where color is used for identification, the color be used throughout the length of the conductor, either by the color of the insulation or by color markers. An acceptable alternative may consist of additional identification at selected locations.

For safety reasons, the color GREEN or the color YELLOW shall not be used where there is a possibility of confusion with the bicolor combination GREEN-AND-YELLOW.

3.7 MARKING

The marking of the motors should be in accordance with NEMA MG7 section 2.5.1 and 4.4, EC 34-1 section 27.2 and 30, EN 60204-1 section 18.1, and EN 60950 section 1.7. Motor rated at 705W or less and special purpose motors rated at 3kW or less only require a, b, j, and g as a minimum. From these standards the following items that are applicable are included on the motor nameplates.

a. manufacturer's name
b. serial number or date code
c. maximum continuous stall torque
d. maximum continuous output power
e. resistance, terminal at 25°C
f. thermal classification
g. rated voltage
h. rated power factor
i. rated output power
j. year of Manufacture
k. maximum speed
l. IP code
m. peak torque
n. rated current
o. maximum ambient temp
p. model number
q. maximum continuous r.m.s amperes

3.8 COMPLIANCE WITH THE EMC DIRECTIVE

It is important to remember that the system builder has the ultimate responsibility for ensuring compliance with the EMC Directive. Compumotor offers an EMC Installation Guide to provide information and guidance to meet the requirements of the EMC Directive. For a copy of the manual contact Compumotor at the location below and ask for document #88-015436-01.

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Compumotor Division
5500 Business Park Drive
Rohnert Park, CA 94928
Telephone: (800) 358-9070
International: (707) 584-7558
Fax: (707) 584-3793
FaxBack System: (800) 936-6939

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SECTION 4 - QUALITY SYSTEM

4.1 GENERAL

Compumotor based at Rohnert Park, California, USA operates a quality system that follows all accepted quality standards. All procedures are documented and changes to the procedures go through an accepted ECO process.

4.2 PRODUCTION TEST

Compumotor includes numerous levels of testing in the manufacturing process. These test are performed on 100% of the motors built. Lot sampling is not an option. The following provides the details and description of the typical types of tests that are currently performed on the Compumotor servo motors.

4.2.1 Windings and Stators

All windings are tested for shorts and resistance before they are potted into the stator. After the stators are potted they are inspected for cosmetic damage and potting flaws.

4.2.2 Rotors

Before the magnets are assembled with the backiron, the magnets are inspected for cracks, chips, and scratches in the coating. After the magnets are assembled with the backiron, they are inspected for a proper glue bond and alignment with the backiron. After assembly, the rotor is magnetized and the flux level is measured for proper strength.

4.2.3 Completed Motor

The completed motor is put on an automatic tester that measures the resistance, inductance, back-electromotive-force and dielectric strength. These measurements are then compared to the specification to accept or reject the motor.

4.2.4 Final Test

The final test verifies the functionality of the feedback device, the proper cabling and the mechanical integrity.

4.3 ENGINEERING CHANGES

4.3.1 Design Modification

A modification to the electrical design or mechanical construction may be needed to improve or change motors characteristics. It is recognized that changes to the mechanical layout of a product can also affect the safety. For this reason, all changes will follow the appropriate ECO process and the new units will be re-tested for safety and compliance. When necessary, the changes will be referred to UL or a Competent Body for evaluation.

Changes that are judged to have a significant impact on the electromagnetic compatibility may require a partial or complete re-test of the system.

4.3.2 Drawings

All drawings contain a change block that summarizes in chronological order all changes made to a drawing. Revision status and relevant ECO number affecting the change is also recorded. All engineering changes follow normal and accepted design practices.

4.3.3 Component Changes

A component change may be necessary for a number of reasons such as obsolescence or performance improvement. No changes may be made to a component without the approval of the engineering and quality department. All component changes will go through the standard ECO process.

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4.3.4 Quick-Fix Changes

In the event that production is halted for some reason, a more rapid response may be needed over the normal ECO route. In this event a Manufacturing Deviation Authorization (MDA) form is written to document the needed change. The document has a specified time limit and specific conditions for which it applies. A formal ECO form follows if necessary or the normal process is restored after the specified time limit. Under no circumstance will an MDA compromise compliance with the Low Voltage Directive.

4.4 ALTERNATIVE SOURCES

An additional vendor may be included on the approved vendor list to fulfill production requirements. However, this is only permitted after an ECO procedure has been followed and a vendor assessment has been carried out. Such changes warrant engineering consideration since the effect on EMC and LVD performance can be significant.

4.5 TEST AND QUALIFICATION

The Qualification Test used to demonstrate compliance of the Compumotor servomotors with the EC Directive on Low Voltage is based on the requirements of the documents listed in Section 3. All of the tests were conducted at the location specified below:

Parker Hannifin Corporation
Compumotor Division
5500 Business Park Drive
Rohnert Park, CA 94928
USA

Test personnel are fully trained in the procedures and methods required to carry out the qualification tests. All procedures and reports are fully documented and controlled.

4.6 EQUIPMENT

All production units used for the qualification test were built to the drawings and specifications in this TF. The configuration information and identification of the Unit Under Test (UUT) are contained in the test documents. Details of the actual test layout and configuration are contained in the test documents.

All test equipment used for the qualification test was calibrated at regular intervals. Any adjustments or repairs carried out during the initial testing are documented in the relevant test documents. No test were performed while the equipment was being serviced or maintained. The equipment was operated in its normal mode of operation except where the achievement of optimum results of the measurement required alternative power levels or operator settings.

4.7 OPERATION AND OPERATOR INTERVENTION

The operation of the UUT was in accordance with normal operating principles and procedures for the complete test program. No operator intervention was allowed that would impact or influence the results of the test.

4.8 TECHNICAL FILE AMENDMENT PROCEDURE

All changes to this TF will go through the standard ECO process. The changes will be documented in Amendment A. The change will include the date, reason for the change, the impact on LVD and EMC and describe any re-testing that may have been done. The change will also include any impact on UL or other Competent Bodies.

4.9 CHANGES AFFECTING UL, COMPETENT BODIES

All design changes to the Compumotor servo motors that affect the rating from UL or a Competent Body will be referred to that agency for their opinion and re-certification.

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ANNEX A: EXTERNAL AGENCY REPORT AND/OR CERTIFICATE

There are no external agency reports

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ANNEX B: TECHNICAL FILE AMENDMENT RECORD

REV B - May 30, 1998

- General spelling and grammatical corrections were made throughout this document.
- Reference to the document UL 547 and the test associated with that document was removed. The requirements of EN 60950 sections B4 and B5 specify identical test. The test complied with the requirements of EN 60950.
- Reference to document IEC 1000-4-2 (Electromagnetic Compatibility - EMC) was removed. EMC Compatibility will be covered in a separate document.
- The test data was added to Annex C the Technical File Test Data.

REV C - April 21, 2000

- General spelling and grammatical corrections were made throughout this document.
- Reference to the BE and the SE series motors where added throughout the document.
- The test data for the BE and the SE series motors was added to Annex C. Description of the thermometer method was added to section 3.5.2.

REV D – October 4, 2001

- General spelling and grammatical corrections were made throughout this document.
- Reference to the BE16 series motors where added throughout the document.
- The vibration test procedure was updated to reflect the actual test preformed
- The IP rating for the exposed encoders was adjusted to IP40.

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ANNEX C: TECHNICAL FILE TEST DATA

DIELECTRIC TEST

I. **Purpose:**

This test will demonstrate compliance with IEC 34-1, section 8, table 14. This specification requires the motors to be tested with a high potential voltage to determine the adequacy of the insulating materials and spacing against a breakdown under normal operating conditions.

II. **Equipment:**

The equipment used for the test is listed below:

SM162BE-NFLN	SM232BE-NFLN
SM230AE-NFLN	N0703FR-NMSN
N0922GR-NMSN	BE230FE-NFLN
BE232FE-NMSN	BE344JJ-NFLN
BE341FE-NMSN	SE161BE-NFLN
BE163CJ-NMSN	

SLAUGHTER Dielectric Breakdown and Leakage Tester

III. **Test Setup:**

The motors windings were connected together and attached to the positive lead of the Slaughter Tester. For the motor windings to housing test, the negative lead of the Slaughter Tester was attached to the rotor. For the winding to thermal switch test, the negative lead was attached to the thermal switch leads. The high potential voltage were done at the voltage level given in the table below.

IV. **Test Results:**

Motor Windings to Case Test

Motor Type	Rated Voltage	High Potential	Time	Test Results
N0703FR	340 volts	2016 volts	1 Sec	Passed
N0922GR	340 volts	2016 volts	1 Sec	Passed
SM233BE	340 volts	2016 volts	1 Sec	Passed
SM162BE	340 volts	2016 volts	1 Sec	Passed
SM230AE	100 volts	840 volts	1 Sec	Passed
BE230FE	340 volts	1680 volts	1 Min	Passed
BE232FE	340 volts	1680 volts	1 Min	Passed
BE341FE	340 volts	1680 volts	1 Min	Passed
BE344JJ	340 volts	1680 volts	1 Min	Passed
BE162CJ	340 volts	1680 volts	1 Min	Passed
BE163CJ	340 volts	1680 volts	1 Min	Passed
SE161BE	170 volts	1340 volts	1 Min	Passed

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Motor Windings to Thermal Switch Test

Motor Type	Rated Voltage	High Potential	Time	Test Results
N0703FR	340 volts	1787 volts	1 Sec	Passed
N0922GR	340 volts	1787 volts	1 Sec	Passed
SM233BE	340 volts	1787 volts	1 Sec	Passed
SM162BE	340 volts	1787 volts	1 Sec	Passed
SM230AE	100 volts	1000 volts	1 Sec	Passed
BE230FE	340 volts	1787 volts	1 Min	Passed
BE232FE	340 volts	1787 volts	1 Min	Passed
BE341FE	340 volts	1787 volts	1 Min	Passed
BE344JJ	340 volts	1787 volts	1 Min	Passed
SE161BE	170 volts	1787 volts	1 Min	Passed

V. **Conclusion:**

All of the motors passed the high potential test and meet the requirements of IEC 34-1.

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MOTOR WINDING TEMPERATURE TEST

I. **Purpose:**

This test will demonstrate compliance with the IEC 34-1 section 7.6. This test requires the motor winding temperature to be read while running the motor at the maximum load it can run without activating the thermal switch.

II. **Equipment:**

The equipment used for the test is listed below:

SM162AE-N10N	SM232AE-NTQN
N0703FR-NMSN	N0921FR-NMSN
BE230FE-NFLN	BE232FE-NMSN
BE344JJ-NFLN	BE341FE-NMSN
SE161BE-NFLN	BE161CJ-NFLN

TQ10 (Driving the SM162AE-N10N and SM232AE-NTQN)
APEX 6151 (Driving the N0703FR and N0921FR)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN, BE232FE-NMSN and BE161CJ-NFLN)
OEM670 (Driving the SE161BE-NFLN)
Fluke Hydra Data Logger model 2625A
Mounting Rack for the motors
Hysteresis Brake
Cole-Palmer model 39650-02 Infe-red Temperature Gun

III. **Test Setup:**

The SM162AE, SM232BE and N0703FR motors were mounted to a 4X4X1/4 inch aluminum plate and the remanding motors were mounted to a 10X10X1/4 inch aluminum plate or equivalent. Type J thermocouples were attached to the top-middle section of the motor housings for the "Modified Thermometer Method" of temperature measurement. Type J thermocouples were attached to the end turns of the motor winding for the "Embedded Temperature Method" of temperature measurement. A Hydra Data Logger recorded the motor temperature until it was stable near the thermal switch set point. The case temperature for the BE161CJ was measured using a Cole-Palmer infer-red temperature gun; the winding temperature was determined using the modified thermometer method.

IV. **Test Process:**

The average ambient temperature during the test was approximately 25°c. The temperature readings were taken in 6 minutes increments until stabilized. The load for the SM motors and N0703FR motor was created with an aggressive move profile which consisted of a high acceleration, high velocity, short distance and oscillating in reverse directions. The load was increased in small increments by increasing the acceleration which resulted in an increase in the r.m.s current to the motors. The load for the remaining motors was created with a dynamic brake and it was increased in small increments by increasing the current to the brake.

SM and N0 Base Data

Motor	Resistance	Acceleration	Velocity	Distance
SM162AE	6.7428	A1600 rps/s	V130 rps	D8000
SM232BE	7.6030	A1600 rps/s	V130 rps	D8000
N0703FR	3.7882	A2000 rps/s	V80 rps	D6000
N0921FR	3.1260	See Note	V1.7 rps	continuous

Final SM and N0 Data

Motor	Resistance	Acceleration	Velocity	Distance
SM162AE	8.0828	A2200 rps/s	V130 rps	D12000

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SM232BE	10.0900	A1200 rps/s	V47 rps	D8000
N0703FR	5.7163	A475 rps/s	V60 rps	D8000
N0921FR	3.1420	See Note	V1.7 rps	continuous

Final SM and N0 Winding Temperature

Motor	Housing Temp.	Thermal Switch Range	Motor Winding Temp.
SM162AE	59.4°c	65°c to 75°c	73.1°c
SM232BE	80.4°c	85°c to 95°c	107.8°c
N0703FR	100.0°c	130°c to 140°c	140.7°c
N0921FR	96.0°c	130°c to 140°c	146.1°c

Note: This motor was run in torque mode so there was no controlled acceleration. The motor accelerated to the velocity set by the applied voltage as quickly as possible.

BE and SE Data

	R_{ca} C/watt	R_{wc} C/watt	Speed RPS	T_{amb} °C	T_{case} °C	T_{wind_mtm} °C	T_{wind_ttm} °C
SE161BE-NFLN	1.51	1.19	2	25	56.7	81.7	N/A
BE230FE-NFLN	0.86	1.28	2	25	69.1	134.7	107.5
BE232FE-NMSN	1.02	0.56	2	25	83.8	116.1	108.2
BE341FE-NMSN	0.88	0.52	2	25	73.2	101.7	106.4
BE344JJ-NFLN	0.78	0.17	2	25	101.3	117.9	120.8
BE161CJ-NFLN	1.35	1.35	83	25	79.2	133.4	N/A

Note: *T_{wind_mtm} was determined from the Modified Thermometer Method and T_{wind_ttm} was determined from the Embedded Temperature Method.*

V. **Conclusion:**

All of the motor winding temperatures were below the requirements of IEC 34-1 while running near maximum load without activating the thermal switch. All of the motors are in compliance with this specification.

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BEARING TEMPERATURE TEST

I. **Purpose:**
This test measures the front and rear bearing temperature of the motor. This is a requirement of the IEC 34-1, section 7.9 as part of the Low Voltage Directive. This test demonstrates compliance with the Bearing Temperature Measurement specification.

II. **Equipment:**
The equipment used for the test is listed below:

SM162AE-NFLN	SM232BE-NFLN
N0342EE-NMSN	N0922FR-NMSN
BE230FE-NFLN	BE232FE-NMSN
BE344JJ-NFLN	BE341FE-NMSN
SE161BE-NFLN	BE161CJ-NFLN

TQ10X – (Driving the SM232BE and the N0342EE motors)
OEM607X – (Driving the SM162AE motor)
APEX 6152 (Driving the N0922FR motor)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN and BE232FE-NMSN)
OEM670 (Driving the SE161BE-NFLN)
Fluke Hydra Data Logger model 2625A
Mounting Rack for the motors
Hysteresis Brake

III. **Procedure for N0 and the SM series motors:**
The motors were mounted to a 4X10X1/4 inch aluminum plate which was mounted to an aluminum frame. An inertia load was added to the N0342EE and the N0922FR motors. A hole was drilled into the front and rear flange of the motors bearing journal to provide access to the bearings. A Type J Thermocouple was glued into each bearing journal of the SM162AE and the SM232BE motors. Another Type J Thermocouple was glued to the top-middle section of the motor housing to measure the motor case temperature. A Type J Thermocouple was used the N0342EE and the N0922FR motors. The thermocouples were in the same location as the SM16 and SM23 motors. The temperature was automatically recorded by a Hydra Data Logger during the test. The temperature was taken with the motors running at a constant velocity and the motor housing at a relatively low temperature. It was also taken with an aggressive move profile which heats the motors to an elevated temperature. The move profiles are given below.

Constant Velocity:
N0922FR — Acceleration = 500 rps/s, Velocity = 70 rps, Continuous mode
N0342EE — Acceleration = 500 rps/s, Velocity = 70 rps, Continuous mode
SM232BE — Acceleration = 100 rps/s, Velocity = 75 rps, Continuous mode
SM162AE — Acceleration = 100 rps/s, Velocity = 75 rps, Continuous mode

Aggressive move:
N0922FR — Acceleration = 1000 rps/s, Velocity = 100 rps, Distance = 8000 steps
N0342EE — Acceleration = 500 rps/s, Velocity = 60 rps, Distance = 12000 steps
SM232BE — Acceleration = 1200 rps/s, Velocity = 130 rps, Distance = 8000 steps
SM162AE — Acceleration = 1500 rps/s, Velocity = 140 rps, Distance = 8000 steps

Procedure for the BE and SE motor bearing temperature test:

Each motor was equipped with a J type thermocouple attached to the case and the front bearing. A thermal couple was not attached to the rear bear due to accessibility. The motors where connected to their respective amplifiers. Each motor was mounted to an aluminum plate that was 10x10x1/4" in

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size or equivalent. Each motor was loaded by a hysterisis brake so that rated current flowed through the motor during the test. The motors where run until steady state conditions resulted. The front bearing and the case temperature was recorded at steady state.

IV. **Test Results:**

The ambient temperature during the test was about 25°c. The final temperature values are as follows:

Aggressive move temperatures:

Motor type	*Housing °C*	*Front bearing °C*	*Rear Bearing °C*
N0922FR	73.8	73.3	76.7
N0342EE	68.6	63.7	67.7
SM233BE	100.3	100.4	100.5
SM162EE	91.7	91.7	91.8

Continuous move temperatures:

Motor type	*Housing °C*	*Front bearing °C*	*Rear Bearing °C*
N0922FR	36.9	36.5	36.6
N0342EE	31.6	30.7	31.9
SM233BE	35.4	35.1	35.9
SM162EE	34.4	34.0	35.1

Bearing temperature at rated Current:

Motor Type	*Housing °C*	*Front Bearing °C*
SE161BE-NFLN	61.6	59.4
BE230FE-NFLN	68.7	49.7
BE232FE-NMSN	83.8	48.6
BE341FE-NMSN	79.1	50.6
BE344JJ-NFLN	101.3	62.9
BE161CJ-NFLN	82.0	50.1

V. **Conclusion:**

Three bearing temperature readings were taken over a 30 minute period and all of them were within a +/- 0.2°c. Though the temperatures were recorded, there are no specifications given in IEC 34-1. This test meets the requirements of IEC 34-1.

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OVERLOAD PROTECTION

I. **Purpose:**

This test will demonstrate compliance with the EN 60950 section B.4. This test requires the motor to be run at its maximum load without activating the thermal switch. The temperature is allowed to stabilize then the load is increased in small increments (about 5%) until the thermal switch activates.

II. **Equipment:**

The equipment used for the test is listed below:

SM162AE-N10N	SM232BE-NFLN
N0703FR-NMSN	N0921FR-NMSN
BE230FE-NFLN	BE232FE-NMSN
BE344JJ-NFLN	BE341FE-NMSN
SE161BE-NFLN	

6250 Controller
TQ10X – (Driving the SM232BE)
OEM607X – (Driving the SM162AE motor)
APEX 6151 (Driving the N0703FR motor)
APEX 6152 (Driving the N0921FR motor)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN and BE232FE-NMSN)
OEM670 (Driving the SE161BE-NFLN)
Fluke Hydra Data Logger model 2625A
Mounting Rack for the motors
Hysteresis Brake

III. **Test Setup:**

The SM162AE, SM232BE and N0703FR motors were mounted to a 4X4X1/4 inch aluminum plate and the N0921FR motor was mounted to a 4X10X1/4 inch aluminum plate. Type J Thermocouples were attached to the top-middle section of the SM162AE and SM232BE motor housings and Type T Thermocouples were attached to the N0703FR and N0921FR motor housings. The temperatures were recorded by Hydra Data Logger.

IV. **Test Process for SM and N0 motors:**

The average ambient temperature during the test was 24.4°c. The temperature readings were taken in 6 minutes increments until stabilized. The load was created with an aggressive move profile which consisted of a high acceleration, high velocity, short distance and oscillating in reverse directions. The profile also included a long constant move to allow the temperature to stabilize and prevent premature drive faults. The load was increased by increasing the acceleration which resulted in an increase in the r.m.s current to the motor.

V. **Test Process for SE and BE motors:**

The ambient temperature during the test was 23°c +/- 1°c. The temperature of the case (and the winding when available) was taken in 5 minute increments until stabilized. The load was created with a hysterisis brake. The load increased by progressively engaging the brake and hence causing the current in the motor to increase. After each stabilization the load was increased by 5% until the temperature switch tripped.

Motors Base Move Profiles

Motor	Acceleration	Velocity	Distance	Acceleration	Velocity	Distance
SM162AE	A950 rps/s	V100 rps	2.00 revs	A800 rps/s	V75 rps	750 revs
SM232BE	A1600 rps/s	V130 rps	2.00 revs	A900 rps/s	V100 rps	750 revs
N0703FR	A1900 rps/s	V100 rps	1.35 revs	A1800 rps/s	V50 rps	250revs
N0921FR	A2000 rps/s	V100 rps	1.35 revs	A2000 rps/s	V50 rps	250 revs

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SM162AE Motor Acceleration and Temperature Data

Acceleration	Temperature
950 rps/s	47.5°c
1075 rps/s	51.1°c
1200 rps/s	54.0°c
1325 rps/s	57.8°c
1450 rps/s	62.3°c Thermal Switch activated

SM232BE Motor Acceleration and Temperature Data

Acceleration	Temperature
1600 rps/s	72.7°c
1775 rps/s	77.8°c
1950 rps/s	82.4°c
2125 rps/s	85.4°c Thermal Switch activated

N0703FR Motor Acceleration and Temperature Data

Acceleration	Temperature
1900 rps/s	85.0°c
2200 rps/s	92.2°c
2500 rps/s	96.4°c
2800 rps/s	104.1°c
3100 rps/s	108.7°c
3400 rps/s	115.5°c Thermal Switch activated

N0703FR Motor Acceleration and Temperature Data

Acceleration	Temperature
2000 rps/s	76.9°c
2400 rps/s	82.1°c
2800 rps/s	86.8°c
3200 rps/s	92.4°c
3600 rps/s	99.7°c
4000 rps/s	105.2°c Thermal Switch Activated

BE and SE Data After Thermal Switch Activated

	R_{ca} C/watt	R_{wc} C/watt	Speed RPS	T_{amb} °C	T_{case} °C	T_{wind_mtm} °C	T_{wind_ttm} °C
SE161BE-NFLN	1.51	1.19	2	25	72.3	109.6	N/A
BE230FE-NFLN	0.86	1.28	2	25	72.5	143.2	113.5
BE232FE-NMSN	1.02	0.56	2	25	92.3	129.2	123.4
BE341FE-NMSN	0.88	0.52	2	25	87.7	124.8	113.6
BE344JJ-NFLN	0.78	0.17	2	25	102.2	119.0	124.5

Note: *T_{wind_mtm} was determined from the Modified Thermometer Method and T_{wind_ttm} was determined from the Embedded Temperature Method.*

V. **Conclusion:**

The motor temperatures were allowed to stabilized while running at a simulated heavy load and without activating the thermal switch. Then the load was increased in small increments until the thermal switch activated. None of the motor windings exceeded their maximum temperature ratings as specified by the EN 60950, section b.4 so the motors are in compliance with this specification.

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LOCKED ROTOR TEST - PART A
THERMAL STABILITY TEST

I. **Purpose:**
This test will demonstrate compliance with the EU Standard, EN 60950 section b.5 - thermal stability test. This test locks the rotor and applies continuous rated current (r.m.s) through the motor until thermal stability is reached, the thermal protection device activates, or a maximum of 18 days.

II. **Equipment:**
The equipment used for the test is listed below:

SM162AE-N10N	SM232BE-NFLN
N0703FR-NMSN	N0921FR-NMSN
BE230FE-NFLN	BE232FE-NMSN
BE344JJ-NFLN	BE341FE-NMSN
SE161BE-NFLN	

6250 Controller
OEM670 (Driving the SE161BE-NFLN)
TQ10 (Driving the SM162AE and SM232BE motor)
APEX 6151 (Driving the N0703FR motor)
APEX 6152 (Driving the N0921FR motor)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN and BE232FE-NMSN)
Fluke Hydra Data Logger model 2625A
Tektronix Dual Channel Oscilloscope model TDS 320
Tektronix Current Probe model TMS502A Current Probe
Mounting Rack for the motors
Hysteresis Brake

III. **Test Setup:**
The SM162AE, SM232BE and N0703FR motors were mounted to a 4X10X1/4 inch aluminum plate. The SE and the BE motors were mounted to a 10x10x1/4 inch plate or equivalent. The rotor was locked in place by strapping it to the mounting plate or by use of a hysteresis brake. Type J Thermocouples were attached to the top-middle section of the SM, SE and BE motor housings and Type J Thermocouples were attached to the N0703 and N0921 motor housings. The temperature was automatically recorded by Hydra Data Logger.

IV. **Test Process:**
The ambient temperature during the test was approximately 25°c. The temperature readings were taken approximately 10 minutes apart until steady state conditions where apparent.

SM and NO Motor Steady State Temperatures

	SM162AE	*SM232BE*	*N0703FR*	*N0921FR*
Six State Amps	4.25	5.2	4.9	4.4
Steady State Temp	91.5	100.0	53.8	58.9

BE and SE Motor Steady State Temperatures

	SE161BE-NFLN	*BE230F-NFLN*	*BE232FE-NMSN*	*BE341FE-NMSN*	*BE344JJ-NFLN*
Six State Amps	4.25	5.2	4.9	4.4	7.8
Steady State Temp	61.6	69.1	83.8	79.1	101.3

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	BE164F-NFLN
Six State Amps	5.1
Steady State Temp	114

V. **Conclusion:**

At a constant continuous rated(r.m.s) current, with the rotor locked in position, the temperature of the motors windings will not exceed their maximum temperature ratings as specified by the EN 60950, section b.5. The motors comply with this specification.

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LOCKED ROTOR TEST - PART B
THERMAL SWITCH CYCLE TEST

I. **Purpose:**

This test will demonstrate compliance with the EU Standard, EN 60950 section b.5 - thermal switch cycle test. This test locks the rotor and enough current is driven through the motor to cause the thermal switch to operate. The motor is cooled down and the cycle is repeated a minimum of 60 times.

II. **Equipment:**

The equipment used for the test is listed below:

SM162AE-N10N
SM232BE-NFLN
N0703FR-NMSN
N0921FR-NMSN
BE230FE-NFLN BE232FE-NMSN
BE344JJ-NFLN BE341FE-NMSN
SE161BE-NFLN

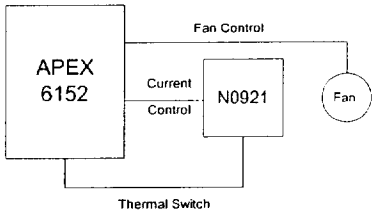
6250 Controller
OEM670 (Driving the SE161BE-NFLN)
TQ10 (Driving the SM162AE and SM232BE motor)
APEX 6151 (Driving the N0703FR motor)
APEX 6152 (Driving the N0921FR motor)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN and BE232FE-NMSN)
Fluke Hydra Data Logger model 2625A
Tektronix Dual Channel Oscilloscope model TDS 320
Tektronix Current Probe model TMS502A Current Probe
Mounting Rack for the motors
Hysteresis Brake

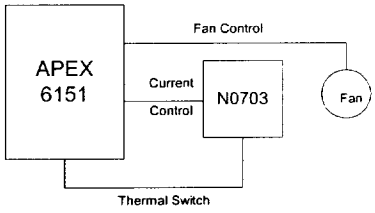
III. **Test Setup:**

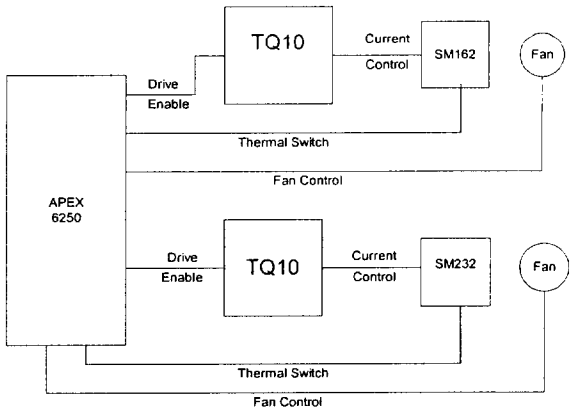
The motors were mounted to a 4X4X1/4 inch aluminum plate or equivalent. Nylon washers insulated the mounting plate from the frame for minimal heat transfer. Type J Thermocouples were attached to the top-middle section of the SM, SE and BE motor housings and Type T Thermocouples were attached to the N0703 and N0921 motor housings. The temperature was monitored and recorded manually during the test.

The fan control, used to cool the SM motors, was connected to an APEX 6250 and the fan control, used to cool the Neometric motors, was connected to an APEX 6151 or APEX 6152 as indicated in the drawing. The fans accelerated the cool down cycle to reduce the total test time.

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IV. **Test Process:**

The motors were operated in torque mode (or open loop mode) so a constant current could be maintained to the motors. In this mode, the current could be set with a fixed voltage level to the drive circuitry and maintained in the absence of any feedback control. The currents were set according to table below. The average ambient temperature during the test was 24.4 c. When the current was applied, the motors would heat sufficiently to activate the thermal switches. The APEX units would sense that the thermal switches activated and the current would be set to zero and the fans would be turned on. This cooled the motors until the thermal switches de-activate. When the APEX units sensed closure (de-activation) of the thermal switches, the current would be turned on and the cycle would be repeated. A variable counter in the APEX software would count the number of cycles. As specified, sixty cycles were completed for each of the motors.

SM and NO Motor Test Results

	SM162AE	*SM232BE*	*N0703FR*	*N0921FR*
Six State Current (Heat Cycle)	3.0	7.0	7.9	9
Six State Current (Cool Cycle)	0	0	0	0
Activation Temp	68.1	106.5	110.1	80.5
De-Activation Temp	36	40.5	91	70.5

Note: Activation and De-Activation Temperatures were measure from the case.

SE and BE Motor Test Results

	SE161BE-NFLN	*BE230F-NFLN*	*BE232FE-NMSN*	*BE341FE-NMSN*	*BE344JJ-NFLN*
Six State Current (Heat Cycle)	4.27	5.44	4.9	4.89	8.7
Six State Current (Cool Cycle)	0	0	0	0	0
Activation Temp	62.1	109.3	115.8	105.1	122.1
De-Activation Temp	36.2	114.0	77.4	65.9	86.3

Note: Activation and De-Activation Temperatures were measure from the case.

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V. **Conclusion:**

The motors were tested according to the Standard EN 60950 section B.5 for the manually resetting thermal protector. The thermal switches operated flawlessly for at least 60 cycles. All motors were tested for functionality at the completion of the test and all motors functioned normally. The Compumotor servo motors comply with this standard.

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OVERSPEED TEST

I. **Purpose:**
This test will demonstrate compliance with IEC 34-1, section 21, table 6 that requires the motors to be run at 1.2 times the maximum rated speed for 2 minutes.

II. **Equipment:**
The equipment used for the test is listed below:
SM162BE-NFLN
SM232BE-NFLN
N0342EE-NMSN
N0922GR-NMSN
BE230FE-NFLN BE232FE-NMSN
BE344JJ-NFLN BE341FE-NMSN
SE161BE-NFLN

OEM670 (Driving the SE161BE-NFLN)
Gemini H20 (Driving the BE344JJ-NFLN and BE341FE-NMSN)
Gemini GV6 (Driving the BE230FE-NFLN and BE232FE-NMSN
TQ10X (Driving the SM162BE, SM232BE and the N0342EE motors)
APEX 6152 (Driving the N0922GR motor)
Mounting Rack for the motors

III. **Test Setup:**
The motors were mounted to a 4X10X1/4 inch aluminum plate which was mounted to an aluminum frame. All motors were run without an inertia load. All motor were run for 2 minutes at a constant velocity in one direction, then run for 2 minutes in the reversed direction.

Motor Type	*Maximum Rated Velocity RPM*	*Test Velocity RPM*
N03442EE	3025	3630
N0922GR	4375	5250
SM233BE	7500	9000
SM162BE	7500	9000
BE230FE-NFLN	5000	6000
BE232FE-NMSN	5000	6000
BE344JJ-NFLN	3000	3600
BE341FE-NMSN	5000	6000
SE161BE-NFLN	5000	6000
BE161CJ-NFLN	5000	6500

V. **Conclusion:**
All of the motors were run the required 2 minutes at the 1.2 times maximum rated speed. This test meets the requirements of IEC 34-1.

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