TELEVAC

A DIVISION OF

THE FREDERICKS COMPANY

HUNTINGDON VALLEY, PA 19006

INSTRUCTION MANUAL FOR

MODEL MC 300 2A & 4A

DUAL CHANNEL THERMOCOUPLE / CONVECTION

VACUUM MEASURING INSTRUMENT

MODEL NO: MC 300 2A 4A
SERIAL NO.

MC300 9/13/01

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LIST OF FIGURES

I – DESCRIPTION and INSTRUMENT OPERATION.

The Model MC 300 vacuum-measuring instrument is a combination gauge, which incorporates various range options as shown in Table 1.

Table 1.

	RANGE OPTIONS	
Model	Range	Sensors
MC2A	20,000 microns To 0 microns	2A Thermocouple
MC4A	Atmosphere To 0 microns	4A Convection

- The 2A thermocouple gauge tube will monitor pressures between 1 millitorr (1 micron) and 20,000 microns.
- The 4A convection gauge tube will monitor pressures between 1 millitorr (1 micron) and 999 Torr. (1 atmosphere = 760 Torr).

The vacuum measuring system consists of various gauge tubes, which sense the vacuum, an electronics unit and interconnecting signal/power cables. The customer must supply power at 115 VAC 50-60 Hz. (220 Volt operation is a factory selectable option) The measured vacuum is displayed on the front panel LED displays. See Figure 1.

The power cable, gauge tubes, relay outputs and output voltages of 0 to 10 VDC connections are on the back panel. See Figure 2.

The MC 300 features :

- **Large bright LEDs**
- **Built-in self diagnostics**
- **Selectable Units: Torr, microns, mBar or Pascal**
- **Gas compensation: Argon, N2**
- **Four process relays with individually assignable set points**
- **Recorder outputs for each sensor**
- **Operator lockout switch**

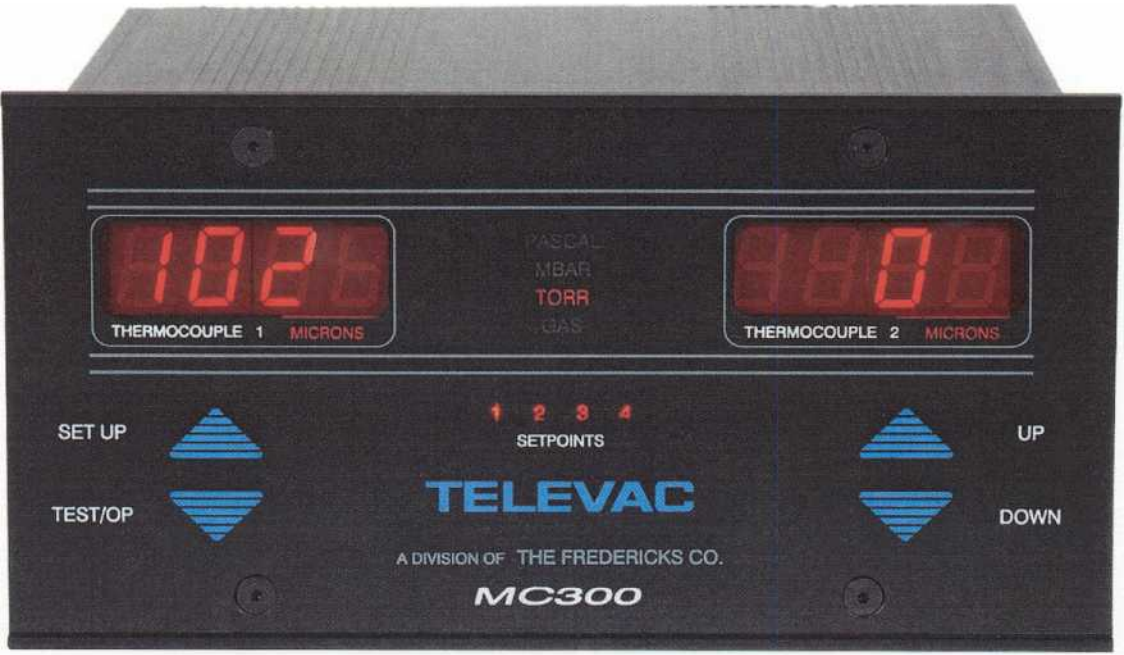

Figure MC 300 Front Panel (Models MC300 2A and MC300 4A)

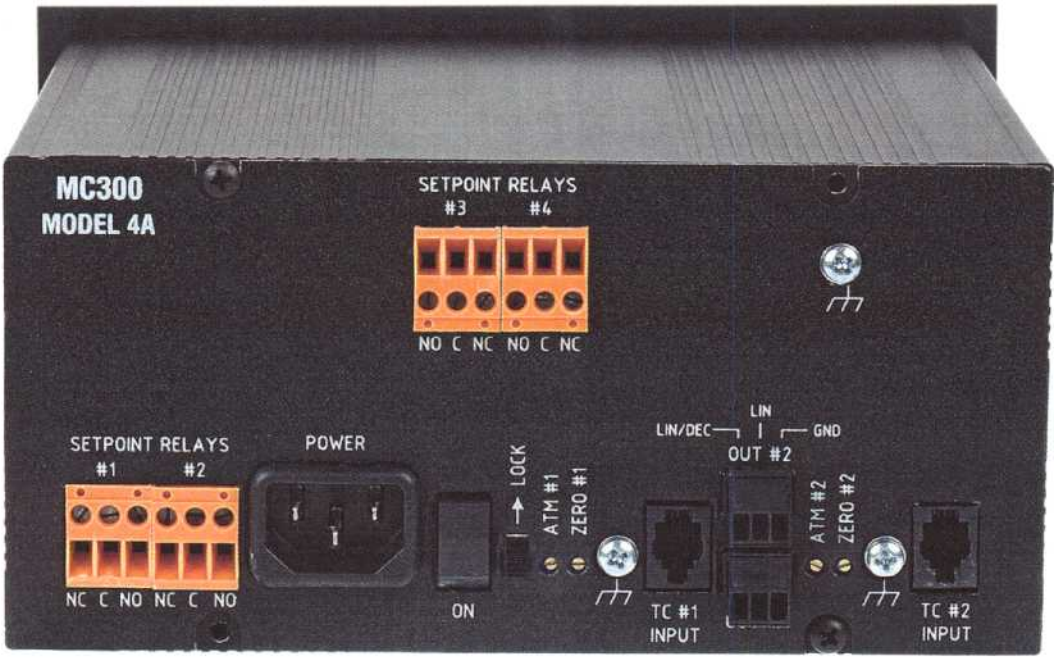

Figure **2** MC 300 Back Panel (Models MC300 2A and MC300 4A)

INSTRUMENT OPERATION

The MC300 is pre configured for immediate installation and use. The unit should be first mounted in the desired location and properly secured. In choosing a location, the display should be clearly visible by an operator and positioned in such a way that the operator can easily make adjustments to the instrument. All wiring should be neatly dressed and bundled with special care not to have any wiring adjacent to AC power distribution. After proper installation of sensors and wiring, the unit can be connected to an AC power source and put into operation. IT IS RECOMMENDED THAT POWER IS NOT APPLIED TO THE INSTRUMENT DURING THE INSTALLATION OF ANY WIRING OR SENSORS.

#1. INSTALL SENSORS: For information on sensor installation and operation please refer to **Section IV** of this manual.

#2. WIRING THE INSTRUMENT

SENSOR WIRING

The MC 300 is supplied with sensor cables for each channel. Certain levels of calibration require that a specific cable and sensor be used with channel 1 or 2. In this case the cable and sensor are marked for use as a set and must be used as such. Otherwise the cables can be used with either rough vacuum channel. To ensure measurement integrity and protection from ambient electrical noise, ground lugs are provided on each sensor cable shield. These lugs should be connected to the ground screws provided on the rear panel.

RECORDER OUTPUT WIRING

Provisions are made to connect the instrument to a chart recorder, data logging device or programmable logic controller. Two different format signals are provided and are described in Section III Analog Recorder outputs. In all cases follow the Recorder's instructions for wiring and using these signals.
Linear (**LIN**) output is computer generated so that the voltage signal is plotted as a straight line as a function of pressure. Traditional (**TRDL**) signal is one that represents the non-linear signal that is representative of the actual sensor raw data. The 4A Convection version has **Linear/Decade** and **Linear** outputs. By means of a factory settable internal jumper a full range **Traditional** signal is available in lieu

of the **Linear** recorder output. Please refer to figure 5 & 6 for a summary of the signals available.

RELAY CONTACT WIRING. (SETPOINT RELAYS)

There are four setpoint relays available for use to control ON/OFF or Open/close (binary state) devices. The relays are assignable to any one of the vacuum signal input channels through front panel software control.
There are three connections for each relay. They are NORMALLY CLOSED (**NC**), COMMON (**C**) and NORMALLY OPEN (**O**). The operation mode of each is described as follows:

NORMALLY CLOSED: In this state there is an electrical continuity path between terminals **C** and **NC**. This continuity path is broken when the software set point values dictates an ON state for the specific measurement channel. Continuity is returned when the OFF state is dictated by software control. In the power off mode of the MC 300 (due to failure of the main power source or turning off the instrument), the relay will revert to this state.

NORMALLY OPEN: In this state there is no electrical continuity path between terminals **C** and **NO**. This Path is established ONLY when the Instrument control software satisfies conditions for the ON state. It will break continuity under the instrument control parameters for the OFF condition or the power off mode of the MC 300 (due to failure of the main power source or turning off the instrument).

Caution: In utilizing the process relays it is important not to exceed the relay's power handling capacity described in section IX and to fully understand the behavior of the control relay state conditions. Failure to do so will result in premature relay or equipment failure.

OPERATING THE INSTRUMENT

This section describes the operation of a properly installed MC300 Instrument.

Prior to using the instrument on a vacuum chamber, the unit can be set up in a test mode using simulators to represent the vacuum gauges. This is done to gain familiarity with the unit and to preset relay setpoints. The following describes operation of the instrument with simulators or vacuum applied to the sensors.

- **POWER ON**:

The instrument is turned on and off by means of a rear mounted power switch. The unit will first display the software version number.

The instrument will then perform a self-diagnosis after which it will begin displaying vacuum measurements. If the unit doesn't pass the self-test, an error code will appear. Pressing the **"TEST OP"** button can clear the code, but proper operation of the instrument may be curtailed. It is recommend not to use the instrument if the self diagnosis fails and contact the factory for instructions. Allow a minimum of 15 minutes from an instrument "cold start" for the sensor readings to stabilize

- **GAS CORRECTION FACTOR**:

The MC 300 has the ability to adjust its pressure readings to compensate for the use of ARGON as a background gas. When Argon gas is selected, the GAS light will flash during operation of the gauge. The instrument is calibrated for use in Nitrogen (dry air) when the gas compensation is turned off.

To change the gas correction factor:

1. Assure the rear mounted operator **lock out switch** is in the "OFF" position. (The switch is in the down position).
2. Press the **SETUP** button once:
3. The Nitrogen (N_2) or Argon (Ar) display will flash.
4. Press the **UP** or **DOWN** arrow pushbuttons to select a gas correction. (The flashing display is the gas selected.)
5. Press the **TEST OP** button to complete the selection.

(Note: If the TEST OP switch is not pressed in 60 seconds the instrument will return to normal operation and the change in gas correction is not accepted.).

• **CHANGE MEASUREMENT UNITS**

The MC 300 has the ability to display vacuum values in PASCALS, MBAR or MICRONS and TORR.

1. Assure the rear mounted operator **lock out switch** is in the " O FF " position. (the switch is the down position).
2. Press the **SETUP** button once :
   The Nitrogen (N2) or Argon (Ar) display will flash.
3. Press **SETUP** a second time .
4. The PASCAL, MBAR or TORR lamp will flash
5. Press the **UP** or **DOWN** buttons to select the desired unit of measurement
6. Press the **TEST OP** button to complete the selection.

(Note : If the TEST OP switch is not pressed in 60 seconds the instrument will return to normal operation and the change in units is not accepted)

- **ASSIGN SET POINT RELAYS AND VALUES.**

The instrument has four relays that are assignable to any of the vacuum measurement channels. Thermocouple (or Convection) channel 1 is Channel 1 (CH 1), thermocouple (or Convection) channel 2 is Channel 2 (CH 2). Set point SP 1 is relay #1 Set point SP 2 is relay #2 etc.

1. Assure the rear mounted operator **lock out switch** is in the "OFF" Position. (The switch is the down position).
2. Press the **SETUP** button once:
3 The Nitrogen (N2) or Argon (Ar) display will flash.
4. Press the **SETUP** a second time.
   The measurement units (TORR, PASCAL or MBAR) lamp will flash
5. Press the **SETUP** a third time
6. The setpoint SP 1 will appear in the left display, the channel number CH 1 or 2 will appear in the right display.
7. Use the **UP** or **Down** Arrows to select the channel number 1 or 2.
8. Press the **SET UP** button again. "**SP1O**" (*set point for channel 1 on*) will appear in the left display, the on value will appear in the right display.
9. Press the **UP/Down** arrows to adjust the "ON" value. Press and hold the **UP/Down** arrow to rapidly advance the "ON" value.
10. Press the **SET UP** Button again. "**SP1F**" (*set point for channel 1 off*) will appear in the left display the relay "OFF" value will appear in the right display.
11. Press the **UP/Down** arrows to adjust the "OFF" value. Press and hold the **UP/Down** arrow to rapidly advance the "OFF" value.
12. Press the **SET UP** button again and the next relay, SP2 will appear. The sequence listed in steps 6 to 11 are repeated until all four relays have been assigned.

The MC 300 will return to its normal operating mode after the fourth relay has been set up or 60 seconds have elapsed since the last button press. Changes are stored after the complete setup of an individual relay channel. These set up parameters are stored in Non volatile memory and are not lost during Power outages.

Note : Setpoint changes are also accepted by the MC 300 by pressing the "Test Op" Button at any point in the setup. Only those channels that have been completely set up are changed. The instrument will not accept OFF values that are lower than the ON value. ON values entered that are greater than OFF Values will automatically change the OFF value one unit higher than ON.

Theory of Operation

The MC300 is a microprocessor-controlled instrument utilizing modern data acquisition techniques to achieve a high degree of accuracy at a reasonable cost. The microprocessor in the instrument performs two basic tasks:

1. Controls the acquisition and conversion of all sensor data.
2. Process all operator interface inputs and requests.

After power is applied to the instrument, the software initializes all of the circuitry associated with acquiring and displaying sensor information then performs a self-test. If there are no errors detected, the MC300's data acquisition process is started.

Both input channels are read periodically and a reading for each sensor is stored. After several readings the data is averaged, then converted using the appropriate sensor, units and gas compensation settings. Set point relays and the microprocessor controlled recorder outputs are also updated at the same time. This method of averaging samples results in a smooth and accurate transition from reading to reading.

Each sensor has its own conversion algorithm. Some algorithms use a technique called linear interpolation. The data conversion process always occurs regardless of the instrument mode (operation or set-up). However, during the set-up mode the converted data is not sent to the display but the set point relay control and analog output operation continue to operate.

Whenever the instrument software is not processing sensor data for the displays or recorder outputs, the Set Up, Test/Operate and Up & Down (if enabled) buttons are checked for operator interaction. The Set Up button is used to sequence through all of the operator settable parameters. Each depression of the Set Up button may change the function of the displays as well as the Up and Down button. Each time the Set Up button is pressed, the data from the previous level is stored in non-volatile memory to ensure that the instrument's gas compensation, units and set-point parameters are preserved. This information is used to restore the instrument's configuration each time power is applied.

For simplicity, the Up and Down buttons are enabled and disabled at the proper time to prevent the operator from entering an invalid value. In addition, each time an On Point is adjusted, the corresponding Off Point it is verified to ensure that it is higher then the new On Point. If lower, the Off Point is adjusted to be one increment higher then the new On Point. In this instance both the On and Off Point values are updated in the non-volatile memory.

II PRINCIPLES OF SENSOR OPERATION

Thermocouple Sensor

The thermocouple sensor (See Figure 3) consists of a metal shell containing fine wire filaments of dissimilar metals, which form a thermocouple. The thermocouple sensor measures absolute pressures by determining the temperature of a heated wire as the surrounding pressure changes. The response of the sensor depends on the gas pressure.

The range of these sensors is from 1 micron to 20,000 microns. The sensor housing is constructed of stainless steel (or alternately nickel plated brass) capable of withstanding 150 psi overpressure.

Figure 3 – 2A Thermocouple Sensor

Figure 4 – 4A Convection Sensor

Convection Sensor

The convection sensor (See Figure 4) measures absolute pressures by determining the heat loss from a thermocouple heated to a constant temperature by a current source. A second thermocouple compensates for ambient temperature changes and extends the vacuum measurement range above 2 Torr by measuring the convection effects.

The range of the convection sensor is 1 micron to 1000 Torr. The convection sensor must be mounted vertically for accurate measurement. The convection sensor is available in stainless steel or nickel plated brass and can withstand 150 psi overpressure.

III. - ANALOG RECORDER OUTPUTS

0-10VDC analog recorder output voltage / pressure conversions are provided for each type of sensor in the figures 7, and 8.

These voltage signals are available at the rear panel of the MC300. See Figure 2 for location of the connections.

Outputs #1 and #2 are for thermocouple or convection gauges. These outputs are 0-10 volts and are available in a the formats listed in the tables that follow. See Figures 5 or 6.

In addition to a 10 volt output there is an jumper option to change the full scale voltage to 10 mv (millivolts) This ensures compatibility with legacy recorders. See Figures 7 or 8 for the location of these jumpers.

RECORDER OUTPUTS

0-10VDC analog recorder output voltage/pressure conversions are provided for each type of Sensor in the figures 5 **and** 6.

These voltage signals are available at the rear panel of the MC300. See figure 2 for locations of the connections.

Outputs #1 and #2 are for thermocouple or convection sensors. These outputs are 0-10 volts and are available in a traditional or linear format.

MICRONS ARGON READS	TRAD'L REC OUT VOLTS	LIN REC OUT OUT
(-5)	10.59	-0.05
(-1)	10.16	-0.01
0	10.00	0.00
1	9.84	0,01
5	9.41	0.05
10	8.92	0.10
20	8.03	0.20
30	7.23	0.30
40	6.63	0.40
50	6.13	0.50
60	5.69	0.60
70	5.31	0.70
80	4.95	0.80
90	4.63	0.90
100	4.37	1.00
150	3.37	2.00
200	2.89	3.00
300	2.23	4.00
400	1.88	5.00
500	1.67	6.00
600	1.58	7.00
700	1.50	8.00
800	1.42	9.00
900	1.34	10.00
1000	1.26	10.20
2000	1.02	10.20
5000	0.92	10.20
10000	0.90	10.20
20000	0.88	10.20
CABLE	0.00	10.20

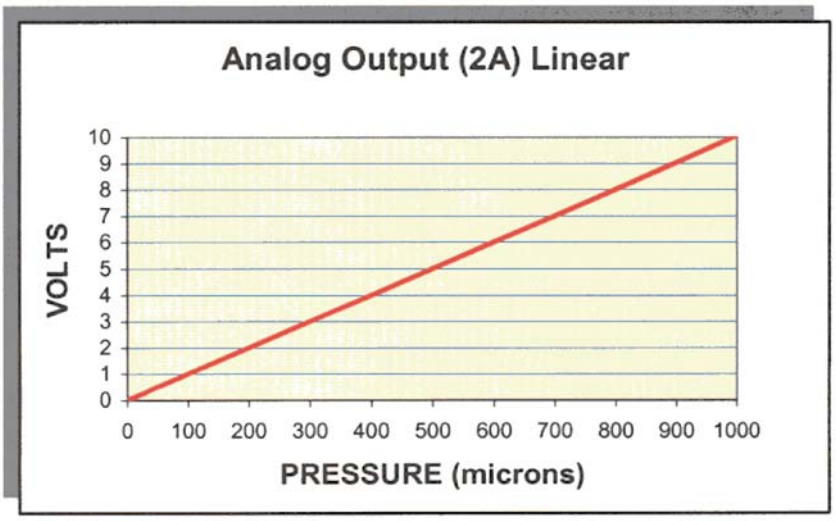

Figure 5- Analog Output (2A)

TORR/ MICR ARG READS	TRDL OUT	L/D REC OUT 1 VOLT/ DEC	LIN OUT VOLTS
(-5)-OL'D	-0.065	3.500	<-.050
(-1)	-0.013	3.900	-.010
0-	0.000	4.000	0.000
1 u	0.013	4.100	0.010
5 u	0.065	4.500	0.050
10 u	0.124	5.100	0.100
20 u	0.238	5.200	0.200
30 u	0.344	5.300	0.300
40 u	0.450	5.400	0.400
50 u	0.546	5.500	0.500
60 u	0.638	5.600	0.600
70 u	0.730	5.700	0.700
80 u	0.816	5.800	0.800
90 u	0.898	5.900	0.900
100 u	0.980	6.100	1.000
150 u	1.350	6.150	1.500
200 u	1.670	6.200	2.000
300 u	2.285	6.300	3.000
400 u	2.630	6.400	4.000
500 u	2.992	6.500	5.000
800 u	3.824	6.800	8.000
1 T	4.226	7.100	10.000
2 T	5.440	7.200	13.500
3 T	6.080	7.300	"
4 T	6.440	7.400	"
5 T	6.772	7.500	"
10 T	7.412	8.100	"
20 T	7.782	8.200	"
30 T	7.910	8.300	"
40 T	7.936	8.400	"
50 T	7.976	8.500	"
60 T	8.006	8.600	"
80 T	8.042	8.800	"
100 T	8.072	9.100	"
120 T	8.124	9.120	"
150 T	8.180	9.150	"
160 T	8.224	9.160	"
170 T	8.256	9.170	"
180 T	8.280	9.180	"
200 T	8.328	9.200	"
300 T	8.756	9.300	"
400 T	9.208	9.400	"
500 T	9.544	9.500	"
600 T	9.772	9.600	"
760 T	10.000	9.760	"
900 T	10.142	9.90	"
1000 T	10.232	10.000	"
CABLE	>10.5	10.11	"

Figure 6 – Analog Output (4A)

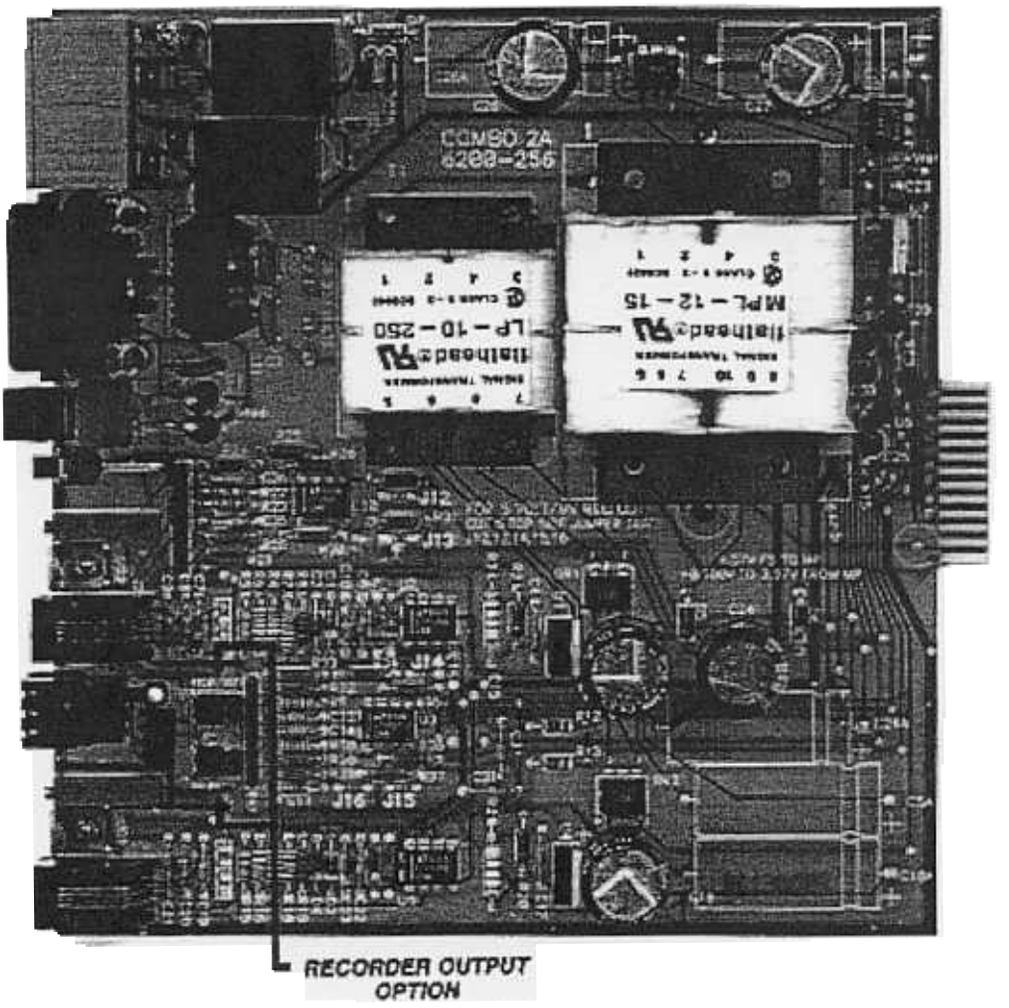

Figure 7 - Recorder output voltage selection 2A

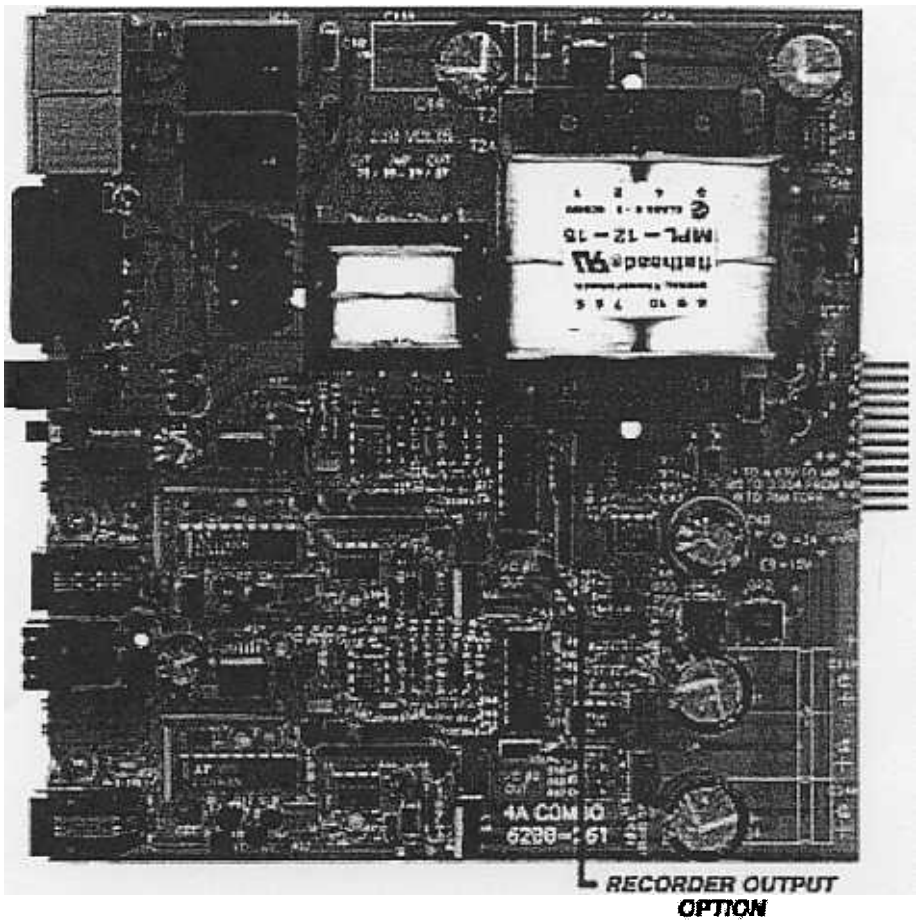

Figure 8- Recorder output voltage selection 4A

IV. SENSOR OPERATION and INSTALLATION

It is desirable for sensors to be mounted on the vacuum system in a VERTICAL POSITION open end extending downward, with the threaded joint thoroughly coated with an acceptable vacuum sealant. Optional mountings (using "0" ring compression fittings) are available. **In the case of the 4A convection gauge VERTICAL POSITION is mandatory.**

The electronic unit is factory calibrated at time of order. To ensure proper operating conditions it is necessary to use factory-manufactured cables.

> **Contamination of the gauge tube, caused by the process occurring in the vacuum vessel, is a critical factor affecting the measurement of high vacuum. Depending upon the degree of contamination and the accuracy required, it is recommended that sensor tubes be periodically replaced and that thermocouple tube filters (with line of sight baffles) be used to protect these gauge tubes (P/N 2-2100-50).**

Typically the thermocouple and convection gauge tubes incorporate a 1/8" National Pipe Thread (1/8" NPT) fitting for connection to the vacuum system. Other mounting configurations are available.

The instrument may be turned on at any time, since atmospheric pressure will not harm the gauge tube elements or cause overdrive on the metering circuit. A brief 15 minute on time is required before vacuum measurements can be made within stated tolerances.

V. MAINTENANCE

The vacuum measuring gauges, if installed properly, require very little maintenance under normal operating conditions. If the unit should cease to operate properly, certain checks can be made:

1. If a gauge tube simulator is available it can be used. The gauge tube Simulators are designed to be used as a check to see if the cable and the Electronics are working properly.

   The simulators are marked for use with the various gauges. Although no maintenance is required to keep the tube simulator in working condition, a periodic check should be done against a calibrated standard unit.

   To use the simulator, disconnect the cable from the gauge tube and plug the gauge tube simulator in its place. Check the output voltage, it should correspond to the pressure that is written on the gauge tube simulator's label.

2. If you do not have a tube simulator, it is still possible to check the operation of the instrument if you are able to reduce the system pressure to 10^{-5} Torr. At this pressure, the thermocouple and convection gauges should read at zero volts. If output still appears to respond incorrectly, a new gauge tube should be substituted to restore the assembly to proper operation.

3. The following table summarizes the messages on the MC300 display under several different operating conditions as well as the expected recorder outputs.

2A

Display	Condition	Traditional Recorder Output (Volts)	Linear Recorder Output (Volts)
-OLd	< -1 micron	+ 10.59	- 0.05
-1	Incorrect ZERO adjust	+ 10.16	- 0.01
0 microns	Lowest Reading	+ 10.00	0.00
20 Torr	Highest Reading	+ 0.88	+ 10.20
CabL	> 20 Torr	+ 0.00	+ 10.20

4A

Display	Condition	Traditional Recorder Output Fact option (Volts)	Linear/ Decade Recorder Output (Volts)	Linear Recorder Output (Volts)
-OLd	< -5 microns	- 0.07	+ 3.50	<-.05
-1	Incorrect ZERO adjust	- 0.01	+ 3.90	- 0.01
0 microns	Lowest Reading	0.00	+ 4.00	0.00
990 Torr	Highest Reading	+ 10.23	+ 9.99	+ 13.50
CAbL	> 990 Torr	> + 10.50	+ 10.11	+ 13.50

VI. CALIBRATION

All instrumentation is calibrated at the factory. No further calibration at the customer's facility should be required.

For a reliable re-calibration at a later date, it is necessary to have a reference standard vacuum system whose pressure is known to be accurate. For such a calibration, the instrument, sensor tube and cable should be returned to the factory for re-certification. However, if the vacuum calibration verification must be done at the customer's facility, equipment of certifiable accuracy should be operated by a knowledgeable electronics technician trained in vacuum calibration.

VII. CALIBRATION VERIFICATION

1. Connect sensor to the known vacuum source.

2. Plug unit into 115VAC. Allow a minimum of 15 minutes warm-up.

3. Pump the system down to high vacuum. At 10^{-5} Torr verify that the thermocouple or convection gauge reads at "0" VDC. If not, adjust the "zero" potentiometer.

4. Make a comparison table of indicated pressure on the instrument to that of the reference vacuum standard. The comparisons should be made typically at "0", (red line) 10, 100 and 1,000 microns and at 1, 10, 100, 500 and 760 Torr. (Depending on the gauge type).

VIII. TROUBLESHOOTING

Troubleshooting of the circuit or components is similar to any industrial electrical equipment, i.e., checking for circuit continuity, shorts, grounds, resistor values, etc.

Generally, those familiar with electrical equipment should have no difficulty locating faults in either gauge or electronics unit by systematically proceeding through the circuit. The enclosed diagram should facilitate maintaining the instrument. In order to troubleshoot the unit, your gauge tube and cable must be in working condition and plugged into the unit.

NOTE: If, after doing some or all of the above, the unit is still inoperative, return to the factory for repair.

SPECIFICATIONS

Range	See Table 1
Calibration medium	Dry air, (or nitrogen)
temp. (tube)	+15 degrees to +50 degrees Celsius
Power	115 VAC
Frequency	60 Hz or 50 Hz
	Internal
Display/output	Digital/analog
Relay Contacts	5 Amps @ 230 VAC W/Gold flash for Dry Circuit.
Weight (instrument)	5 lbs. max. exclusive of gauge tubes.

X DIMENSIONS

FRONT PANEL	MM	INCHES
Height	102	4.0
Width	197	7.75
UNIT		
Height	88.9	3.5
Width	184.15	7.25
Depth		
Excluding connectors	197	7.75
Including connectors (approx.)	234.95	9.25
PANEL CUT OUT		
Height	92.86	3.66
Width	186.69	7.35

XI. UNPACKING AND INSPECTION

Before each unit is installed or operated, a quick inspection should be performed and the following noted:

a. Damage to the unit (scratches, nicks, dent, cracks, etc.)
b. Missing: screws, switches or switch hardware.
c. Broken barrier strips, etc.
d. Broken or loose components within instrument

Should any of the above problems be encountered, contact the factory immediately. Any unauthorized repairs will void the warranty.

XII. WARRANTY INFORMATION

The Televac division warrants instruments and components to be free of defects in material and workmanship for a period of one year after the date of shipment unless otherwise specified in the quotation or product literature. No Salesman, Representative or agent of The Fredericks Company, or its divisions is authorized to give any guarantee or warranty or make any representation in addition or contrary to those stated herein.

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APPENDIX

SCHEMATICS

MC300 Assembly drawing	#4503-401
MC300 Display/logic schematic	#6200-266
MC300 2A board schematic	#6200-256
MC300 4A board schematic	#6200-261
MC300 Relay board schematics	#6200-273