Model 164

Digital Flow Rate Indicator

USER'S MANUAL

HP-225
August 1995

HOFFER Flow Controls

Perfecting Measurement™

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Notice

HOFFER FLOW CONTROLS, INC. MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

This manual has been provided as an aid in installing, connecting, calibrating, operating, and servicing this unit. Every precaution for accuracy has been taken in the preparation of this manual; however, HOFFER FLOW CONTROLS, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that may result from the use of products in accordance with information contained in the manual.

HOFFER FLOW CONTROLS' policy is to provide a user manual for each item supplied. Therefore, all applicable user manuals should be examined before attempting to install or otherwise connect a number of related subsystems.

During installation, care must be taken to select the correct interconnecting wiring drawing. The choice of an incorrect connection drawing may result in damage to the system and/or one of the components.

Please review the complete model of each item to be connected and locate the appropriate manual(s) and/or drawing(s). Identify all model numbers exactly before making any connections. A number of options and accessories may be added to the main instrument, which are not shown on the basic user wiring. Consult the appropriate option or accessory user manual before connecting it to the system. In many cases, a system wiring drawing is available and may be requested from HOFFER FLOW CONTROLS.

HOFFER FLOW CONTROLS' policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering. The information contained in this document is subject to change without notice.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the Hoffer Flow Controls Customer Service Department, telephone number (252) 331-1997 or 1-800-628-4584. BEFORE RETURNING ANY PRODUCT(S) TO HOFFER FLOW CONTROLS, PURCHASER MUST OBTAIN A RETURNED MATERIAL AUTHORIZATION (RMS) NUMBER FROM HOFFER FLOW CONTROLS' CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned RMA number should then be marked on the outside of the return package and on any correspondence.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting HOFFER FLOW CONTROLS:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS OR **CALIBRATIONS**, consult HOFFER FLOW CONTROLS for current repair/calibration charges. Have the following information available BEFORE contacting HOFFER FLOW CONTROLS:

1. P.O. number to cover the COST of the repair/calibration,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

LIMITED WARRANTY

HOFFER FLOW CONTROLS, INC. ("HFC") warrants HFC's products ("goods") described in the specifications incorporated in this manual to be free from defects in material and workmanship under normal use and service, but only if such goods have been properly selected for the service intended, properly installed and properly operated and maintained. This warranty shall extend for a period of (1) year from the date of delivery to the original purchaser (or eighteen (18) months if the delivery to the original purchaser occurred outside the continental United States). This warranty is extended only to the original purchaser ("Purchaser"). *Purchaser's sole and exclusive remedy is the repair and/or replacement of nonconforming goods as provided in the following paragraphs.*

In the event Purchaser believes the goods are defective, the goods must be returned to HFC, transportation prepaid by Purchaser, within twelve (12) months after delivery of goods (or eighteen (18) months for goods delivered outside the continental United States) for inspection by HFC. If HFC's inspection determines that the workmanship or materials are defective, the goods will be either repaired or replaced, at HFC's sole determination, free of additional charge, and the goods will be returned, transportation paid by HFC, using the lowest cost transportation available.

Prior to returning the goods to HFC, Purchaser must obtain a Returned Material Authorization (RMA) Number from HFC's Customer Service Department within 30 days after discovery of a purported breach of warranty, but no later than the warranty period; otherwise, such claims shall be deemed waived. See the Return Requests/Inquiries Section of this manual.

If HFC's inspection reveals the goods are free of defects in material and workmanship or such inspection reveals the goods were improperly used, improperly installed, and/or improperly selected for service intended, HFC will notify the purchaser in writing and will deliver the goods back to purchaser upon (i) receipt of Purchaser's written instructions and (ii) the cost of transportation. If Purchaser does not respond within 30 days after notice from HFC, the goods will be disposed of in HFC's discretion.

HFC does not warrant these goods to meet the requirements of any safety code of any state, municipality, or any other jurisdiction, and purchaser assumes all risk and liability whatsoever resulting from the use thereof, whether used singly or in combination with other machines or apparatus.

This warranty shall not apply to any HFC goods or parts thereof, which have bee repaired outside HFC's factory or altered in any way, or have been subject to misuse, negligence, or accident, or have not been operated in accordance with HFC's printed instructions or have been operated under conditions more severe than, or otherwise exceeding, those set forth in the specifications for such goods.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTLY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. HFC SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE RESULTING, DIRECTLY OR INDIRECTLY, FROM THE USE OF LOSS OF USE OF THE GOODS. WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, THIS EXCLUSION FROM LIABILITY EMBRACES THE PURCHASER'S EXPENSES FOR DOWNTIME, DAMAGES FOR WHICH THE PURCHASER MAY BE LIABLE TO OTHER PERSONS, DAMAGES TO PROPERTY, AND INJURY TO OR DEATH OF ANY PERSON. HFC NEITHER ASSUMES NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OR USE OF HFC'S GOODS, AND THERE ARE NO AGREEMENTS OR WARRANTIES COLLATERAL TO OR AFFECTING THE AGREEMENT. *PURCHASER'S SOLE AND EXCLUSIVE REMEDY IS THE REPAIR AND/OR REPLACEMENT OF NONCONFORMING GOODS AS PROVIDED IN THE PRECEDING PARAGRAPHS. HFC SHALL NOT BE LIABLE FOR ANY OTHER DAMAGES WHATSOEVER INCLUDING INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.*

Disclaimer:
Specifications are subject to change without notice.
Some pages are left intentionally blank.

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SECTION I

SECTION II

FLOWMETER INSTALLATION

GENERAL

Proper application of the turbine flowmeter requires a suitable piping installation in order to achieve accurate and reliable operation.

The piping configuration immediately preceeding and following the flowmeter is termed the meter run. Refer to the manufacturer's outline and installation instructions when installing the flowmeter and meter run.

RELATIVE - The performance of the turbine flowmeter is affected by fluid swirl and non uniform velocity profiles. The following recommendation will reduce such flow irregularities.

It is advisable not to locate the meter run immediately downstream of pumps, partially opened valves, bends or other similar piping configurations. In addition, the area surrounding the flowmeter should be free of sources of electrical noise such as motors, solinoids, transformers and power lines which may be coupled to the pickoff device.

The metering section should not be subjected to excessive vibration or shock. Such a condition may result in an mechanically induced output signal from the pickoff device.

METER RUN - In general, the meter run should be chosen to have the same inner diameter as the meter bore. A minimum of 10 pipe diameters of straight pipe up stream and 5 pipe diameters downstream are required. Where this optimum line configuration can not be implemented, it is advisable to install a flow straightner properly positionned upstream of the flowmeter. Orientation is not a critical factor, however, horizontal is a preferred orientation.

BYPASS RUN - A properly sized bypass run with suitable blocking valves may be equipped where an interruption in fluid flow for turbine meters servicing can not be tolerated.

STRAINER - A strainer, filter and/or air eliminator is recommended to reduce the potential of fouling or damage. See table for recommended mesh size.

On initial startup of a line, it is advisable to install a spool piece purging the line to eliminate damaging the flowmeter, due to flux, tape, solder, welds or other contaminates carried along by the fluid stream.

CAVITATION - Cavitation caused measurement inaccuracies in turbine flowmeters and should be avoided by suitable line and operating configurations.

Whenever the pressure within a pipeline instantaneously falls below the equilibrium vapor pressure of the fluid, a portion of the fluid vaporizes and forms bubbles in the pipe line. This is termed cavitation. Cavitation is eliminated by maintaining adequate back pressure on the flowmeter. A downstream valve that provides the necessary back pressure is on means for preventing cavitation in the metering run. Control valves should be located downstream, if possible. Some installations may also make use of a vapor eliminator upstream of the flowmeter.

The minimum required back pressure may be estimated using the following equation:

Min. Back Pressure = 1.25 X Vapor Pressure + 2X Pressure Drop

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Installation of the Series 164

The Series 164 should be placed in a convenient location where both ease of viewing and wiring access are maintained. Viewing considerations should include due consideration of excessive ambient lighting or glare.

The panel cutout requirements are depicted in drawing 160/250-701. Be sure to allow adequate space behind the panel for the wiring terminations. The mounting brackets are easily removed by pushing them forward and then across the side of the enclosure. Slide the case thru the cutout and reattach the mounting brackets to the case. Tighten the bracket screw to finish the mounting to the panel.

Before making any connections verify that the Series 164 has the desired options by checking the Model number.

Two connector schemes are available for the 164. The first is a terminal block that directly accepts wire leads, the second in a card edge, solder type connector.

The terminal block style connector directly accepts wire leads but it is a prefered practice to tin stranded wire leads before inserting them into the connector. Each wire should be stripped to a length of 5/8" +/- 1/16" before inserting into the connector. Care must be exercised to assure that each wire is inserted into the correct terminal of the connector. The connector holes are labeled both on the back plate and the connector body itself. Odd numbers are on the back row (closer to the case), even numbers are in the front row.

The solder style connector has a single row of contacts to which wires must soldered. It is recommended that the wires have a sleeve of heat shrink tubing installed around each wire to provide for a neatly dressed installation. When installed the connector must have the number/wire edge of the connector facing the top of the case.

The complete wiring terminations are shown on drawing 164-701 for the case of an ACC-27 Signal Conditioner.

Refer to the other wiring installation drawings for details of the connections for each option.

Magnetic Inputs are directly connected to terminals 21 and 22 with the shield terminated on 20. See drawing 164-702.

It is recommended that the high level outputs from remote Flowmeter Signal Conditioners be used to drive the Opto-Isolated Inputs. Typical connections are shown on the drawing for this option on drawing 164-701.

The PC-85 REP pickup must be connected to the magnetic pickup input. For connections to this pickup see drawing 164-703.

The pulse output option requires both rear wiring and in some cases internal solder gap/jumper connections to program it. Sample connnections are shown on the user wire drawing for this option. The form of the output is specified by the user when ordering although it may be changed in the field by a competent person family with P.C. Board repair procedures.

Connections for power should assure the proper line voltage is present before making connections to the Series 164. A ground wire is required. The line should be an 'instrument grade' whose various loads do not contain solinoid valves, motors, or other similiar transient producing loads which might adversely effect the operation of the system. In addition, the power line to the Series 164 should be fused or otherwise overcurrent protected by a 1/4 amp fuse.

After all connections have been made double check the complete wiring to verify conformance before applying power.

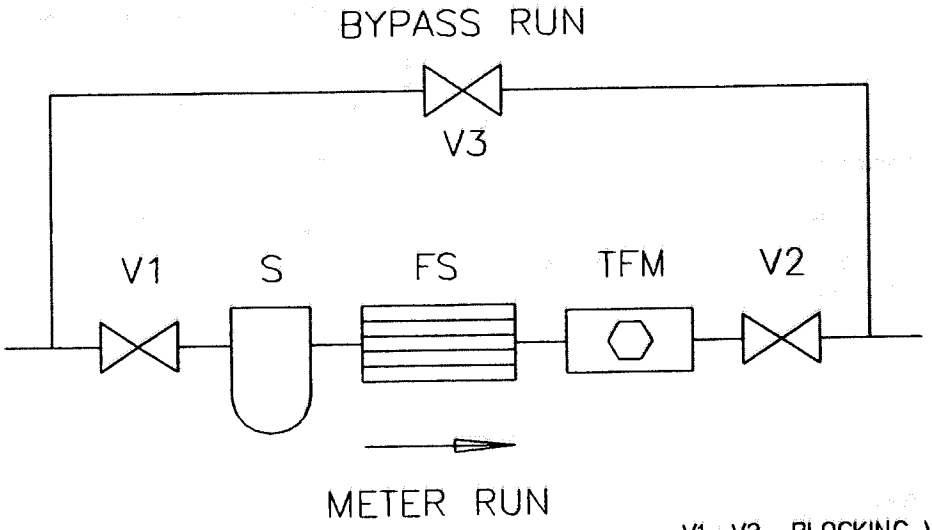
Most systems supplied by Hoffer come setup to user specifications if provided at the time of purchase. Review the factory calibrated systems appear to be in conformance with expectations. If the unit has not been calibrated or is different than originally requested, proceed to Section III for setup instructions.

When all installations and setup procedurers have been completed, go to Section IV for a discussion of initial startup and any final adjustments which might be necessary.

NOTES:
1. FACTORY RECOMMENDS 10" PIPE DIA. UPSTREAM AND 5 PIPE DIA. DOWNSTREAM OF SAME SIZE PIPE AS FLOWMETER. A FLOW STRAIGHTENER IS RECOMMENDED IF THIS IS NOT POSSIBLE OR FOR CUSTODY TRANSFER APPLICATIONS.

REVISIONS

REV	DESCRIPTION	DATE	APP
A	REDRAWN	1-31-92	
B	ADDED NOTE 2, CHG'D MESH SIZE	3-17-92	
C	DRAWING NO. WAS INSTL-104.	950907	JD



METER SIZE	MESH SIZE
MF SERIES	100
1/4" - 1/2"	100
5/8" - 1 1/4"	70
1 1/2" - 3"	40
4" - 12"	24

V1, V2	BLOCKING VALVE
S	STRAINER
FS	FLOW STRAIGHTENER
TFM	TURBINE FLOWMETER
V3	BYPASS VALVE

REPLACES INSTL-104

NEXT ASSY	USED ON
APPLICATION	

MATERIAL

FINISH

		DATE
DRAWN	DW	1-31-92
CHECK	JD	1-31-92
QA	H.COVELL	1-31-92
PROJ ENG	KRH	1-31-92

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES OTHER THAN RAW MATERIAL SHALL BE HELD AS FOLLOWS:

2 PLACE DECIMAL	±.01
3 PLACE DECIMAL	±.005
FRACTIONAL	±1/64
ANGULAR	±1/2°

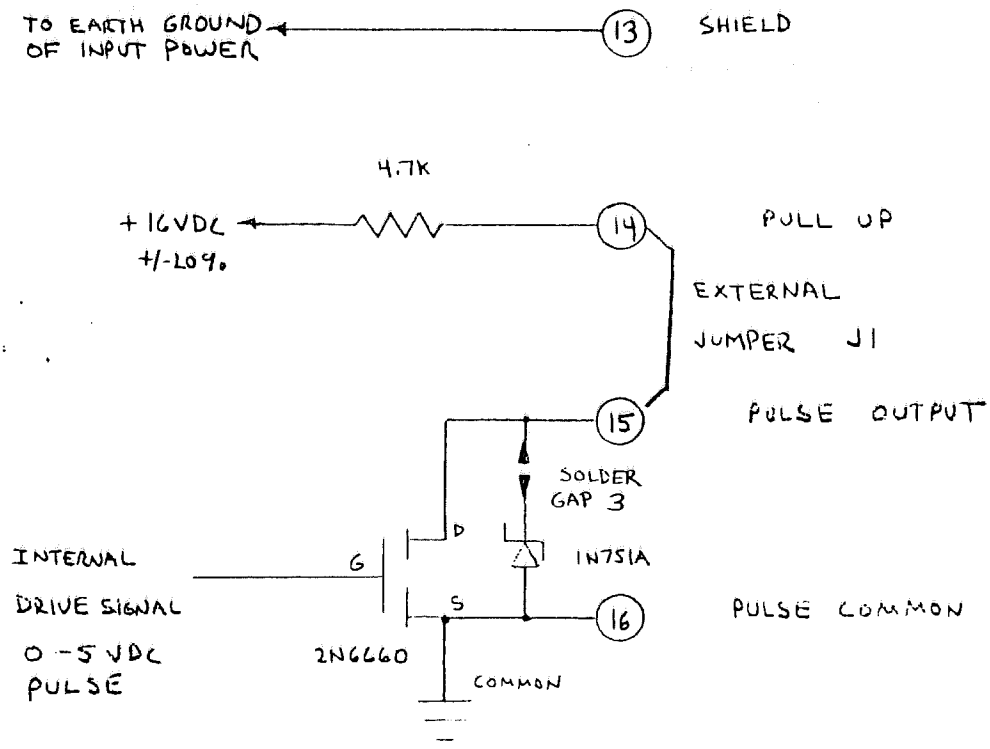
HOFFER FLOW CONTROLS, INC.
ELIZABETH CITY, NC 27909

TITLE
TYPICAL TURBINE INSTALLATION

SIZE	CAGE CODE	DWG NO	REV
A	33321	500-0194	C

SCALE		SHEET
NONE		1 OF 1

H:\dRAWINGS\500\50001941.DWG



PULSE FORM	WIRING DESCRIPTION	SIGNAL +	SIGNAL -
OPEN COLLECTOR	OMIT J1, SOLDER GAP 3	15	16
TTL / CMOS	EQUIP J1, SOLDER GAP 3	15	16
HTL	EQUIP J1, OMIT SOLDER GAP3	15	16
OPTO DRIVE	OMIT J1, SOLDER GAP 3	14	15

LET.	DATE	CHANGE	BY	APP.
REVISIONS				
DWN.		DATE	CK.	
ENGR.		MFR. ENGR.	DATE	

TITLE
CONFIGURING THE 164
PULSE OUTPUT STAGE

HOFFER FLOW CONTROLS, INC.
CODE 33321

DWG. SIZE A | 164-301 | REV.

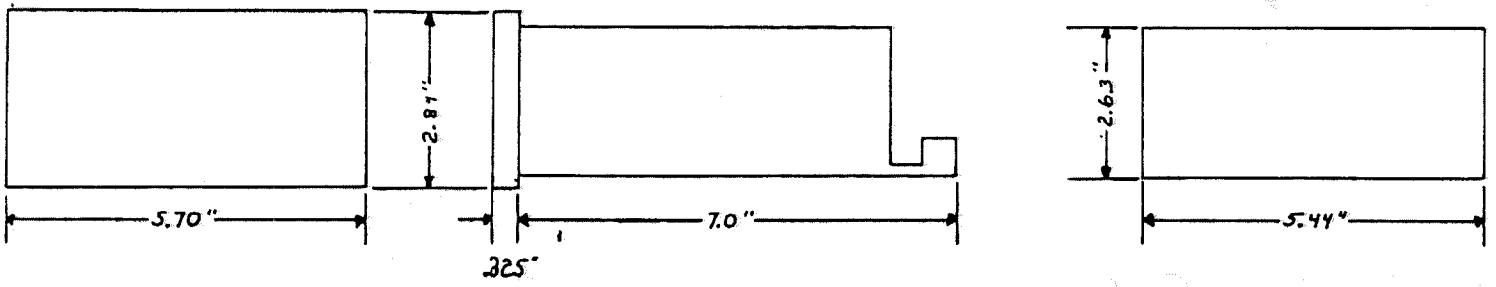
SCALE N/A | SHEET | OF 1

55459

FRONT

SIDE

PANEL CUTOUT



NOTES:

1. CASE CONFORMS TO DIN STANDARD 43700.
2. CASE IS CONSTRUCTED OFF NORY (GLASS FILLED) PLASTIC, WHICH IS TEMPERATURE RESISTANT TO 130°C.
3. ALL DIMENSIONS ARE NOMINAL VALUES

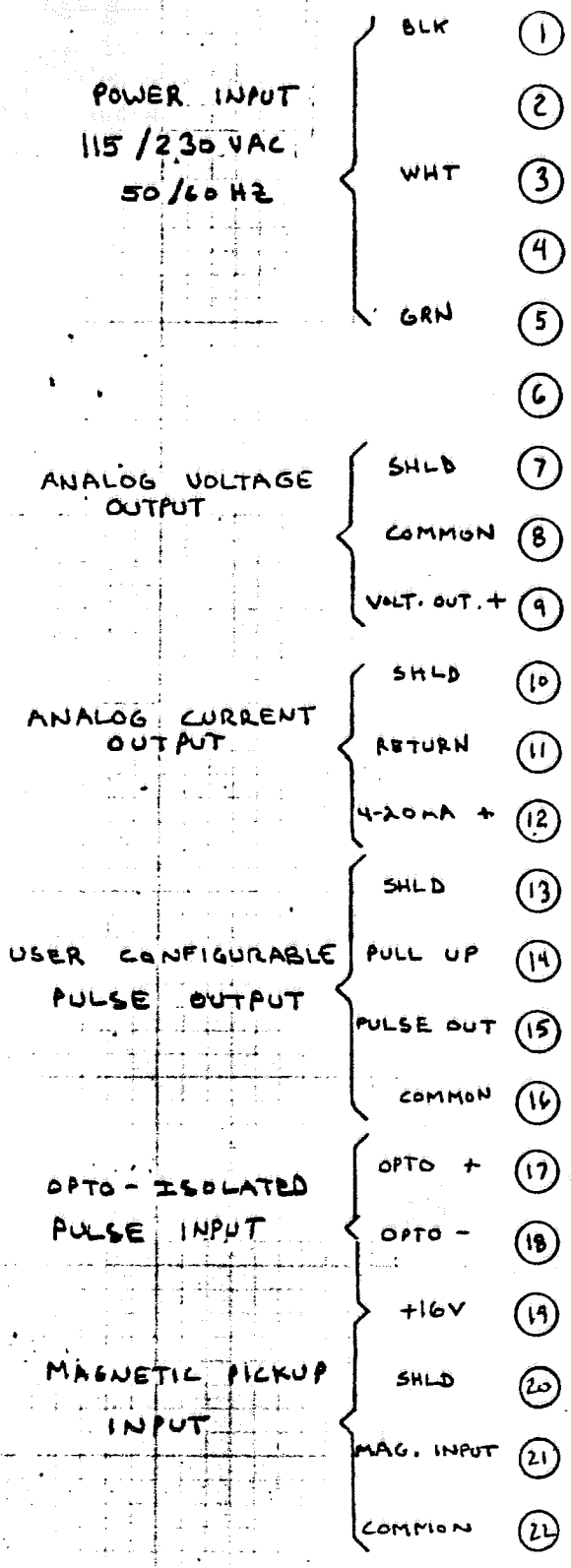
LET	DATE	CHANGE	BY	APP
		REVISIONS		
DRN	GP	DATE	11/05	
TRACE		APPD. TRACE	DATE	

TITLE: CASE DIMENSIONS FOR SERIES 160/250

HOFFER FLOW CONTROLS, INC.	CODE 33321

SIZE B | 160/250 - 701

SCALE N/A



NOTES -

1. POWER OPTION FACTORY WIRED
2. EITHER A VOLTAGE OR CURRENT OUTPUT IS AVAILABLE
3. PULSE OUTPUT MAY BE CONFIGURED TO SUIT NEEDS. SEE MANUAL
4. FLOWMETER SIGNAL MAY BE INPUT TO EITHER THE MAGNETIC PICKUP OR OPTO-ISOLATOR INPUT BASED ON SIGNAL TYPE AVAILABLE. SEE MANUAL.

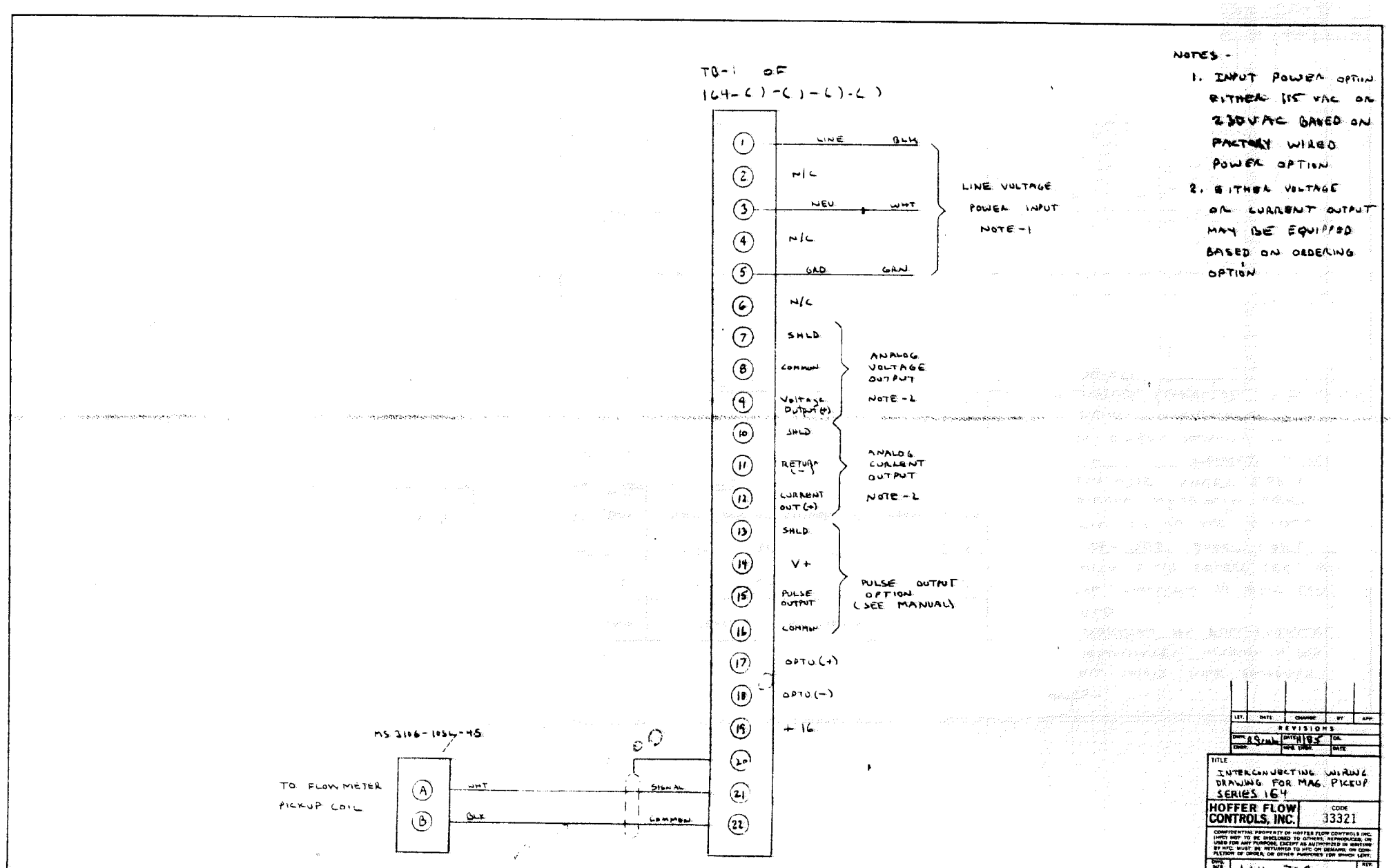
LET.	DATE	CHANGE	BY	APP.
REVISIONS				
DWN. R.S.M.L.	DATE	CK.		
ENGR.	MFR. ENGR.	DATE		

TITLE: USER WIRING FOR SERIES 163/164

HOFFER FLOW CONTROLS, INC. CODE 33321

DWG. SIZE		REV.
A	163/164-701	
SCALE N/A	SHEET 1 OF 1	

55459



NOTES -

1. INPUT POWER OPTION EITHER 115 VAC OR 230 VAC BASED ON FACTORY WIRED POWER OPTION
2. EITHER VOLTAGE OR CURRENT OUTPUT MAY BE EQUIPPED BASED ON ORDERING OPTION

LET.	DATE	CHANGE	BY	APP.
REVISIONS				
DWN.		DATE	CK.	
ENGR.		APPR. ENGR.	DATE	

TITLE
INTERCONNECTING WIRING DRAWING FOR MAG PICKUP SERIES 164

HOFFER FLOW CONTROLS, INC. CODE 33321

DWG. SIZE B | 164-702 | REV.

SCALE N/A | SHEET 1 OF 1

PIN	DESCR.	VERBAL DESCRIPTION	
1	POL	POLARITY (OR BUSY) OUTPUT	
2	OR	OVER RANGE OUTPUT	
3	10,000	DIGIT 5 BIT 1	(10,000'S)
4	OE3	TRISTATE / SELECT FOR D5 - STATUS BYTE	
5	8000	DIGIT 4 BIT 8	(1000'S)
6	4000	DIGIT 4 BIT 4	(1000'S)
7	2000	DIGIT 4 BIT 2	(1000'S)
8	1000	DIGIT 4 BIT 1	(1000'S)
9	OE2	TRISTATE / SELECT FOR D4 - D3 BYTE	
10	800	DIGIT 3 BIT 8	(100'S)
11	400	DIGIT 3 BIT 4	(100'S)
12	200	DIGIT 3 BIT 2	(100'S)
13	100	DIGIT 3 BIT 1	(100'S)
14	80	DIGIT 2 BIT 8	(10'S)
15	40	DIGIT 2 BIT 4	(10'S)
16	20	DIGIT 2 BIT 2	(10'S)
17	10	DIGIT 2 BIT 1	(10'S)
18	OE1	TRISTATE / SELECT FOR D2 - D1 BYTE	
19	8	DIGIT 1 BIT 8	(1'S)
20	4	DIGIT 1 BIT 4	(1'S)

PIN	DESCR.	VERBAL DESCRIPTION	
21	2	DIGIT 1 BIT 2	(1'S)
22	1	DIGIT 1 BIT 1	(1'S)
23	BUSY	BUSY (END OF CONVERSION) INTERUPT OUTPUT	
24	RUN/HOLD	RUN / HOLD INPUT	
25	COM	DIGITAL COMMON	

NOTES -

1. ALL INPUTS ARE PROPERLY TERMINATED INTERNALLY FOR OPERATION AS FULL PARALLEL BCD
2. FOR CONNECTION TO 8 BIT BUSS WITH DIGIT SELECT SEE DWG 164-705 SHEET 1 OF 2 FOR TIMING AND CONTROL SIGNAL WAVEFORM SEE 164-705 SHEET 2 OF 2
3. PIN 1 IS INTERNALLY JUMPERED TO EITHER POLARITY OR BUSY SIGNAL DEPENDING ON USE.
4. MATING CONNECTOR PART NUMBER DB-25P

LTR.	DATE	CHANGE	BY	APP.
REVISIONS				

DWN. [illegible] DATE [illegible] /86

TITLE BCD CONNECTOR PIN DESCRIPTIONS FOR 164 BCD OPTION

HOFFER FLOW CONTROLS, INC. CODE 33321

DWG. NO. B 164-704

SCALE N/A SHEET 1 OF 1

SECTION III

SERIES 164 CALIBRATION AND SETUP WORKSHEET-

APPLICATION REQUIREMENTS-

Desired Units of Rate Indication _____
Maximum Rate _____

Desired Analog Output Type _____
Desired Span _____

Desired Pulse Output Type _____
Limitations On Pulse
Output Frequency _____

FLOWMETER SPECIFICATIONS-

K-Factor _____

Maximum GPM Limit _____

164 SETUP PARAMETERS-

R(MAX) _____

GPM(MAX) _____

F(MAX) _____

Range Selected _____

Scaling Factor _____

Decimal Point _____

SET(ZERO) _____

SET(SPAN) _____

Pulse Output Setup-

Pulse Output Form _____ Pulse Scaling _____

Pulse Output
Calibration Factor _____

User Requirements and Use Limitations-

_____

_____

CALIBRATION OF SERIES 164 DIGITAL RATE INDICATOR

General Considerations-

In general, all flow measurement systems supplied by Hoffer Flow Controls have been factory calibrated free of charge as specified by the user, at the time of purchase.

All systems which underwent such a factory calibration have a calibration sheet which accompanies the unit. This sheet contains the following information which should be verified upon receipt of any order:

1- The corresponding flowmeter model and serial number
2- The Series 164 model and serial number
3- Accessories, Connectors, and Cables provided
4- The Range and Units of Rate Indication
5- The Type and Span of the Analog Output
6- Special notes concerning other aspects of the system such as the pulse output type and notes to the operator

This information should be reviewed and verified by the user prior to installing or using the equipment. Questions which may arise should be addressed to the applications group at Hoffer.

Field calibration or setup is only required when a change has occured or is sought to the measuring system. Such a change may be due to repair, replacement, or recalibration of the system or one of it's components. In addition, a change in the range of the analog output or the readout units will also require a new setup of the Series 164.

PROCEDURE-

The procedure for calibration of a digital rate indicator involves setting up the indicator to display in the desired units of measure and setting up the analog output have the desired output span based on the frequency signal generated by the input transducer at the maximum rate. As such it involves addressing the specifics of the input transducer and the units of measure desired by the user for display and analog output.

The Equipment Specifications give the desired units of measure and the maximum rate, designated R(Max), and the range and type of analog output desired. The Calibration Sheet for the flowmeter, or other input device, gives the specifics of the input transducer. Use the setup sheet provided in this section.

Begin by noting the required Units of measure for indication, and analog output (i.e. 4-20mA is 0 to 150 L/S). The maximum rate in the desired units of measure, R(max), is equivalent to the full scale of the analog output. Record this as R(Max) on the setup sheet.

The following discussion relates primarily to rate indicators used with pulse producing flowmeters. The setup with other input devices will be similiar.

From R(Max), determine the equivalent maximum volumetric flow rate in gallons per minute expected by this application. Term this quanity GPM(MAX).

GPM(MAX) is usually determined from R(Max) thru a conversion factor for the desired range of the analog output from the desired units of measurement but alternately it may be based on the maximum flowrate limit for the flowmeter when readout is in GPM.

For example, for a flowmeter with a flowrange of 6 to 93 GPM, a convienent analog output range might have a span of 0 to 100 GPM. Alternately 0 to 93 GPM could be used since this is the range of the flowmeter.

For units where the output is in mass units, for example pounds per hour, GPM(MAX) is determined from R(Max) and the density at the flowing conditions of temperature and pressure.

For example, for a mass flowrange of 0 to 1000 pounds per hour, at a density of 8.337 pounds per gallon, the GPM(Max) would be 1.9991 GPM. The most convenient analog output would have a range of 0 to 1000 PPH.

From the calibration sheet for the flowmeter, obtain the Average Calibration Factor for the flowmeter, designate this as K-Factor.

For MF Series miniflowmeters, an external linearizer is required. The Hoffer ACC-100 is the only linearizer which will offer an accuracy suitable for use with the Series 164. The "Linearized K-Factor is listed on the setup sheet for the ACC-100.

For insertion flowmeters this Calibration Factor is that for the total metering run and must be first calculated from the metering run dimensions and the K-Factor for the flowmeter rotor. See the insertion meter manual and perform this calculations at this time, then return to this section.

Perform the following calculation to obtain the setup full scale frequency and designate it as F(Max):

$$F(max) = \frac{\text{K-Factor X GPM(MAX)}}{60}$$

Record F(MAX) as it is used in later steps during the setup of the instrument.

Concerning the 4 1/2 Digit Indicator-

At this point, it is necessary to determine how the maximum flowrate can be best represented within the limitations for a 4 1/2 digit display.

The display may indicate any number between 0000 and 19999.

The decimal points may be arbitrarily programmed in any one of the following positions (0.0.0.0.0).

For number greater than 19999, a decal can be provided indicating a convient unit which can fit within the limitations of the display. For example, 1,500,000 gallons per minute could be represented as 1500.0 thousands of gallons per minute or as 1.5000 millions of gallons per minute.

To decide on how best to represent R(MAX), consider the following:

Ignoring the decimal point for a moment, examine how many significant figures of R(MAX) in the desired units may be represented in a 4 1/2 digit display without exceeding the displays capabilities at the maximum flowrate. As you can see the significant digits of R(MAX) should be greater than 2000 and less than 19999.

For example , suppose the maximum flowrate is 21.765 GPM. The significant digits of 21765 will not fit within the range of 2000 to 19999. A reading of 0021 or 0217 would not be making full use of the available resolution. A reading of 2176 is therefore the best representation which is avilable on a 4 1/2 Digit display. Rounding off to the nearest significant digit, 2177, would give higher accuracy. For this example, in subsequent calculations involved in the setup of the instrument 2177 would be used for R(MAX). After setting up the display, the "decimal point" switch may be used to program the decimal point to the desired position for the final indication of 21.77 GPM.

At this point you should have decided on the number and value of significant digits of R(MAX) to be used in subsequent calculations as well as the decimal point location and whether or not the trialing zero will be used.

TEST SETUP FOR CALIBRATING THE SERIES 164-

The 164 does not require the use of any external test equipment to set up the display indicator within an accuracy of 0.25% of Full Scale.

To achieve greater precision in the indicator setup and to calibrate the analog output requires some external test equipment to generate an accurate frequency during calibration. This calibration procedure assumes that the external signal sourse and test setup are being used. Two common signal generation methods are presented.

The test setup to perform a calibration of the Series 164 requires the use of a stable, low frequency oscillator which is capable of being set to desired frequency to at least the nearest 1/10 Hz. The oscillator should generate either a sinusoidal, a triangular or a AC square wave signal of a nominal 50/50 duty cycle. Also required is a Frequency Counter with a resolution to the nearest 1/10 th Hz.

Alternately, a more accurate test setup may be performed with the aid of a programmable, crystal oscillator based, signal generator such as the Hoffer model ACC-6. This setup does not require the use of a frequency counter since the desired frequency is directly selected by programmed the signal generator. The resolution of 1/10 th Hz allows for extremely fast, and accurate setup of the Series 164 since no drift or difficulty in establishing the desired frequency is encountered.

The Calibration Test Setup is shown in Figure 3A.

Connections from the signal generator to the Series 164 are made to Terminal 21 (Signal) to 22 (Signal Common). The signal level should be between 100 mVrms and 5 Vrms.

Power connections are made to 1(Blk), 3(Wht), and 5(Grn). The line voltage should be the same as the power option specified in the model number.

The analog output, either the voltage or the current output depending on the option supplied, should be monitored with a digital multimeter which has an accuracy of 0.05% and at least 4-1/2 Digits.

DETAILED SETUP PROCEDURE FOR SERIES 164

Indicator setup requires the electronics subassembly to be removed and a course range DIP switch be selected and a scaling factor be calibrated and selected on a rotary switch array.

Once setup the unit is then reassembled in the case and the fine indicator adjustments as well as the analog output adjustments are made in a powered up state thru calibration controls visable with only the bezel and lens removed.

To remove the electronic subassembly from the cases, first unplug the rear connector. Power should be off before disconnecting the two captive screws and unplugging the connector.There is no need to disconnect any wiring to the unit.

Next remove the front bezel and lens assembly. This is accomplished by pulling off the bezel on units which have not yet been mounted to a panel, and removing the red lens. On units already installed in the panel, remove the bezel by pushing down and pulling out the bezel with the finger tips. The lower portion of the frame will distort with moderate pressure and enable the user to pop off the bezel.

The ejector knobs are now visable. Pull on these two knobs to remove the electronics subassembly from the case. See Controls and Adjustment Drawing to identify the appropriate switch locations referenced in upcoming discussions.

Before continuing with the remainder of this procedure you should have calculated the following setup parameters:

F(MAX)
R(MAX)
Analog Output Span and Zero

Decided on the switch settings for:

Decimal Point Selection

Indicator Display Setup for all Flowmeter Types-

The Course Range Selection Table is shown in Table 3-1. This corresponds to the frequency range at which any display between 2000 and 19999 may be made with a accuracy of +/- 0.25% or better.

Given R(max), F(max), and the course range divide factor, calculate the scaling factor setting corresponding to the desired full scale flowrate setting R(max).

$$\text{Scaling Factor} = \frac{R(max)\ X\ M\ X\ F(clk)}{F(max)\ X\ 66670} = \frac{R(max)\ X\ M\ X\ 30}{F(max)} \text{ for 2 MHz}$$

Dial in the desired Course Range Selection and the Scaling Factor.

Note that Position 6 must also be "ON" on the Course Range Select Switch.

Reassemble the unit into case. Reconnect the rear connector and captive screws. Apply power to the unit.

With input signal source off (no input frequency present), adjust Display Zero Adjust, P7, to obtain an indication of 0000.

Turn the Sensitivity Adjust, P1, fully clockwise, or 20 turns.

Apply a input signal frequency F(Max) corresponding to the desired Full Scale Rate, R(max).

The unit should now be indicating a number within 0.25% of R(max).

To trim the display indication to the exact number simply adjust Full Scale Trim Adjust to obtain R(max). (Ignore as yet un-selected Decimal Points which is to be inserted later.)

If a decimal point is to be used, use the decimal point switch to illuminate the desired location.

Analog Output Setup-

Turn Off the Signal Source. Adjust the Zero Adjustment to obtained the desired zero as measured with the digital multimeter within the tolerance specified in Table 3.2.

Turn On the Signal Source with a frequency equal to R(max). Adjust the Span Adjustment to obtain the desired span as measured with the digital multimeter within the tolerance specified in Table 3.2.

Iterate the above two steps as necessary to bring the result within the recommended tolerances. Note that oscillator drift will manifest itself as drifting readings on the analog output is non-crystal oscillators are used.

Table 3.1 Course Range Selection for 2 MHz Crystal

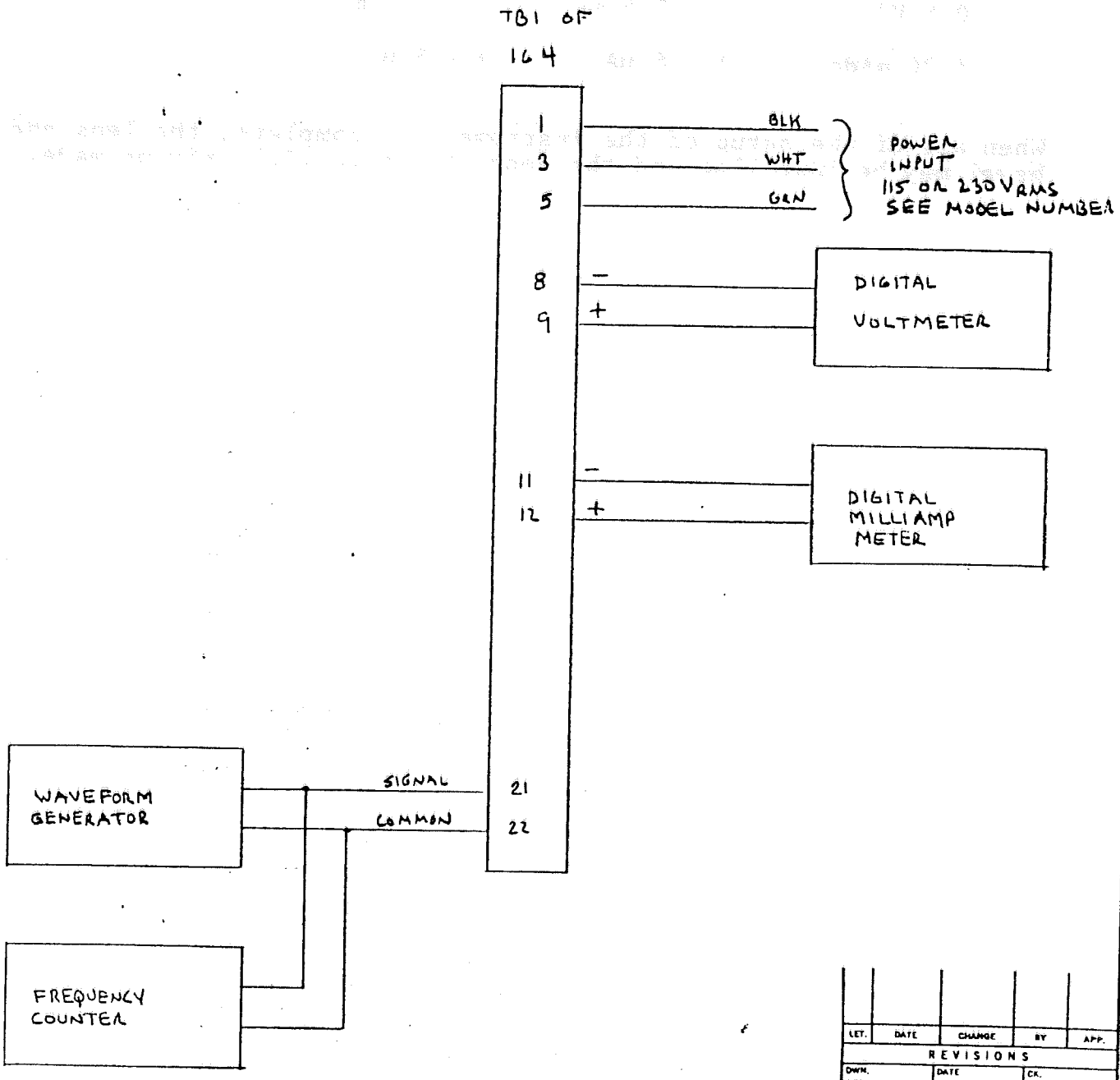
Full Scale Frequency	Switch Position	M Scaling Factor
60 - 150	1	1
120 - 300	2	2
240 - 600	3	4
480 - 1200	4	8
960 - 2400	5	16

NOTE: 30-75 range on Sw. Position 1 available with MHz Crystal as special option only.

Table 3.2 Analog Output Setup Tolerances

Desired Output Range	Set up Tolerance Span	Zero
0-10 Vdc	+/- 5 mV	+/- 5 mV
0-5 Vdc	+/- 2.5 mV	+/- 2.5 mV
4-20 mAdc	+/- 8 uA	+/- 8 uA

When all of the setup of the instrument is complete, the lens and bezel may be installed and the connections to field wiring made.



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TITLE
CALIBRATION TEST
SETUP FOR SERIES 164

HOFFER FLOW CONTROLS, INC. CODE 33321

DWG. SIZE		REV.
A	FIGURE 3A	
SCALE N/A	SHEET	OF

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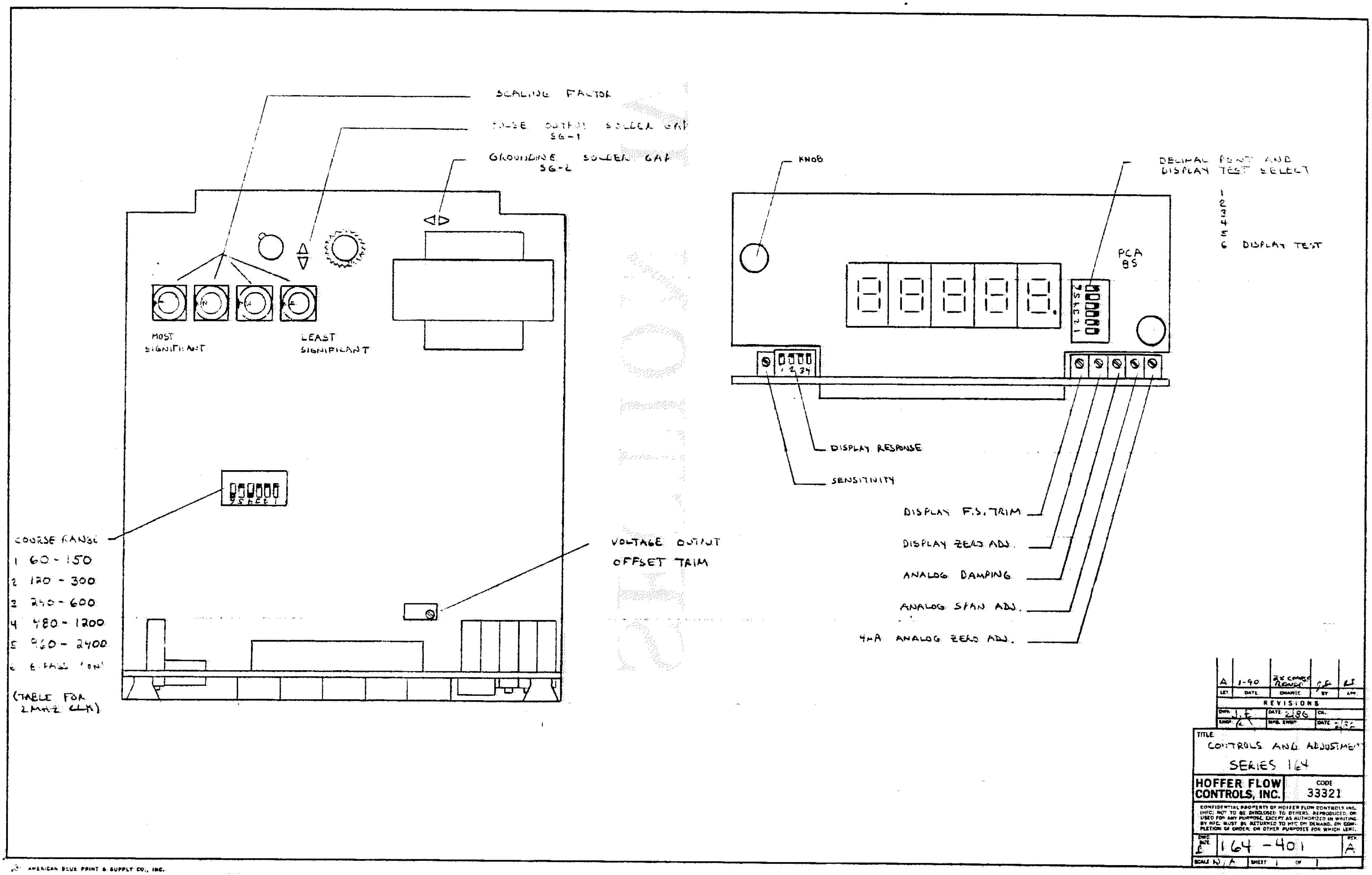
SCALING FACTOR
PULSE OUTPUT SOLDER GAP SG-1
GROUNDING SOLDER GAP SG-2
MOST SIGNIFICANT
LEAST SIGNIFICANT
COURSE RANGE
1 60 - 150
2 120 - 300
3 240 - 600
4 480 - 1200
5 960 - 2400
6 E-FALL 'ON'
(TABLE FOR 2MHZ CLK)
VOLTAGE OUTPUT OFFSET TRIM
KNOB
PCA BS
DECIMAL POINT AND DISPLAY TEST SELECT
1
2
3
4
5
6 DISPLAY TEST
DISPLAY RESPONSE
SENSITIVITY
DISPLAY F.S. TRIM
DISPLAY ZERO ADJ.
ANALOG DAMPING
ANALOG SPAN ADJ.
4mA ANALOG ZERO ADJ.
A 1-90 2X COURSE RANGE
REVISIONS
TITLE
CONTROLS AND ADJUSTMENTS
SERIES 164
HOFFER FLOW CONTROLS, INC.
CODE 33321
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164-401
A
SCALE N/A SHEET 1 OF 1
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SECTION IV

INITIAL STARTUP-

On initial startup of any new piping system, a high risk of damage to a turbine flowmeter exists until the lines has been flushed of debris from the piping assembly process. Perform any purging of the piping with a blank spool piece substituted for the turbine flowmeter.

Once the lines have been cleared, install the flowmeter and make connections to the pickup and/or signal conditioner before applying power to the Indicator.

Turn power to the indicator "ON". With no flow, the display should indicate 0000 (Ignoreing the decimal point a any trialing zero).

If the display instead indicates some other constant or varying value, noise pickup may be present. Turn the "Sens." control on the 164 (Or on the Signal Condition if one is used) Counter Clockwise untill a zero reading is achieved. The sensitivity control on the 164 effects the magnetic input only.

The unit is now ready to be used. The units of measurement are those that were established during the setup of the instrument. The analog output span corresponds to that type equipped with a span and zero as established during the setup procedure.

If during operation of this unit objectional bounce in the display is found to occur, it is possible to minimize bounce by slowing the response time of the display. Turning "ON" Positions 1,2,3, and/or 4 of SW-2, provides for a wide range of rate averaging. This does slow the response of the instrument to changing flow rates.

In like manner, if objectionable bounce or ripple is found on the analog output, turning the "Analog Damping" Adjustment P5 Counter Clockwise will reduce this behavior by slowing the response of the analog output to changing flowrates.

For additional information on how to successfully apply the Series 164, contact the Applications Group of Hoffer Flow Controls.

Theory of Operation-

General Discription-

The Series 164 is a Digital Rate Indicator whose basic theory of operation may be summarized in the following manner.

The Series 164 contains Input Signal Conditioning circuitry suitable for use with magnetic pickups or with compatible remote signal conditioners. A shaped and buffered form of the input signal is output. The frequency signal proportional to rate is then converted into a DC voltage signal whose magnitude is proportional to rate with a Frequency to Voltage Converter. This signal is then passed to a Digital Voltmeter Circuit for final display. In like manner the output of the Frequency to Voltage Converter is also scaled and passed to an analog output stage for remote transmission as either a standardized voltage or current signal. A power supply circuit provides the necessary operating bias.

A more detailed discription of operation now follows. Drawing 164-601 is a pictorial Block Diagram which highlights each of the major functional blocks and which represents the signal flow occuring within the unit. As such, this drawing should be referenced while proceding thru the theory of operation.

Detailed Discription of the Theory of Operation-

Magnetic Pickup Signal Conditioner-

The magnetic pickup signal conditioning is composed of a variable attenuator, a bandpass filter, and a comparitor with hysterisis. The bandpass filter is used to reject spurious noise which is out of the normal frequency range generated by a turbine flowmeter(i.e. 10 to 2500 Hz) while amplifing the in band signal of the turbine flowmeter. The attenuator and comparitor with hysterisis function to provide a selectable trigger level which is usually set above background noise pickup yet below the signal normally generated by a turbine flowmeter. This combination assures that zero flow is indicated when zero flow conditions exist.

Opto-Isolated Input-

The opto-isolated input is constructed about a opto-isolated transistor with suitable input current limiting and output conditioning to provide a isolating signal path. This configuration is intended to be used with remote signal conditioners. The isolated input eliminates the installation problems related to equipment grounding and can accept 3 to 30 Vdc pulses of the appropriate polarity. The output conditioning circuitry produces a output swing suitable for use with the logic circuitry found within the Series 164.

Pulse Combinator-

The Pulse Combinator functions as a "OR" Gate so that either the conditioned outputs of either the Magnetic Pickup Compatible Input or the Opto-Isolated Input may be used to drive the Indicator.

Pulse Output-

The conditioned frequency signal proportional to flowrate is passed to a user configurable pulse output buffer. This circuit is configured thru a combination of rear user wiring and internal solder gap jumper programming to meet the required signal type and level to assure interface compatibiliy with the remote recieving instrument. The basic output is a open collector transistor of adequate drive capabilty for most applications. By rear termal jumpering a pullup resistor this output may be configured to produce a high level pulse output. With the addition of a internal solder gap jumper, the output becomes TTL/CMOS compatible.

Precision Pulse Width Generator-

The precision pulse width generator is composed of a binary frequency divider, a frequency range select switch and a adjustable Pulse Width Generator Circuit.

The Precision Pulse Width Generator has been designed for maximum accuracy over a 200:1 range of input frequency, and to provide a time and temperature independent , adjustable pulse width generator.

The combination of the binary divider and selection switch divide down the input frequency so that the resulting scaled frequency is within the optimum range to assure resolution in setup and in linearity.

The Precision Pulse Duration Generator is a crystal based timing circuit which basically counts N number of clock cycles, where N is the scaling factor switch setting. The four BCD coded switches allow for +/- 0.25% resoltion for switch settings from 400 to 9999 clock cycles.

Precision Level Drivers-

The output of the Precision Pulse Width Generator is of a fixed width. To assure the amplitude stability required in precision Frequency to Voltage conversion this signal is passed thru the Precision Level Drivers prior to being Low Pass Filtered into a DC Voltage proportional to flowrate. These circuits are powered by a precision voltage reference found within the power supply circuitry so that the output levels are virtually independent of power line and temperature induced variations.

The outputs of the precision level drivers may then be passed thru a low pass filter to complete the frequency to voltage conversion. The Low Pass Filters have been made switch programmable in order to provide for signal averaging in pulsating flow applications. Thes switches are termed "Display Response".

Digital Voltmeter/Indicator-

A variable attenuator designated "Display FS Trim" is used to trim already scaled output of the Frequency to Voltage Converter to a voltage equal to the desired display indication.

The "Display Zero" control is used to null out any residual DC Offset Voltages left over from the F/V Conversion.

The Digital Voltmeter Circuit converts the DC Voltage proportional to flowrate into multiplexed BCD and Digit Select signals. These signals are then passed to the BCD Output Option and the Display Driver Circuitry for decoding.

The Display Decoder Drivers provide the necessary timing and drive levels necessay to drive the LED's of the Rate Display.

Decimal Points are illuminated by selecting the appropriate segment of the display thru a switch and a current limiting resistor(s). A display test is also available.

The BCD Output Decoder/Buffer decodes the multiplexed output of the A/D Converter into the full, parallel BCD necessary for easy user interface on the 25 Pin Subminiature "D" Connector.

Analog Voltage and Current Output Amplifiers-

The Analog Output Amplifiers are configured to generate the required industry standard output voltage and current levels from the output levels occuring at the output of the F/V Converter.

Although output pins are available for both voltage and current outputs only one may be used at a time.

See specifications for drive levels available.

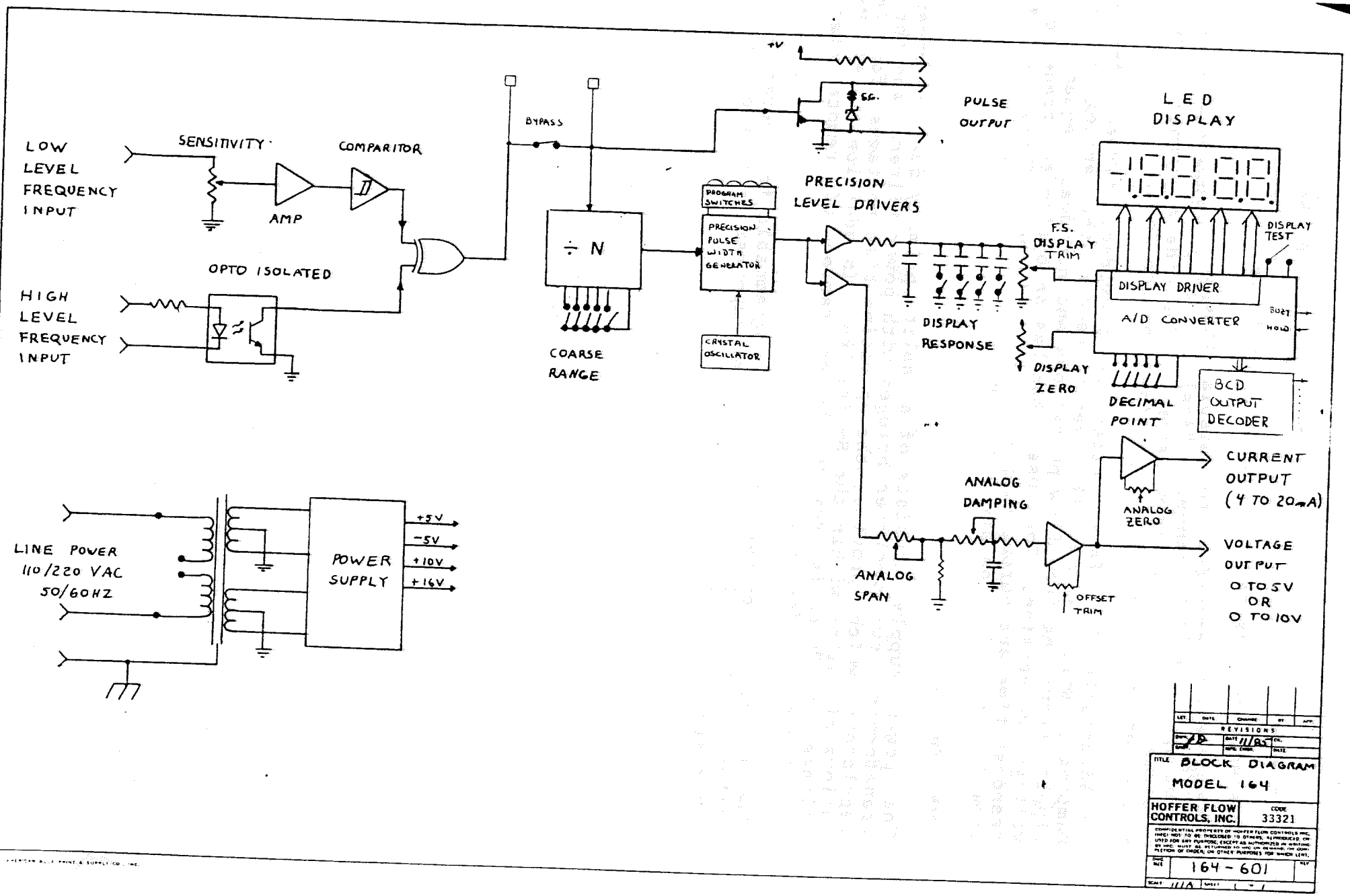
"Analog Span" provides for display independent tuning of the output span. In like manner, "Analog Zero" provides for limited adjustment of the zero output signal. The wide adjustment ranges on the span are required and provided for the Span.

An Adjustable Low Pass Filter is provided, termed "Analog Damping", which allows the user to reduce the analog output ripple resulting from flow pulsations and nonideal frequency to voltage conversion. The user than has an option to trade off response time and output ripple content. Response Times (10-90%) from 0.25 to 5 Seconds are possible.

Power Supply-

The power supply consists of a split primary/dual secondary transformer, two rectifier bridges with power filters, and three regulators which provide the operating bias voltages for the various circuitry within the Series 164. In addition, a +16 Vdc voltage at 20 mA is provided for excitation of remote signal conditioners if desired.

The transformer primary is jumper programmable for operation at either 115 Vac or 230 Vac. Transient suppression is provided by surge suppression MOV's.



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TITLE: BLOCK DIAGRAM
MODEL 164

HOFFER FLOW CONTROLS, INC. CODE 33321

DWG NO. 164-601 REV

SCALE NONE SHEET 1 OF 1

SECTION V

Trouble Shooting and Maintenance for Series 164

In case of an inoperable or malfunctioning system, the following procedurers can be used to isolate the faulty wiring, printed circuit board and/ or other causes.

A recommended spare parts list is given immediately following this trouble shooting section.Recommended spare parts for the flowmeter are listed in the flowmeter manual and are also available from the manufacturer.

Factory consultation is available to assist in diagnosing problems. Note that in some cases factory repairs can be performed more easily than can be accomplished in the field since repair and replacement of components mounted on printed circuit assemblies is beyond the exposure of most individuals who will be servicing this equipment.

To test the Model 164 requires the use of a digital multimeter, a frequency generator and a frequency counter. The required test setup is the same as that discribed in Section IV.

Hoffer offers a number of low cost test accessories for testing Rate Indicators and flow totalizers. These items should be considered for those individuals who do not have the recommended test equipment at this time. Contact the application group at Hoffer for a discussion of the benefits offered by these low cost trouble shooting aids.

Proper operation of the 164 may be assumed when:

a. With power applied to the unit the displays are lit.

b. Injecting a test frequency signal equal to F(max) results in the expected display R(max)

c. Injecting a test frequency signal equal to F(max) results in a a analog output equal to Set(span).

d. Injecting a test frequency signal results in a Pulse Output signal of the anticipated voltage drive levels.

e. The appropriate excitation voltage is available for use by the Remote Signal Conditioner (If present).

f. With no flow present, the display indicates 0000 and the analog output is equal to Set(zero).

g. With flow present, the indicator and analog output function as expected without excessive display bounce or analog output ripple over the flow range (frequency range) expected by the application.

Problem Diagnosis and Corrective Action-

OBSERVED CONDITION	CORRECTIVE ACTION
Unit repeatedly blows fuses to it	1. Inspect wiring for conformity to installation requirements 2. Verify fuse size 3. Trouble shoot PCA-90 Assembly.
Unit Indicates Flow on no flow conditions	1. Noise pickup is present. Turn "Sens." control C.C.W. untill zero reading is obtained 2. Input wiring error or bad pickup correct,repair, or replace 3. Display zero drift occured. Null display with Display Zero Adjust. 4. Trouble Shoot PCA-90 Assembly
Unit displays 0000 with flow present	1. Input Wiring Error or bad pickup or signal conditioner. Correct, repair or Replace. 2. Turn "Sens." C.W. 3. Unit not setup correctly. See Section III. 4. Malfunction. Trouble shoot PCA 90
Unit inaccurate at low flow rates	1. Noise present. Check grounds and shields. Adjust "Sens.". 2. Flowmeter out of linear range or requires maintenance.
Objectionable Display bounce	1. Use Display response select swithes to minimize bounce 2. Pulsating Flow is really present, install surge tank
Objectionable Analog Output Ripple	1. Adjust Analog Damping to minimize ripple 2. Check grounding and shielding 3. Pulsations in flow are really present, install surge tank
Display Segment Failure or Malfunction suspect	1. Try switching on display test on PCA-85. If O.K. 1888 will be displayed. 2. Trouble shoot PCA 85 and 90

Voltage Output Malfuction	1. Check for shorts on output wiring. Correct as required. 2. Load resistance to low. 3. Trouble shoot PCA-90
Current Output Malfunction	1. Check wiring for open circuits Correct as required. 2. Input Resistance to high on recieving device. 3. Trouble Shoot PCA-90
Pulse Output Malfunction	1. Check wiring to pulse output 2. Verify correct jumper options are equipped on PCA-90 3. Verify recieving device 4. Trouble Shoot PCA-90
Opto-Isolator Input Does not work properly	1. Verify Wiring and polarity of Input Pulse 2. Input wave form duty cycle not 30/70 to 70/30 3. Input drine levels not 3-30 V 4. Trouble Shoot PCA-90 5. Random noise comimg in on magnetic pickup input. Turn Sens. 20 turns C.C.W.
Magnetic Pickup Input does not work properly	1. Check Input Wiring 2. Turn "Sens." C.W. 3. Inadequate Signal Level 30 mVp-p minimum 10 to 2500 Hz. 4. Input signal waveshape not of compatible waveform 30/70 to 70/30 duty cycle 5. Trouble Shoot PCA-90
BCD Output Malfunction	1. Check Operation with output wiring removed. Verify Wiring 2. Trouble Shooting PCA 89 3. Trouble Shoot PCA-90
Indicator Inaccurate with HO Series Flowmeter	1. Check Setup of 164 2. Null display with no flow 3. Check for Noise Pickup. Adjust Sensitivity. 4. Inspect Flowmeter for damage. 5. Many fluid and installation factors may cause this. Contact Manufacturer.

Indicator Inaccurate with MF Series Flowmeter	1. Check setup of MF Linearizer 2. Check setup of 164 3. Check for noise pickup. Adjust Sensitivity 4. Inspect Flowmeter for damage. 5. Many Fluid and installation factors may influence accuracy. Check with manufacturer.
Indicator Inaccurate with HP Series Flowmeter	1. Check Insertion Deapth and allignment with pipe 2. Check calculations for meter factor and setup of 164 3. Check for noise pickup 4. Check for rotor damage 5. Many Fluid and installation factors influence accuracy. Contact Manufacturer.
LED Segments fail to light	1. Trouble Shoot PCA-85 2. Trouble Shoot PCA-90
Display and Analog Output decrease above certain flowrate with increasing flow	1. Display and Output overranged, recalibrate for higher range 2. MCP Signal Conditioner and Flowmeter overrange. Purchase Flowmeter of correct range. 3. Inadequate input signal level or unsuitable waveform or duty cycle.
Signal Conditioner Failure or Malfunction	1. See manual for specific model wiring and corrective action recommendations

Detailed Printed Circuit Assembly Trouble Shooting Aids for Technicians available from Hoffer

A. Schematic Drawings
   1. PCA-90-201
   2. PCA-85-201
   3. PCA-89-202

B. Component Lists
   1. PCA-90
   2. PCA-85
   3. PCA-89

C. Component Assembly Drawings
   1. PCA-90-401
   2. PCA-85-401
   3. PCA-89-402

D. Test Waveforms
   1. PCA-90
   2. PCA-85
   3. PCA-89

Model 164 Available Spare Parts List-

The specific spare parts list applicable to user will depend on the options the user has specified for his application. See the Model Numbering Guide in Section I for details.

Due to the limited modular construction of this product series the user is advised to simply purchase a spare unit to function as the spare part while a defective unit is being serviced.

The recommended spare parts list for the flowmeter may be found in the manual for the flowmeter or may be obtained from the manufacturer. General Items worthy to be considered are listed below. In addition, it is important to note that in most cases factory repairs may be made at a small fraction of the cost of purchasing a new system. All products made by Hoffer are factory repairable.

The following list presents a number of the most frequently requested items applicable to this model.

Partial Available Spare Parts List

Parts Number	Discription	Quality
PCA-90	Main PCA with analog outputs	1
PCA-85	Display Subassembly	1
PCA-89	BCD Output Option Subassembly	1
	Pickup Coil	1
	Flowmeter Electrical Connector	1
	Flowmeter Signal Conditioner	1
	Lens	1
	Bezel	1
	Enclosure	1
	Mounting Bracket Set	1
	Card Edge Connector	1
	Spare Cable Set	1