TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

(INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

DC VOLTAGE CALIBRATOR

JOHN FLUKE MODELS 332B/AF, AND 332B/D

This copy is a reprint which includes current pages from Changes 1 and 2.

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OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL, INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST: DC VOLTAGE CALIBRATOR, JOHN FLUKE MODELS 332B/AF AND 332B/D (NSN 6625-00-150-6994)

MODEL 332B/AF ADDENDA

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INTRODUCTION

The Model 332B/AF is a special version of the Model 332B. Subsequently, much of the information in the Model 332B Instruction Manual is directly applicable. Any differences in the Model 332B/AF are described in this Addenda.

SPECIFICATIONS

Electrical and mechanical specifications are identical except as follows:

Accuracy of Output

Accuracy specifications apply after one hour warm-up at standard reference conditions of 23 (±)°C, up to 90% relative humidity, constant line voltage, and constant load.

Relative Humidity

0 to 90%

Input Power

115/230V ac ±10%, 50 to 60 or 400 Hz, single phase. Approximately 130 volt amperes under full load.

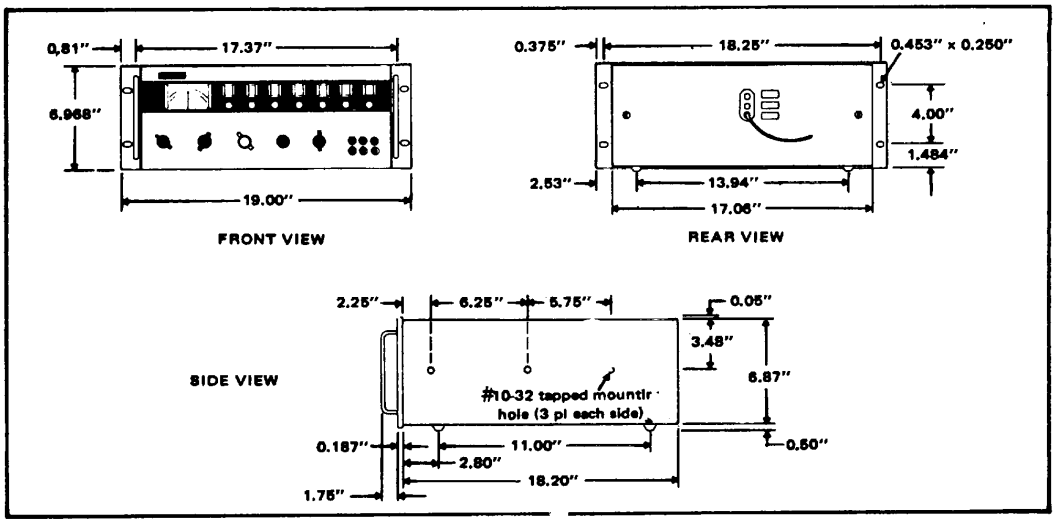

Figure 1. MODEL 332B/AF OUTLINE DRAWING

OPERATING INSTRUCTIONS

Operation of the Model 332B/AF is identical to the Model 332B.

THEORY OF OPERATION

The following descriptions are for assemblies peculiar to the Model 332B/AF. All other assemblies are described in Section III of the Model 332B manual. Schematic diagrams for the Model 332B/AF assemblies are located at the rear of this Addenda.

Voltage Control Circuitry

REFERENCE SUPPLY. The master reference voltage for the instrument is produced in the A5A1 Reference Supply (Schematic No. 332B/AF-1083). This assembly consists of a +15V dc reference supply, an oven temperature regulator for the reference supply, and divider networks for compensation of offset voltages when the output is set to zero.

The Reference Supply is composed of differential amplifier U2 and zener reference amplifier A1. The reference amplifier is enclosed in an oven which maintains a constant temperature for environmental stability. Selection of the values of R7A and R7B scales the output of the Reference Supply to +15V dc. Variable resistor R9 allows adjustment of the resulting V_{REF} output. Temperature coefficient of the base/emitter voltage for A1 is accurately matched to the zener element through selection of R13. The resulting stable reference at the collector of A1 is applied to the noninverting input of U2. The other input to U2 receives an equivalent voltage from the divider composed of R14 and R15. Any change in VREF is sensed at the base of A1 and the resulting amplified change applied to the noninverting input of U2. This change then alters the conduction of U2 such that VREF is maintained at +15V dc. Constant operating temperature for the reference amplifier A1 is provided by the Oven Temperature Regulator Q1, U1, and oven R21. The series-pass regulator composed of Q1 and U1 establishes a constant voltage across the heater, R21. Any variations in heater voltage is sensed by U1 and amplified. The resulting output of U1 ther alters the conduction of Q1 to maintain a constant voltage across the heater, R21. The heater element of R21 consists of a semiconductor material which has moderate conductivity at temperatures below a specific stabilization point and a marked decrease in conductivity as the temperature approaches the stabilization point. Application of a constant voltage to R21 provides a fast warm-up and a much more stabile operating temperature. The dividers composed of R1 through R6 provide a bias voltage to one input of the A5A4 Chopper Amplifier. R2, R4, and R6 are adjusted to compensate for offsets in the 10V, 100V, and 1000V ranges when the output is set to zero.

SAMPLE STRING. The A2 Sample String (Drawing No. 332B/AF-1051) together with the selected range resistor in the A4 Range Cal forms a resisting divider whose ratio is controlled by the front panel decade dials. The output voltage of the Sample String is proportional to the reference voltage multiplied by the ratio of the Sample String resistance to the A4 range resistance.

RANGE RESISTORS. The A4 Range Cal (Drawing No. 332B/AF-1052) provides three separate adjustable range resistors. These resistors together with the A2 Sample String form a resistive divider which determine the output voltage of the instrument.

CHOPPER AMPLIFIER. The A5A4 Chopper Amplifier (Drawing No. 332B/AF-1058) compares low frequency and dc control signals from the A2 Sample String output to the +SENSE terminal voltage and amplifies any difference. The circuitry consists of an input filter, a MOSFET chopper, an operational amplifier, a synchronous demodulator, an output filter, and a multivibrator.

Low frequency and dc control signals at terminal 6 are passed through the input filter C2, R1, and C3 to reject frequencies above 30 Hz. The MOSFET chopper Q1 modulates the signal appearing at the junction of its drain and R2. C4 couples the resultant to the gate of JFET Q2. The output signal at the drain of Q2 is then amplified by the operational amplifier IC1, which has a gain of approximately 420. The paraphase amplifier Q3 amplifies the output of IC1 and provides two equal amplitude, but 180° out-of-phase signals. The collector signal of Q3 is coupled by C16 to the shunt demodulator Q4. The resulting demodulated signal appearing at the junction of C17 and R24 is filtered by R24, R26 and C18, leaving only the amplified dc and low frequency signals. The emitter signal of Q3 is applied through C14, R21, C15, R25, R23, and C22 to C18, where it is used to cancel any chopper ripple at 270 Hz.

The 270 Hz multivibrator is formed by Q6, Q7 and associated timing networks, in addition to a driver Q5. Variable resistor R43 adjusts the level of the signal applied to the driver Q5, and subsequently the output signal applied to the gate of Q1. The collector signal of QS is applied to the drain of Q1 to compensate for spikes coupled between

the gate and drain. Variable resistor R34 provides adjustment of the compensation signal. An output signal at the collector of Q7 is applied to the base of Q4, which synchronously demodulates the Chopper Amplifier output.

SERIES PASS. The A7A1 Series Pass (Drawing No. 332B/AF-1061) contains the series-pass transistors which control the output voltage. It also contains a voltage controlled oscillator (VCO) and control amplifiers which are part of the preregulator, a power supply, and an automatic "crowbar" driver.

The power supply composed essentially of CR1 through CR4 produces the required operating voltages for the Series Pass circuitry. AC voltage at terminals 8 and 9 is rectified by CRI through CR4 to provide an unfiltered positive voltage. This voltage is isolated by CR5 and filtered by C2 to provide a +150V dc operating voltage for the series-pass transistors. The voltage divider of RI through R3 and zener CR6 produces a clipped, full-wave rectified 16V synchronizing signal for the VCO.

Output voltage of the instrument is established and maintained by the series-pass transistors, Q1 through Q8. The transistors Q1 through Q7 are normally saturated and Q8 is absorbing the total voltage required to maintain the output of the instrument. However, when the output level or load current is changed and the voltage across Q8 exceeds 150V, Q1 through Q7 absorb the additional voltage. The preregulator circuitry then reduces the output of the A7 H.V. Mother Board until the voltage across Q8 is less than 150V. When this condition is reached, Q1 through Q7 again saturate and Q8 absorbs the total regulation voltage.

The automatic "crowbar" consisting of Q10 monitors the total voltage drop across the series-pass transistors. Load or output changes that cause the voltage across the series-pass to exceed 225V will cause Q10 to conduct. Its conduction energizes K2 on the A7 H.V. Motor Board and places a load across the high voltage rectifier, thus limiting the voltage across the series-pass transistors.

Unijunction transistor Q9 and C3, L3, R37, CR18, R35, and CRI9 form a VCO which furnishes turn off pulses to the preregulator circuitry. This VCO is synchronized to the ac line zero crossing through amplifiers Q11 and Q12.

A clipped 16V pulse is rectified by CR32 and C5 to provide operating voltage for the base of the VCO, Q9. This voltage is clamped to zero during the ac line zero interval by amplifiers Q11 and Q12. The divider composed of R36 and R42 provides a sample of the clipped 16V pulse at the base of Q12. When the pulse is at OV, Q12 produces an amplified positive pulse at its collector. This pulse is differentiated by C4 and R41 and the resulting positive spike momentarily turns on Q11. Conduction of Q11 clamps the output of rectifier CR32, C5 to zero, thus synchronizing the output of Q9 to the ac line zero crossing. The output pulses from Q9 are dependent upon the voltage charge on C3. The voltage is sensed across Q8 through the divider consisting of L3, R37, R35, CR18, and CR19. If this voltage increases. Q9 will produce a preregulator turn off pulse earlier in the ac line cycle, thus reducing the ac power available to the A7 H.V. Mother Board. Conversely, should the voltage across Q8 decrease, the ac power to the A7 H.V. Mother Board is increased.

PREREGULATOR. The A7A2 Preregulator (Drawing No. 332B/AF-1082) controls the ac power supplied to the instrument by passing only enough power to the A7 H.V. Mother Board to meet the output load requirement. It consists of a ±V supply, a relay power supply, preregulator control drivers, a preregulator bridge, and a current limiter.

±V and +10V dc operating voltages are produced for the A7A2 Preregulator by the rectifier CR1 through CR4 and associated components. A 10V ac input is applied to CR1 through CR4. The dc output at the junction of CR2 and CR4 is filtered by C3 to provide a -V operating voltage. The dc voltage at the junction of CR3 and CR1 is heavily loaded by R1 to provide an unfiltered +V operating voltage. This voltage is also isolated through CR5 and filtered by C4 to provide a +10V dc operating voltage.

Operating voltage for relay K1, which supplies ac voltage to the preregulator bridge, is produced by bridge rectifier CR6 through CR9 and K2. AC return for the bridge rectifier is provided through the contacts of K2. This relay is energized only in the OPR mode by a control voltage from the A5A2 Series Pass Driver. The A5A2 Series Pass Driver automatically removes the control voltage from K2 should a VOLTAGE TRIP occur, thus removing ac power to the preregulator bridge and establishing a STDBY condition.

The circuitry consisting of Q2 through Q9 controls the conduction of the preregulator bridge altenuator, Q1. Input pulses from the VCO in the A7A1 Series Pass are supplied to terminal 14 and the base of Q7. The first pulse turns on Q7 and Q6, which through regenerative action, saturate. This condition turns off Q5 and causes Q4 and Q8 to also turn off. Q9 is subsequently turned on by the -V collector voltage of Q8 and provides a negative voltage at the base of
Q2.