ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *TSI 7610* at our website: *Click HERE*

Instruction Manual

Model 3760

Condensation Nucleus Counter

This manual is printed on cleanroom-compatible paper

TSI®

Part Number 1933760 / July 1991 / Revision C

Copyright ©TSI Incorporated / September 1987 / All rights reserved

Address TSI Incorporated / 500 Cardigan Road / P.O. Box 64394 / St. Paul, MN 55164 / USA

Telex No. 6879024

Limitation of Warranty and Liability

TSI Incorporated warrants that this product, under normal use and service, shall be free from defects in workmanship and material for a period of twelve (12) months from the date of shipment to the customer. This limited warranty is subject to the following exclusions:

1. Batteries, hot wire or hot film sensors are warranted for a period of 90 days from the date of shipment to the customer.
2. With respect to any repair services rendered, Seller warrants that the parts repaired or replaced will be free from defects in workmanship and material, under normal use, for a period of 90 days from the date of shipment to the customer.
3. Seller does not provide any warranty on finished goods manufactured by others.
4. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, any goods which are incorporated into other products or equipment by the Buyer.

The foregoing is IN LIEU OF all other warranties and is subject to the conditions and LIMITATIONS stated herein. No other express or implied warranty of fitness for particular purpose or merchantability is made.

THE EXCLUSIVE REMEDY OF THE USER OR PURCHASER, AND THE LIMIT OF THE LIABILITY OF SELLER OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGE IN CONNECTION WITH THIS PRODUCT (INCLUDING CLAIMS BASED ON CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT, OR OTHERWISE) SHALL BE THE RETURN OF THE PRODUCT TO THE FACTORY OR DESIGNATED LOCATION AND THE REFUND OF THE PURCHASE PRICE, OR, AT THE OPTION OF SELLER, THE REPAIR OR REPLACEMENT OF THE PRODUCT. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES. NO ACTION, REGARDLESS OF FORM, MAY BE BROUGHT AGAINST THE SELLER MORE THAN ONE YEAR AFTER THE CAUSE OF ACTION HAS ACCRUED.

The purchaser and all users are deemed to have accepted the terms of this limitation of warranty and liability, which contains the complete and exclusive warranty of the Seller. This limitation of warranty and liability may not be amended or modified nor may any of its terms be waived, except by a writing signed by an authorized representative of Seller.

Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (612) 483-4711.

Contents

About This Manual v

Chapters

1 Introduction 1-1

2 Setup and Operation 2-1
What you Received 2-
Setting up the CNC 2-
Filling the CNC with Butanol 2-
Flow Control—Vacuum Source 2-
Status Lights 2-
Draining the CNC of Butanol 2-
Counting Single Particles 2-
Viewing Analog Pulses 2-
Correcting for Coincidence 2-
Calibrating the CNC 2-

3 Description of the CNC 3-1

4 Specifications and Electrical Schematics 4-1
Specifications 4-
Electrical Schematics 4-

Figures

1-1 Back Panel of the CNC
1-2 Advisory Labels
2-1 Front Panel of the CNC
2-2 Inside View of the CNC
2-3 Front-Panel's Main Circuit Board for the CNC
2-4 Analog Pulse Trace of the Photodetector Signal
3-1 Schematic Diagram of the Cleanroom CNC

Table

1-1 Components of the CNC

About This Manual

The Model 3760 Condensation Nucleus Counter Instruction Manual is written for both the installer and the operator, whether a technician or the head of cleanroom contamination control.

Organization

This instruction manual is organized as follows:

Chapter 1: Introduction
Describes the sensor and gives a brief description of the many features of the CNC.

Chapter 2: Setup and Operation
Explains how to set up and operate the Condensation Nucleus Counter.

Chapter 3: Description of the CNC
Explains the Basic Operation of the CNC.

Chapter 4: Specifications and Electrical Schematics
Gives the primary specifications of the CNC and provides two electrical schematics.

Help!

To obtain assistance with this hardware, or simply to submit suggestions, please contact Customer Service:

TSI Incorporated
P.O. Box 64394
St. Paul, MN 55164 USA
Fax (612) 481-1220
Telex 6879024
Telephone (612) 483-4711

1 Introduction

The Model 3760 Condensation Nucleus Counter (CNC) operates with the multisensor Cleanroom Monitoring System (CRMS) using the Model 3701 Multiplexer/Processor or the Model 3704 Single-Channel Processor in conjunction with an IBM personal computer.

Refer to the CRMS Instruction Manual (P/N 1933700) and the CRMS Advanced Software Instruction Manual (P/N 930037) for detailed information about the complete monitoring system. Much of the information in these manuals that applies to the Model 3755 Laser Particle Counter applies to the CNC as well.



Figure 1-1
TSI Model 3760 Condensation Nucleus Counter

Important Information: Laser Warnings

The CPC is a laser-based instrument. As such, certain precautions must be taken when using and servicing it. Do not remove any parts unless instructed to do so in this instruction manual—otherwise you may expose yourself to hazardous optical radiation.

WARNING:	*The use of controls, adjustments, or procedures other than those specified within this manual may result in exposure to hazardous optical radiation.*

Several advisory labels are attached to the components of the counter for your benefit (see figure 1-2). Reproductions of them, and a note on their locations, are given below.

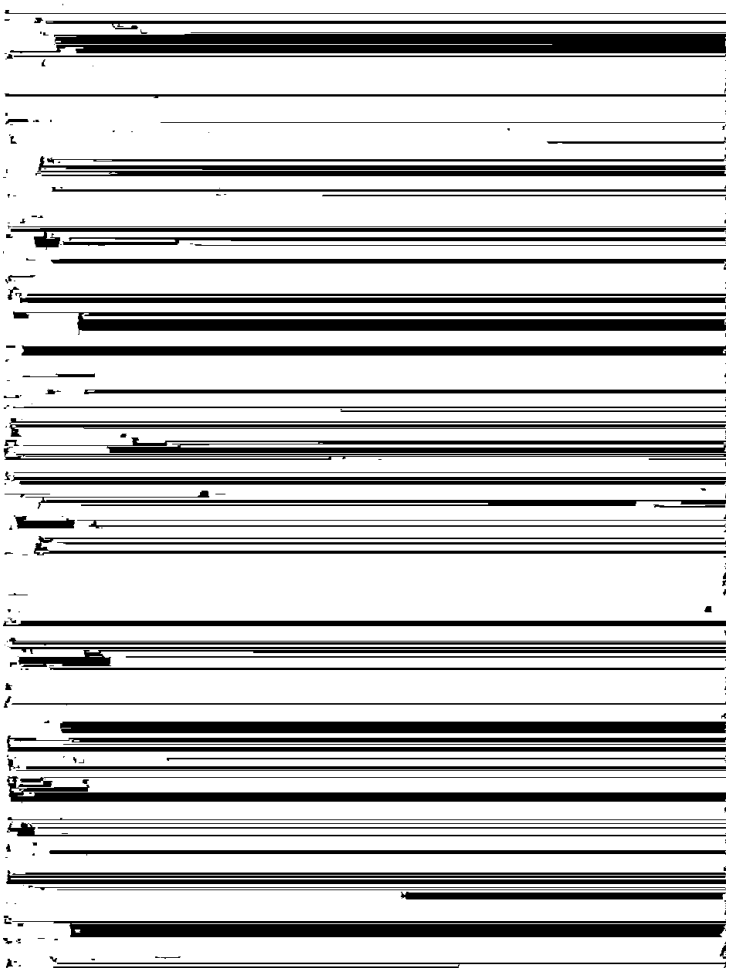


Figure 1-2
Advisory Labels: a identification label (on the underside); b power requirements label (on heatsink); c warning label (on the optics housing); d compliance label (on the underside)

2 Setup and Operation

What you Received

The Model 3760 CNC includes the components listed in table 2-1:

TABLE 2-1 Components of the CNC

Qty	Description		Part No
1	CNC sensor		376000
1	Alcohol fill bottle		2002017
3 ft	Tubing, ¼ in. OD x $^1/_8$ in. ID		3001257
1	Connector with shutoff valve		1601758
1	Instruction manual		1933760
1	Power-cable assembly	(120 V) *or*	1030817
		(240 V)	1030818

Carefully unpack the hardware from its packing boxes. If anything is missing, contact TSI customer service.

Setting up the CNC

To set up the CNC, follow these five steps:

1 Operate the CNC only in an upright position.

2 Remove the protective caps from the inlet and exit ports and from the electrical CNC connector.

3 Check the label on the back panel to make sure the CNC is set for the proper line voltage (figure 2-1).

4 Plug the enclosed power cord into the CNC connector on the back panel and then into an AC source. The cord contains a special line filter to reduce both line noise and the potential for false particle counts.

5 Connect a BNC cable to the back-panel connectors so both the CNC and Multiplexer/Processor (or other counter).

The Multiplexer/Processor (M/P) applies the proper multiplying factors for calculating the concentration; but first you must set up the M/P sensor selection; refer to the Model 3701 M/P's instruction manual.

If you are using a Model 3701 M/P, set the DIP switch 5 for the correct flowrate according to these two steps:

1 To properly display the particle concentration on the Model 3701 M/P, the 3700 ROM version level must be 1.4 or higher. (This is automatically true for 3700s with serial number 165 or higher.) The Model 3700 cannot distinguish among different types of CNCs (Models 3760 or 3020) so the display will be

correct for only one type of CNC if more than one type is used. DIP switch 5 must be *off* for the Model 3760; switches 5 and 7 must be *on* for the Model 3020.

2 Switch on the CNC once you connect power. If the CNC reservoir is filled with butanol, the CNC starts sampling and counting particles when you connect the vacuum.

The measured concentration is displayed on the M/P and/or on the computer. However, this measurement will not be accurate until the instrument has reached thermal equilibrium (as indicated by a *green* status light; see "Status Lights" below).

Filling the CNC with Butanol

Fill the supplied bottle with reagent grade n-butyl alcohol (butanol).

WARNING: *Butanol is flammable and may be toxic if inhaled in sufficient quantities. Use it only in a well-ventilated area. Its vapor is strong and foul. If you smell butanol and develop a headache, faintness or nausea, leave the area at once. Ventilate the area before returning.*

The alcohol will not drain from the connector unless it is connected to the mating part of the CNC. Loosen the bottle cap to provide an air vent; then connect the fitting to the CNC mating fitting as shown in figure 2-1. Hold the bottle above the CNC to allow liquid to flow into the CNC and observe the liquid level through the window on the front panel. When the liquid level reaches the center of the window, disconnect the filling tube.

Caution: *Do not overfill the bottle.*

The CNC contains an automatic shutoff valve to prevent overfilling the reservoir. However, this feature is not intended to be used for connecting the fill bottle for continuously replenishing alcohol from the fill bottle into the reservoir. Always disconnect the filling tube once the reservoir is full.

If you are running the CNC continuously, make sure the alcohol in the reservoir is replenished about twice per week. It is better to keep some alcohol in the CNC's reservoir at all times rather than to allow it to dry out between refills. This helps prevent air from leaking into the sample airstream from the reservoir and generate stray particle counts.



Figure 2-1
Back Panel of the CNC: *a* fill connector, *b* drain connector, *c* vacuum exhaust, *d* power

Flow Control—Vacuum Source

*Flexible 1/2-inch OD and 1/4-inch ID tubing is recommended.

The CNC flow, controlled by a critical orifice inside the instrument, requires an external vacuum source, such as the plant vacuum or central vacuum or a vacuum pump outside the clean area. Connect the vacuum tubing* between the vacuum source and the exit port on the back panel of the CNC. The CNC requires a minimum vacuum pressure of 18 inches of mercury and draws a total flowrate of 0.1 scfm. Only 0.05 cfm makes up the sample flowstream. The remaining airflow is purge air for the cabinet.

To measure the instrument's flowrate, connect a low-pressure-drop flowmeter to the CNC's inlet. A bubble meter or thermal flowmeter (such as TSI's Model 2011B) works best. The flowrate should be 0.05 cfm (1.415 L/min) ±10 percent. If the flowrate is too low, the orifice may be plugged, the vacuum may be less than 18 inches of mercury, or the pressure drop of the test flowmeter may be too high. If you suspect a clogged orifice, contact TSI to learn how to correct this.

Caution:	*If you are using a vacuum pump, the vacuum exhaust containing malodorous butanol vapors should be channeled to a hood ventilator or to an absorbent. Do not exhaust the vapors into an unventilated area.*

Status Lights

There are two status lights on the front panel of the CNC (figure 2-2). The top light flashes red each time a particle is detected. The bottom light is either red or green. Red means that while power is being
supplied to the instrument, the instrument is not thermally stable or else the laser is malfunctioning. Green means that the condenser is cold enough and that the laser is operating properly.

On initial power-up, the CNC takes about 20 minutes to reach thermal stability. Note that the status light does *not* indicate whether there is flow through the instrument or whether the flow is correct.

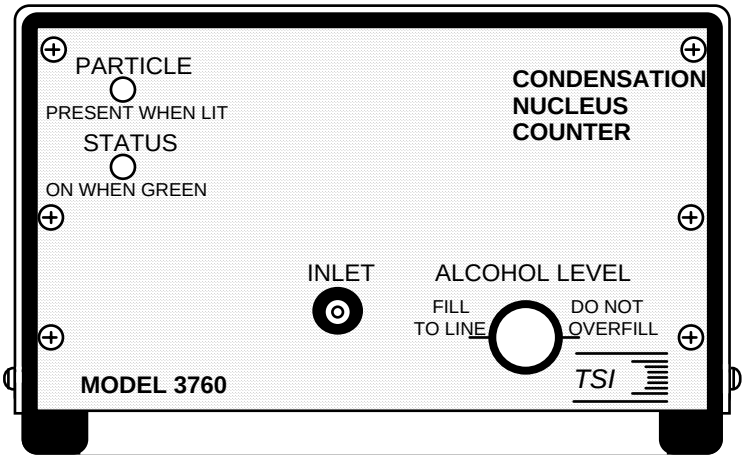


Figure 2-2
Front Panel of the CNC

Draining the CNC of Butanol

Draining the CNC is essentially the same as filling it. Follow these three steps:

1 Connect the drain tube that runs to the lower connector on the back panel of the CNC (figure 2-1).

2 Loosen the cap on the fill-bottle and hold the bottle below the instrument.
3 Tip the CNC toward the connector to drain the last drops. Even after draining by gravity, keep in mind that much alcohol will remain soaked in the saturator block.

To dry the block faster and more completely, first seal off the vacuum exit tube and the purge-air inlet. The purge-air inlet is inside the cabinet next to the optics (see figure 2-3).

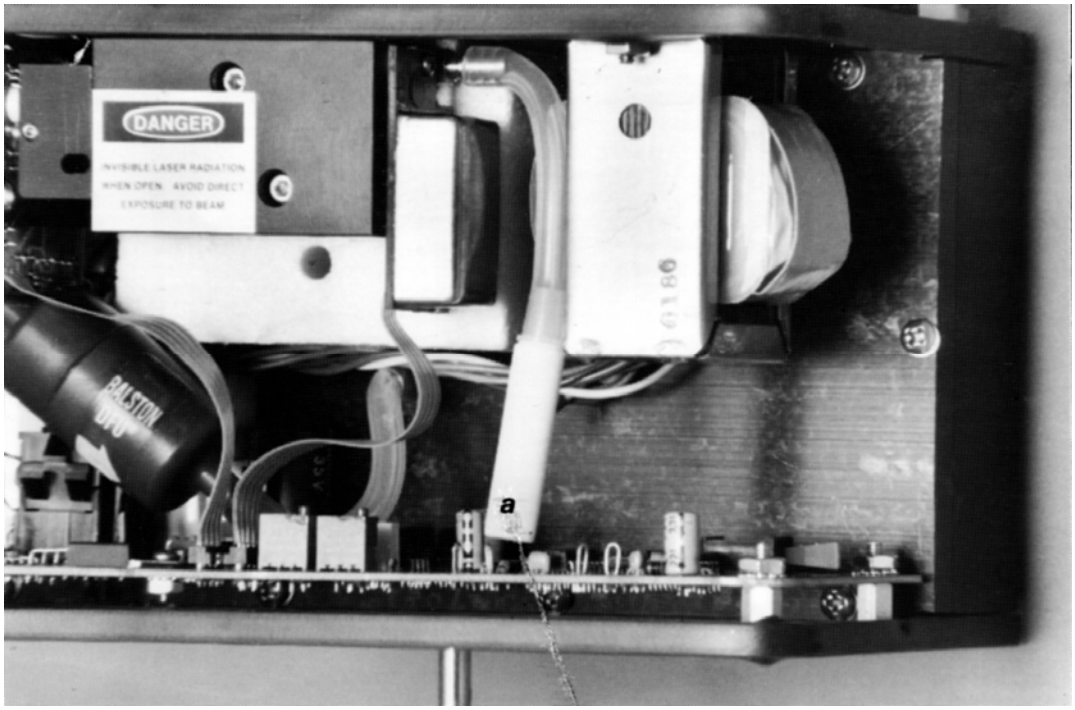


Figure 2-3
Inside View of the CNC; a Purge-Air Inlet and Filter

The purge inlet tube has a porous plastic filter on one end. Remove the filter and insert a plug. Be sure that the drain connector from the bottle is attached to the mating connector on the CNC; it functions as an air escape. Very carefully introduce slight pressure into the instrument with a clean (filtered), dry, compressed-air source. The pressure forces the liquid out of the saturator block and out through the drain. With about 5 psig of air pressure, the saturator will dry out in a few hours. Vent the air from the drain tube into a hood or other ventilator.

You can also dry the saturator block by draining the liquid and then drawing dry air through the instrument with the vacuum source for 24 to 48 hours.

If you plan to leave the CNC power *off* for more than two days, drain the alcohol from the CNC. It is not necessary to dry the alcohol from the saturator block unless you are shipping the instrument. Moreover, moving the instrument from room to room does not require the CNC to be drained, provided you keep it upright during the process.

Counting Single Particles

When connected to the M/P, the maximum concentration that can be measured is 10 million particles per cubic foot (353 particles/cm^3). The digital pulses emitted through the BNC connector on the back panel are 15 volts for 6.4 microseconds. The maximum output frequency is limited to 17 kilohertz. The CNC can measure up to 10^4 particles per cubic centimeter with only 6 percent coincidence, but the particles must be counted with the Single-channel Processor (Model 3704) or some other "event" counter.

To enable the electronics to measure high concentrations, first remove the CNC cover. Locate the red toggle switch on the front panel's main circuit board (figure 2-4). Set it to the position marked "other." The digital pulses from the BNC connector are now output at 15 volts for approximately 0.25 microsecond. The frequency of pulses is not restricted electrically; the higher the output frequency, the greater the coincidence level (see "Correcting for Coincidence" below). The switch *must* be set to "3700" to operate with the M/P.

Viewing Analog Pulses

You can observe the analog electrical pulses from the photodetector on an oscilloscope. Connect the two test pins with a jumper, TP1 and TP2, as shown in figure 2-4.

The minimum pulse amplitude is about 200 millivolts and the pulse width is about 0.25 microsecond. The pulse amplitudes may range as high as 600 millivolts. The electrical noise level is about 10 millivolts, giving an overall signal-to-noise ratio of better than 20:1. Figure 2-5 shows a typical pulse trace on a digital oscilloscope.

Correcting for Coincidence

The CNC counts single particles, such that each particle scatters a separate pulse of light. At high concentrations, two or more particles are occasionally in the viewing volume at the same time. The pulses they generate overlap and are counted as one particle. The frequency of this event depends on the particle concentration. Within limits, TSI can determine a correction for coincidence.

The coincidence correction is particularly important at high concentrations. For most of the range, especially in clean air, the coincidence effect is insignificant. At a concentration of 35 particles/cm^3 (1,000,000 particles/ft^3), the coincidence error is only 0.02 percent. At a concentration of 1×10^4 particles/cm^3 (2.8×10^8/ft^3), the coincidence error is 6 percent.



Figure 2-4
Front-Panel's Main Circuit Board for the CNC; Viewed from the Back

For maximum accuracy, compute the actual particle concentration according to the following equation:

$$N_a = N_i \, exp \, (N_a \, Q \, t)$$

where N_a = the correct concentration (particles/cm^3)
N_i = the indicated concentration (particles/cm^3)*
Q = 46.7 cm^3/s
t = 0.25 microsecond is the effective time each particle resides in the viewing volume

The N_a in the exponent can be approximated by N_i.

Calibrating the CNC

Apart from the optics alignment, the initial factory checkout of the electronics, and the periodic flow verification, the CNC requires no calibration. The flow is controlled by a critical orifice, and thus, no

adjustments are needed. The minimum detectable particle size is controlled by the supersaturation ratio of the butanol vapor in the condenser. Since the butanol droplets grow to nearly the same size, there is no particle size discrimination by electrical pulse-height measurement. Particle detection is unaffected by slight degradation in laser power or dirty optics. Finally, since the CNC is a single-particle counter, there is no photometric calibration for concentration.



Figure 2-5
Analog Pulse Trace of the Photodetector Signal While the CNC Samples Ambient Laboratory Room Air. The bottom trace is a 100x expansion of one of the pulses from the top trace. The pulse on the bottom trace is approximately 320 millivolts in amplitude and 0.25 microsecond wide.

3 Description of the CNC

The Model 3760 CNC measures the number concentration of particles that measure 0.014 micrometer in diameter and larger. The particles are detected by condensing n=butyl alcohol vapor onto the particles, causing them to grow into droplets. The droplets are easily counted by a simple optical particle detector.

The CNC is small, quiet and clean; it is designed to be operated continuously with the Model 3701 Multisensor Cleanroom Monitoring System.



Figure 3-1
Schematic Diagram of the Cleanroom CNC

The sample flow is drawn into a saturator where n-butyl alcohol (butanol) evaporates into the sample stream. Although the saturator portion is not heated, it tends to be several degrees above room temperature. The sample then cools by thermal diffusion in a cooled condenser tube. The butanol vapor becomes supersaturated and condenses on the particles. A thermoelectric device, cools the condenser, which is sandwiched between the condenser and a heatsink. The temperature of the condenser is based on the temperature of the saturator. The particles are detected by a simple single-particle-counting, laser-diode, optical

detector; its flow is controlled with a critical orifice and maintained by an external vacuum source.

The heatsink, which makes up the entire back panel of the CNC, dissipates heat by natural convection. Fans are not used because they could contaminate the surrounding area. Operate the CNC so that the heatsink is exposed to the cooling ambient; avoid using the CNC in a tightly-closed space.

The cabinet purse airflow (0.05 cfm) helps to cool the electronics within the cabinet and creates a slight negative pressure within the instrument. Particles that may be generated inside the cabinet are quickly carried out through the vacuum line and do not contaminate the surrounding area.

4 Specifications and Electrical Schematics

Specifications

The following specifications—which are subject to change—describe the most important data of the major components.

Sample flowrate	1.41 L/min (0.05 cfm)
Total exit flowrate	2.83 L/min (0.1 cfm)
Vacuum source minimum	18 in. Hg (0.1 cfm)
Particle size	>0.01 µm
Working fluid	n-butyl alcohol
Light source	laser diode
Analog pulse signal typical	200 mV 0.25 µs
Signal-to-noise ratio	20:1 minimum
Digital output square pulse (M/P 3701) square pulse (single-channel processor or other counter)	 15 V (6.5 µs) 15 V (0.25 µs)
Concentration (M/P 3701) (single-channel processor or external counter)	0 to 10 million ft3 0 to >2.8 x 108 ft3
Size (HLW)	140 x 155 x 220 mm 5.5 x 6 x 8.5 in.
Weight	4 kg (8 lbs)
Power	100/120/220/240 VAC 50–60 Hz

Electrical Schematics

The electrical schematics are no. 9060148 (sheets 1 and 2).

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP