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ELGAR

PLUG-IN OSCILLATORS

SERIES 400

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SECTION I
INTRODUCTION AND GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. This manual describes the Series 400 plug-in oscillators manufactured by Elgar Corporation for use with the Elgar Power Sources. The manual contains installation, operation, maintenance instructions, circuit descriptions, circuit diagrams, and parts lists.

1-3. GENERAL DESCRIPTION

1-4. The Elgar oscillators are contained in a plug-in enclosure which can be inserted into the front panel opening of an Elgar Power Source. The plug-in enclosure contains a horizontally-mounted printed circuit board, and a terminal connector which mates with a similar connector in the power source. The 0.1% model is provided with a front panel access hole for a screwdriver frequency adjustment. The oscillators are available in 50, 60, and 400 Hz output frequencies, or any frequency from 45 to 10 kHz on special order.

1-5. PURPOSE OF EQUIPMENT

1-6. The Elgar Series 400 plug-in oscillators provide stable input frequency signals for the Elgar Power Sources. The plug-in provide frequency accuracy

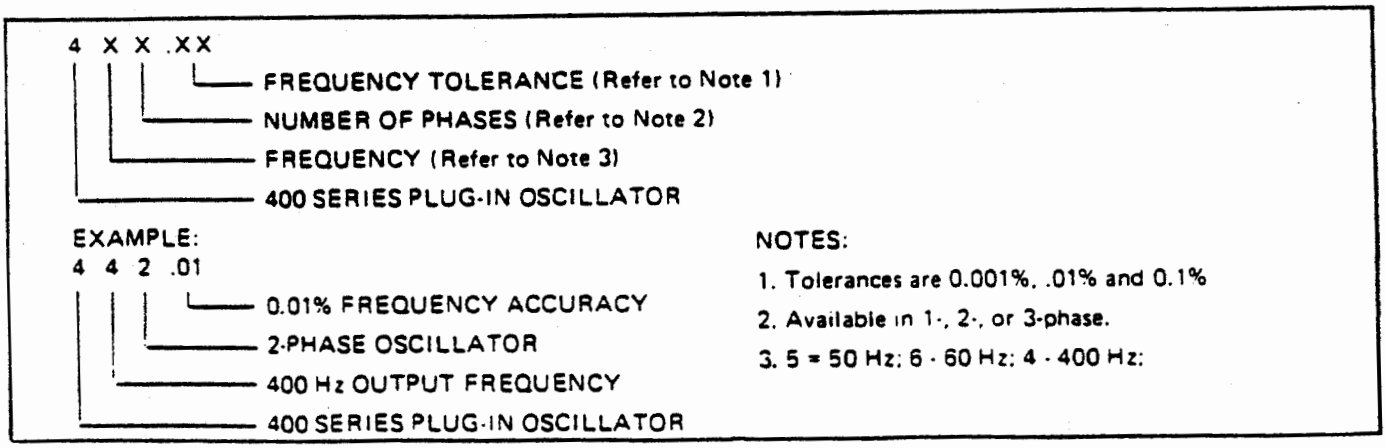


Figure 1-1. Model Numbering System

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of 0.1%, 0.01%, and 0.0001% (see Figure 1 for an explanation of model numbering). The 0.01% and 0.0001% oscillators use a crystal-controlled oscillator. In the 0.1% models, a square wave is generated by positive feedback around the filter to generate the basic frequency signal which is filtered in two series operational amplifier filters. Frequency adjustments may be made from the front panel.

1-7. In the 0.01% and 0.0001% models, the crystal oscillator output is divided through a series of integrated circuit flip-flops to obtain the desired output frequency. The output of the frequency divider flip-flops is filtered in two operational filters connected in series.

1-8. RESISTANCE PROGRAMMING

1-9. When an Elgar plug-in oscillator has been equipped for resistance programming of the output voltage of the AC Power Source, the model number will indicate so by including a "P" at the end of the number.

1-10. Resistance programming is accomplished by connecting an external resistor between pins 11 and 12 of connector J1, located on the rear panel of the AC Power Source. The value of the resistor is typically 100 ohms per volt, referenced to the output of the AC Power Source on the 0.0 to 130V range.

1-11. The external resistor is in fact taking the place of the feedback resistor in the operational amplifier circuit of the oscillator. It is important to know that during initial calibration this resistor must be matched to the input resistor of the operational amplifier to obtain a gain of 1. Once this is accomplished the front panel amplitude control may be rotated to the desired full scale output voltage on the AC voltage meter located on the front panel of the power source. The reading is typically 130V and in effect provides the 500 ohms per volt calibration.

1-12. TANDEM OPERATION

1-13. For all single phase Series 400 plug-in oscillators whose model number ends in a T (4X1.XXT) R115, a 475 ohm, 1% resistor and a jumper between pins 9 and 21 have been added for tandem operation.

1-14. For all two or three phase oscillators whose model number ends in a T (4X3.XXT) a jumper has been added between pins 9 and 21 for tandem operation. (Note: R115 is already present.)

1-15. The addition of the jumper between pins 9 and 21 enables the master A0 signal to also be routed to the slave unit allowing the system to be operated in the tandem configuration.

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SECTION II
INSTALLATION AN OPERATION

2-1. INTRODUCTION

2-2. 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 that the instrument has suffered no damage during shipment.

2-3. UNPACKING THE INSTRUMENT

2-4. 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, which will provide instructions for repair or replacement of the instrument.

2-5. Visually inspect the 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.

2-6. INSTALLATION

2-7. 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 Power Source when installing oscillator.

2-8. OPERATION

2-9. After installation in the Elgar Power Source, the oscillator operates automatically, receiving its power from the power source. The amplitude of

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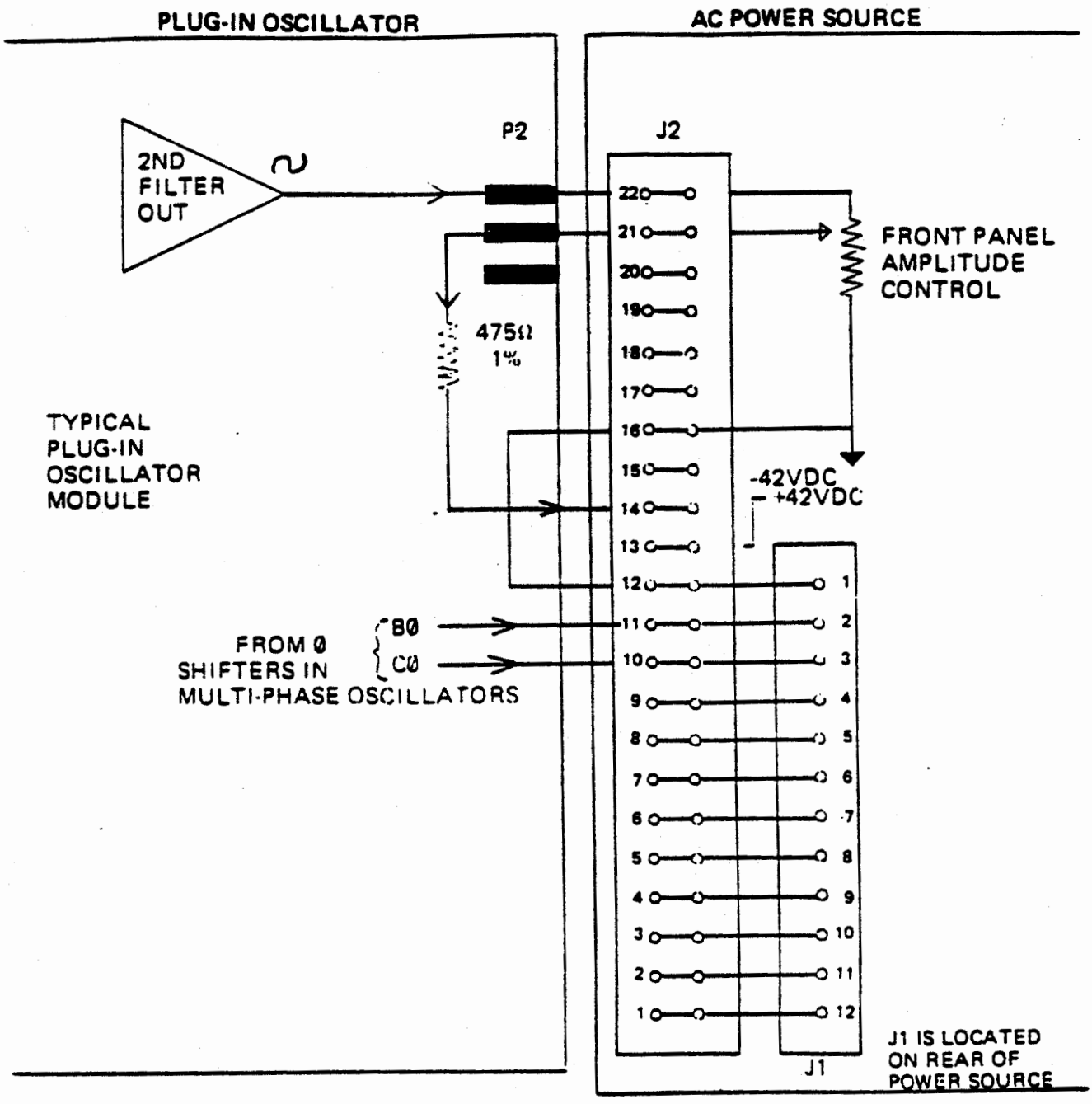


Figure 2-1. Typical Plug-In Oscillator/Power Source Interconnection

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of the power source output is controlled by the AMPLITUDE control on the front panel of the power source.

2-10. OPERATION WITH EXTERNAL SYNC

2-11. The .1% oscillators with model numbers ending in "ES" are equipped for external synchronization. The external sync signal should be approximately 10V peak-to-peak either sine or square wave. This signal is transformer isolated in the oscillator to avoid cross-grounding problems. The external sync terminals are connected to pins 11 and 12 of J1, on the rear panel of the Elgar Power Source. The phase angle between the power source output and the synchronizing signal is a function of the synchronizing signal amplitude and waveshape and the difference between the oscillator free-running frequency and the sync signal frequency. Figure 2-1 illustrates a typical plug-in Oscillator/AC Power Source Interconnection.

2-12. INTERCONNECTIONS FOR TWO OR THREE PHASE OPERATION

2-13. Three-phase oscillators may be installed directly in Elgar three-phase power sources without special connections. Where two-phase or three-phase power is 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 J1 sockets on the rear panels of the power source. The B-phase and C-phase power sources must have Model 400B and 400C signal routing plug-ins installed to complete the signal interconnections. The front panel AMPLITUDE control on the A-phase power sources acts as a master control to vary all the output 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.

2-14. 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 synthesized by inverse series connection of the remaining two windings, as diagrammed in Figure 2-2.

2-15. EXTERNAL SIGNAL

2-16. Single-phase 0.1% and 0.01% oscillators are equipped with a front-panel closed-circuit jack for external signal operation. A 2-3V RMS external signal may be introduced through a jack on the oscillator front panel. The closed-circuit jack automatically disconnects the internal signal. The front panel amplitude control is effective with the external signal connection.

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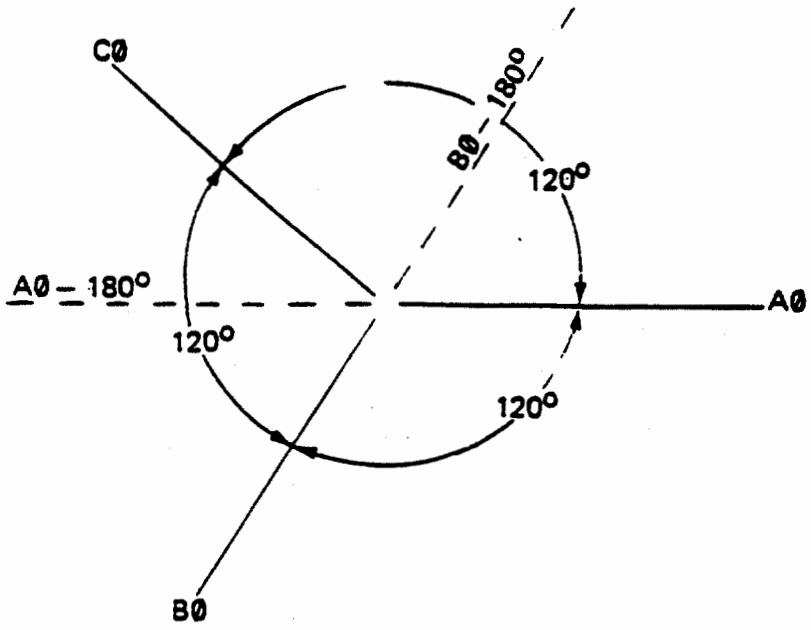


Figure 2-2. .2 Amplifier 3Ø Wye Configuration

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SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The Elgar Series 400 plug-in oscillators all use similar low voltage supplies and operational amplifier filters, and obtain operating power from the Elgar Power Source. The amplitude of the output signal for all units is controlled by an amplitude control potentiometer located on the front panel of the AC Power Source. The .1% models use a positive feedback square wave input to the operational amplifier filters. The .01% and .0001% oscillator contain a crystal-controlled oscillator and a frequency-dividing circuit formed by TTL integrated circuits. The output of the integrated circuits is a symmetrical square wave free from even harmonics.

3-3. .01% AND .0001% OSCILLATOR CIRCUIT DESCRIPTION

3-4. The .01% oscillators generate the output frequency by means of a crystal-controlled oscillator formed by Q111 and Q112. In .0001% oscillators this circuit is replaced with an oven-controlled oscillator module. Both oscillators operate at a frequency of 153.6 kHz. The square wave at the collector of Q112 or at the output of the oscillator module is then counted down to the operating frequency by integrated circuit counters Z106, Z107 and Z108. The square wave at the output of the counters is then used to drive Q113, operating as a saturated switch. T.C. zener diode CR103, connected from collector to emitter of Q113, limits the positive half cycle of the square wave to approximately +6.2V. The symmetrical square wave at the collector of Q113 is then taken to the input of the first active filter consisting of operational amplifier Z101 and filter-tuning components R122, R123, R124, C103 and C104. The output of Z101 is then taken to the input of the second active filter consisting of Z102 and tuning components R127, R128, R129, C105 and C106. Action of this two-section active low-pass filter is to remove harmonics from the square wave and thereby produce a pure sine wave at the output of Z102 whose amplitude is approximately 3V RMS. The active filters are tuned for a peak response at the operating frequency and have a total of 180° phase shift. Refer to the table at the bottom of Figure 5-4 for filter tuning values. Table 3-1 details Z106-Z108 for various output frequencies.

3-5. .1% OSCILLATOR CIRCUIT DESCRIPTION

3-6. .1% oscillators also operate by generating a square wave and then filtering it in a two-section action low-pass filter. However, in these oscillators the square wave is generated by positive feedback around the filter through a voltage comparator. Referring to Figure 5-2, the output of the second filter

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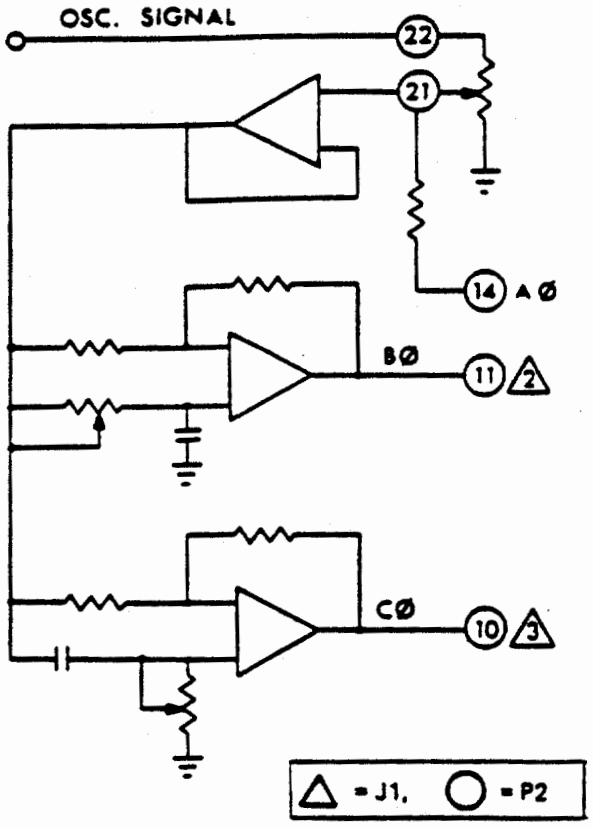


Figure 3-1. Two- and Three-Phase Circuit Block Diagram

TABLE 3-1. OUTPUT FREQUENCY, I.C. SELECTION

FREQUENCY	10	11	12
10 KHz	MC7490P		
9.6 KHz	MC7493P		
4.8 KHz	MC7493P		MC7493P
3.2 KHz	MC7492P		MC7493P
1.2 KHz	MC7493P		MC7493P
800 Hz	MC7492P		MC7493P
400 Hz	MC7492P	MC7493P	MC7493P
60 Hz	MC7490P	MC7493P	MC7493P
50 Hz	MC7492P	MC7493P	MC7493P

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drives the voltage comparator Z106 through R116. The square wave at the output of Z106 is limited to +6.2V by T.C. zener diode CR103. The square wave is then coupled to the two-section active filter whose operation is explained in Paragraph 3-4. above. R130 in the second active filter is used to adjust the frequency over a small number of cycles around the nominal output frequency. Initial frequency tuning is accomplished by factory-selected trim capacitors in the two active filters.

3-7. TWO-PHASE AND THREE-PHASE OSCILLATORS

3-8. In two-phase and three-phase oscillators, the oscillator signal from the AMPLITUDE control arm in the A-phase power amplifier is buffered by unity gain amplifier Z105 and applied to two operational amplifier all-pass phase shifters, Z103 and Z104. A block diagram of circuitry used to generate two- and three-phase signals is provided in Figure 3-1. In three-phase oscillators, the B-phase signal lags the A-phase signal by 120° and the C-phase signal lags the B-phase signal by 120°. In two-phase oscillators the B-phase signal lags the A-phase signal by 90° and the C-phase components are omitted. The B-phase and C-phase signals are connected through plug-in connector P2 to the 12-pin Jones S312AB receptacle, J1, on the rear of the A-phase power source. Interconnecting cables then carry these signals to the B-phase and C-phase power sources in stacked amplifier systems (see Figure 3-2).

3-9. The A-phase AMPLITUDE controls acts as a master control to control the amplitude of all three phases simultaneously. When single-phase power amplifiers are stacked for two- or three-phase power, the B-phase and C-phase amplitude controls are used only as balance adjustments to set the B-phase and C-phase outputs equal to the A-phase output.

3-10. OSCILLATOR POWER SUPPLIES

3-11. The oscillator circuitry is operated from plus and minus 15VDC regulated power supplies which are derived from the unregulated plus and minus 42VDC power supplies in the associated power source. In the plus 15V power supply, differential pair Q103 and Q104 compare the plus 15V regulated output to the reference voltage from CR102, developing an error signal to control compound-connected pass transistors Q101 and Q102. R102, R103, and CR101 ensure that the regulator starts when power is applied. R101 limits the fault current if the +15V output is accidentally shorted.

3-12. The minus 15V regulator, differential pair Q107 and Q108 develop the error signal by comparing the -15V regulated output to the regulated +15V. The error signal is used to control compound-connected pass transistors Q106 and Q107. R109 limits the fault current if the -15V output is accidentally shorted.

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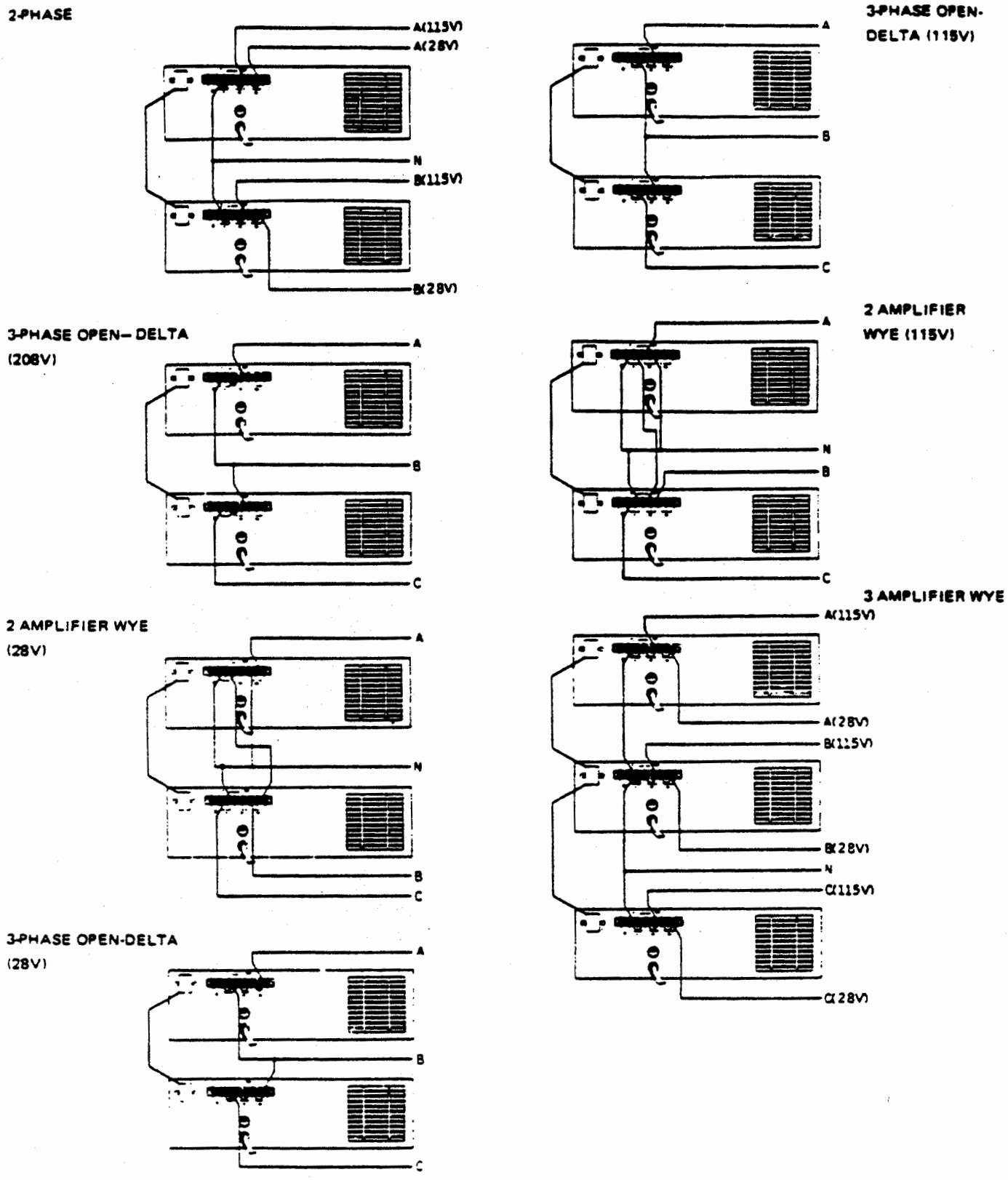


Figure 3-2. Rear Panel Connectors for Two- or Three-Phase Operation

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SECTION IV
MAINTENANCE

4-1. SERVICE INFORMATION

4-2. Questions concerned with the operation, repair, or servicing of this instrument should be directed to the Elgar Repair Department, Elgar, 9250 Brown Deer Road, San Diego, CA 92121-2294. Include the model number and serial number in any correspondence concerning the instrument.

4-3. FACTORY REPAIR

4-4. Should it be necessary to return an instrument to the factory for repair, please contact the Elgar Repair Department for authorization to make shipment. DO NOT RETURN THE UNIT FOR REPAIR WITHOUT AUTHORIZATION.

4-5. SHIPPING DAMAGE

4-6. It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be tested and inspected as soon as 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 Repair Department. You will be advised as to the action necessary to have the instrument repaired or replaced.

4-7. TEST POINTS

4-8. Test points on the plug-in oscillator are shown in Figure 5-1 and Figure 5-3. These test points are accessible by removing the top cover of the power source.

4-9. The outputs of the various test points are as follows:

Square Wave	≈ .6V P-P
First Filter	≈ 10V P-P
Second Filter	≈ 10V P-P
B-Phase	≈ 10V P-P sine wave
C-Phase	≈ 10V P-P sine wave

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4-10. TROUBLESHOOTING

4-11. Whenever trouble is suspected in the plug-in unit, substitution of a unit known to be good will provide a quick check. If it is determined that trouble does exist in the plug-in unit, the first step is a check of the +15VDC and -15VDC. If the output is greatly reduced, check the oscillator operation at the collector or Q113. If a square wave of the proper frequency and amplitude is present, the trouble may be in the filter. Check the output of the first filter section at Q106.

NOTE

If a crystal-controlled oscillator is not working, check the crystal. Dropping the unit, or other rough handling may fracture the crystal.

4-12. Troubleshooting is accomplished by signal tracing at the test points shown in Figure 5-1 and Figure 5-3. For the crystal-controlled models, test for a signal at the crystal oscillator, the flip-flop dividers, a square wave at CR103 and a sine wave at the two filter outputs, and at the B- and C-phase outputs.

4-13. If no output is present on the 0.1% model, inject a 3V RMS signal at appropriate frequency through a 3.3K resistor into pin 3 of Z103. Check for 6.2V peak-to-peak signal at CR103 and for correct signals at the filter and B- and C-phase outputs.

4-14. The output frequency of the 0.0001% oscillator is adjustable by a screwdriver adjustment at the top of the oscillator module. Access is gained to this adjustment by removing the top cover of the power source. Allow a 30-minute warmup period. Do not change frequency setting unless a frequency standard of adequate accuracy is available for comparison.

4-15. PHASE-ANGLE ADJUSTMENT

4-16. The phase-angle adjustments are set at the factory and should not be disturbed unless appropriate test equipment is available to determine the output phase angles. If an accurate phase-angle meter is not available, phase angles may be determined by line-to-line voltage measurements. The front-panel voltmeters in the Elgar power sources are only accurate to ±3% and are not suitable for precision phase angle adjustment.

4-17. Open Delta Connection: Set the two amplifier outputs E_{CA} and E_{CB} to 120V. Adjust B-phase, R136, until the line-to-line voltage E_{AB} equals 207.84 volts. The C-phase adjustment, R133, has no effect.

4-19. 3-Amplifier Wye Connection: Set the amplifier outputs, E_{NA}, E_{NB}, and E_{NC} to 120V. Adjust B-phase, R136, for line-to-line voltage equal to 207.84 volts. Adjust C-phase, R133, for line-to-line voltage E_{AC} equal to 207.84 volts.

4-20. 2-Phase Connection: Set both amplifier outputs to 120V. Adjust B-phase, R136, until line-to-line voltage E_{AB} equals 169.71 volts.

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SECTION V
DIAGRAMS

5-1. GENERAL

5-2. This section contains the schematic diagrams and parts layout for the Series 400 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.

5-3. DIAGRAMS

5-4. Diagrams included in this section are as follows:

a. Component Layout for 0.1% Oscillators.

b. Schematic Diagram for 0.1% Oscillators.

c. Component Layout for 0.01% Oscillators.

d. Schematic Diagram for 0.01% Oscillators.

5-6. The schematics included in this section use ◯ to indicate P2 and △ to indicate pins related to Connector J1. J1 is located on the rear panel of the AC Power Source and P2 is the pins of the oscillator board which plug into Receptacle Connector J2 of the AC Power Source.

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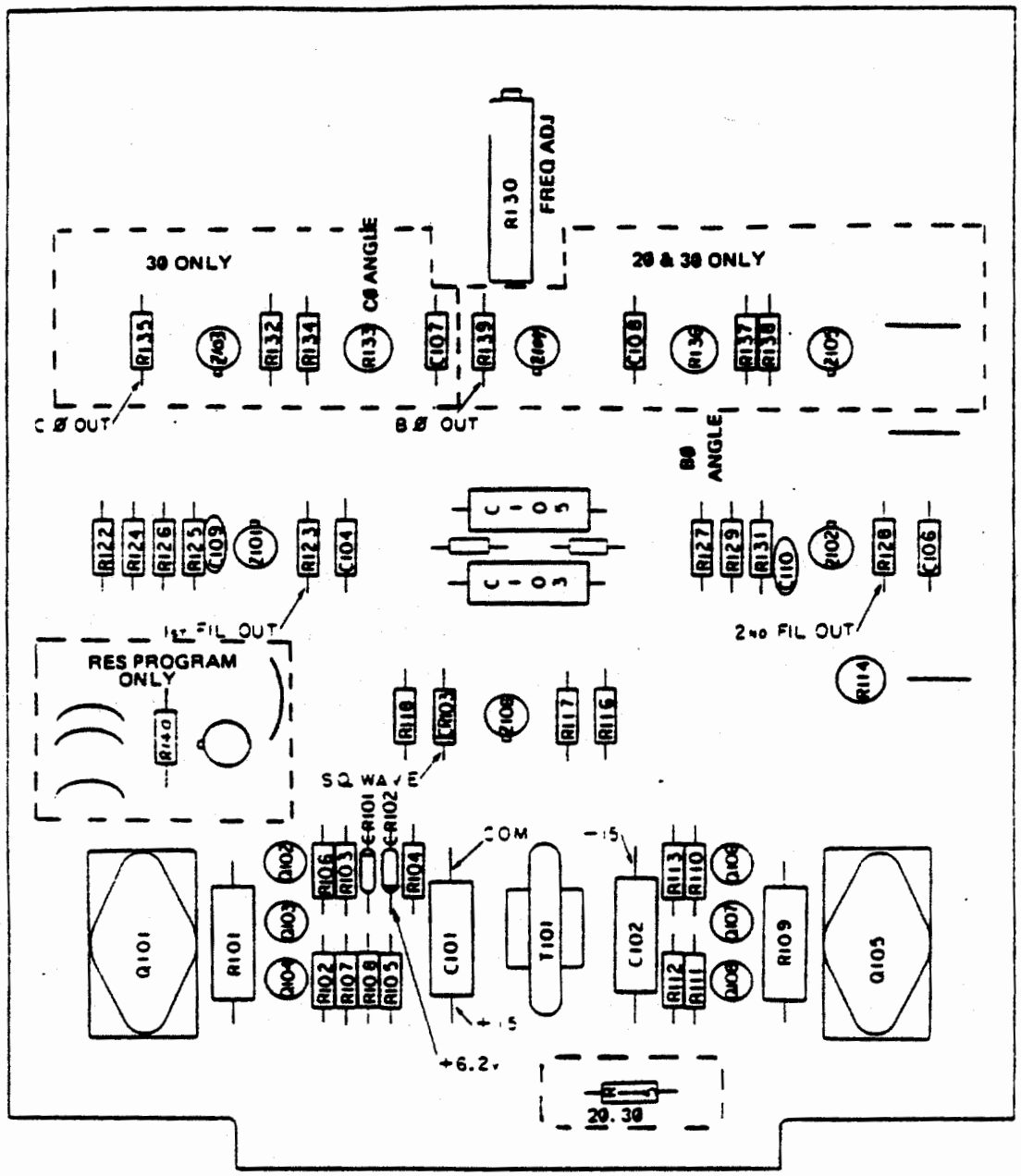
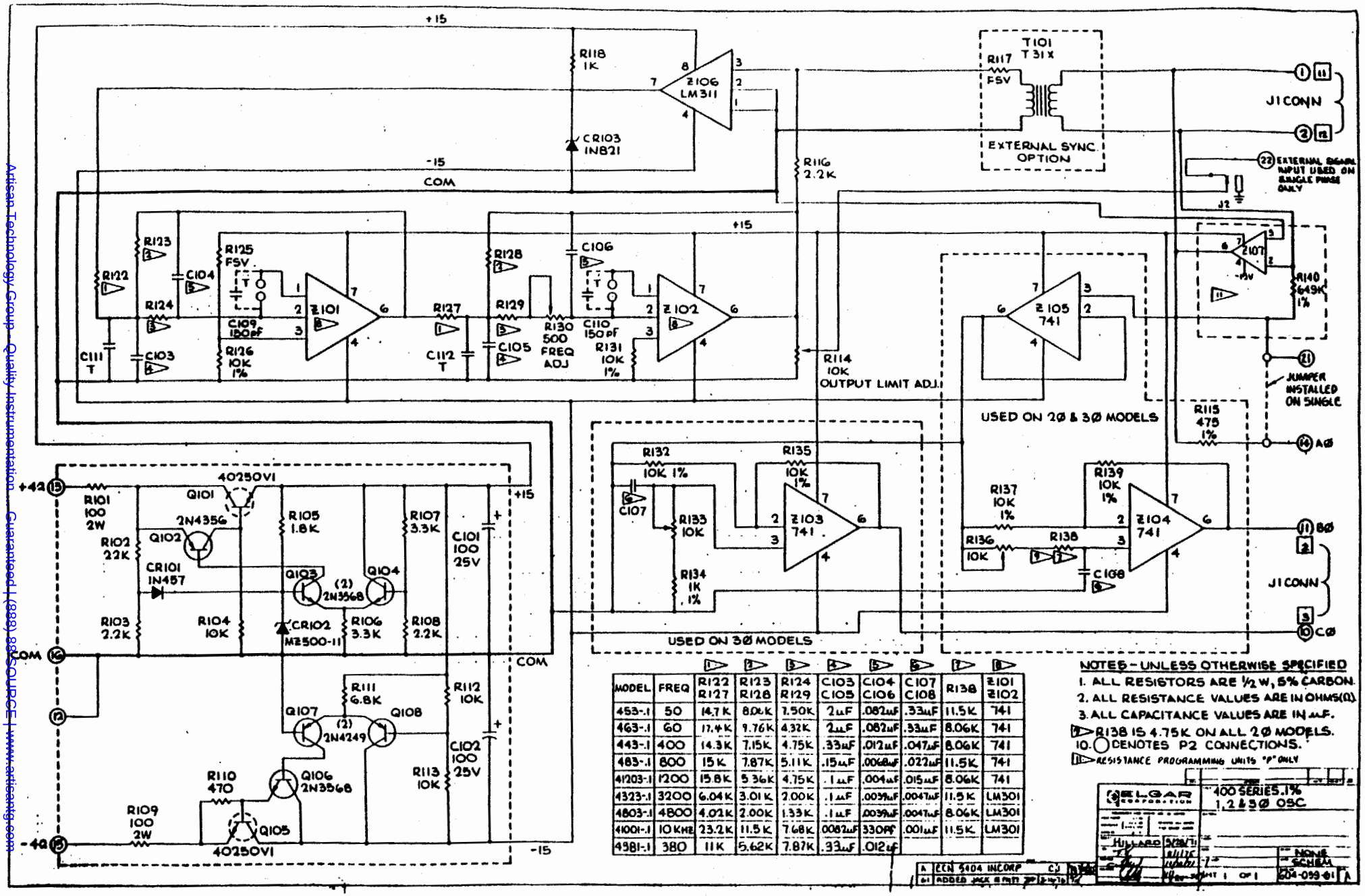


Figure 5-1. Component Layout for 0.1% Oscillators

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MODEL	FREQ	R122 R127	R123 R128	R124 R129	C103 C105	C104 C106	C107 C108	R138	Z101 Z102
453-.1	50	14.7K	8.06K	7.50K	2μF	.082μF	.33μF	11.5K	741
463-.1	60	17.4K	9.76K	4.32K	2μF	.082μF	.33μF	8.06K	741
443-.1	400	14.3K	7.15K	4.75K	.33μF	.012μF	.047μF	8.06K	741
483-.1	800	15K	7.87K	5.11K	.15μF	.0068μF	.022μF	11.5K	741
41203-1	1200	15.8K	5.36K	4.75K	.1μF	.004μF	.015μF	8.06K	741
4323-.1	3200	6.04K	3.01K	2.00K	.1μF	.0039μF	.0047μF	11.5K	LM301
4803-.1	4800	4.01K	2.00K	1.33K	.1μF	.0039μF	.0047μF	8.06K	LM301
4100I-.1	10KHz	23.2K	11.5K	7.68K	.0082μF	330PF	.001μF	11.5K	LM301
4581-.1	380	11K	5.62K	7.87K	.33μF	.012μF			

Figure 5-2. Schematic for 0.1% Oscillators

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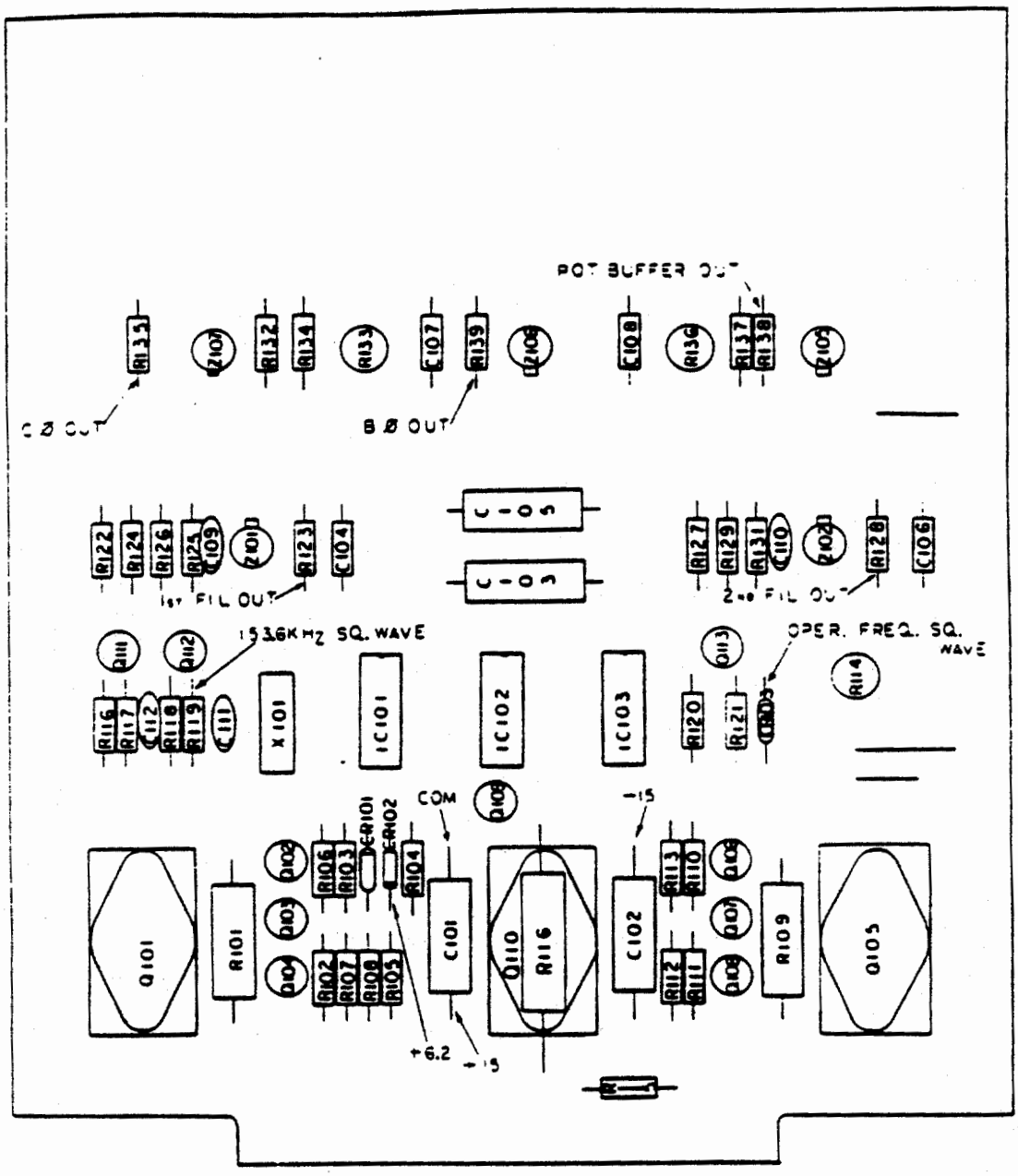


Figure 5-3. Component Layout for 0.01% Oscillators

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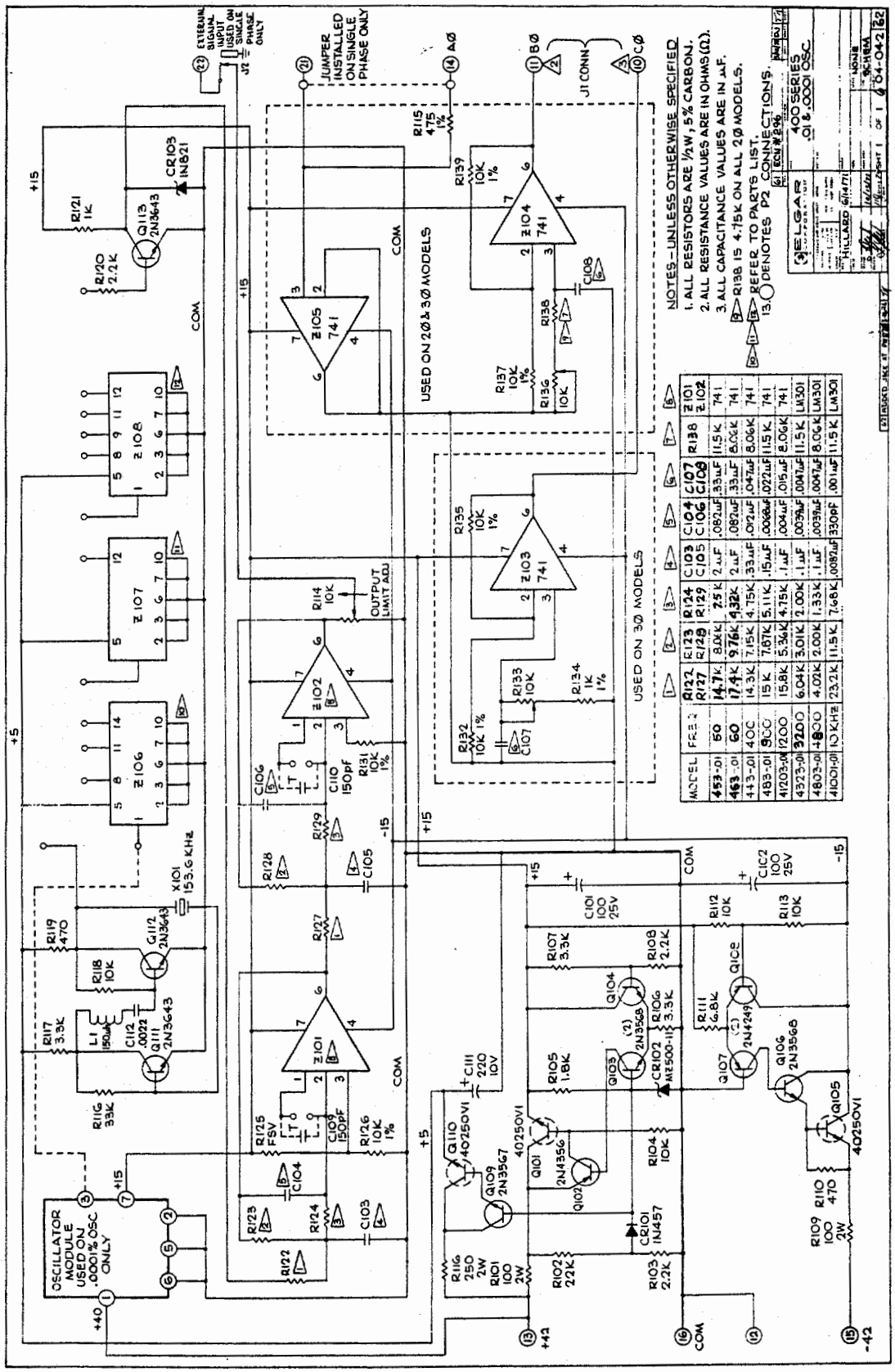


Figure 5-4. Schematic for 0.01% Oscillators

5-9/5-10

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SECTION VI
REPAIR PARTS LIST

6-1. GENERAL

6-2. This section contains a listing of all parts necessary for factory authorized repair of the unit. Parts are located on the diagrams in Section V and correlated on the parts list by using their reference designators. Also included in this section is Table 6-1 which the resistor and capacitor values to be used for frequencies between 50 Hz and 60 Hz are listed.

6-3. SPARE PARTS ORDERING

6-4. When ordering spare parts, specify part name, part number, manufacturer, component value and rating. If complete assemblies are desired, contact:

ELGAR ELECTRONICS CORPORATION
Sales & Technical Support
9250 Brown Deer Road
San Diego, CA 92121-2294
1-800-733-5427
Tel: (858) 450-0085
Fax: (858) 458-0267
E-mail: sales@elgar.com
www.elgar.com

Specify assembly number, instrument series number and instrument name when ordering.

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SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
PARTS COMMON TO ALL SERIES 400 PLUG-IN OSCILLATORS						
RESISTORS						
R101,109	100 ohm	Carbon Comp	2W, 5%	Speer	RC42GF101J	804-101-05
R102	22K	Carbon Comp	½W,5%	Speer	RC20GF223J	802-223-05
R103,108	2.2K	Carbon Comp	½W,5%	Speer	RC20GF222J	802-222-05
R104,112,113	10K	Carbon Comp	½W,5%	Speer	RC20GF103J	802-103-05
R105	1.8K	Carbon Comp	½W,5%	Speer	RC20GF182J	802-182-05
R106,107	3.3K	Carbon Comp	½W,5%	Speer	RC20GF332J	802-332-05
R110	470 ohm	Carbon Comp	½W,5%	Speer	RC20GF471J	802-471-05
R111	6.8K	Carbon Comp	½W,5%	Speer	RC20GF682J	802-682-05
R114	0-10K	Wire Wound	¼W	Spectrol	84-3-8-103	819-103-84
R122-124, 127-129	SEE TABLE					
R125	FSV	Carbon Comp	½W,5%	Speer	RC20GF__J	FSV
R126,131	10K	Metal Film	1/8W,1%	Dale	RN60C1002F	813-100-2F
CAPACITORS						
C101,102	100 uF	Alum Elect	25V	Sprague	500D107G025DD7	824-107-51
C103-106	SEE TABLE					
C109,119	FSV	Dip Mica	500V	Elmenco	DM15__J	FSV
DIODES						
CR101		Glass Diode		Sylvania	1N457A	844-457-XX
CR102		Surmetic Zener		Motorola	1N5234	843-500-XX
TRANSISTORS						
Q101,105		Silicon		RCA	40250-V1	839-402-5V
Q102		Silicon		Fairchild	2N4356	834-435-6X
Q103,104,106		Silicon		Fairchild	2N3568	835-356-8X
Q107,108		Silicon		Fairchild	2N4249	832-424-9X

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SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
INTEGRATED CIRCUITS						
Z101,102	SEE TABLE 6-1					
ADDITIONAL PARTS FOR TWO-PHASE OSCILLATORS						
RESISTORS						
R115	475 ohm	Metal Film	¼W,1%	Dale	RN60C4750F	813-475-0F
R136	0-10K	Wire Wound	¼W	Spectrol	84-3-8-103	819-103-84
R137,139	10K	Metal Film	1/8W,1%	Dale	RN60C1002F	813-100-2F
R138	SEE TABLE 6-1					
CAPACITORS						
C108	SEE TABLE 6-1					
INTEGRATED CIRCUITS						
Z103,105		Op Amp		Amelco	741CE	849-174-1X
ADDITIONAL PARTS FOR THREE-PHASE OSCILLATORS						
RESISTORS						
R132,135	10K	Metal Film	1/8W,1%	Dale	RN60C1002F	813-100-2F
R133	0-10K	Wire Wound	¼W	Spectrol	84-3-8-103	819-103-84
R135	SEE TABLE 6-1					
CAPACITORS						
C107	SEE TABLE 6-1					
INTEGRATED CIRCUITS						
Z104		Op Amp		Amelco	741CE	849-174-1X

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SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
PARTS PECULIAR TO 0.1% OSCILLATORS						
RESISTORS						
R116	2.2K	Carbon Comp	¼W,5%	Speer	RC20GF222J	802-222-05
R118	1K	Carbon Comp	¼W,5%	Speer	RC20GF102J	802-102-05
DIODES						
CR103		Zener		I.R.	1N821	843-821-XX
INTEGRATED CIRCUITS						
Z106		Volt. Com.		National	LM311	849-LM3-11
PARTS PECULIAR TO 0.01% OSCILLATORS						
RESISTORS						
R116	33K	Carbon Comp	¼W,5%	Speer	RC20GF333J	802-333-05
R117	3.3K	Carbon Comp	¼W,5%	Speer	RC20GF332J	802-332-05
R118	10K	Carbon Comp	¼W,5%	Speer	RC20GF103J	802-103-05
R119	470 ohm	Carbon Comp	¼W,5%	Speer	RC20GF471J	802-471-05
R120	2.2K	Carbon Comp	¼W,5%	Speer	RC20GF222J	802-222-05
R121	1K	Carbon Comp	¼W,5%	Speer	RC20GF102J	802-102-05
CAPACITORS						
C112	.01 uF	Cer. Disc	50V,10%	Centralab	DD103	821-103-00
INDUCTORS						
L1	150 uH			Nytronics	SWD150	851-150-01
X101	153.6kHz	Crystal		Valpe-Fisher		864-153-R6
INTEGRATED CIRCUITS - SEE TABLE 3-						

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SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
PARTS PECULIAR TO 0.0001% OSCILLATORS						
Z101	153.6kHz	Crystal		Monitor	153-6kHz	863-153-C0
PARTS PECULIAR TO PROGRAMMABLE 'P' OSCILLATORS						
RESISTORS						
R150	64.9K	Metal Film	1/8W,1%	Dale	RN60C6492F	819-649-2F
INTEGRATED CIRCUITS						
Z107		Op Amp		Motorola	MC1741CG	849-174-1X

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TABLE 6-1

FREQUENCY	R122 R127	R123 R128	R124 R129	C103 C105	C104 C106	C107 C108	R138	Z101 Z102
50	19.6K	9.53K	6.34K	2 uf	.082 uf	.33 uf	11.5K	741
60	17.4K	9.76K	4.32K	2 uf	.082 uf	.33 uf	8.06K	741
400	14.3K	7.15K	4.75K	.33 uf	.012 uf	.047 uf	8.06K	741
800	15K	7.87K	5.11K	.15 uf	.0068 uf	.022 uf	11.5K	741
1200	15.8K	5.36K	4.75K	.1 uf	.004 uf	.015 uf	8.06K	741
3200	6.04K	3.01K	2.00K	.1 uf	.0039 uf	.0047 uf	11.5K	LM301
4800	4.02K	2.00K	1.33K	.1 uf	.0039 uf	.0047 uf	8.06K	LM301
10 KHz	23.2K	11.5K	7.68K	.0082 uf	330 pf	.001 uf	11.5K	LM301

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