

MANUAL
FOR
MECHANICAL PYRANOGRAPH
MODEL 3008
3009
3010
3011

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MANUAL NO: 3010-001
DATE: JUNE 1985
ECN: 2239

MECHANICAL PYRANOGRAPH
MODEL 3008
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1.0 INTRODUCTION

1.1 Mechanical Pyranographs are survey type instruments designed for continuous recording of the intensity of direct and scattered solar radiation. Daily totals can be calculated from the collected data. The Pyranographs work on the principle of the difference in the temperature of four parallel rectangular bimetallic strips 2 white and 2 black. The temperature difference is proportional to the intensity of solar radiation.

1.2 Qualimetrics, Inc. provides four models of mechanical pyranographs, the primary differences in the models being the clock and chart paper. The Model 3010 Pyranograph features a spring driven 1 day/7 day clock, Model 8828. Pyranograph Model 3011 uses a battery powered, quartz crystal clock, Model 8834 with 1 day/7 day rotation. Model 3008 uses a spring driven clock, part number M666073, with 1 day/7 day rotation. Pyranograph Model 3009 uses a battery powered, quartz crystal clock, part number M666074, with 1 day/7 day rotation.

1.3 The clock Models 8828 and 8834 provide recordings with 26 hour and 176 hour time bases. Clocks with part number M666073 and M666074 record with 24 hour and 168 hour time bases.

1.4 For recording with clocks Models 8828 and 8834 use chart paper with 5 digit part numbers such as 30101. The chart paper with 6 digit part numbers such as M699170 is used only with clocks M666073 and M666074. Refer to Section 2.0.

2.0 SPECIFICATIONS

2.1 Sensing element.....Black and White
bimetallic strips
Calibration..... gm Cal/cm²-min, W/m²
Scale divisions.....Approximately 0.05 gm Cal/cm²-min
Range.....Approximately 2.5 gm Cal/cm²-min
Spectrum..... 0.36 to 2.0 micron
Lag coefficient.....Approximately 5 minutes
Drum rotation.....One day or seven day
Clock drive:.....Spring wound

Pen Type.....1.5 VDC battery
 Chart size.....Cartridge
3.5"H x 11.5"L
(89 x 292 mm)
 Size.....13"L x 8.25"W x 8.75"H
(330 x 210 x 220 mm)
 Weight/Shipping.....14 lbs/25 lbs
(6.4 kg/11.3 kg)

2.2 Pyranograph Charts for Models 3010 and 3011:

<u>Chart Catalog Number</u>	<u>Chart Range</u>	<u>Drum Rotation</u>	<u>Charts/ Package</u>
30101	0-2.5 Ly/min	176 hour	55
30102	0-2.5 Ly/min	26 hour	400
30103	0-1500 W/m ²	176 hour	55
30104	0-1500 W/m ²	26 hour	400

2.3 Pyranograph charts for Models 3008 and 3009:

<u>Chart Catalog Number</u>	<u>Chart Range</u>	<u>Drum Rotation</u>	<u>Charts/ Package</u>
M699170	0-2.5 Ly/min	24 hour	400
M699171	0-2.5 Ly/min	168 hour	55

3.0 INSTALLATION

3.1 This instrument is thoroughly tested and fully calibrated at the factory and is ready for installation. Please refer to the return authorization card included in the packing box if damage has occurred. Also, notify Qualimetrics, Inc.

3.2 The Mechanical Pyranograph is shipped in a dual fiberboard container. The inner container is packed with styrofoam panels to protect the instrument from damage during shipment. The outside container is also filled with foam chips for further protection.

3.3 The following instructions (Section 3.3 to 3.6) apply to the spring wound clock. Remove the clock and winding key from the packing box. The clock is shipped from the factory with the seven day gear attached. The one day gear is located on the pyranographs. The gears for the Model 8828 and 8834 clocks are different than the gears on the

M666073 and M666074 clocks. Make certain that the correct gears are used with the correct clock.

- 3.4 Select the desired chart time period (one or seven days). This clock comes standard with two gears for selecting chart speed. The one day gear (88262) is the larger diameter and has 22 teeth (M666002 has 21). The seven day gear (88263) is the smaller diameter, having 18 teeth (M666003 has 17). Be sure to install the correct gear over the corresponding shaft. If incorrectly installed, or if both gears are installed at the same time, severe damage may occur to the clock mechanism. Insert the winding key in the top of the clock, through the sliding door opening. Wind the clock in the direction of the arrow (counter-clockwise) approximately seven turns. Do not force the winding key. The clock will automatically start keeping time. Remove the key and close the door while in operation.
- 3.5 Remove the chart clip from the side of the clock drum. Select the appropriate chart and write in the station number and date the chart was started. Place the right hand margin of the chart in line with the right side of the chart clip notch. Wrap the chart around the drum in a clockwise motion. The left-hand edge of the chart should overlap the right-hand edge. Place the chart clip over both layers of the chart and seat it in the notch.
- 3.6 Place the clock over the gear post and secure it with the knurled nut. Go to Step 3.14 for further instructions.
- 3.7 The following instructions (Step 3.7 to 3.13) apply to the 1.5 VDC battery operated clock. Remove the clock from the packing box. Carefully remove the drum from the clock mechanism by twisting the drum counter-clockwise and lifting up.
- 3.8 Select the chart time interval by using the correct gear. The instrument is supplied with the seven day gear installed. Remove the black rubber bushing and install the one day gear if desired. The one day gear is located inside the clock mechanism. Do not use both gears at the same time or severe damage may occur to the clock mechanism.
- 3.9 Use one 1.5 VDC "D" cell battery to operate the clock. Place the battery in the battery holder with the negative end facing the knurled screws or black wire. Alkaline "D" cells are recommended for cold climates.
- 3.10 The clock is self starting as soon as the battery is installed. The small gears inside the clock mechanism can be seen moving if closely observed.

- 3.11 Replace the clock drum over the clock mechanism and rotate it clockwise.
- 3.12 Place the chart paper on the clock drum as described in Step 3.5.
- 3.13 Remove the two hex nuts from the clock shaft. Place the clock/clock shaft assembly through the base of the instrument and tighten both hex nuts. Be sure that the spacer bushing is between the base and the clock assembly.
- 3.14 Turn the clock assembly so that the pen is set to the correct time mark.
- 3.15 Remove the pen tip cover. Remove the shipping clip on the pen arm. Return the pen onto the chart using the pen lift lever mounted on the base of the instrument.
- 3.16 Remove the packing material from around the desiccant glass and empty the desiccant into the glass. If the desiccant is blue in color, it is ready to use. If it is pink, it must be dried. Place the desiccant in an oven at 180°F for two to four hours or until it turns blue. The glass container is pyrex and can be used in the oven for drying.
- 3.17 Locate the instrument outdoors so that it is not obstructed from the path of the sun. The Model 3012 mast is an ideal mount for this instrument. When installing this instrument, take care not to locate it where shadows will appear. Level the instrument using the three feet and the bull's-eye level on the base. The window on the front of the instrument should be oriented toward north in the northern hemisphere to guard against solar radiation entering the case.
- 3.18 Close the lid of the instrument, being sure that the internal mechanism is sealed from the outside environment. The base gasket and wing nut latch provide this protection.

4.0 THEORY OF OPERATION

- 4.1 Solar radiation passing through the glass hemisphere falls on four bimetallic strips. The hemisphere will transmit 90% of the radiation in the range of 0.36 to 2.0 micron. Two of the bimetallic strips are painted white and reflect the incoming radiation. These strips only respond to ambient temperature conditions. The other two bimetallic strips are painted black. They absorb the incoming radiation, as well as the ambient radiation. One black and one white strip are connected so that the ambient conditions cancel each other, with the remaining bimetallic curvature representing the incoming radiation.

- 4.2 One end of each white strip is attached to the instrument frame. The other end of each white strip is attached to one end of a black strip. The opposite end of the black strips are tied together and connect to the pen arm linkage. A baseline adjustment screw is provided for the full scale range. The plate under the bimetallic strips is used to reflect radiation not falling on the strips so that internal parts will not exhibit temperature changes.
- 4.3 The case is painted white to insure that the internal components will stay at ambient temperatures. A window is provided in the case for viewing the chart readings. The desiccant and gasket seals keep the inside of the case dry. Without them, condensation would form on the inside of the glass hemisphere, causing large errors in data collection.

5.0 CALIBRATION

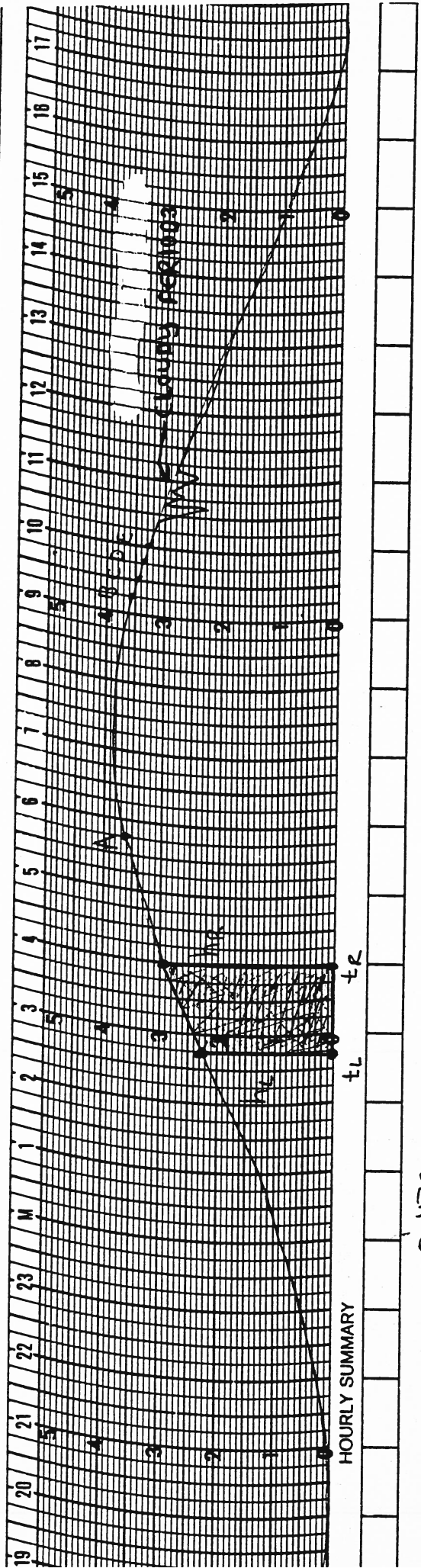
- 5.1 Calibration of this instrument is a very delicate operation. Only a qualified instrument technician with precision instruments should attempt this procedure.
- 5.2 Place the instrument in a completely dark room and after leveling the instrument, set the baseline or zero point by adjusting the pinion head screw on the sensor mounting rod located under and toward the back of the white reflective plate. An alternate method would be to make this adjustment at night during the dark hours.
- 5.3 The full scale value is derived from a calibration constant. Generally, the full scale is not adjusted but instead the calibration constant is changed.

$$\text{Solar Radiation} = K \times \text{chart reading}$$

From the above formula, solar radiation in gm cal/cm²-min can be determined by multiplying the chart reading by the calibration constant. For this instrument the calibration constant is approximately 0.470. The actual value is:

$$K = \underline{\hspace{2cm}}$$

- 5.4 Locate this instrument next to an instrument of a known calibration. Take several readings at different radiation exposures and determine a new calibration constant. NOTE: This instrument has a lag time of approximately five minutes so it should not be calibrated during partially cloudy conditions.
- 5.5 The spring driven clocks have an internal adjustment for speed on the escapement mechanism. Moving the adjustment



INSTRUMENT CONSTANT 0.470 (K)
 RADIATION (cal./cm²/min) = K x CHART VALUE

DAILY TOTAL _____

FIG. 5.8

arm toward "+" will speed up the clock, while moving it toward "-" will slow it down.

- 5.6 To open a spring wound clock, remove the chart and the chart clip, turn the clock drum counter-clockwise and lift it off. The adjustment is also on the clock mechanism. Quartz clocks have no adjustments.
- 5.7 Calibration of the clocks can be performed by a reputable time piece repairman or by the Qualimetrics Customer Service Department.
- 5.8 The procedure outlined in the following steps is for reading the charts of the pyranograph. A sample chart is used to obtain the values indicated.
 - 5.8.1 To obtain the value for a single point on the chart, locate the arc passing through the point of interest. Refer to point A on the sample chart.
 - 5.8.2 For the example shown, point "A" is at division number 3.6. The reading at point "A" is $3.6 \times .470 = 1.69$ with units of gram calories per centimeter squared minute (gm cal/ cm²-min).
 - 5.8.3 To obtain the equivalent value in Watts per square meter (Wm⁻²), multiply 1.69 by 698.
 - 5.8.4 The hourly summary box is the total of the 4 readings during the hour. For hour number 10 there are 4 readings at 15 minute intervals. In the example these 4 readings are indicated as "B", "C", "D", and "E". The individual results are 1.669, 1.636, 1.575, 1.542. The hourly summary total is 6.422.
 - 5.8.5 The daily total value is the total of the hourly summaries, representing the total amount of solar energy measured during the time period.
 - 5.8.6 A more accurate method for obtaining the daily total is to integrate the area under the curve of the trace. The area under the curve may be measured directly with a planimeter or indirectly by dividing the area under the trace into small trapezoidal figures and computing the area of each trapezoid. The area of a trapezoid is determined by the equation:

$$A = \frac{(h_L + h_R)}{2} \times (t_R - t_L)$$

Where h_L is the left side
 h_R is the right side
 t_R is the time at h_R
 t_L is the time at h_L

- 5.8.7 For the sample chart shown, the results of the area calculation for the trapezoid shown is

$$A = \frac{(2.3 + 2.9)}{2} \times \frac{(4 - 2.75)}{2} = 3.25$$

The sum of all the trapezoidal shaped areas equals the daily total solar energy.

6.0 MAINTENANCE

- 6.1 The instrument should be routinely maintained preventing dust and dirt build-up. Whenever a chart change is required, simply brush the dust and dirt from the instrument. This type of preventive maintenance will provide long reliable recorder operation. At routine intervals, three to six months, clean all pivot points with solvent and with a small brush apply a light coat of instrument oil.

- 6.2 The outside surface of this instrument should be maintained in a highly polished state to reflect direct solar radiation. Paint the surfaces of the case with a high gloss white enamel when required. The bimetallic strips are painted with a special paint and should not be painted except by the factory.

- 6.3 When the desiccant turns a pink color, immediately replace it with a new container or dry it as described in Section 3.16.

- 6.4 Alkaline batteries should be used for battery operated clocks. Change batteries every six months.

- 6.5 The clock mechanism should be cleaned and adjusted by a time piece repairman.

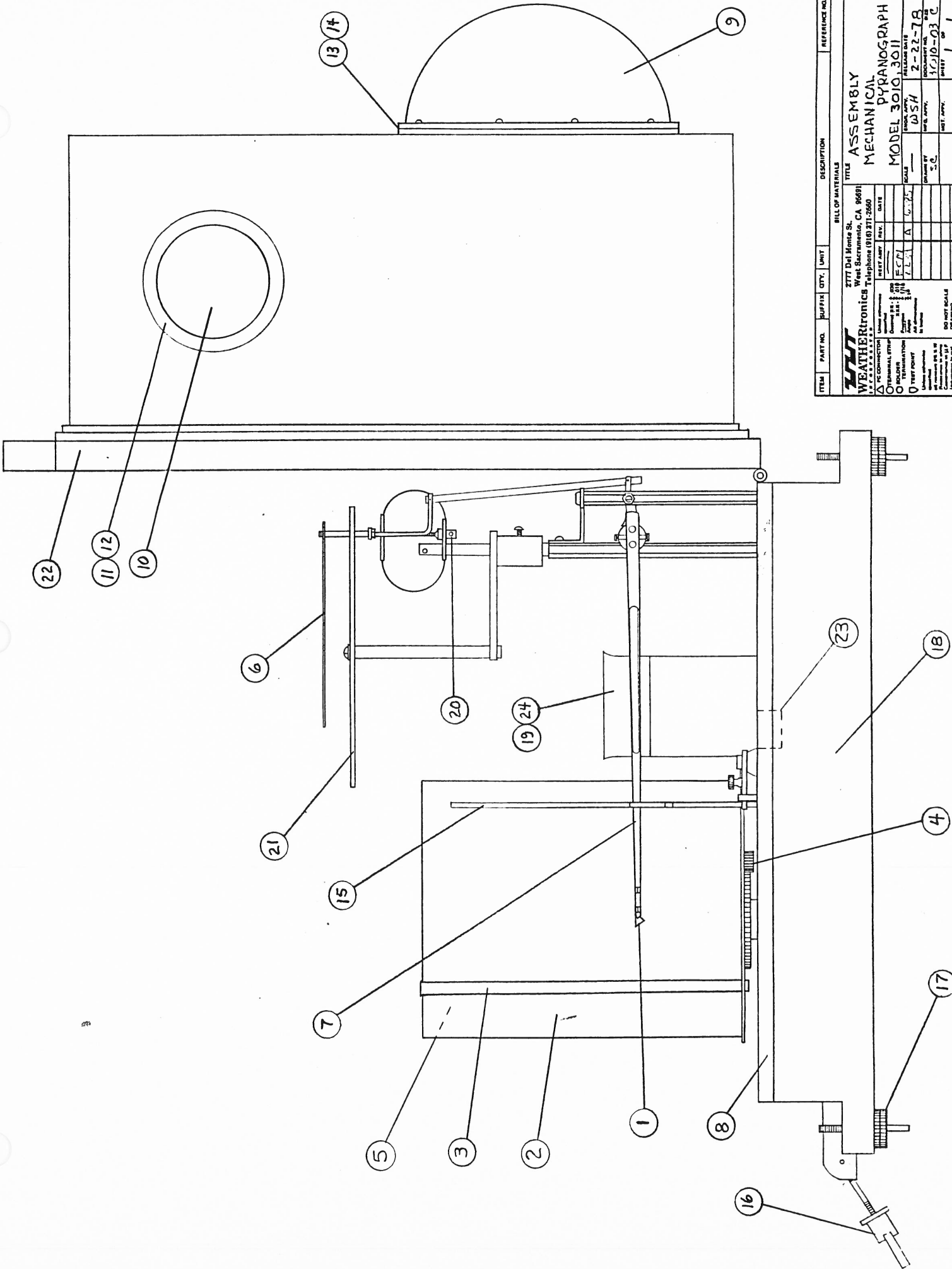
7.0 SCHEMATIC & PARTS LIST

- 7.1 The following pages include schematics, assembly drawings, and parts list for this instrument. Please note that the parts lists are arranged in assembly/subassembly form. Each subassembly is on its own page. Subassemblies and parts are listed in the smallest economical size available from Qualimetrics.

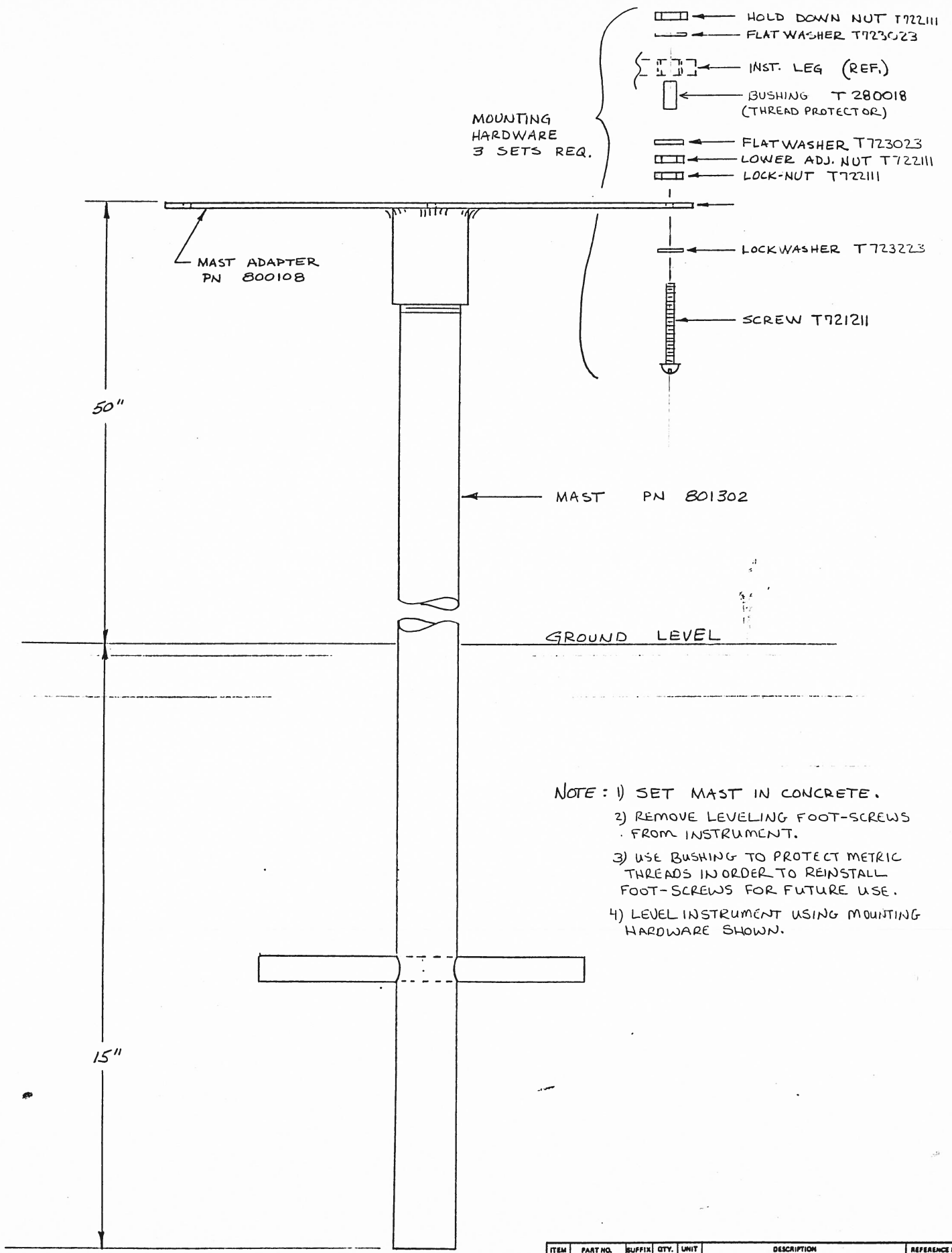
8.0 WARRANTY

- 8.1 All instruments are warranted for one year, unless otherwise specified, against defects in material or workmanship. Should any instrument prove to be defective within the warranty period, upon written notice and return of the instrument freight prepaid, Qualimetrics will, at its option, repair or replace the defective unit and return it

freight collect. Instruments abused, improperly used or installed, and modified or altered by others, may cancel warranty.



ITEM	PART NO.	QTY.	UNIT	DESCRIPTION	REFERENCE NO.
WEATHERRONICS 2777 Del Monte St. West Sacramento, CA 95691 Telephone (916) 371-2860					
PC CONNECTION	DATE			BILL OF MATERIALS	
TELEPHONE	REV.	DATE		TITLE	
TELETYPE	REV.	DATE		ASSEMBLY	
TELETYPE	REV.	DATE		MECHANICAL	
TELETYPE	REV.	DATE		PYRANOGRAPH	
TELETYPE	REV.	DATE		MODEL 3010, 3011	
TELETYPE	REV.	DATE		SCALE	
TELETYPE	REV.	DATE		WASH	
TELETYPE	REV.	DATE		RELEASE DATE	2-22-78
TELETYPE	REV.	DATE		PREPARED BY	JCB/gjs
TELETYPE	REV.	DATE		CHECKED BY	W.S.
TELETYPE	REV.	DATE		APPROVED BY	
TELETYPE	REV.	DATE		SCALE	1/1
TELETYPE	REV.	DATE		DO NOT SCALE	
TELETYPE	REV.	DATE		DRAWING	



MOUNTING
HARDWARE
3 SETS REQ.

- ← HOLD DOWN NUT T722111
- ← FLAT WASHER T723023
- ← INST. LEG (REF.)
- ← BUSHING T 280018
(THREAD PROTECTOR)
- ← FLAT WASHER T723023
- ← LOWER ADJ. NUT T722111
- ← LOCK-NUT T722111

- ← LOCKWASHER T723223
- ← SCREW T721211

← MAST PN 801302

GROUND LEVEL

- NOTE: 1) SET MAST IN CONCRETE.
 2) REMOVE LEVELING FOOT-SCREWS FROM INSTRUMENT.
 3) USE BUSHING TO PROTECT METRIC THREADS IN ORDER TO REINSTALL FOOT-SCREWS FOR FUTURE USE.
 4) LEVEL INSTRUMENT USING MOUNTING HARDWARE SHOWN.

ITEM	PART NO.	SUFFIX	QTY.	UNIT	DESCRIPTION	REFERENCE NO.																		
BILL OF MATERIALS																								
WWT WEATHERtronics <small>INCORPORATED</small>					2777 Del Monte St. West Sacramento, CA 95691 Telephone (916) 271-2660																			
<input type="checkbox"/> PC CONNECTOR <input type="checkbox"/> TERMINAL STRIP <input type="checkbox"/> HOLDER <input type="checkbox"/> TERMINATION <input type="checkbox"/> TEST POINT					TITLE ASSEMBLY DRAWING MAST, PYRANOGRAPH PART NO. 3012																			
<small>Unless otherwise specified</small> <small>Quantity in brackets</small> <small>Engineering</small> <small>Approved</small> <small>All dimensions in inches</small>					<table border="1"> <tr> <th>REV.</th> <th>DATE</th> </tr> <tr> <td>ECB</td> <td></td> </tr> <tr> <td>7239 A</td> <td>6/95</td> </tr> </table>		REV.	DATE	ECB		7239 A	6/95												
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7239 A	6/95																							
<small>Unless otherwise specified</small> <small>All dimensions in inches</small> <small>Standard sizes in inches</small> <small>ASME Y14.5</small>					<table border="1"> <tr> <th>SCALE</th> <th>ENGR. APP.</th> <th>RELEASE DATE</th> </tr> <tr> <td>-</td> <td>RH</td> <td>5-18-78</td> </tr> <tr> <th>DRAWN BY</th> <th>IMP. APP.</th> <th>DOCUMENT NO.</th> </tr> <tr> <td>RDH</td> <td>RAH</td> <td>3012-03-C</td> </tr> <tr> <th>NOT. APP.</th> <th>SHEET</th> <th>OF</th> </tr> <tr> <td></td> <td>1</td> <td>1</td> </tr> </table>		SCALE	ENGR. APP.	RELEASE DATE	-	RH	5-18-78	DRAWN BY	IMP. APP.	DOCUMENT NO.	RDH	RAH	3012-03-C	NOT. APP.	SHEET	OF		1	1
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RDH	RAH	3012-03-C																						
NOT. APP.	SHEET	OF																						
	1	1																						
DO NOT SCALE																								

BILL OF MATERIALS

MODEL/PART NUMBER 3008, 3009, 3010, 3011

DESCRIPTION MECHANICAL PYRANOGRAPH

DATE JUNE 1985

SAL
CUS

Item No.	Part No.	Suffix	Qty.	Unit	Description	Reference No.	
1	88101		1	ea	Pen Tip Cartridge BLUE		
3	8828		1	ea	Clock, Spring Wound 26/176	3010	
	8834		REF		Clock, 1.5 DCV 26/176	3011	
	M666073		REF		Clock, Spring Wound 24/168	3008	
	M666074		REF		Clock, 1.5 DCV 24/168	3009	
3	88281		1	ea	Clip, Chart (ALL MODELS)		
4	88262		1	ea	Gear, 26 hour, 22 Teeth	3010,3011	
	M666002		REF		Gear, 24 hour, 21 Teeth	3008,3009	
5	88263		1	ea	Gear, 176 hour, 18 Teeth	3010,3011	
	M666003		REF		Gear, 168 hour, 17 Teeth	3008,3009	
6	T930000		1	ea	Bimetallic Strip Assembly		
7	T930001		1	ea	Pen Arm		
8	T930002		1	ea	Gasket, Base		
9	T930003		1	ea	Glass Hemisphere		
10	T930004		1	ea	Glass Window		
11	T930005		1	ea	Mounting Ring, Window		
12	T930006		1	ea	Gasket, Window		
13	T930007		1	ea	Mounting Ring, Hemisphere		
14	T930008		1	ea	Gasket, Hemisphere		
15	T930009		1	ea	Pen Lifter Assembly		
A	3010	01	MANUAL		Rev.	Date	Orig. WSH
B	3010	03	ASSY. DWG.		A	6/85	Engr. WSH
C	N/A	04	SCHEMATIC				Appv.
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CC

BILL OF MATERIALS

MODEL/PART NUMBER 3008, 3009, 3010, 3011
 DESCRIPTION MECHANICAL PYRANOGRAPH
 DATE JUNE 1985

SA
CL

Item No.	Part No.	Suffix	Qty.	Unit	Description	Reference No.	
16	T930010		1	ea	Wing Nut Latch		
17	T930011		3	ea	Leveling Foot		
18	T930012		1	ea	Base		
19	T930013		1	ea	Glass Holder, Desiccant		
20	T930014		1	ea	Zero Adjust Screw		
21	T930015		1	ea	Reflector Plate		
22	T930016		1	ea	Cover		
23	T930017		1	ea	Level		
24	T930145		4	oz	Desiccant		
A	3010	01	MANUAL		Rev.	Date	Orig. WSH
B	3010	03	ASSY. DWG.		A	6/85	Engr. WSH
C	N/A	04	SCHEMATIC				Appv.
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QUALIMETRICS, INC.
BILL OF MATERIALS LISTING

06/12/85
PAGE 1

MASTER PART # 3012-
DESCRIPTION MAST FOR 3010/3011

COMPONENT PART # \ DESCRIPTION	QTY	REFERENCE
T280018- BUSHING NYLON	3	
T721211- SCREW 10-32 X 2" CAD PL	3	
T722111- NUT 10-32 HEX SS	9	
T723023- WASHER FLT NO. 10 S. S.	6	
T723223- WASHER LK SPLT NO. 10 S. S.	3	
T800108- MAST ADAPTER	1	
T801302- MAST	1	

MASTER PART # 3013-
DESCRIPTION SPARE PARTS 3010-11

COMPONENT PART # \ DESCRIPTION	QTY	REFERENCE
88101- BLUE INK CARTRIDGES	1	
T930001- PEN ARM	1	
T930002- RUBBER GASKET 3010	1	
T930003- GLASS DOME FOR 3010	1	
T930145- SILICA GEL, 4OZ. /PKG	1	