MKS

Instruction Manual

108267-P1
REV G, 7/93

MKS Type 286 Thermal Conductivity Vacuum Gauge Controller and Type TC-1 Gauge

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Thermal Conductivity Vacuum Gauge Controller
and Type TC-1 Gauge

The MKS Warranty for Type XXXX Equipment that appears in the Manual for said product (the "Standard Warranty") is modified and supplemented as follows:

Year 2000

MKS warrants that the equipment subject to the Standard Warranty, when installed and used in accordance with its specifications, will correctly perform all date-related operations, including without limitation accepting data entry, sequencing, sorting, comparing, and reporting, regardless of the date the operation is performed or the date involved in the operation, provided that, if the equipment exchanges data or is otherwise used with equipment, software or other products of others, such products of others themselves correctly perform all date-related operations and such products store and transmit dates and date-related data in a format compatible with the MKS equipment. This warranty is subject to the time limitation, the remedy limitation, the damages limitation, and the other requirements and limitations, set forth in the Standard Warranty. NOTWITHSTANDING THE TERMS OF THE STANDARD WARRANTY, THIS WARRANTY IS MKS' SOLE WARRANTY CONCERNING DATE-RELATED OPERATIONS AND IS IN LIEU OF ALL OTHER RELEVANT WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

Calibration

MKS recommends that all MKS pressure and flow products be calibrated periodically (typically every 6 to 12 months) to ensure accurate readings. When a product is returned to MKS for this periodic re-calibration it is considered normal preventative maintenance **not covered by any warranty.**

CONTENTS

SECTION 1

GENERAL DESCRIPTION

TRANSDUCER

The Type TC-1 transducer is for general purpose use in non-corrosive environments up to a maximum temperature of $100^{o}C$. It may be mounted to the system using its 1/8 MNPT fitting or in a 1/2" o-ring compression fitting.

CONTROLLER

The 286 is a 1/2 rack/cabinet mounted dual-channel controller and display. Each channel contains a regulated power supply to power the transducer, two setpoints and a remote recorder output. Pressure is displayed on a dual 200 element bargraph display and all interface connections are made on the rear panel via the appropriate connector.

SECTION 2

INSTALLATION & OPERATION

INSTALLATION

The Type TC-1 transducer may be attached to the vacuum system by either screwing it into a mating 1/8 FNPT fitting or sliding it into a 1/2" o-ring fitting such as a Cajon Ultra Torr. It is recommended that the inlet port be oriented downward so that dirt will fall away from the thermocouple element.

THE 286 MUST BE MOUNTED IN SUCH A MANNER AS TO PROVIDE ADEQUATE AIR CIRCULATION ABOUT THE UNIT.

REAR PANEL CONNECTIONS & CONTROLS

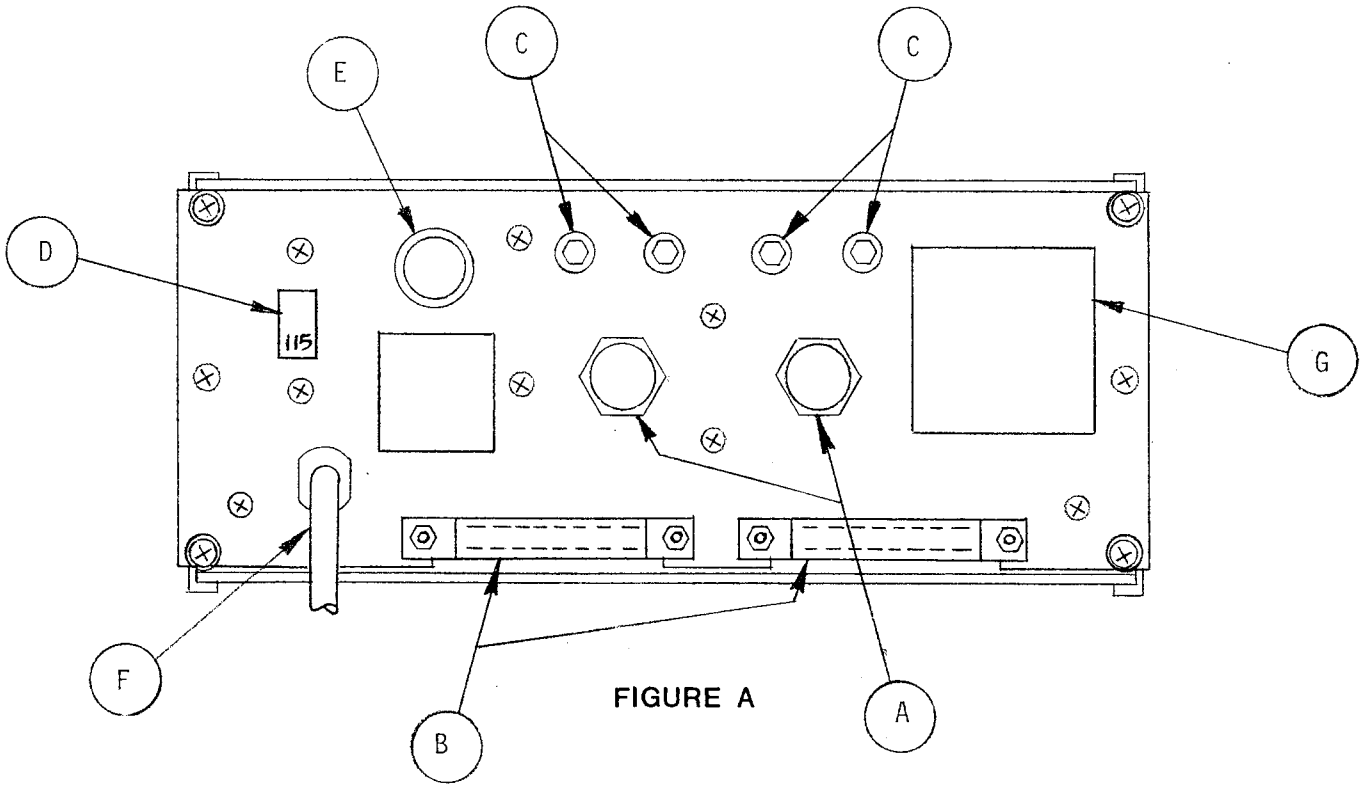

FIGURE A

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FRONT PANEL CONTROLS

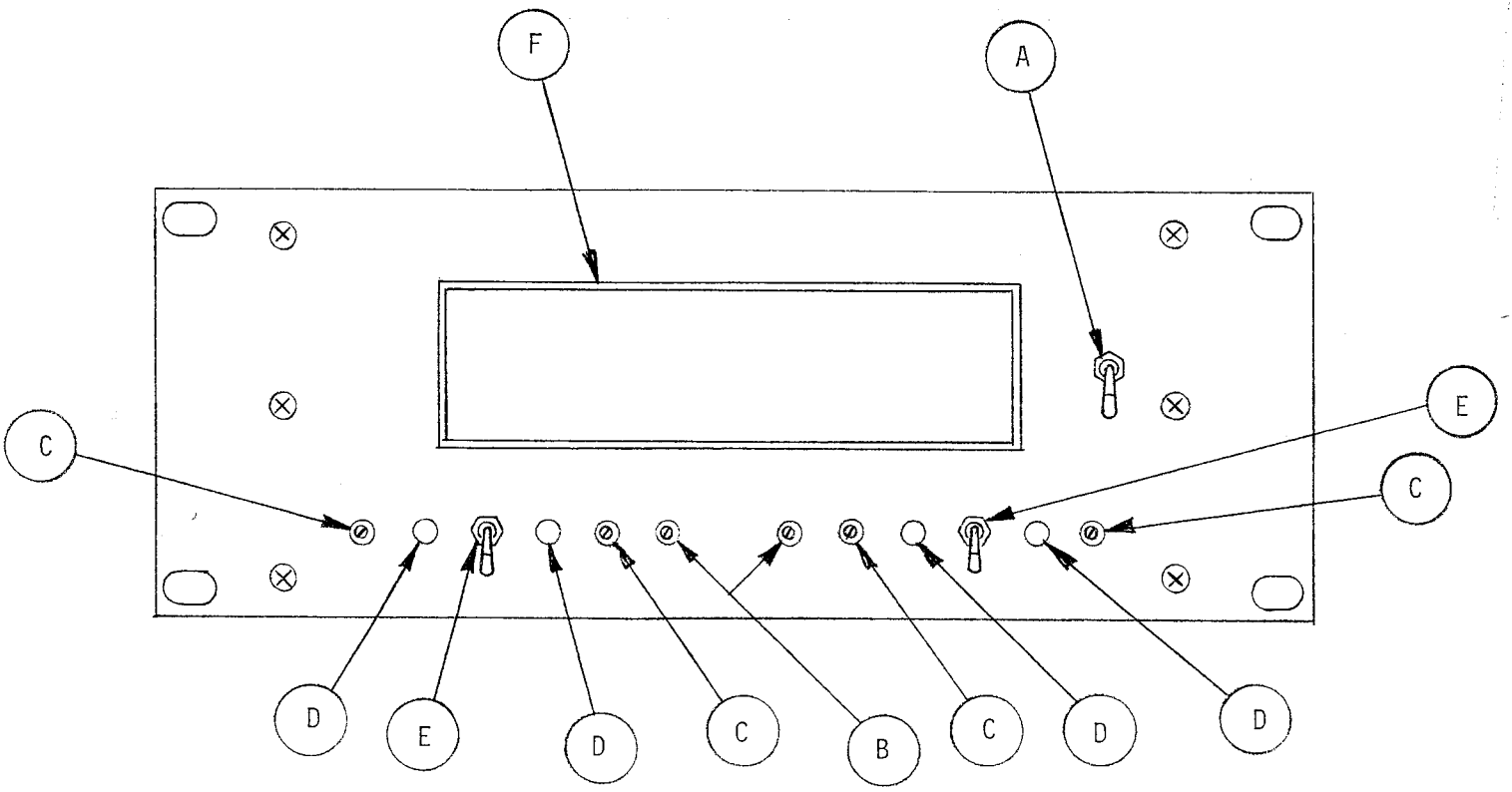

FIGURE B

REAR PANEL CONNECTIONS & CONTROLS

(See Figure A)

TRANSDUCER CONNECTORS (A)

These 5 contact connectors provide a power and signal interface between the controller and the transducer.

SETPOINT CONNECTORS (B)

These 20 contact connectors bring out the setpoint relay contacts and latch control lines. The pin outs are :

10 - COMMON #1	L - COMMON #2
9 - N.C. #1	J - N.C. #2
8 - N.O. #1	K - N.O. #2
7 - $\overline{\text{LATCH}}$ #1	6 - $\overline{\text{LATCH}}$ #2
2 - DIGITAL GND	

DC OUTPUT JACKS (C)

The jacks provide a linear DC output voltage which corresponds to the pressure displayed by the 286. (Note: + 1V corresponds to zero pressure, NO display, while 0V corresponds to no gauge connected, FULL display.) This voltage is capable of driving a load of 10K ohms or greater.

LINE VOLTAGE SWITCH (D)

This slide switch sets the power transformer to receive 115 or 230 VAC. The value of the line voltage that the unit is set to is visible in the cutout.

FUSE (E)

Line fuse to protect internal circuitry. The "High Side" of the line is fused. Fuse Values:

1/4 A.S.B. @ 115 VAC
1/8 A.S.B. @ 230 VAC

LINE CORD (F)

Provides 115 or 230 VAC to the 286. The proper input voltage is selected by the line switch. (See item D.)

ACCESSORY POWER OUTPUT (G)

This connector provides power to other units. It is wired in parallel with the input power cord. This connector is NOT FUSED and assumes the potential of the power line that the 286 is connected to regardless of the position of the line voltage switch.

286
FRONT PANEL CONTROLS
(See Figure B)

POWER SWITCH (A)

This switch controls the power to the 286 as well as the transducer connector.

ZERO ADJUST (B)

This control is used to set the zero when the corresponding transducer has been properly pumped to zero.

SETPOINT ADJUST (C)

This control is used to set the level at which the setpoint is energized.

RELAY LAMP (D)

Each setpoint has a relay lamp which is illuminated when the relay for that setpoint has been energized.

READ SETPOINT SWITCH (E)

This switch connects the front panel display to the pressure signal when it is in the center position. When is is switched toward a setpoint, it connects the display to the setpoint buffer amplifier to read the value of the setpoint. The switch is spring loaded to return to the center position when released.

DISPLAY (F)

The pressure reading for each channel is displayed by a bargraph display. The non-linear pressure range is screened on a lens which covers the display. The lens is graduated in Microns and identifies the Channel 1 and Channel 2 bars.

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OPERATION

1. Connect the transducers to the 286 via CB286-2 (up to 25 feet) or CB286-3 (over 25 feet).
2. Wire the setpoint relay connectors for desired mode of control, if used.
3. Inspect the line voltage switch to verify that it is set to the proper input voltage.
4. Apply power to the 286 and check for a display in, or very near, the atmosphere band when the transducers are exposed to atmosphere.
5. Use the setpoint adjusts to set the desired setpoint levels. The 286 energizes the setpoint relay when the pressure falls below the setpoint. This action can be reversed by cutting jumpers. See appendix for detail.
5. Pump the transducers down to 10^{-4} and use the zero pot to adjust the display to a point where the second element is just becoming illuminated. (Note: This first element is always illuminated and there is a delay between the adjustment of the zero control and the movement of the display.

The system is now ready for use.

SECTION 3

THEORY OF OPERATION

TC-1

The transducer consists of a pair of thermo-couple wires mounted in a cross configuration. The two dissimilar wires are spot welded at their ends to a 4-pin header. The wires are also spot welded together at the cross, this weld forming the hot junction. The cold junction then becomes the weld at the pins of the header, and this junction stays at ambient temperature. The 286 supplies a constant square wave current through one of the two wires thus raising its' temperature and the junction temperature.

Since the wire is very fine and the transducer's body massive, the heat generated in the wire does not raise the transducer temperature significantly. At vacuum, the temperature difference between hot and cold junction will be maximum (gas removed from the hot junction) and this situation then corresponds to zero pressure. As pressure rises, the temperature difference will decrease. At atmospheric pressure, the temperature difference will be about 5% of the maximum. The temperature difference is however not a constant, but varies with ambient. This means that the transducer is somewhat sensitive to ambient in a non-linear fashion.

A negative temperature coefficient device very closely compensates for the transducer's sensitivity to room ambient by varying input power to the hot junction.

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POWER SUPPLIES (Refer to drawing D107801 Sheet 1)

The 286 uses linear supplies to produce internal voltages of +240 VDC, +73 VDC, ±15 VDC and +1.2 VDC.

A DC to DC converter is used to generate the regulated square wave drive for the transducers.

Regulator U112 converts the DC input from DB101 and C119 into a 1/2 amp +15 volt supply. A single turn pot, R165 is used to set the output valve. A low current -15 volt supply is derived from C120 and VR104. These voltages are used to supply the internal circuitry and to power the setpoint relays.

Transistors Q107 and Q108 form a series regulator to produce a +240 VDC output to be used for the anode voltage on the bargraph display. VR102 and VR103 produce a +73 VDC output to be used for cathode bias on the bargraph. The anode voltage is adjusted to +240 VDC with a single turn pot, R160.

The DC-to-DC converter receives its' input from DB101 and C119. This voltage is then regulated down to +15 VDC by U108. This voltage drives the converter which consists of Q105, Q106 and T101. This produces two 25KHz square drive signals, one for each channel.

U111 and VR101 are used to produce a +1.2 VDC reference voltage to drive the setpoint pots.

SIGNAL PROCESSING (Refer to drawing D107801 Sheet 1)

Each transducer is driven through a 10 ohm zero pot (R139, R147) and a series limiting resistor (R138, R137). Rectifiers CR109-CR112 clamp the drive when a transducer is removed. This prevents calibration shifts on one channel when the transducer is removed from the other. The signal from the transducer is amplified (U109, U110) and applied to the bargraph and setpoint circuits that correspond to that channel. Each amplifier has an internal null and span control which are factory set for the proper level.

SETPOINTS (Refer to drawing D107801 Sheet 1)

All four setpoints are identical. The following description pertains to Setpoint #1 - Channel #1. The setpoint level is set by R101. The level is buffered by U101 - Section and applied to the negative input of the comparator, U101 - Section 2. The output voltage is applied to the positive input of the comparator. When the voltage exceeds the setpoint, (Pressure below setpoint),* the comparator output goes high. This signal is passed through the latch circuit to drive the relay transistor Q101. This energizes the relay and illuminates the front panel lamp I101. If the $\overline{\text{LATCH}}$ line is connected to digital ground

* The output voltage from the signal amplifier INCREASES as pressure DECREASES.

then the relay will remain energized, even though the voltage falls below the setpoint and the comparator signal goes low. If the $\overline{\text{LATCH}}$ line is left high (open) then the relay will drop out when the voltage falls below the setpoint.

Removing the jumper from B to C and connecting it to A to C reverses the operation of the setpoint. i.e. the relay is energized until the voltage falls below the setpoint. When this happens, the relay drops out. See appendix for modification instructions.

BARGRAPH DISPLAY (Refer to D107801 Sheet 2)

Since signal processing is identical for both channels, the operation of Channel 1 will be described.

The output of the Channel 1 signal amplifier is applied to U201-B which reverses the signal to make the +1 volt at zero pressure input correspond to a zero volt at zero pressure for no display on the bargraph. The output from this amplifier is applied to the "stop comparator" U202 to determine the length of the bargraph display.

A free running 10KHz clock is formed by U206, R224, R225 and C207. The output from this clock is applied to a five stage counter U207. This counter produces the five phase drive for the baragraph tube.

U201-D and VR201 form a constant current generator which is used to charge C204 when Q205 is off. The slope of the ramp is set by R218. This ramp is applied to the inputs of all comparators U201-A, U202, U203.

U201-A is a "reset comparator". One input is set at +1 volt and the other is connected to the ramp created by the constant current source charging C204. When the ramp reaches +1 volt, the comparator output goes high which generates the reset signal. This sets the length of the bargraph display so that the 200 elements corresponds to +1 VDC.

A complete cycle (approximately 20 msec) is described as follows:

1. U201-A generates a result pulse
2. This pulse is applied to the D input of U205-A.
3. This produces a one clock cycle (100μ sec) reset to the five stage counter U207.

4. Also produced is a two clock cycle (200μsec) reset which is applied to Q205 to discharge C204 to zero and to Q202 and Q203 to remove anode voltage from the display.

5. With C204 held at zero, the output of the "reset comparator" U201-A goes low and removes the reset input to U205-A.

6. After two clock cycles C204 begins to charge, anode voltage is applied to both channels and U207 begins to count through its five phases.

7. The glow from the ionized reset cathode is transferred to Cathode 1 and so on up the line.

8. When the voltage on C204 exceeds the input voltage on the Channel 1 "stop comparator", U202, the output goes high which turns on Q201 shutting off the anode voltage and the Channel 1 display is turned off. If for example, the input voltage had been +0.5 volts then C204 would have been 1/2 way toward its' full charge of +1 volt. Therefore, Channel 1 would display 50% illumination.

9. When C204 reaches +1 volt then the "reset comparator" goes high and the entire cycle begins again.

   Since this happens at a rate of approximately 50 times per second, the display appears to be always illuminated.

SECTION 4

MAINTENANCE AND TROUBLESHOOTING

GENERAL

Should any difficulties be encountered in the use of you instrument, it is recommended that you contact any authorized MKS Sales Office or Home Office for repair instructions.

> IF IT IS NECESSARY TO RETURN THE INSTRUMENT TO MKS FOR REPAIR, PLEASE CONTACT THE NEAREST MKS SERVICE FACILITY FOR AN ERA NO. (EQUIPMENT RETURN AUTHORIZATION NUMBER), TO EXPEDITE HANDLING AND ASSURE THE PROPER SERVICING OF YOUR INSTRUMENT.

If the display is deflected fully to the right past the atmosphere band when the transducer is being pumped then the transducer is not producing an input to the 286.

1. Test the resistance between pins 1 & 5 and 3 & 7 of the transducers. They should be 1.4 ohms $\pm$ 0.1 ohms. (Count CW from key.)

2. Check cable continuity as indicated in the wiring schematic. Cable substitution may also be used if a spare cable is available.

3. Should tests 1 & 2 find no problem, then attempt to read the set-points on the channel in question. Adjust the setpoint fully CW and fully CCW. This should cause the display to go from maximum to minimum. If the unit responds correctly to this, then the error lies somewhere in the signal amplifier or surrounding circuitry. (U109 for Channel 1 or U110 for Channel 2.)

4. If the problem appears to be in the 286 rather than the transducer, you should proceed in the following manner:

A. Check for proper power supply voltages. The proper operating voltages are shown on the schematic (D107801 Sheet 1). These voltages are only approximate and should be used as a reference only. Note: Adjustment of any internal pots will destroy the factory calibration.

B. Should the +240 volt not be present, check to be sure that F101 is not open. Replace if necessary. (This fuse is mounted on terminals on the PC board.)

C. If the power supply voltages are correct, then use the waveforms on the schematics and the theory of operation (Section 3) to troubleshoot the unit.

To aid in troubleshooting the setpoints, a small negative input, 0 to -10mv, can be injected into the signal input. (GND to B and HIGH to A.) This replaces the transducer and aids in checking out the setpoints.

SECTION 5

APPENDIX

SETPOINT MODIFICATION

The setpoints in the 286 become energized when the pressure falls below the setpoint level. This mode of operation can be modified to cause the relay to be energized until the pressure falls below the setpoint.

This is done by cutting a PC jumper on the board and installing a wire jumper. The following chart lists two columns of jumper positions. The first column represents the standard jumper as supplied by the factory and is the jumper that must be cut. The second column indicates the position of the new jumper that is required to modify the setpoint operation.

SETPOINT	STANDARD JUMPER	OPTIONAL JUMPER
CH. 1-1	B-C	A-C
CH. 1-2	E-F	D-F
CH. 2-1	H-J	G-J
CH. 2-2	L-M	K-L

The locations of these jumpers are shown on the Main Electronics PC assembly. (D107816 Sheet 1)

SPECIFICATIONS

TC-1 TRANSDUCER

Materials of Construction	C.R.S. nickel plate Glass
Mounting	1/8 NPT or 1/2" O-ring
Temperature Operating Range	0-50^{o}C
Temperature Coefficient at zero pressure	<.05μ/^{o}C
Bake-out temp (connector removed)	150^{o}C
Junction temperature at zero pressure	250-300^{o}C
Internal volume	4.92 cc
Resistance between pins	1.4Ω
Achievable accuracy after setting zero, using correction factor	20% of reading

286 READOUT

Input	117/234 ±15%, 50-60HZ
Power	22 Watts
Fuse	1/4 or 1/8 Amp
Signal	0-1 VDC
Output	≥ 10K Load
Display	Dual Channel Bargraph 200 Plasma Elements/Channel 0-2000μHg
Channels	2
Setpoints	Four (2 per channel) energize on falling pressure, latching option.
Contacts	DPDT. 1A Resistive @ 110 VAC Available on 2 Individual Rear Connectors.
Operating Temperature Range	0-50^{o}C

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