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INSTRUCTION MANUAL

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MODEL 400SD/SP

PRECISION POWER
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ELGAR

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Elgar Corporation warrants each instrument it manufactures to be free from defects in material and workmanship. The corporation's obligation under this warranty is limited to servicing the instrument and replacing defective parts. This warranty is effective for one year after delivery of the instrument to the original purchaser. Defects caused by improper operating conditions, misuse, negligence, or the alteration or removal of the nameplate, will void the warranty. Elgar Corporation shall in no circumstance be liable for any direct or consequential loss or damage of any nature resulting from the malfunction of the instrument. This warranty is effective in lieu of any or all other obligations or liabilities on the part of Elgar Corporation, its agents, or representatives.

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COMPLETION OF THE 400SD OR 400SP MODEL NUMBER

"THREE DIGIT OPTIONS CODE"

400SD- 1 1 1

MODEL 400SD OR 400SP

First digit:

0 - No external programming

1 - External resistance programming
0 to 13K ohm for 0 to full scale

2 - External voltage programming
0 to 10VDC for 0 to full scale

3 - External voltage programming
0 to 13VDC for 0 to 130V output

4 - External voltage programming
0 to 26VDC for 0 to 260V output

5 - External resistance programming
0 to 10K ohm for 0 to 130V output

Second digit:

0 - No remote sense with servo control

1 - 1 Phase remote sense with servo control

2 - 2 Phase remote sense with servo control

3 - 3 Phase remote sense with servo control

4 - 3 Phase open DELTA

5 - 3 Phase open DELTA remote sense with servo control

6 - Local front panel control for output range change

Third digit:

1 - 0 to 130V output of power source

2 - 0 to 260V output of power source

3 - 0 to 32V output of power source

4 - 0 to 65V output of power source

5 - Frequency range of 400SD extended
to 15Hz to 10KHz

6 - 15Hz to 5KHz extended range

7 - 45Hz to 10KHz extended range

Note that options -001, -002, -003 and -004 have no impact on the 400SD or 400SP oscillators themselves and are only used for general clarification of the power amplifier and oscillator combinations.

<u>SAMPLE MODEL NUMBERS:</u>

401SD-111	Single Phase, resistance program, servo control 0-130V output
403SP-400-402	Three Phase, fixed 400Hz, voltage programming 0-26VDC, no servo control, 0-260V output
403SD-103	Three Phase, resistance programming, 0-13K ohms, no servo control, 0-32V output
401SD-002	Standard oscillator with no options indicating that the accompanying power amplifier jumpered for the 0-260VAC output voltage.

Refer to Section I for operational descriptions of optional features.

SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 The Series 400SD variable frequency oscillators are plug-in units which provide variable frequency signals for the Elgar AC Power Sources. The frequency is determined by four decade switches on the front panel.

1.1.2 The Series 400SP oscillators are plug-in units which provide fixed frequency signals for the Elgar AC Power Sources. The frequency may be changed by setting DIP switches internal to the oscillator.

1.1.3 The output amplitude of the 400SD or the 400SP is uncalibrated and is adjusted by the gain potentiometer on the front panel of the associated power source.

1.2 SCOPE OF MANUAL

1.2.1 This manual describes the Elgar Series 400SD and Series 400SP oscillators. It includes specifications, operating instructions, circuit descriptions, circuit diagrams, maintenance information and parts lists.

1.3 GENERAL DESCRIPTION OF OPERATION

1.3.1 The 400SD oscillator plugs into the front panel of the Elgar power source and is secured by two captive screws. Frequency output of the Model 400SD is controlled by four decade switches and a X1, X10, X100 frequency range switch. The decimal for reference is silkscreened on the oscillator front panel between the center two decade switches. Frequency resolution is 1 part in 10,000.

The frequency limit LED on the front panel of the oscillator will light if a frequency below 44 Hz or a frequency above 5100 Hz is selected. If this occurs, the output of the oscillator will drop to zero. When a proper frequency is selected, the Limit light will go out and the oscillator output will rise at an exponential rate to full output in about 250 milliseconds.

1.3.2 The 400SP oscillator plugs into the front panel of the Elgar Power Source and is secured by two captive screws. Frequency output is controlled by two 8 position DIP switches which are internal to the oscillator. These are inverted logic, thus the off position of the switch enables the bit. The code for these switches is shown in Figure 1-1. The Range is set by a jumper which is also shown in Figure 1-1. The X1 to Com sets the 45 to 99.99 Hz range, the X10 to Com sets the 45 to 999.9 Hz range and the X100 to Com sets the 45 Hz to 5 kHz range.

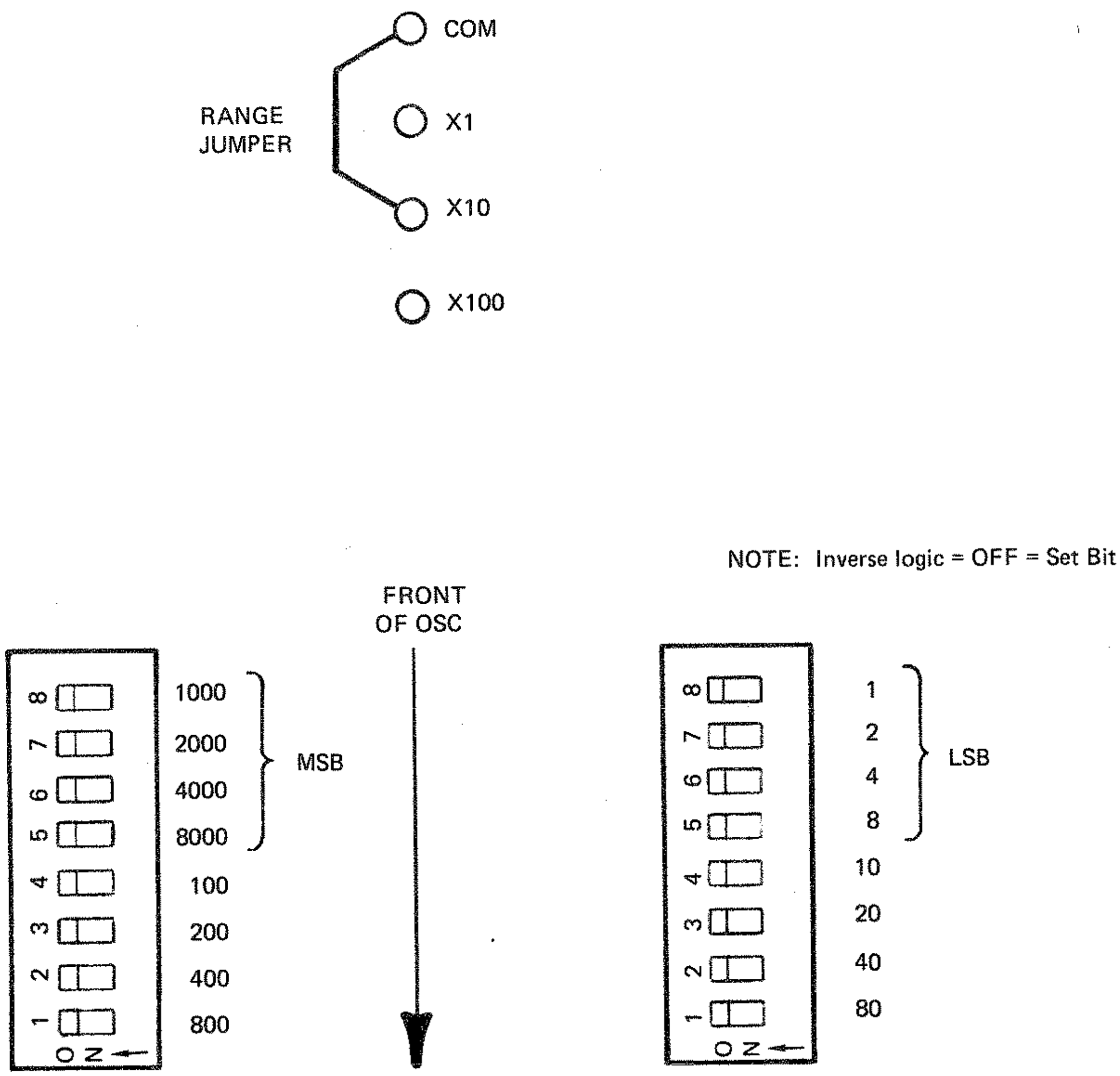
COM
RANGE JUMPER
X1
X10
X100
NOTE: Inverse logic = OFF = Set Bit
FRONT OF OSC
8 7 6 5 4 3 2 1
ON
1000
2000
4000
8000
MSB
100
200
400
800
1
2
4
8
LSB
10
20
40
80

Figure 1-1

1.4 RESISTANCE PROGRAMMING

1.4.1 When the Model 400SD/SP has been equipped for resistance programming, the output amplitude of the power source may be varied by changing the value of an external resistor connected between Pins 7 and 8 of connector J1 on the rear of the power source. The value of this resistor is 100 ohms per volt on the 130V output range and 50 ohms per volt on the 260V output range. The associated power source will have the Gain knob removed and a shaft lock installed. This potentiometer now becomes the full scale calibration and R8 in the oscillator is 10% of scale calibration. Note: In the Model 400SD these calibrations will be affected by changing frequency.

1.5 VOLTAGE PROGRAMMING

1.5.1 When a Model 400SD/SP is equipped for voltage programming, the output of the power source may be controlled by a positive input voltage applied to Pin 6 with common to Pin 1 of J1 on the rear of the power source. The associated power source will have the Gain knob removed and a shaft lock installed. This is the full scale adjustment for voltage programming and may be set so that +10 volts equals 130V out or where +13V equals 130V out. This also applies to the 260V output range where +10V equals 260V or +26 equals 260V out. The 10% of the FS adjustment is R8 on the oscillator.

1.6 TANDEM OPERATION

1.6.1 All model 400SD/SP are equipped for tandem operation. Pins 9 and 14 of the oscillator are connected together.

1.7 SPECIFICATIONS

1.7.1 Specifications for the Series 400SD/SP are listed in Table 1-1.

TABLE 1-1. SPECIFICATIONS

Output Signal Amplitude	Approximately 2V RMS
Harmonic Distortion	Less than 0.25% of oscillator output 45 Hz to 5 kHz
Frequency Accuracy	±0.001% of set value
Temperature Coefficient:	
Of output frequency	±0.0003%/°C
Of output amplitude	±0.02%/°C
Frequency Ranges	X1 Range 45 Hz to 99.99 Hz X10 Range 45 Hz to 999.9Hz X100 Range 45 Hz to 5000 Hz*
MODEL	OUTPUT CONFIGURATION
401SD/SP	1 Phase
402SD/SP	2 Phase
403SD/SP	3 Phase

*In Series 400SD this will be set to conform with upper full power frequency limit of associated power source and can be disabled for operation to 9999 Hz.

SECTION II
PRELIMINARY INSPECTION AND OPERATION

2.1 INSPECTION UPON RECEIPT

2.1.1 The Elgar plug-in oscillators are aligned, calibrated, and tested prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure the instrument has suffered no damage during shipment.

2.1.2 Make a visual inspection of the shipping container prior to accepting the package from the carrier. If extensive damage to the shipping container is evident, a description of the damage should be noted on the carrier's receipt, and signed by the driver or carrier agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier and all shipping containers and filler material saved for inspection. Forward a report of damage to the Elgar Service Department, who will provide instructions for repair or replacement of the instrument.

2.1.3 Visually inspect instrument for physical damage when it is removed from shipping container. Test functional operation of instrument as soon as possible. If damage is evident, or instrument does not function properly, notify the carrier immediately. Carrier's claim agent will prepare a report of damage to be forwarded to the Elgar Service Department. You will be advised as to the action necessary to have the instrument repaired or replaced.

2.2 INSTALLATION

2.2.1 The oscillator is quickly and easily installed by plugging it into the space provided on the front panel of the Elgar power source. When the oscillator is fully inserted, and the captive screws secured, the unit is ready for operation.

NOTE

Remove power from amplifier when installing oscillator.

2.3 OPERATION

2.3.1 After installation in the Elgar power source, the oscillator operates automatically, receiving its power from the power source and requiring only that the front panel controls be set for the desired frequency and range. The amplitude of the power source output is controlled by the AMPLITUDE control on the front panel of the power source.

2.4 INTERCONNECTIONS FOR TWO OR THREE PHASE OPERATION

2.4.1 Three-phase oscillator may be installed directly in Elgar three-phase power sources without special connections. Where two-phase or three-phase power sources are made up by stacking two or three of the Elgar single-phase power sources, the oscillator is installed in the A-phase power source. Oscillator signals are carried to the B-phase and C-phase power sources through a cable (furnished with the oscillator) interconnecting the Jones S312AB sockets on the rear panels of the power source. The B-phase and C-phase sources must have Model 400B and 400C dummy plug-ins installed to complete the signal interconnection. The front panel AMPLITUDE control on the A-phase power source acts as a master control to vary all the outputs simultaneously, while the B-phase and C-phase AMPLITUDE controls act merely as balance controls to set the B-phase and C-phase output voltages equal to the A-phase output voltage.

2.4.2 With those single-phase Elgar power sources which have dual output windings, two power sources may be interconnected for three-phase wye operation. One of the output windings on each of the A-phase and B-phase sources is used for the A-phase and B-phase outputs. The C-phase output is sythesized by inverse series connection of the remaining two windings, as diagrammed in Figure 2-1.

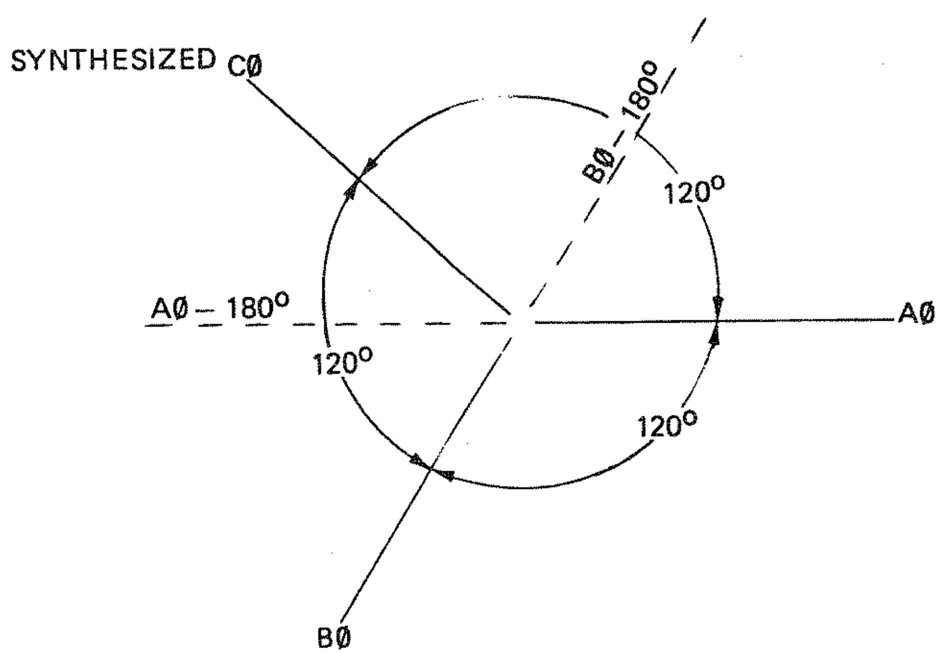

Figure 2-1. 2 Amplifier 3Ø Wye Configuration

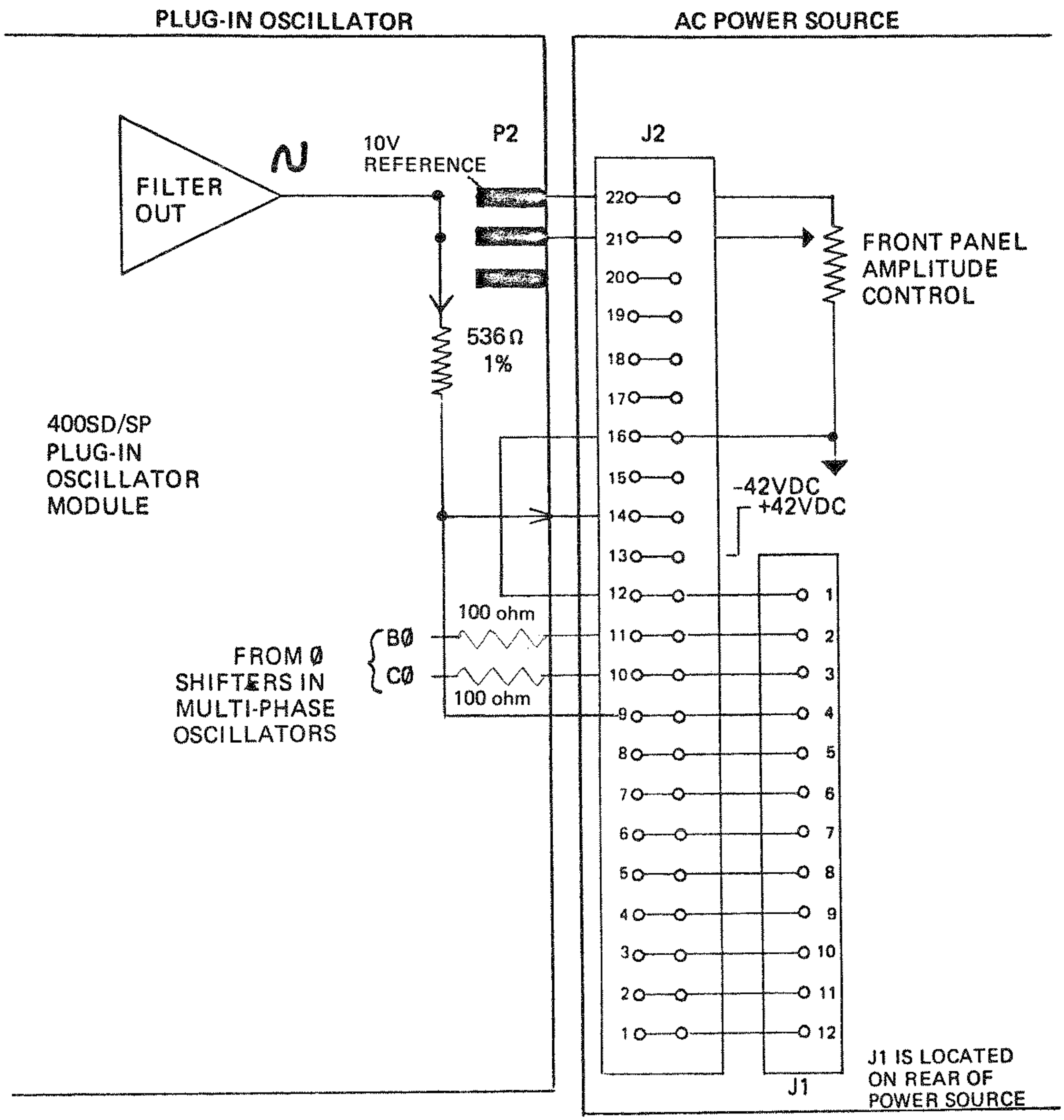

Figure 2-2. Typical Plug-in Oscillator/Power Source Interconnection

SECTION III
THEORY OF OPERATION

3.1 OSCILLATOR CIRCUIT

3.1.1 The oscillator output contains 1024 bits or steps per cycle which have been synthesized from a fixed 10.24 MHz crystal oscillator. This gives a frequency accuracy of 0.001%.

3.1.2 The synthesis starts with the 10.24 MHz crystal oscillator which drives the Rate Multipliers U1, U2, U4 and U5. These rate multipliers will produce an output at U3B pin 8 which is proportional to the formula: Output equals crystal frequency divided by the quantity 10,000 multiplied by the BCD input from the switches. As an example: If the switches are set to 4000, the output at U3 pin 8 will be 4.096 MHz.

3.2.3 The frequency Range is controlled by U13A, U13B and S7. S7 allows direct through, divide by 10 or divide by 100 of the Rate Multiplier output. In the example of 4.096 MHz out of the Rate Multipliers, if we use the divide by 10 position of the switch S7, we will have 409.6 kHz to U10 pin 5.

3.1.4 Binary counters U10,U11 and U12 are up/down counters which are counting up only. U10 and U11 are counting by 256 for each quarter wave of the output signal and U12 is counting by 4 for each full cycle of the output frequency. This is a total count of 1024 per output cycle. Thus in the example the 409.6 kHz is counted to 400 Hz in the output.

3.1.5 The outputs of the binary counters are controlled by exclusive OR gates U6 and U7 which, when controlled by U12 pin 3, create the equivalent of an up/down drive to U9.

3.1.6 Integrated circuit U9 is a 256 by 8 Prom which has been programmed with a sine look-up table. When the address input lines are driven by U6 and U7, it will produce the digital output code for a sine table.

3.1.7 The digital outputs of the sine Prom drive multiplying digital to analog converter (DAC) U14. When U14 is thus driven, it will put out a current waveform which is proportional to the digital input multiplied by the reference current input through R52.

3.1.8 The current waveform out of DAC U14 is converted to a voltage waveform by amplifier A1B. This waveform will be a series of half wave, positive going signals. See timing diagram Figure 3-2 waveform B. This series of half wave signals is fed to amplifier A1A.

3.1.9 Amplifier A1A is an invert/noninvert amplifier with a gain of one. When enhancement mode FET Q3 has a positive on the gate, the source to drain resistance is very low. Thus if Q3 is on, pin 3 is shorted to common and the circuit is a normal inverting operational amplifier. Conversely, when Q3 is off, A1A will act as a non-inverting operational amplifier. Thus when waveform A of timing diagram (Figure 3-2) is applied to Q3 in synchronization with the analog signal of waveform B, the result will be the sine wave of waveform C on the output. This is filtered by the two pole filter of A2A and becomes the A phase output.

3.2 MULTI-PHASE OPTION

3.2.1 On the phase board, U1 is a Prom with a cosine look-up table. This is driven by the same address lines as is the sine prom of the basic oscillator. Thus the generation of the D phase, or -90° phase is done in the same manner as the A phase.

3.2.2 Differential amplifier A5B takes the difference of the -90° phase and the A phase and produces a B phase which is +240 degrees from the A phase.

3.2.3 Amplifier A6B takes the +240° B phase and the 0° A phase and produces the difference which is the C phase at +120°.

3.3 FREQUENCY DETECTOR CIRCUIT (Model 400SD only)

3.3.1 Each half wave of the output frequency will cause U8 pin 6 to produce a narrow plus going spike. This will retrigger U15B which is a retriggerable monostable multivibrator. So long as the frequency is high enough, U15B will never time out. When the output frequency drops below 45 Hz, U15B will time out and U16B will clock in this information. When U16 is set, the front panel LED FREQUENCY LIMIT LIGHT will come on and the reference voltage will shut down which in turn shuts down the oscillator. When the frequency is selected back into limit, Q1 will turn off and the reference voltage will rise at the rate set by R14 and C8. This causes a soft-start of the power source.

3.3.2 The high frequency limit works in the opposite manner to the low frequency limit. Monostable multivibrator U15A must time out before the next pulse or the frequency is too high. If U15A has not timed out, the next pulse from U8 pin 6 will clock U16A and it will in turn, drive Q1 into the limit condition shutting down the oscillator output.

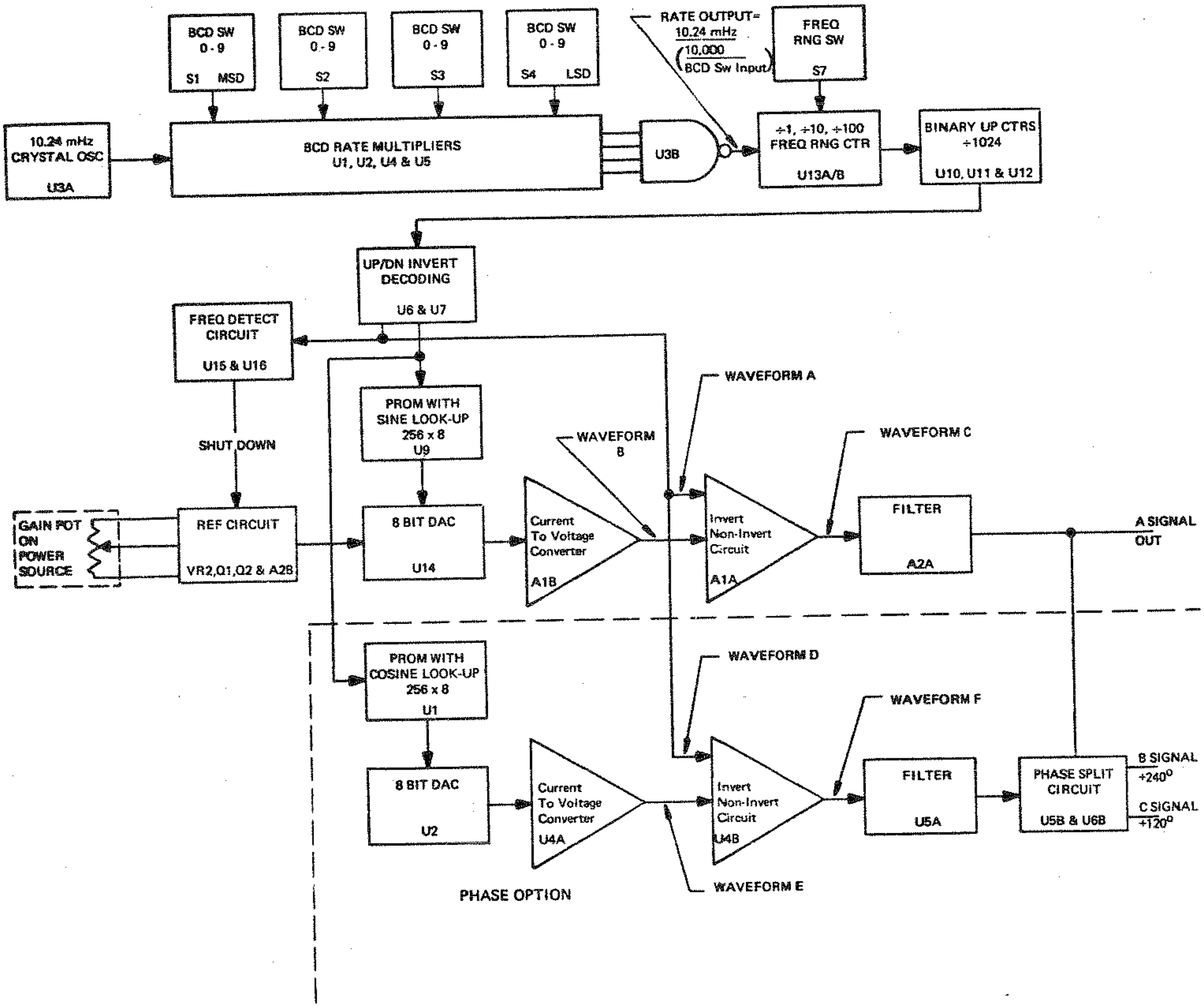

Figure 3-1. 400SD/SP Block Diagram

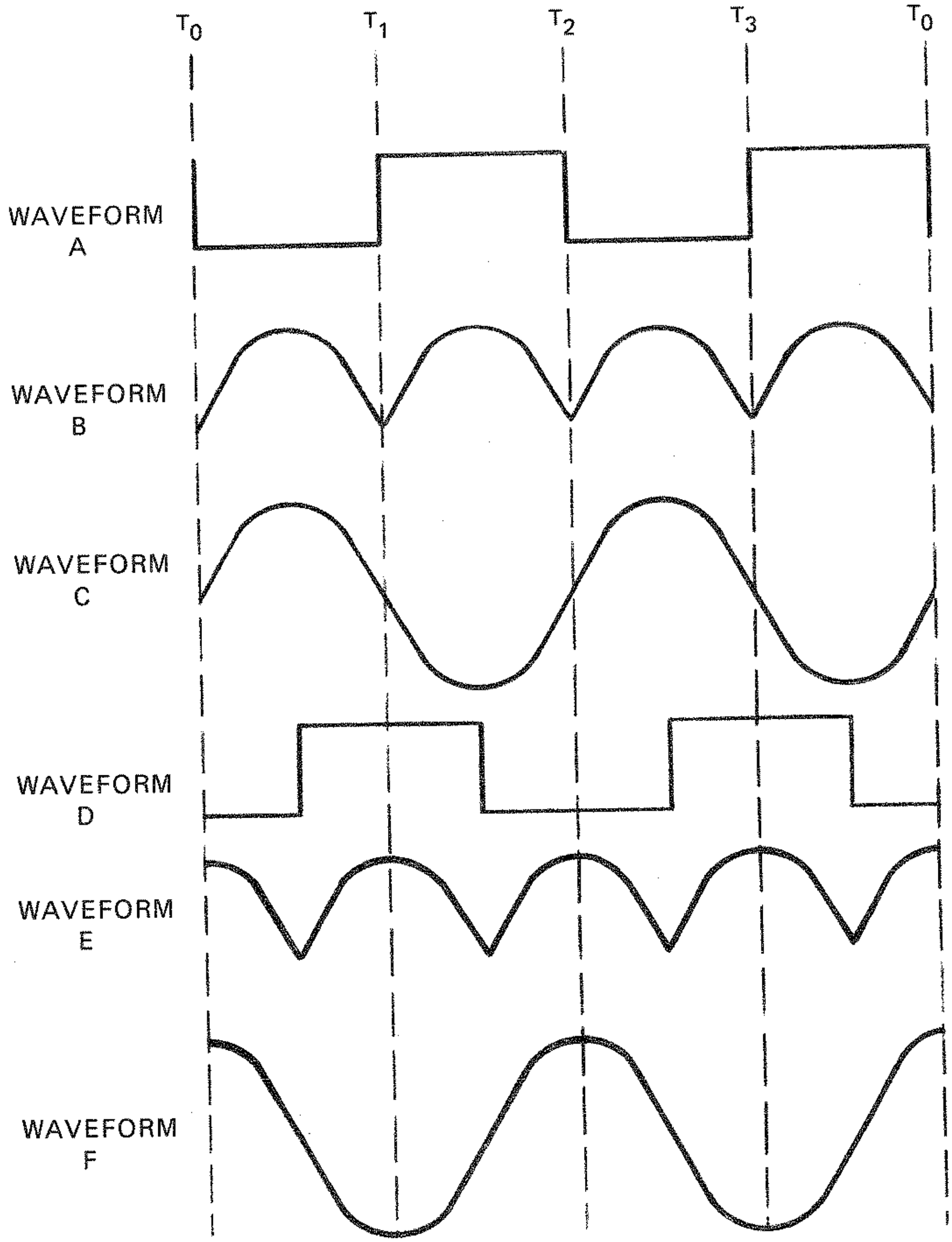

Figure 3-2. Timing Diagram

SECTION IV
MAINTENANCE

4.1 SERVICE INFORMATION

4.1.1 Questions concerned with the operation, repair or servicing of this equipment should be directed to the nearest Elgar representative or to the Service Department, Elgar Corporation, 9250 Brown Deer Rd., San Diego, CA 92121. Include model number and serial number in any correspondence concerning the instrument.

4.2 FACTORY SERVICE

4.2.1 Should it be necessary to return an instrument to the factory for repair, please contact the Elgar Corporation Service Department for authorization to make shipment. DO NOT RETURN THE UNIT FOR REPAIR WITHOUT AUTHORIZATION.

4.3 SHIPPING DAMAGE

4.3.1 It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be inspected and tested as soon a it is received. If the instrument shows signs of damage, notify the carrier immediately. The carrier's claim agent will prepare a report of damage to be forwarded to the Elgar Service Department. You will be advised as to the action necessary to have the instrument repaired or replaced.

4.4 SINGLE PHASE CALIBRATION

4.4.1 Single phase calibration for the 400SP is as follows:

1. Turn R10 fully counterclockwise and front panel Gain fully clockwise.

2. Turn S5-1 off and all other S5 and S6 switches on (sets 800 Hz).

3. Monitor A phase output with Distortion Analyzer (TP1).

4. Turn power on and adjust R10 so power source output is approximately 132V RMS.

5. Adjust R45 for minimum distortion output.

6. Adjust R51 for minimum distortion output.

4.4.2 Single phase calibration for the 400SD is as follows:

1. Turn R10 fully counterclockwise and front panel Gain fully clockwise.

2. Select 800 Hz on X10 range.

3. Monitor A phase output with Distortion Analyzer (TP1).

4. Turn on power and adjust R10 for approximately 132V RMS output.

5. Adjust R45 for minimum distortion output.

6. Adjust R51 for minimum distortion output.

7. Set oscillator to 45.00 on X1 range.

8. Turn R20 clockwise until front panel Freq Limit comes on, then turn counterclockwise until light just goes off.

9. Set Frequency to 51.00 on X100 range. Turn R17 counterclockwise until front panel Freq. Limit comes on, then turn clockwise until Freq Light just goes off.

4.5 PHASE BOARD CALIBRATION

4.5.1 Phase board calibration for the 400SD/SP is as follows:

1. Add phase board to tested 400SD/SP oscillator.

2. Set oscillator to 800 Hz and monitor phase board TP1 with Distortion Analyzer. Apply power.

3. Adjust R9 for minimum distortion output.

4. Adjust R10 for minimum distortion output.

5. Monitor main board TP1 with AC DMM and record reading (not required on recalibration).

6. Monitor phase board TP1 with AC DMM and adjust phase board R6 so reading is the same as recorded in previous step (not required on recalibration).

7. Set oscillator output frequency to 5 kHz (customer desired frequency in Model 400SP).

8. Connect phase angle meter with reference input to A phase TP1 and signal input to phase board TP1.

9. Adjust phase board C9 so phase angle is -90° (+270°).

10. Reduce oscillator frequency to 50 Hz. (Leave Model 400SP at customer desired frequency.)

11. Move phase angle meter signal input to C phase output.

12. Adjust R6 for +120 phase angle.

4.6 RESISTANCE PROGRAMMING CALIBRATION

4.6.1 Connect a 13K ohm precision resistor between pins 7 and 8 of J1 on rear of power source. Turn on power.

4.6.2 Adjust locking Gain potentiometer on front panel of power source for 130V RMS output.

4.6.3 Change 13K ohm resistor to a 1K ohm resistor and adjust R8 on oscillator for 10V RMS output.

4.6.4 Repeat steps 4.6.1, 4.6.2 and 4.6.3 as required to compensate for interaction of adjustments. Set lock on power source front panel Gain.

4.7 VOLTAGE PROGRAMMING CALIBRATION

4.7.1 Apply +10VDC* to pin 6 with common to pin 1 of J1 on rear of power source. Turn on power.

4.7.2 Adjust locking Gain potentiometer on front panel of power source for 130V RMS output.

4.7.3 Reduce +10VDC* to +1VDC* and adjust R8 on oscillator for 13V RMS output.

4.7.4 Repeat steps 4.7.1, 4.7.2 and 4.7.3 as required to compensate for interaction. Set lock on power source front panel Gain.

*The voltage programming may be calibrated where +13VDC equals 130V RMS or where +10VDC equals 130V RMS output. This is customers option and is only where locking Gain potentiometer and R8 are set.

4.8 CIRCUIT BOARD COMPONENT LOCATION

4.8.1 Component location diagrams are given for the basic oscillator (Figure 5-1) and for the phase option (Figure 5-2). Those components in Figure 5-1 which are marked 6 are used in the model 400SD only.

4.9 TEST EQUIPMENT REQUIRED

Distortion Analyzer	Krohn-Hite 6800 or equal
Digital Voltmeter	Fluke 8050A or equal
Phase Angle Meter	Dytronics 224 or equal
Frequency Counter	Hewlett Packard 5307A or equal

SECTION V
DIAGRAMS

5.1 GENERAL

5.1.1 This section contains the schematic diagrams for the Series 400SD/SP Plug-In Oscillators. The schematic diagrams should be used to understand the theory of operation and as an aid in troubleshooting the unit. Reference designators shown on schematics correspond to reference designators shown in parts lists where exact component values are given.

5.2 DIAGRAMS

5.2.1 Diagrams included in this section are as follows:

1. Schematic diagram for Model 400SD/SP main board.
2. Schematic diagram for Model 400SD/SP phase board.

5.2.2 The schematics in this section use ○ to indicate P2 connections from the oscillator to J2 in the power source and □ to indicate an interconnection from the oscillator main board to the phase board.