

**AM49
AC-DC
Linear Integrating
Amplifier**



Validyne ENGINEERING CORPORATION

INSTRUCTION MANUAL

AM49 PLUG-IN AC-DC LINEAR

INTEGRATING AMPLIFIER

FOR

THE MC1 SYSTEM

SN EFFECTIVITY 0193-2 (1-50)

2/77
Rev. 5/78

P.O. BOX 9025 • NORTHRIDGE • CALIF. 91328 • (213) 886-8488 • Telex No. 65-1303

WARRANTY

VALIDYNE ENGINEERING CORPORATION warrants equipment of its own manufacture to be free from defects in material and workmanship under normal conditions of use and service.

VALIDYNE will repair or replace any component found to be defective on its return to VALIDYNE within the time specified below:

1. Pressure Transducers and Pressure Transmitters (including transducers supplied as part of Digital Manometer Systems) within three (3) years of its original purchase.
2. Electronic products (Transducer indicator, carrier demodulators, plug-in signal conditioners, module cases, etc.) within one (1) year of its original purchase.

Buyer is requested to secure authorization of VALIDYNE, and to describe defect prior to return of equipment under warranty. Shipment to VALIDYNE shall be at Buyer's expense, with return at VALIDYNE's expense. NON-VERIFIED problems or malfunctions whether warranty or not are subject to a \$80.00 evaluation charge.

The warranty carries no liability, either expressed or implied, beyond our obligation to repair or replace, at VALIDYNE's option the unit which carries the warranty to the original purchaser. Prices, specifications and designs subject to change without notice. This warranty is void if the product is subjected to misuse, accident, neglect or improper application, installation or operation.

REPAIR POLICY

Units returned to VALIDYNE for repair which are not under warranty will be subject to the following conditions.

1. A description of the problem or malfunction shall accompany the unit returned for repair, or be communicated to VALIDYNE prior to shipment. Otherwise there will be a minimum evaluation and/or calibration charge of \$80.00.
2. Unit will be repaired automatically if charge is less than 65% of current list price unless other specific instructions are received. Above 65%, VALIDYNE will request authorization by buyer.
3. If quotation is required before proceeding with repairs, unit should be accompanied by paper so stating, or information communicated to VALIDYNE prior to shipment.
4. Buyer is to secure authorization and shipping method from VALIDYNE prior to return of equipment or shipment will be rejected. (Applies to Canada only)

REPAIR WARRANTY

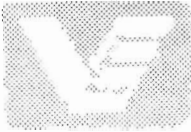
Warranty coverage on repairs is 90 days on work done, or to the end of the original warranty period, whichever is longest.



VESC120-8/88 REVISED

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MODEL AM49

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SECTION 1

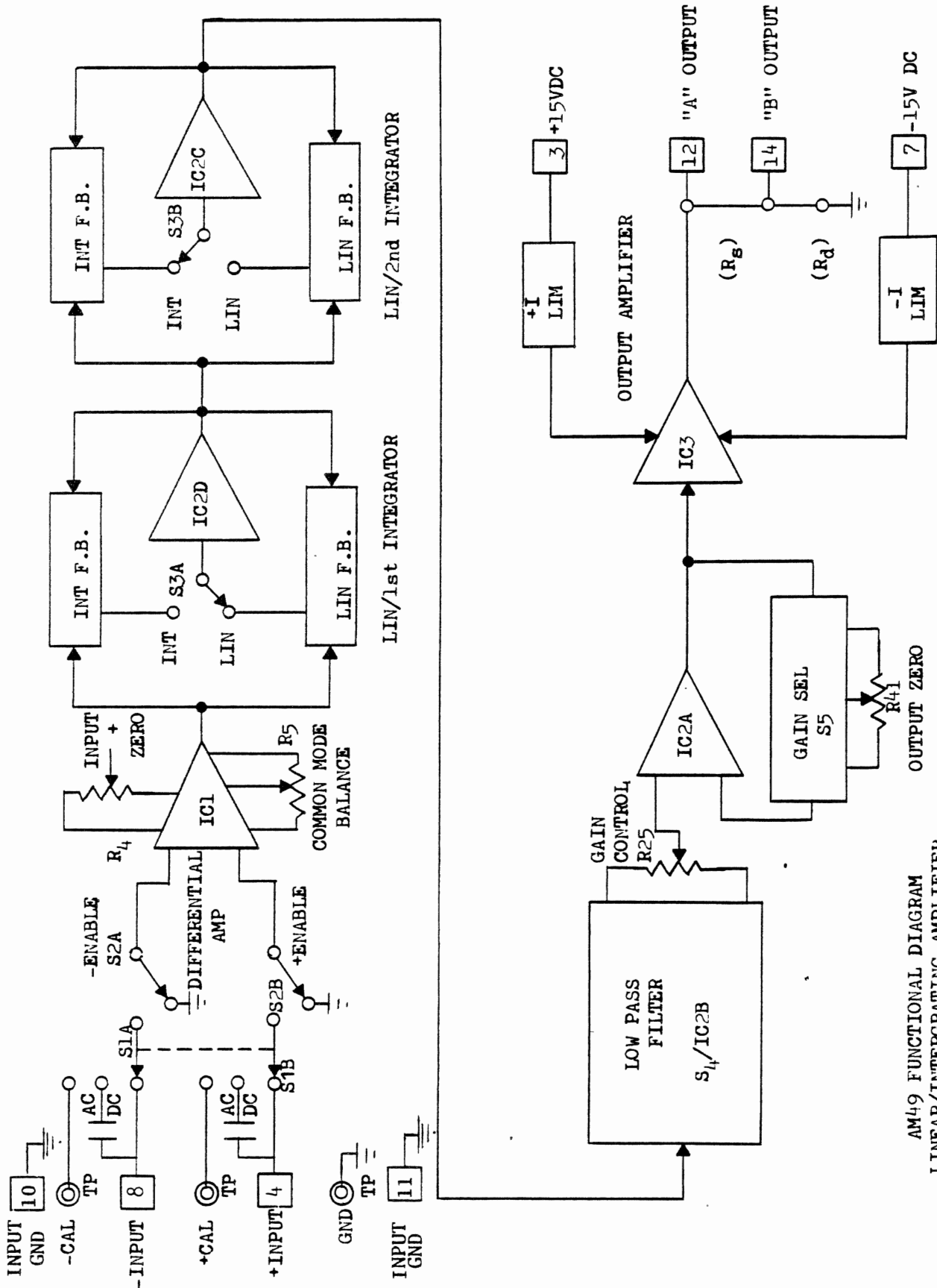
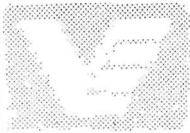
GENERAL DESCRIPTION

1.1 DESCRIPTION

The AM49 Linear/Integration Amplifier is a general multi-purpose plug-in module designed for use with the Validyne MC1 System. The unit is capable of operation in the following six (6) modes:

1. Single ended non-inverting AC or DC Linear Amplifier
2. Single ended inverting AC or DC Linear Amplifier
3. Differential input AC or DC Linear Amplifier
4. AC integrator, High Range
5. AC integrator, Low Range
6. AC double integrator

The MC1 Module Case provides the necessary DC operating voltages. The rear panel of the module case contains the input/output connectors for each plug-in channel.



AM49 FUNCTIONAL DIAGRAM
LINEAR/INTEGRATING AMPLIFIER

FIGURE 1

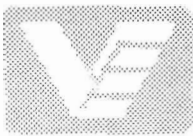


SECTION II

SPECIFICATIONS

2.1 ELECTRICAL SPECIFICATIONS

Gain Switch:	2.5, 5, 10, 25, 50, 100
Gain Potentiometer	10 to 110%, 10-turn calibrated dial
Frequency Response:	0 to 5kHz DC operation 2Hz to 5kHz AC operation
Filter Switch:	Low pass; 0 to 50, 100, 1000 and 5000Hz
Output:	Dual: A is $\pm 10V$ at 100ma B is derived from attenuator divider from A Output. Bifurcated terminals provided for easy field change.
Input Impedance:	2 Meg Ohm Differential 1 Meg Ohm + Input, 2 Meg Ohm - Input
Common Mode Input:	$\pm 10V$ Peak, $\pm 100V$ DC each side without damage
Integrator Time Constant: (T =RC)	#1 = .05 Seconds $\pm 5\%$ #2 = .02 Seconds $\pm 5\%$
Maximum Integrator Input: @ $f = 1/(2\pi RC)$	#1 = 10 V (Peak Sine Wave Input) #2 = 10 V (Peak Sine Wave Input)
Integrator Output:	#1 $E_{OUT} = \text{Selected Amp Gain} \times \frac{3.183E_{IN}}{f}$ #2 $E_{OUT} = \text{Selected Amp Gain} \times \frac{7.958 \text{ #1 OUT}}{f}$
Double Integrator Output:	$E_{OUT} = \text{Linear Amp. Gain} \times \frac{25.33E_{IN}}{f^2}$

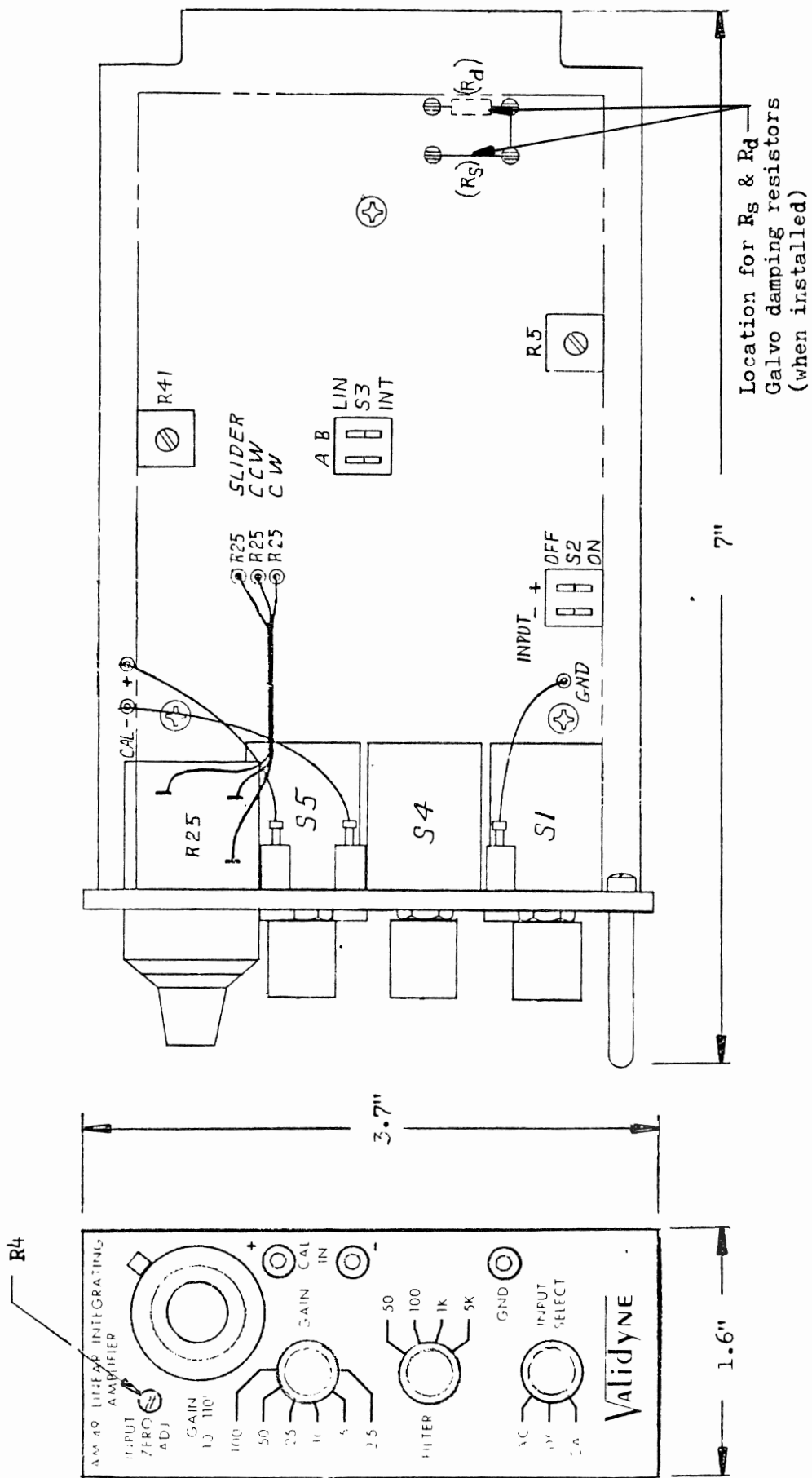


2.2 MECHANICAL SPECIFICATIONS (See Figure 2)

Front Panel Controls:	Multi-turn DC balance screwdriver adjust	R4
	10-turn calibrated gain potentiometer	R25
	AC-DC Calibrate Switch	S1
	4-position low pass filter switch	S4
	6-position gain switch	S5
	Plus and minus calibrate input jacks	

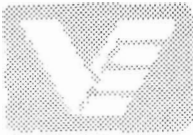
Signal ground jack

Behind the Panel Circuit Board Mounted Controls:	Linear - Integrated Switch #S3A & S3B	
	Plus enable on-off switch -S2B	
	Minus enable on-off switch - S2A	
	Common Mode Balance Adjustment - R5	
	.05 & .02 Sec. Integrator Calibration Controls - R8 & R15	
	Output Zero Adjustment - R41	



AM49 COMPONENT LAYOUT

FIG. 2



SECTION III

INSTALLATION AND OPERATION

3.1 INSTALLATION

The AM49 may be plugged-in to any channel of the MC1 Module Case and intermixed with any other Validyne plug-in units. All plug-in units have a common signal ground. Therefore, when interconnecting various plug-in units, it is not necessary to carry a separate ground lead.

3.2 INPUT-OUTPUT CONNECTIONS

The input/output connections are made to the connectors on the back panel of the MC1. Input is connected to the WK-4-32S connector, one for each channel.

- Pin 1 - Ground
- 2 - Plus Input to AM49
- 3 - Minus Input to AM49
- 4 - Ground

The output connectors are XLR-3 audio connectors, 2 for each channel. Pin connections are the same on both outputs.

- Pin 1 - Output
- 2 - System Ground
- 3 - Chassis Ground

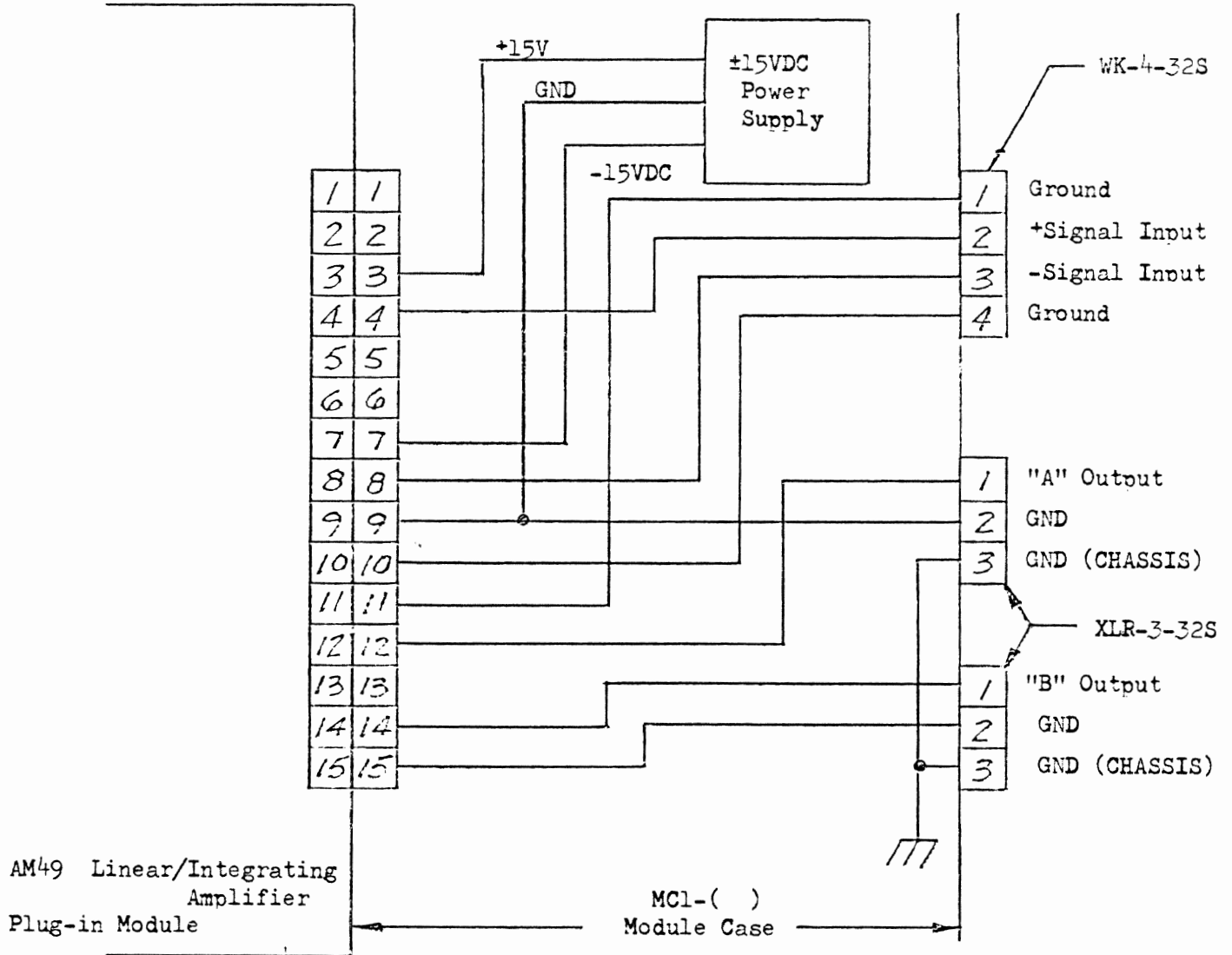


Figure 3
Wiring Configuration
AM49 to MCl Case



3.3 OPERATIONAL MODES

The AM49 has six (6) basic modes of operation or nine (9) actual operational conditions. They are:

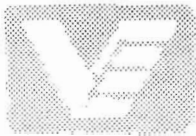
1. Single ended non-inverting AC/DC linear amplifier
2. Single ended inverting AC/DC linear amplifier
3. Differential input AC/DC linear amplifier
4. AC integrator, high range (second integrator)
5. AC integrator, low range (first integrator)
6. AC double integrator

Input Amplifier Stage See Figure 1

The input amplifier stage is configured as a differential amplifier to operate in one of three modes. The modes are Differential Input, Inverting Single Ended and Non-inverting Single ended. When operating as a differential amplifier, the two inputs are of opposite gain polarity with respect to the output. When operating as single ended inverting or non-inverting, either input may be referred to ground to accomplish the desired function.

Linear/Integrator Stage

The two integration stages are chosen so that the frequency dependent gain is different so as to produce a high gain and low gain integrator. The first integrator has a frequency dependent gain of approximately $\frac{3}{f}$ X selected front panel gain. The second integrator has approximately $\frac{8}{f}$ X selected gain. When operating as a double integrator, the gain is approximately $\frac{25}{f^2}$ X selected gain. When operating as a linear amplifier, the gain for each stage is 1. An integrator is an operational amplifier with feedback configuration that results in an output signal porportioned to the time integral of its input signal.



3.3 OPERATIONAL MODES (Continued)

Filter Amplifier

The filter amplifier is a non-inverting amplifier which has an input selector switch selecting one of four low pass filter ranges of 50Hz, 100Hz, 1kHz and 5kHz.

Gain Amplifier

The gain amplifier is a non-inverting amplifier with a variable input potentiometer and a feedback selection switch which can practically select and adjust output gain from .25 X input to 110 X input with the output of the total package being limited to 10V.

Output Amplifier

The output amplifier is an inverting amplifier with current limiting protection. Outputs "A" and "B" are identical in the standard package.

The switch positions and input connections for the various modes of operation are as follows:

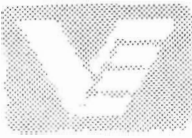
Type 1 - Single ended non-inverting AC or DC amplifier.

Step A: Front panel AC/DC/CAL switch to appropriate position. \pm enable switches select to position, S2B-On, S2A-Off. S3A and S3B to Linear Position.

Step B: Connect input signal to Pin 2, and input signal return to pin 1 or 4 of WK4.

Step C: Adjust front panel gain switch and gain potentiometer to obtain desired output level.

The maximum peak input signal that will not cause overloading of the input amplifier is ± 10 volts.



3.3 OPERATIONAL MODES (Continued)

Type 2 - Single ended inverting AC/DC linear amplifier.

Step A: Front panel AC/DC/CAL switching to appropriate position.

± enable switches select to S2B-Off, S2A-On. S3A and S3B to Linear position.

Step B: Connect input signal to Pin 3, signal ground to Pin 1 or 4 of WK4 connector on MC1 rear panel.

Type 3 - Differential Input AC/DC Linear Amplifier:

Step A: Front panel AC/DC/CAL switch appropriate position. ± enable switches S2A and S2B to "ON", S3A and S3B to Linear Position.

Step B. Connect differential input signals to Pins 2 and 3 WK-4 connector on MC1 rear panel. Pin 2 is plus. Pin 3 is minus.

Step C: Same as Type 1.

Type 4 - #2 AC Integrator

Step A: Front panel AC/DC/CAL switch S1 to DC position. ± enable switches to S2B-On, S2A-Off, S3A Linear, S3B Integrate.

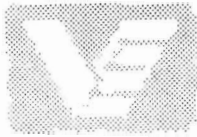
Step B. Connect input signal to Pin 2, signal ground to Pin 1 or 4 of WK-4 connector on MC1 rear panel. The output of AM49 will be a non-inverted integral of the input signal. The integrator time constant will be approximately .02 seconds.

Type 5 - #1 AC Integrator

Step A: Front panel AC/DC/CAL switch to DC position. ± enable switches to S2B-Off, S2A-On, S3A Integrate, S3B Linear.

Step B: Connect input signal to Pin 3, signal ground to Pin 1 or 4 of WK4 connector on MC1 rear panel. The output will be the inverted integral of the input with the integrator time constant approximately .05 seconds.

Step C: Same as Type 1.



3.3 OPERATIONAL MODES (Continued)

Type 6 - AC Double Integrator:

Step A: Front panel AC/DC/CAL switch to DC position. S2A-ON, S2B-OFF, S3A and S3B Integrate.

Step B. Connect input signal to Pin 3, signal ground to Pin 1 or 4 of WK4 Connector on MC1 rear panel. The output of the AM49 will be the inverted second integral of the input signal.

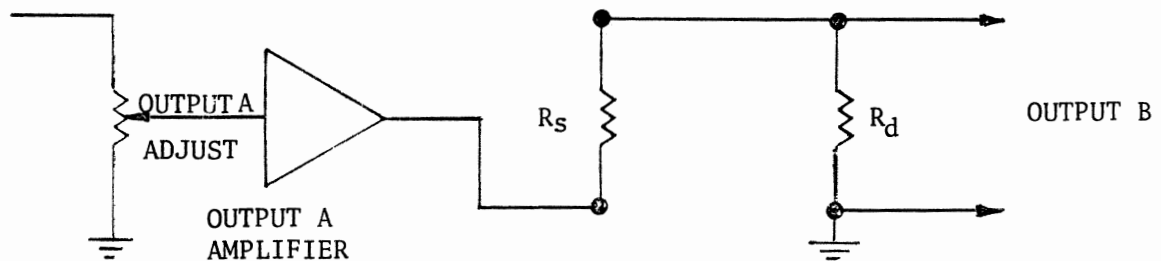
Step C: Same as Type 1.

With DC operation, the sum of the DC and the peak AC voltage on the input should not exceed ± 10 Volts. With AC operation, the DC component on the input should not exceed ± 100 Volts, with a signal of ± 10 Volts peak.

3.4 OSCILLOGRAPH GALVANOMETER OPERATION - OUTPUT B

3.4.1 Output B is designed to drive most commercially available galvanometers. It is capable of providing 100 ma maximum into a 100 ohm load and has an open circuit voltage of 10 volts. Terminals are provided for mounting damping resistors to obtain optimum galvanometer characteristics. (See Figure 2)

3.4.2 Referring to Figure 2, the R_s and R_d (damping resistor) terminals are arranged schematically as follows:





3.4 OSCILLOGRAPH GALVANOMETER OPERATION - OUTPUT B (Continued)

As the output impedance of the amplifier is negligible for all practical purposes, a resistor in the R_S terminals will provide damping for most high frequency fluid damped type galvanometer applications. That is:
 R_S = specified damping resistor from the galvanometer manufacturers galvo-performance specifications.

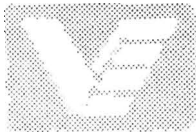
It is recommended in general, that the value of R_S never be lower than 50 ohms. If a damping resistance of less than 50 ohms is required, it is recommended that a value for R_D be calculated to obtain the correct damping:

$$R_D = \frac{50 R_D}{50 - R_D} \quad \text{Where } R_D = \begin{array}{l} \text{required galvo} \\ \text{damping resistance} \end{array}$$

Then, $R_S = 50$ ohms and $R_D =$ calculated value

For low frequency magnetically damped type galvanometers a high source impedance or R_S resistance will be required to obtain the proper galvo current and deflection control.

Using a value of $R_S = 100K$ ohms the value of R_D will, for all practical purposes, be equal to the required galvo damping resistance. Thus,
 $R_S = 100K$ ohms $R_D =$ specified galvo damping resistance. Increasing R_S will decrease the deflection. Doubling R_S will decrease the deflection approximately 50%. Decreasing R_S will increase the deflection in a like manner.



SECTION IV

PRINCIPLES OF OPERATION

4.1 PRINCIPLES OF OPERATION

The AM49 is comprised of five (5) basic sections. They are: Differential Amplifier Input, Linear/Integrator Stages, Selectable Low Pass Active Filter, Gain Amplifier, and Output Buffer Amplifier.

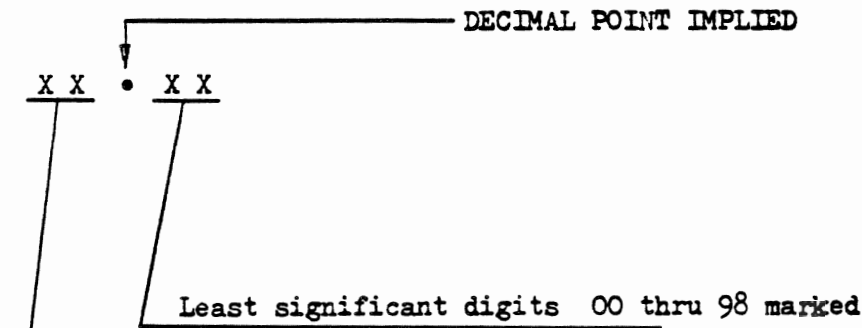
Referring to Schematic #7249 and Figure 1, 1C1 is a balanced input amplifier to provide for differential input operation. Either input of 1C1 can be grounded depending on whether inverting or non-inverting operation is desired. 1C2D is the first stage of the linear integrator operating section. 1C2C is the second half of the linear/integrator section. In the linear positions, each amplifier has unity gain when operating as a single ended amplifier.

AC or DC operation is selected by the front panel switch, S1. In the integration mode either 1C2C or 1C2D may be converted to integrating amplifiers by switches S3A and S3B. In the double integration mode, both integrators are being operated as integration amplifiers as selected by S3A and S3B. Switch S7 selects the appropriate capacitors for the low pass active filter operation. R25 is the calibrated front panel gain potentiometer. S5 selects the feed-back resistor for the various gain positions. 1C3 is an inverting amplifier. R4 adjusts the offset voltage of 1C1 and is accessible through the front panel to adjust the overall DC balance of the AM49 so that zero input voltage produces zero output voltage. R5 is a common mode balance adjustment.

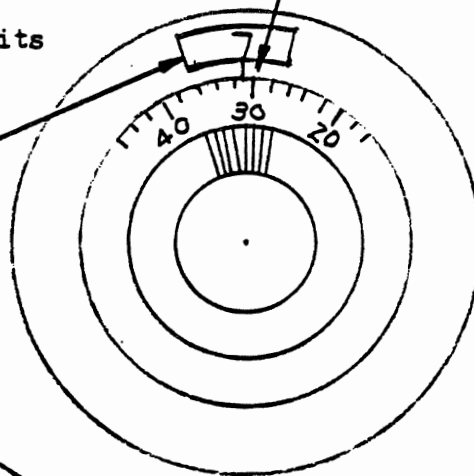


Calibration and Adjustment

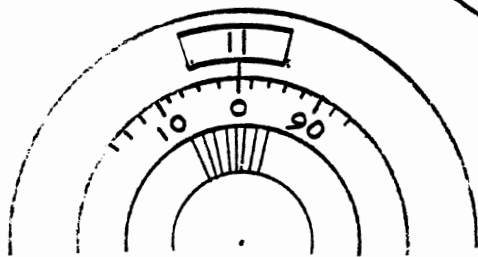
The following sketches are provided to exhibit the convention established for the setting of the Digital dial vernier control. All readings are considered correct, however one must be consistent when interpreting dial settings.



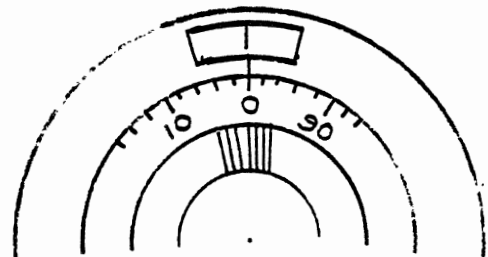
Most significant digits reads (0-14 normal) some stops are set at 1 & 11.



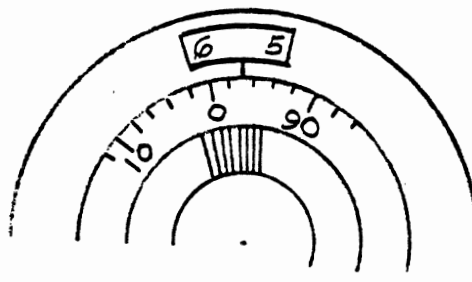
Reading = 731
or 7.31
or 73.1%



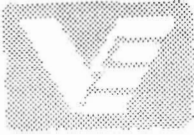
Reading = 1100
or 11.00
or 110%



Reading = 100
or 1.00
or 10%



Reading = 597
or 5.97
or 59.7%



SECTION V

CALIBRATION

5.1 CALIBRATION

Calibration of the AM49 is factory set and should not require re-calibration. The following procedures are presented for customer use when resetting controls resulting from questionable data from one of the many modes of operation is required.

AM49 Null Procedure

Use an extension cable from the MC1 case to the AM49. A digital type volt meter, or equal, and a stable 1 volt source will be required for the test verification.

A. Preset

1. Gain Pot to 10 (100%)
2. Lo pass filter to 5K
3. Gain switch to 100
4. S1 to DC
5. S3A and S3B to linear
6. S2A and S2B to off (which shorts inputs to GRD)

B. Remove cable from transducer input connector on MC1 rear panel.

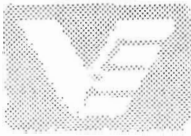
DC-Null Adjustment

1. Adjust DC bal pot R4 for 0.000VAC at Pin 6 of 1C1
2. Adjust R41 for 0.000VDC at output "A" (Pin #2 of WK4 connector on rear of MC1 rear chassis).

AM49 Type 1 Operation (Calibration Input)

A. Preset

1. Set gain pot to 5 (50%)
2. Lo pass filter to 1K
3. Gain switch to 10



5.1 CALIBRATION (Continued)

AM49 Type 1 Operation (Calibration Input)

4. S1 to Cal
5. S2A to OFF, S2B to On
6. S3A and S3B to Linear

B. Connect input signal to +Cal and signal ground to ground of amplifier test jacks on front panel.

Verify with a known (say 1VDC) input that output has a gain of 5 times input. Now verify that output can be controlled by gain potentiometer on front panel.

For further testing use same approach. To verify switch positions, refer to Paragraph 3.3 on Modes of Operation.



REPAIR

Validyne products, as a function of their basic design, do not require periodic re-calibration or maintenance, as such. If abnormalities in performance occur which cannot be corrected by calibration and adjustment procedures, the unit should be returned to the factory, transportation PREPAID, for evaluation and repair.

Turn around time will be improved when, along with a brief statement about the malfunctions or performance degradation, information regarding purchase order date and number are enclosed with the instrument.

An estimate of repair costs, if necessary, will be provided prior to commencement of work.

Warranty repairs will be handled as outlined in Validyne Engineering Corporation's Warranty Policy contained elsewhere in this manual.

Address all shipments and correspondence regarding returned units to:

Validyne Engineering Corporation
8626 Wilbur Ave.
Northridge, California 91324

Attention: Customer Returns Group

1

REVISIONS
 DATE: 12/21/61
 BY: J. H. B. / J. H. B.
 C. REVISED 1 REPAIRMAN
 10 25 50 10 25 50

DATE: 12/21/61	BY: J. H. B. / J. H. B.
C. REVISED 1 REPAIRMAN	
10 25 50 10 25 50	
HIGHEST REF DES USED	
REF DES NOT USED	
Validyne Engineering Corporation	
33107	
SCHEMATIC, AMPLIFIER	

The schematic diagram shows a differential amplifier circuit. It features two input channels, each with an input switch (S1, S2-A, S2-B) and a zero-adjust potentiometer (P1, P2). The inputs are connected to a differential amplifier stage using two 741 op-amp chips (IC1, IC2). The circuit is powered by a +15V supply (pin 3) and a -15V supply (pin 7). Various resistors (R1-R44) and capacitors (C1-C20) are used for biasing, feedback, and compensation. The output is taken from pin 12 (A-OUTPUT) and pin 14 (B-OUTPUT).

OPTIONAL EXTERNAL CHASSIS GROUND

13

OUTPUT ZERO ADJ

NOTES:

- INDICATES CIRCUIT BOARD CONNECTOR PIN NUMBER.
- POLAR CAPACITOR ARE ±10%.
- CAPACITOR VALUES ARE IN MICROFARADS.
- RESISTORS = ±1% / 1/8W METAL FILM.
- * = FRONT PANEL ACCESS PARTS.

UNLESS OTHERWISE SPECIFIED.