

OWNERS MANUAL

# **MODEL 90A**

## **HIGH LEVEL VLF SIGNAL SOURCE**

**SIGNALCRAFTERS TECH, INC.**

**57 Eagle Rock Avenue, East Hanover, NJ 07936**

**Tel: 973-781-0880 or 800-523-5815**

**Fax: 973-781-9044**

**[www.signalcrafters.com](http://www.signalcrafters.com)**

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## SIGNALCRAFTERS LEAD ACID BATTERY INFORMATION

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TO OBTAIN THE MAXIMUM OPERATING PERFORMANCE AND TO MAINTAIN THE WARRANTY OF YOUR INSTRUMENT, THE FOLLOWING OPERATING NOTES MUST BE OBSERVED AND FOLLOWED:

### OPERATING NOTES

1. THE BATTERIES IN THIS INSTRUMENT HAVE BEEN SHIPPED IN A FULLY CHARGED CONDITION. HOWEVER BEFORE PLACING THE INSTRUMENT IN SERVICE OR STORAGE, THE BATTERIES SHOULD BE CHARGED 14 TO 16 HOURS.
2. AFTER EACH USE AND BEFORE PLACING THE INSTRUMENT IN STORAGE, FULLY CHARGE THE BATTERIES.
3. THE BATTERY CHARGER DESIGN IN THIS PRODUCT ALLOWS CONTINUOUS CHARGING FOR STAND-BY APPLICATIONS AND WILL, WITHOUT MAINTENANCE, SUSTAIN A FULLY CHARGED BATTERY CONDITION. THIS WILL PROLONG THE LIFE OF THE BATTERIES AND INSURE IMMEDIATE USAGE OF THE EQUIPMENT.

### CAUTION

1. THESE BATTERIES CONTAIN TOXIC MATERIAL (LEAD ELECTRODES)
2. LEAD-ACID BATTERIES CONTAIN SULFURIC ACID, WHICH CAN CAUSE MATERIAL DAMAGE AND PERSONAL INJURY. IF CONTACT IS MADE WITH THE ACID, IMMEDIATELY FLUSH THE AREA WITH WATER. SHOULD THE EYES BE AFFECTED, FLUSH IMMEDIATELY LIBERALLY WITH WATER AND SEEK MEDICAL ATTENTION AS SOON AS POSSIBLE. A GOOD NEUTRALIZING SOLUTION FOR SULFURIC ACID IS HOUSEHOLD BAKING SODA IN WATER.
3. DO NOT SHORT CIRCUIT BATTERY TERMINALS AS THIS CAN CAUSE AN EXPLOSION OR FIRE.
4. DO NOT PUNCTURE, DISASSEMBLE, MUTILATE OR INCINERATE.
5. DISPOSE OF BATTERY WITH AUTOMOTIVE BATTERY SCRAP AT AN E.P.A. REGISTERED RECLAIMER.
6. IT IS UNLAWFUL TO DISPOSE OF BATTERIES IN A LANDFILL
7. IF NO E.P.A. APPROVED DISPOSAL SYSTEM IS AVAILABLE IN YOUR STATE, YOU MAY SHIP THE BATTERY FREIGHT PREPAID TO:

57 Eagle Rock Avenue, East Hanover, NJ 07936  
Tel: 973-781-0880 or 800-523-5815  
Fax: 973-781-9044

PLEASE CALL (800) 523-5815 FOR A RETURN AUTHORIZATION NUMBER PRIOR TO SHIPPING BATTERIES.

### IMPORTANT

REMEMBER, ALL LEAD-ACID BATTERIES ARE RECYCLABLE. PROPER DISPOSAL OF BATTERIES IS VERY IMPORTANT TO PROTECTING THE ENVIRONMENT. PLEASE DO YOUR PART BY DISPOSING OF LEAD ACID BATTERIES WITH AN E.P.A. CERTIFIED BATTERY RECYCLER. THANK YOU, SIGNALCRAFTERS TECH., INC.

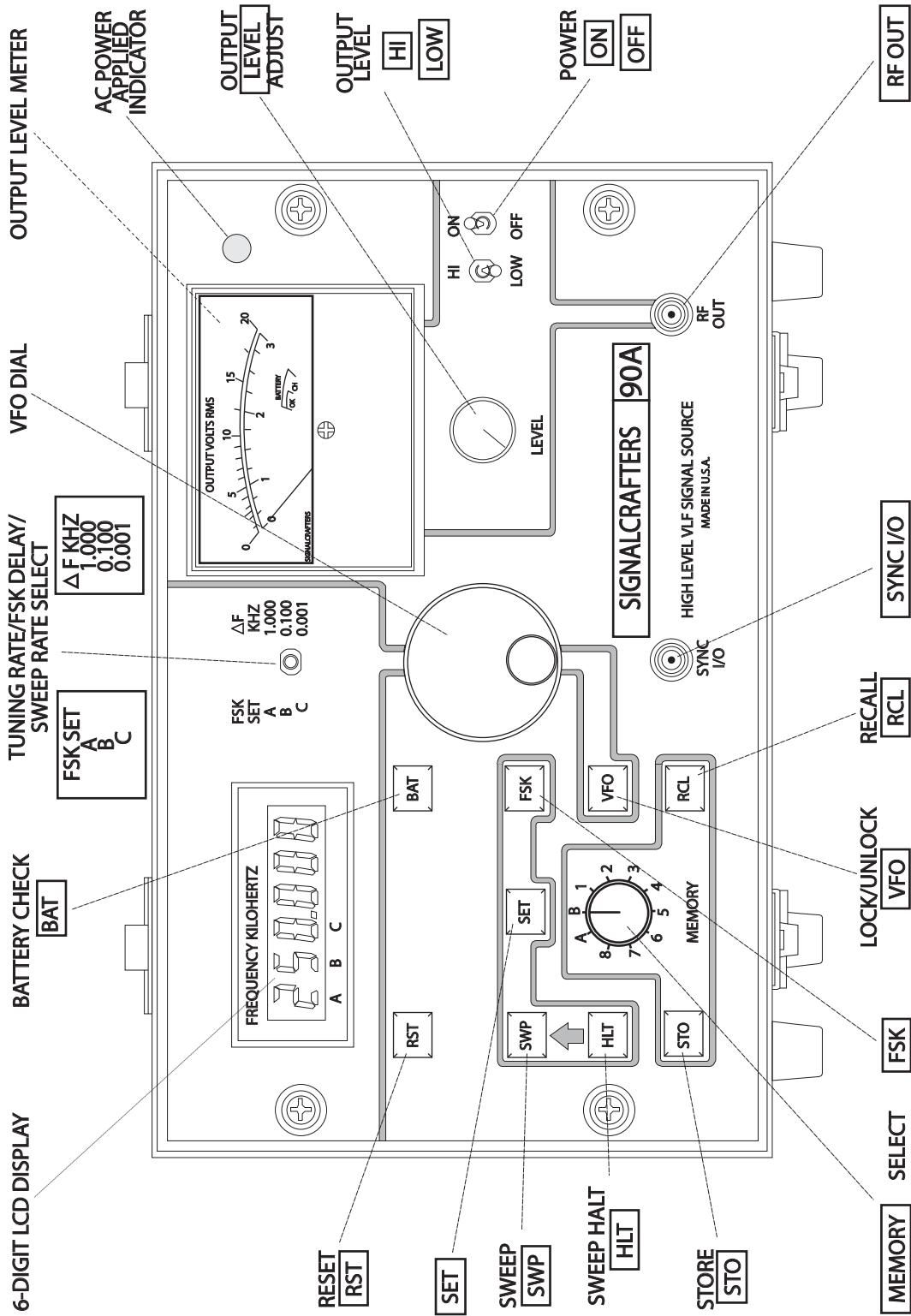


Figure 1 Model 90A High Level VLF Signal Source front panel



## 1. Description of the Model 90A High Level VLF Signal Source

### 1.1 Overview

The Model 90A is a directly-synthesized, microprocessor-controlled signal source operating in the very low frequency (VLF) range of 0.100 to 500 kHz (100 to 500,000 Hz.) The variable frequency oscillator is adjusted using a convenient “spin dial” which is adjustable in switchable increments of 0.001; 0.100, or 1.000 kHz (1,100 or 1000 Hz) steps for fine and course tuning.

The output frequency, displayed on a six-digit liquid crystal display (LCD), is accurate and stable to one part per million over a temperature of 14° to 122° F (-10 to 50° C). Harmonics are at least 60 decibels (dB) below the fundamental signal level and other spurious frequencies are 60 dB below the fundamental signal level.

The signal output level may be adjusted up to 2 watts or 10 volts, into a 50 ohm load, over the unit’s frequency range. Continuous output level adjustments are in two ranges, 0 to 1.9 and 0 to 10 volts root mean square (RMS), into 50 ohms or to 2.5 and 12 volts RMS, respectively, into an open circuit. This output voltage level at the RF OUT connector is indicated on the Output Level/Battery analog meter.

In addition to the Model 90A’s two watt power output and wide frequency range it includes:

**Frequency sweeping** - Perform single or repetitive sweeping and store the start and stop frequencies in our memory registers. Also when in the sweep mode, a synchronizing pulse is presented at the SYNC I/O connector at the start of each sweep for use with other equipment.

**Memory registers** - Ten handy storage locations for storing frequencies used for: sweeping, FSK and general testing.

**Frequency shift keying (FSK)**- Shift between any two frequencies via manual control key entry or a slave frequency shift can be initiated by supplying synchronizing pulses to the SYNCH I/O connector from the SYNC I/O connector of a second Model

90A or 90. A user adjustable delay from 0 to 999 milliseconds (ms) is also provided so when a frequency shift key is initiated the current output frequency is interrupted and the second frequency appears after the programmed delay. For external equipment a synchronizing pulse is generated each time a frequency shift is initiated from the panel keypad.

**AC and battery operation** -The Model 90A may be powered from a 90 to 264 volt, 46 to 440 Hz AC line or from its internal rechargeable batteries. When the batteries are fully charged, the device can deliver 2 watts continuously for 6 hours at 77° F (25° C), longer operation at reduced output power. The batteries can be fully recharged by the internal charger in 14 to 16 hours.

The batteries are automatically charged every time AC power is applied, regardless of the front panel power switch position. With AC power applied the unit will operate even if the batteries were completely discharged. Operating the unit from an AC source can also be done with the batteries disconnected.

**Wide operating temperature range** - The Model 90A will operate normally over the temperature range of 14° to 122° F (-10° to 50° C). But battery life will fall in a nearly linear fashion from 100% at 77° F (25° C) to 55% at 32° F (0° C). Storage is permitted at temperatures of -22° to 185° F (-30° C to 85° C) but battery self-discharge increases at the higher temperatures (50% self-discharge in 9 months at 77° F (25° C) decreasing to 4 months at 104° F (40° C).

Options are available as follows: Low Level Attenuator and digital level display mounted in the Model 90A lid (Option 04).

### 1.2 Function of the panel controls and indicators

Please reference Figure 1 with following descriptions.

ON  OFF power switch

The power switch turns the unit on and off. When the switch is placed in the “ON” position the following occurs: the instrument will be powered up; a firmware system-wide check is performed; the output frequency will be set to the frequency shown on the LCD display when the instrument was previously turned off and the VFO tuning dial will be locked.

When the switch placed in the “OFF” position all memory functions are retained (and will be retained even if the internal rechargeable batteries are disconnected). Closing the instrument lid will mechanically throw the switch to the “OFF” position.

Please note, the “AC power indicator” is not related to the position of the power switch. See the following paragraph. Power Indicator

This red LED indicates the presence of DC voltage at the input of the battery charging circuit. For the LED to light the appropriate AC power must be applied and the AC to DC power supply must be functioning. It is not related to the position of the “power ON/OFF switch”.

### Frequency LCD display

The 6-digit frequency LCD display actually serves multi-function: it shows the output frequency in kilohertz; the decimal point indicates a VFO tuning dial lock/unlock condition; when programming sweep rates it will display selectable sweep increments of 50, 100, or 200 per second, along with single or repetitive sweeps; when programming the FSK second-frequency-onset delay it will display in milliseconds 0 to 999; and a low battery voltage condition will be indicated by flashing dots between the 2<sup>nd</sup> and 3<sup>rd</sup>, and 4<sup>th</sup> and 5<sup>th</sup> digits.

### Output level/battery meter

This analog meter displays the signal voltage level appearing across the “RF OUT” connector. The upper scale reads 0 to 20 volts RMS and is used when the “Output Level HI, LOW” switch is in the “HI” position. The middle scale reads 0 to 3 volts RMS and is used when the “Output Level HI, LOW” switch is in the “LOW” position. The short bottom scale labeled “BATTERY” indicates the battery voltage when the “BAT” key is pressed.

### VFO tuning dial

The VFO (Variable frequency oscillator) tuning dial allows manual tuning of the output frequency as well as presetting frequencies into the 10 “MEMORY” registers. To prevent accidentally changing the output frequency the VFO tuning dial can be locked (indicated by a non-flashing decimal point on the LCD display)

or unlocked (indicated by a flashing decimal point on the LCD display) by pressing the “VFO” key.

The VFO tuning dial changes frequency in 64 increments per revolution. The size of the frequency increments is set by the position of the “ΔF KHz 1.000, 0.100, 0.001” switch, and can be 1.000, 0.100 or 0.001 kHz (1000, 100 or 1 Hz) per increment. When the Model 90A is first turned on using the “ON/OFF power switch” the VFO tuning dial will be locked and the output frequency will be set to the frequency shown on the LCD display when the instrument was previously turned off.

The VFO tuning dial must be locked in order to: store or recall frequencies from the MEMORY registers; FSK operation and sweep operations.

### **VFO** lock/unlock key, VFO tuning dial

The VFO tuning dial can be locked or unlocked by pressing the “VFO” key. When the dial is unlocked the decimal point on the LCD display will flash. When the dial is locked the decimal point on the LCD display is non-flashing.

### **HI** **LOW** output level switch

When the switch is in the “HI” position the output level can be adjusted from 0 to 12 volts (open circuit) by the LEVEL dial and read on the upper scale, 0 to 20, of the “Output Level/Battery meter”. When the switch is in the “LOW” position the output level can be adjusted from 0 to 2.5 volts (open circuit) by the LEVEL dial and read on the middle scale, 0 to 3, of the “Output Level/Battery meter”.

### **LEVEL** Output level dial

The output level can be set to any open circuit voltage between 0 and 12 and 0 and 2.5 volts, as determined by the setting of the HI/LOW output level switch. The voltage level of the output is read on the appropriate scale on the “Output Level/Battery meter”.



A low-level attenuator and digital output level display is available as Option 04. If this option has been installed, see Section 6.4 Option 04.  $\Delta F$ :KHZ 1.000, 0.100, 0.001

Tuning rate/ FSK delay/ sweep rate select

**Tuning Rate** - This switch sets the frequency change increments made by the VFO tuning dial to: 1.000, 0.100 or 0.001 kHz (1000, 100 or 1 Hz) per dial increment. This yields a VFO tuning dial tuning rate of 64, 6.4 or .064 kHz per revolution.

**Sweep Rate** - This switch sets the increment size in the sweep mode to: 1.000, 0.100 or 0.001 kHz (1000, 100 or 1 Hz) Since there are 3 MEMORY programmable sweep rates of 50, 100, or 200 increments per second, 9 selectable sweep rates can be obtained from .050 to 200 kHz per second.

#### **FSK SET A B C**

Tuning rate/ FSK delay/ sweep rate select

**FSK Delay** - The switch selects the time-delay digits A, B, or C that may be altered by the FSK and SET keypads for setting the FSK second-frequency – onset delay.

The digit selected by the switch corresponds to the A, B, C labels directly below the Frequency LCD display. Position “A” represents hundreds of milliseconds, “B” represents tens of milliseconds, and “C” represents units of milliseconds delay.

#### **MEMORY Memory select switch**

This switch allows storing and recalling frequencies to 10 MEMORY registers.

Registers A and B also serve as the location of the low and the high frequency limits, respectively, in continuous, repetitive sweep operations.

Register B also serves as the location of the second, delayed, onset frequency in FSK operation. It is recommended that the FSK first, or starting frequency, be stored in register A.

#### **STO Store key**

When the “VFO lock/unlock” key is locked

(indicated by a non-flashing decimal point on the LCD display) pressing the “STO” key will store the displayed frequency into the “MEMORY” register indicated by the “MEMORY” switch position. This action will replace any frequency formerly stored in that register.

Please note, only the frequency is saved, not the voltage output level.

When the “VFO lock/unlock” key is unlocked (indicated by a flashing decimal point on the LCD display) this key is inoperative.

When the DIAL is locked, pressing the RCL keypad will retrieve, and output, the frequency stored in the

#### **RCL Recall key**

When the “VFO lock/unlock” key is locked (indicated by a non-flashing decimal point on the LCD display) pressing the “RCL” key will retrieve, display and output the frequency stored in the “MEMORY” register indicated by the “MEMORY” switch position. This action will not alter the frequency stored in the register.

When the “VFO lock/unlock” key is unlocked (indicated by a flashing decimal point on the LCD display) this key is inoperative.

#### **SET**

##### **Setting sweep, FSK delay, or Master / slave FSK**

The SET key is used during the set-up of: Frequency Sweeping (SWP); Frequency Shift Keying (FSK); and Master/Slave FSK operations. When the “VFO lock/unlock” key is locked pressing the SET key will replace the frequency shown on the LCD Display with “- - - .” Output will continue at the frequency formerly displayed. If no other keypads have been pressed, pressing SET again will restore the display of the output frequency. This key is inoperative when the VFO tuning dial is unlocked,

##### **Setting the sweep rate (SWP) in single or repetitive mode**

Pressing the SWP key immediately after pressing the SET key will bring up, on the Frequency LCD display, the step increment per second value last stored in MEMORY (50, 50P, 100, 100P, 200, or 200P). The numbers represent the step increments per second that the frequency will increase during the sweep operation. The P signifies the sweep will be repetitive otherwise it will be a single sweep. Pressing SWP again will advance

the LCD display to the next step and mode choice and continue for each SWP key press. When the desired increment rate and repetitive or single sweep mode is displayed, pressing SET again will place the selection into MEMORY and take the instrument out of the SET mode. The magnitude of the frequency increments is determined by the position  $\Delta F$  KHZ switch.

#### **Setting FSK second-frequency-onset delay**

Pressing the FSK key immediately after pressing the SET key will bring up, on the Frequency LCD display, the three digit millisecond value last stored in MEMORY. This number represents the milliseconds delay in the onset of the second-frequency output stored in MEMORY register B.

Each additional press of the key will advance one of the displayed digits, 0 to 9, as determined by the position of the FSK SET switch. With the A, B, C positions

corresponding to the A, B, C labels directly below the Frequency LCD display.

“A” represents hundreds of milliseconds, “B” represents tens of milliseconds, and “C” represents units of milliseconds delay.

When all three digits have been selected for the desired delay in milliseconds, pressing SET key again will place the delay in MEMORY and take the instrument out of the set mode.

#### **Master Slave FSK, HLT Operation**

Master-slave FSK operation of a pair of Model 90A's (or 90A and 90) can be done by interconnecting each SYNCH I/O connector. Each Model 90A or 90 may be programmed for its own starting-frequency, second-frequency, and second-frequency-onset delay. The “slave” Model 90A or 90 must have the starting frequency stored in MEMORY register A. The starting-frequency for the “master” is that showing on its Frequency LCD display. It is recommended, for convenience, that the “master” also have its starting-frequency stored in MEMORY register A and the MEMORY switch be in the “A” position. Pressing the SET key on the “master” will bring up to the Frequency LCD display “- - - .” There will be no change in the output frequency of either instrument. Next, pressing the HLT key on the “master” will bring to its LCD display “- - - .H”. This will not change the “master”

output frequency but will cause the “slave” to output the frequency stored in its MEMORY register A, if not already providing such an output. The FSK cycle of both Model 90As or 90 will then be initiated by pressing the “master” FSK key. When the FSK key is pressed, each output will be muted simultaneously for the delay programmed in each. Following the individual delays, each will output its MEMORY register B frequency. Either Model 90A or 90 may be the “master”. This is simply determined by which one is activated by the SET, HLT, and FSK key pressing sequence.

Master-slave FSK operation may be replaced with TTL-driven FSK from an external signal source applied to the SYNCH I/O connector by the installation of Option 01. If this option has been installed, see Section 6.1 Option 01.

#### **SWP Sweep key**

Pressing the SWP key will initiate a sweep by increasing the frequency from that shown on the display to the frequency stored in MEMORY register B, providing: (a) the VFO tuning dial is locked, (b) the instrument is not in the SET mode and (c) the display frequency is lower than that stored in MEMORY register B.

The rate of frequency increase is determined by the step increment per second value stored in MEMORY (50, 100 or 200) multiplied by the position of the  $\Delta F$  KHZ switch (1.000, 0.100 or 0.001). For example, if the step increment per second was 50 and the  $\Delta F$  KHZ switch was in the 1.000 position, the frequency increase per second would be:  $50 \times 1 \text{ kHz} = 50 \text{ kHz}$  per second.

The sweep will stop at the frequency stored in MEMORY register B, if a single sweep mode was stored in memory. If a repetitive mode was selected, upon reaching MEMORY B's frequency, the frequency will instantly change to that stored in MEMORY register A and again sweep to B. This sweeping will repeat continuously.

No sweep will occur and an audible 0.5 second error alarm tone will sound if the SWP keypad is pressed when the display frequency is equal to, or greater than, the frequency stored in MEMORY register B or, in the repetitive sweep mode, the frequency in register A is higher than that in register B.

This key is inoperative when the VFO tuning dial is unlocked,

### **HLT** Sweep halt

Pressing the HLT key while in the sweep mode will cause an immediate cessation of the sweep. The displayed output frequency is the frequency that was occurring when the key was pressed. The sweep may be resumed from this displayed frequency, if the VFO tuning dial is locked, by pressing the SWP key.

This key is inoperative when the VFO tuning dial is unlocked, or if not in the sweep mode or the set mode,

### **FSK** Frequency shift keying

When the VFO tuning dial is locked and the instrument is not in the set mode, pressing the FSK key will initiate frequency shift keying. Upon pressing the FSK key the displayed output frequency and voltage will immediately cease and, after the delay stored in MEMORY, the second frequency, which is that stored in MEMORY register B, will appear at the output. Pressing the FSK key again will repeat this process.

This key is inoperative when the VFO tuning dial is unlocked,

### **RST** Reset

Pressing the RST key performs a hard microprocessor reset and the RF output goes to zero. When the RST key is released the output level and frequency will reflect their prior "Reset" keyed state and the VFO tuning dial will be locked. MEMORY will not be altered. This key is seldom utilized in normal operation.

This key is always operational when the power switch is "ON".

### **BAT** Battery check key

Pressing the "BAT" key will indicate the voltage of the internal batteries on the bottom scale, labeled "BATTERY" of the "OUTPUT LEVEL/BATTERY" analog meter. Perform this test with the AC source disconnected and the power switch "ON". A reading within the "BATTERY" scale's range indicates a normal battery voltage. A "normal battery voltage" reading does not correlate with how long the unit will operate on battery power only. The best

operating practice is to keep the unit on AC power for 14 to 16 hours before taking it into the field.

This key is always operational and independent of the position of the "power ON/OFF" switch.

A low battery voltage condition will also be indicated by flashing dots between the 2<sup>nd</sup> and 3<sup>rd</sup>, and 4<sup>th</sup> and 5<sup>th</sup> digits.

### **SYNC I/O** Synchronizing input and output

A positive 3.75-volt, 1 millisecond-wide pulse, behind 100 ohms, appears on this connector at the start of each sweep (sweep mode) and an 8 millisecond-wide pulse at the moment the FSK key is pressed (FSK mode.)

Application of a pair of pulses to this connector from a second Model 90A or Model 90 SYNCH I/O will initiate a master-slave frequency shift.

The input function of the SYNCH I/O connector is significantly changed if Option 01 is active. If this option is active, see section 6.1 Option 01.

### **RF OUT** RF signal output

The frequency indicated on the Frequency LCD display and the voltage level indicated on the Output level/battery meter appears on this BNC connector. The source impedance of this output is approximately 3.3 ohms.

## **2. Using the Model 90A**

### **2.1 I/O Connections**

#### **AC Power**

The Model 90A may be powered from a 90 to 264 volt, 46 to 440 Hz AC line or from its internal rechargeable batteries. The unit is furnished with a "standard" US 115 volt plug. For 230 volt AC the user should provide a suitable UL/OSHA- approved cord with the proper male connector and IEC320/CEE-22 female connector to mate with the Model 90A ac power connector. Such possibly suitable cords would be Belden Type 17566, -7, -8, or -9, or equivalents.

The battery charging circuit is active whenever the power cord is connected to line power, independent

of the position of the ON/OFF switch. The charging circuit will automatically charge the batteries, or maintain a trickle charge, as needed, by responding to their terminal voltage. Proper battery charging normally does not require any user action other than connecting the power cord. Charging will proceed, as needed, while the instrument is being operated on line power.

## RF OUT

The output from the Model 90A, RF OUT, may be connected to a reactive or resistive load of any impedance from 0 to open circuit. The source impedance of the Model 90A output is approximately 3.3 ohms. Since the analog output level meter reads the voltage directly across the RF OUT connector, the source impedance, for most purposes, should be regarded as 0 ohms of that of a true voltage source. If any other source impedance is required (to drive attenuators or the source impedance-sensitive loads), simply place a resistor of a value equal to the desired source impedance, in series with the RF OUT center terminal. The output level meter will then read the output voltage behind this resistor value.

**Caution: While performing tests you might be connecting this unit to a low impedance circuit that already has a signal on it. These signals must not exceed  $\pm 5$  volts. To connect more than one Model 90A together you must have a hybrid.**

Because the actual source of impedance is greater than zero, severely nonlinear loads can alter the output wavehape and introduce distortion products. Low impedance, series resonant loads can attenuate the fundamental output signal and thus emphasize the otherwise low level harmonic and spurious frequencies present in the output. This, too, will create a distorted output signal. In this regard the Model 90A does not differ from any other high quality signal generator.

## SYNC I/O

The SYNC I/O connector supplies (or receives) a TTL-level pulse of between +3 and +5 volts (3.75 volts, normal) behind 100 ohms. A rectangular, 8 millisecond-wide pulse is generated each time the FSK key (VFO tuning dial locked) is pressed. A 1 millisecond-wide pulse is generated at the start of each frequency-increase sweep. The pulse may be used to trigger the time base of an oscilloscope or to slave the frequency-shift of a

second Model 90A or 90.

Synchronized master-slave frequency shift keying may be produced by using a pair of Model 90A's or 90's with their SYNC I/O terminals interconnected. Either instruments may serve as "master" by pressing its keypads in the SET-HLT-FSK sequence. Other instruments must be pre-programmed for their independent second frequency in MEMORY registers B, as well as their second-frequency-onset delays. The "slave" must have its desired starting frequency in its MEMORY register A. The "master" starting frequency will be that showing on its LCD display.

The SET-HLT-FSK function, as described above, does not apply if the driven FSK/on-off keying option (Option 01) has been activated. See Section 6 Options, Option 01.

## 2.2 Tuning Frequency Guidelines

The Model 90A can provide an output of any frequency, in 1Hz increments, from 0.100 kHz to 500.000 kHz. This is true for manual tuning as well as sweeping and FSK between any two frequencies.

### FSK SET/ $\Delta$ F KHZ and DIAL tuning

The VFO tuning DIAL alters frequency by 64 increments per revolution. The size of the frequency increments, or frequency resolution, is set by the FSK SET/ $\Delta$ F KHZ switch position. This may be 0.001, 0.100, or 1.000 kHz per increment. Because of this selectable resolution, the lowest and the highest frequency that can be tuned with the DIAL may be greater than 0.100 kHz, or less than 500.00 kHz, respectively, depending upon the switch position and the initial frequency. The lowest frequency that can be reached will be the starting frequency displayed minus an integral number of increments that is equal to, or greater than, 0.100 kHz. Similarly, the highest frequency that can be reached will be the starting frequency displayed plus an integral number of increments that is equal to, or less than 500.000 kHz. Note that **ANY** frequency can be reached from **ANY** starting frequency when the switch is in the "0.001" kHz position, but possibly, no closer than 0.099 kHz from the low and high limits when using the "0.100" or "1.000" kHz switch positions, respectively.



FSK SET/ $\Delta$ F KHZ and sweeping

In the sweep mode, the frequency increases in incremental steps of 0.001, 0.100, or 1.000 kHz as determined by the position of the FSK SET/ $\Delta$ F KHZ switch. Therefore, in a manner similar to that described above for DIAL tuning, how closely the sweep reaches the upper frequency stored in MEMORY register B depends upon the switch setting and the starting frequency. The highest frequency reached, each sweep will be the starting frequency plus an integral number of increments that is equal to, or less than, the frequency stored in MEMORY register B. Note that the register B frequency WILL be reached, each sweep, when the switch is in the "0.001" kHz position, but possibly, no closer than 0.099 kHz when the switch is in the "0.001" or "1.000" kHz positions, respectively.

When in the repetitive sweep mode, the sweep will always start at the frequency stored in MEMORY register A, independent of the position of the FSK SET/ $\Delta$ F KHZ switch position.

### 2.3 VFO Tuning DIAL (VFO lock/unlock)

The VFO tuning DIAL operates a 64 increment/revolution optical encoder for manually changing the display and output frequency, and for entering frequencies into the MEMORY registers. The size of the frequency increments is determined by the position of the FSK SET/ $\Delta$ F KHZ switch placed immediately above the DIAL on the front panel. These increments may be 0.001, 0.100, or 1.000 kHz, which will produce tuning rates of 0.064, 6.4, or 64.0 kHz per DIAL revolution. Thus one can choose from tuning in fine steps of 1 Hz to rapid tuning over the entire frequency span in a few turns by simply positioning the FSK SET/ $\Delta$ F KHZ switch. Clockwise DIAL rotation will increase the frequency counter-clockwise rotation will decrease the frequency.

The DIAL is locked and unlocked by pressing the VFO keypad. When the DIAL is in the unlocked state, the LCD decimal point will blink. When the DIAL is locked, its rotation will produce no action of any kind.

The DIAL must be locked in order to store, or retrieve, frequencies to, or from, the MEMORY registers. Likewise, the DIAL must be locked to set the FSK delays and sweep rates, or for operating in the FSK mode or sweep mode. When the Model 90A is powered up by

placing the OFF/ON switch in the "ON" position, the display and output frequency will be the frequency formerly present when the instrument was turned off. To change the frequency, simply press the VFO keypad once to unlock the DIAL. Manual tuning may now be done to any desired new frequency. This new frequency may then be locked for some further purpose by pressing the VFO keypad. The blinking (DIAL unlocked) or non-blinking (DIAL locked) LCD display decimal point will always indicate the DIAL's state.

### 2.4 MEMORY register operation (STO/RCL)

Up to 10 frequencies can be stored in, or recalled from, the MEMORY registers. These registers are selected by the MEMORY switch positions of "A" or "B", and "1" through "8".

To store the frequency, first unlock the DIAL (obtaining a blinking decimal point on the LCD Display) and tune to the desired frequency. Next, lock the DIAL by pressing the VFO keypad (obtaining a steady decimal point). Position the MEMORY switch to the desired register. Now, pressing the STO keypad will replace whatever was stored in that register with the frequency shown on the LCD Display. The frequency stored will remain in this register until changed by repeating the storage procedure, independent of all other instrument manipulations.

To recall a frequency the DIAL must be in the locked state (steady decimal point). Place the MEMORY switch in the desired register position. Press the RCL keypad. The frequency in this register will now show on the LCD display and be presented to the RF OUT connector. Recalling from a register is non-destructive and the frequency will remain in the register for unlimited further recalls.

For simple storing and recalling registers A and B can be used in the same manner as registers 1 through 8. However, register A and B also serves special functions in sweep and FSK mode operations (see Section 2.5 and 2.6 below.)

## 2.5 Frequency sweeping (SWP)

Sweep mode operation is started by pressing the SWP keypad when the DIAL is locked and the displayed frequency is lower than the stored in MEMORY register B. When initiated, the frequency will immediately increase, from that currently shown on the LCD display, at a uniform rate. The rate of frequency increase, in kHz per second, will be determined by the product of the size of frequency increments in kHz, as set by the position of the FSK SET/ $\Delta$ F KHZ switch, and the increment rate per second stored in MEMORY. Sweep can be interrupted at any point by pressing the HLT keypad. The frequency will remain at the occurring when the keypad was pressed and any other Model 90A operation may be initiated. The sweep may be resumed from the frequency showing on the LCD display (providing it is lower than frequency B) by pressing the SWP keypad again.

As shown in Figure 3, two types of sweeps are available from selections stored in MEMORY: single sweep and repetitive sweep. In the single sweep mode the sweep may be started from any frequency that is lower than that stored in MEMORY register B. upon pressing the SWP keypad the frequency will rise, from whatever is shown on the LCD display, to frequency B and then remain there. In the repetitive sweep mode, again may be started from any frequency lower than that stored in MEMORY register B. In this case the frequency will rise to frequency B, then quickly jump to the frequency stored in MEMORY register A, rise to frequency B and continue sweeping from frequency A to frequency B, indefinitely.

To set the choice of single or repetitive sweep and the rate of frequency increase (sweep rate) in MEMORY, the DIAL must be locked. First, press the SET keypad. This action will replace the presentation of the current output (output frequency on the LCD display) with “—.” (Output will continue at the formerly displayed frequency.) Next, press the SWP keypad. This will bring up the LCD display of “50.”, “50.P”, “100.”, “100.P”, “200.”, or “200.P”. These represent the number of frequency increments per second the frequency will increase during the sweep Operation and whether the sweep will be repetitive (“-P”), or not (“-.”). By pressing the SWP keypad again the next choice will appear on the LCD display. Rollover will occur from “200.P” to “50.” on repeated pressing of the SWP keypad. When the desired sweep rate and mode is

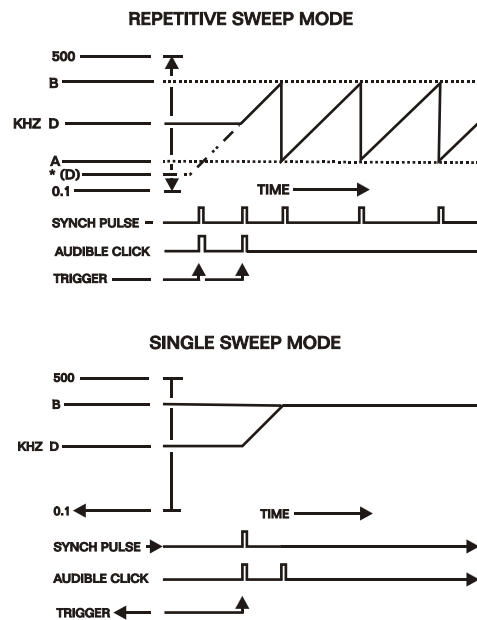


Figure 3. Output frequency, SYNC I/O pulses, and audible clicks versus time. A - Low frequency limit; B - High frequency limit; D - Indicated display frequency when SWP keypad pressed. If the indicated display frequency is lower than the MEMORY A frequency, the MEMORY A frequency is ignored on the first sweep in the repetitive sweep mode.

presented on the LCD display, pressing the SET keypad will place the selection in MEMORY. This action will also take the instrument out of the set mode.

The desired upper frequency limit, for either single or repetitive sweep must be stored in MEMORY register B. The procedure for storing these frequencies is described in section 2.4, above. Single sweep operation is always initiated from whatever frequency showing on the LCD display (that is lower than frequency B), and does not require the use of MEMORY register A. Once the sweep has started, the initial frequency that was showing on the LCD display will be lost. If another identical single sweep is desired, the starting-frequency must be restored. This might be done by unlocking the DIAL with the VFO keypad, tuning to the starting frequency (if it could be remembered) and locking the DIAL with another press of the VFO keypad. Now, pressing SWP will produce another single sweep like the first one. But, again, the starting-frequency will be lost. Therefore, it is recommended that the starting frequency, even for single sweep operation, be stored in MEMORY register A. In this way, the starting-frequency can always be brought to the LCD display by simply placing the MEMORY switch in the “A” position and pressing the RCL keypad.

A single 1 millisecond- wide, +3.75 volt pulse will appear at the SYNC I/O connector on each press of the SWP keypad and at the start of each repetitive sweep (frequency B to frequency A transition).

An audible click will be presented at each of the SWP keypad and at the moment the sweep reaches frequency B in this single sweep mode.

If sweep initiation is attempted in the single sweep mode the LCD display frequency equal to, or greater than, frequency B, a half a second error alarm tone will be sounded and no sweep will occur. If a repetitive sweep is attempted with a higher frequency stored in MEMORY register A than in MEMORY register B, or the LCD display frequency is greater than frequency B, an alarm tone will be sounded and no sweep will occur.

## 2.6 Frequency shift keying (FSK)

Frequency shift keying can only occur when the DIAL is locked and may be triggered by either pressing the FSK keypad or slaved from a second Model 90A by interconnecting their SYNC I/O connectors. The initial frequency will be that shown on the LCD display. Upon triggering, the new second-frequency will appear on the LCD display and the output will be muted. After the delay period, that was programmed into MEMORY, the muting will be terminated and the second frequency will appear at the output. The second-frequency is always the frequency stored in MEMEORY register B. If the frequency shift was initiated by pressing the FSK keypad, a TTL-level (+3.75 volts behind 100 ohms), 8 millisecond-wide pulses will appear at the SYNC I/O connector at the moment of the keypad press. The falling edge of the pulse is the moment of the initial muting and start of the delay period.

To program the second-frequency-onset delay, the DIAL must be locked. Begin by pressing the SET keypad. This will replace the LCD display of the current frequency with “—.” (Output of the formerly –displayed frequency will continue through out the SET process.) Next, press the FSK keypad. This will bring up the LCD display a 3-digit number of some value from “000” to “999”. This number represents the second-frequency-onset delay, in milliseconds, currently stored in MEMORY.

The delay period may be changed, one digit at a time. Place the FSK SET/ΔF KHZ switch (immediately)

above the DIAL) in position “A”. Next, press the FSK keypad to advance the “A” digit shown on the display. Repeated pressing of the FSK keypad will continue to advance the digit, one unit per press, and roll over from “9” to “0”. At rollover neither carry nor borrow occurs. When the desired “A” digit has been obtained, place the FSK SET/ΔF KHZ switch to the “B” position. Again, advance the “B” digit, on the LCD display, with the FSK keypad until the desired number is obtained. Repeat for the “C” digit by placing the FSK SET/ΔF KHZ switch in the “C” position. When all three digits are showing the desired delay, press the SET keypad. This action will replace the old delay value with the one shown on the LCD display of the output frequency, and take the instrument out of the set mode.

Storing the FSK second-frequency in MEMORY register B is carried out in the same manner as storing any frequency in any MEMORY register (Section 2.4 above).

Once the desired delay period and FSK second-frequency have been programmed, a frequency shift cycle may be initiated, starting from the current frequency showing on the LCD display. However, after the shift has occurred the initial frequency will be lost, being replaced by the FSK second-frequency from MEMEORY register B. The initial frequency can be restored by unlocking the DIAL, manually retuning to the initial frequency, and re-locking the DIAL. The next press of the FSK keypad will produce another frequency shift identical to the original.

A more convenient method for repeating frequency shifts from the same starting frequency, is to store the starting frequency in MEMORY register A. Now, by placing the MEMORY switch at the “A” position, simply pressing the RCL keypad will restore the initial frequency after each frequency shift cycle.

In some circumstances it may be desirable to have two frequencies shifted simultaneously, each with independent initial – and second- frequencies and the second-frequency-onset delays. This might be the case in dual-shift, transfer-trip testing. This may be done by slaving one Model 90A to a second Model 90 by connecting a cable between each of the SYNC I/O connectors. Each instrument’s output will be connected to the tested system load through an appropriate external combining network.

When so connected, the frequency shift cycle for both instruments can be initiated from either instrument. Other than the moment of the frequency shifts, the parameters of each instrument can be programmed, and will function, quite independently of the other.

To carry this out form of master-slave frequency shift keying, after two instruments have been interconnected, requires a specific order of keypad operations. First, the “slave” Model 90A must have its desired initial- or starting-frequency stored in its MEMORY register A. Next, the second frequency and second-frequency-onset delay must be programmed into each instrument as for ordinary FSK operation. The master-slave frequency shift can now be initiated by first pressing the SET keypad on the “master” instrument. This action will bring up to it the LCD display of “—.”, and no change will occur in either instrument’s output. Next press the HLT keypad on the “master” instrument. This will change its LCD display to “—.H”. Again, there will be no change in the “master” output frequency but the “slave” Model 90A’s output will change to the frequency stored in its MEMORY register A - if not already providing such output. Finally, the FSK cycle for both instruments will be initiated by pressing the “master” FSK keypad. Upon this key-press, the output of both instruments will be muted and the new second-frequencies, stored in each MEMORY register B, will appear on each LCD display. Following the delay, programmed in each instrument, the MEMORY B frequencies will appear at each instruments output. The master-slave frequency shift can be repeated by simply restoring the initial-frequency to the “master” instrument and repeating the SET-HLT-FSK key-press sequence on the “master” instrument. While the “master” initial frequency could be restored by unlocking the DIAL and returning, it is far more convenient to have previously stored it in MEMORY register A, placing the MEMORY switch in the “A” position, and restoring it by simply pressing the RCL keypad. If both Model 90A’s have the desired initial-frequency stored in MEMORY register A, than either instrument can serve as the “master”.

This is simply determined by which instrument is chosen for the SET-HLT-FSK key-press sequence.

Master-slave FSK is replaced by logic-driven FSK if option 01 has been activated. See Section 6.1 Option 01.

### 3. Maintenance

#### 3.1 Batteries

The Model 90A employs sealed lead-acid batteries for a reliable portable power source. The user should apply the following guidelines for maintenance in order to obtain the greatest useful battery life.

In normal battery-powered use the instrument will operate in the powered-up state for 6 to 8 hours and produce a complete battery recharge (when connected to the AC power line) in 16 to 18 hours. Before using the instrument after a recharge cycle, check the battery voltage on the “BATTERY” scale of the OUTPUT VOLTS meter by pressing the BAT keypad. If after removing AC line power from the unit the reading is near the top of the “OK” section, the batteries are fully recharged; otherwise, more charging time is required to bring them up to full charge.

The batteries can suffer some loss of recharge capability if they are discharged to a cell terminal voltage below 4.25 volts or 8.5 volts across the battery pack terminals. This condition will not occur under most circumstances. The power switch circuit protects the batteries from a hazardous discharge state by disconnecting the generator from the battery supply when the voltage at the generator drops below 9 volts. The LCD frequency display will indicate a low battery condition of less than 10 volts at the generator by flashing dots between the 2<sup>nd</sup> and 3<sup>rd</sup> and between the 4<sup>th</sup> and 5<sup>th</sup> digits. If the batteries are allowed to remain in a discharged state for a period of time, some difficulty in recharging may occur. If this happens, a prolonged recharge time of 24 hours, or longer is suggested. A short period of discharge followed by another normal 16 to 18 hour recharge cycle may be required to restore the batteries to their full recharge capability. If this procedure fails to recharge the batteries, please consult the factory. Other methods, beyond the scope of the Owner’s Manual, may be able to restore the batteries to their normal operating state.

Lead-acid batteries will self-discharge is left without recharging for an extended period. For best results, the batteries should be recharged every 90 days.

Continued charging of lead-acid batteries, after they have reached the charged state, liberates hydrogen



oxygen gases. The Model 90A internal battery charging circuit minimizes such overcharging and thus, minimizes the production of these gases. Since it is not possible to completely eliminate some outgassing, it is important to maintain ventilation of the instrument case. Do not allow the ventilation plugs, on the sides of the case, to become obstructed while the batteries are being charged.

### **3.2 Fuse replacement**

Fuses protect the circuits of the Model 90A in two places and can be accessed by removing the front panel.

The AC Line Fuse, XF2, affects operation of the instrument from the AC power lines as well as battery charging. The position of this fuse is shown in Figure 4. When necessary it should be replaced with a 3AG(1/4" X 1 1/4") 1A fuse.

The battery pack is protected from overload by Fuse XF1 and is also shown in Figure 4. If no battery voltage is shown on the Output Level meter when the BAT keypad is pressed, this fuse may be open. It should be replaced with a 3AG 5A fuse. Both fuse-holders for XF2 and F2 require 1/4 turn with a screwdriver for opening and closing.

### **3.3 Cleaning**

The front panel may require periodic cleaning to maintain appearance and readability. When cleaning is required, first remove loose debris with a soft cloth or brush. More stubborn soil and stains may then be removed with a soft cloth dampened with a mild water-solution of detergent. Care should be taken to see that the detergent solution does not flow through the panel holes into the instrument and panel controls. Always work with a rather "dry", only slightly dampened, cloth. Avoid the use of chemically harsh or abrasive cleaners or any form of organic solvents.

The aluminum case may also be cleaned with a mild water-detergent solution. If such detergent fails to remove such substances as grease or tar, naphtha may be used. Do not use "lacquer thinners", as they will damage the paint.

### **3.4 Repairs**

The instrument should be returned to the factory for repairs beyond the replacement of fuses and minor mechanical adjustments. Please telephone the factory (973) 781-0880 for a Return Authorization Number and return the instrument prepaid. Be sure to include a short description of the trouble.

### **3.5 Subassembly cable connections**

The Model 90A consists of subassemblies, a front panel, and a cabinet. The cable interconnections of these components are shown in Figure 5. Before disconnecting any cable, take careful note of the orientation of the connector. Many connectors are not self-polarizing and may be reconnected in the wrong polarity.

#### 4. Specifications

##### Frequency

Range ..... 0.100 to 500kHz  
 Resolution ..... 1 Hz  
 Accuracy ... Typ: 2ppm, Max: 5ppm, -10 to 50 C  
 Stability ..... 1 ppm, -10 to 50 C

##### Tuning

Dial mechanism ..... Optical encoder  
 Resolution ..... 1Hz; 100Hz; 1 kHz - Selectable  
 Rates ..... 64 Hz; 6.4 kHz; 64 kHz / revolution

**MEMORY** ..... 10 User programmable Frequency Storage Registers.;  
 FSK delay & second-freq.; Sweep increment rate & frequency limits.

	Low Level 0.100 - 500 kHz	Hi Level 0.100 - 500 kHz
Max. undistorted power into 50 ohm load	0.8 W	2.0 W
Max. undistorted power into 50 ohm load	2.00 VRMS	10 VRMS

-1 Output voltage accuracy ..... Low Power  $\pm 5\%$  of Full Scale (3V  $\pm 0.15V$ ), High Power  $\pm 2.5\%$  of Full Scale (20V  $\pm 0.5V$ )  
 -1 Spurious output ..... -70 dB  
 -1 Harmonics ..... -55 dB

##### SWEEP

Resolution	Sweep Rate		
	50 incrm./s	100 incrm./s	200 incrm./s
1 Hz/incrm.	50 Hz/s	100 Hz/s	200 Hz/s
100 Hz/incrm.	5 kHz/s	10 kHz/s	20 kHz/s
1 kHz/incrm.	50 kHz/s	100 kHz/s	200 kHz/s

##### FREQUENCY SHIFT (FSK)

Shift range ..... 0 to  $\pm 499.9$  kHz  
 Delay range, accuracy ..... 0 to 999 milliseconds,  $\pm 0.2\%$   
 Delay resolution ..... 1 millisecond

**SYNC INPUT/OUTPUT** ..... TTL Level/3.75 V behind 100 ohms

**CONNECTORS --- RF Out and Sync I/O** ..... BNC female

##### BATTERY

Capacity ..... 7.5 AH  
 Recharge Rate ..... 0.5 AH

**AC OPERATION** ..... 120 / 240 VAC  $\pm 10\%$ ; 50/60Hz

##### TEMPERATURE RANGE

Operating ..... -10 to 50 C  
 Storage ..... -30 to 85 C

**SIZE** ..... 18 x 28 x 24 cm (7 x 11 x 9.5 in)

**WEIGHT** ..... 6.36 kg (14 lbs)

## 5.0 Options

The following options are available for the Model 90A.

### 5.1 Option 01 Driven FSK/On-Off keying

This is a firmware change that affects only the function of the SYNC I/O port. The change eliminates master-slave FSK operation of the standard Model 90A but provides the replacement feature of logic drive of either FSK or On-Off keying by a suitable signal applied to the SYNC I/O connector. (Note: the SYNC I/O output pulses arising from single-button initiation of sweep or FSK are still present and unaffected by this option.)

#### SYNC I/O drive requirements.

The drive signal must be TTL-level positive logic square waves; i.e., 0 volts to represent logic 0 and +4.75 volts to represent logic 1. CMOS or TTL inverters or gates (not “open collector” types) are suitable driving sources.

#### Driven FSK mode [‘SET’ – ‘HLT’ – ‘FSK’ Key sequence]

- a. The Model 90A sends either of two frequencies depending on the logic level supplied to the SYNC I/O connector.

Logic 0 (0 volts) sends the frequency in MEMORY register A.

Logic 1 (+4.75 volts) sends the frequency in MEMORY register B.

During the driven FSK mode only the A frequency will be shown on the LCD display.

- b. The driving frequency should not exceed 1000 Hz. If a particular baud rate is desired, set the drive frequency to half the desired rate. For example, if 1200 baud is required, set the drive frequency to 600 Hz.
- c. To enter the driven FSK mode press ‘SET’, then ‘HLT’ and then ‘FSK’.
- d. To exit this mode pres “RST’

#### Driven On-Off keying mode [‘SET’ – ‘HLT’ – ‘SWP’ key sequence.

- a. The Model 90A sends the frequency in MEMORY register A when logical 1 (+4.75 volts) is applied to the SYNC I/O connector and is muted when a logical 0 (0 volts) is applied.
- b. The maximum reliable keying rate, set by the SYNC I/O input drive frequency, is limited to 100 Hz.
- c. To enter the Driven On-Off keying mode press ‘SET’, then ‘HLT’ and then ‘SWP’.
- d. To exit this mode pres ‘RST’.

## **5.2 OPTION 04 Low-Level Attenuator**

This option, installed in the lid of the Model 90A, is a three-range attenuator using a combination of resistive and transformer voltage division. With an nominal attenuator input of 10 Volts from the MODEL 90A RF OUT connector, the Attenuator output can be adjusted continuously from 3.0 to 30.0 millivolts, 30 to 300 millivolts, and 0.30 to 3.00 volts. A 3-11/2- turn vernier potentiometer allows easy setting of the desired output level within each range. Each range can be extended 50% higher or lower by setting Model 90A RF OUT level to 15 and 5 volts, respectively. The Attenuator RMS output level, shown as the voltage across its output connector, is indicated on a 3-digit liquid crystal display. The displayed level is accurate to  $\pm 5\%$  over the frequency range to 15 to 500 kHz and all levels into loads of 27 ohms and higher. The Attenuator is powered by a pair of 9 volt “transistor” batteries with a typical life of 4 hours when used for 2 hours per day. A LO BAT message is shown on the LCD display when the batteries should be replaced.

### **Panel controls, Connectors and Display**

Please refer to Figure 7 for the following descriptions.

#### **ON/OFF POWER switch**

This switch turns the internal battery power on or off to the LEVEL display circuitry. The Attenuator itself is entirely passive and continues to function in either position of the power switch.

Closing the lid will automatically throw the power switch to the OFF position by the lever installed under the lower left mounting screw of the Model 90A panel.

## MODEL 90A KEYPAD FUNCTIONS

- RST Restores the instrument to its last used condition, dial locked.
- VFO Locks or unlocks the frequency tuning dial.
- SET Enables operator to SWP select sweep increment rate.
- SWP Starts or restarts the sweep function.
- HLT Interrupts the sweep function.
- STO Stores or retrieves or frequencies to and from RCL the memory registers.
- SET Enables operator to FSK select FSK delay interval.
- FSK Initiates frequency shift function.

**CAUTION**

KEEP BATTERIES CHARGED  
USE OF HIGH RANGE AT  
FREQUENCIES BELOW 4KHZ  
MAY RESULT IN DISTORTED  
WAVESHAPES

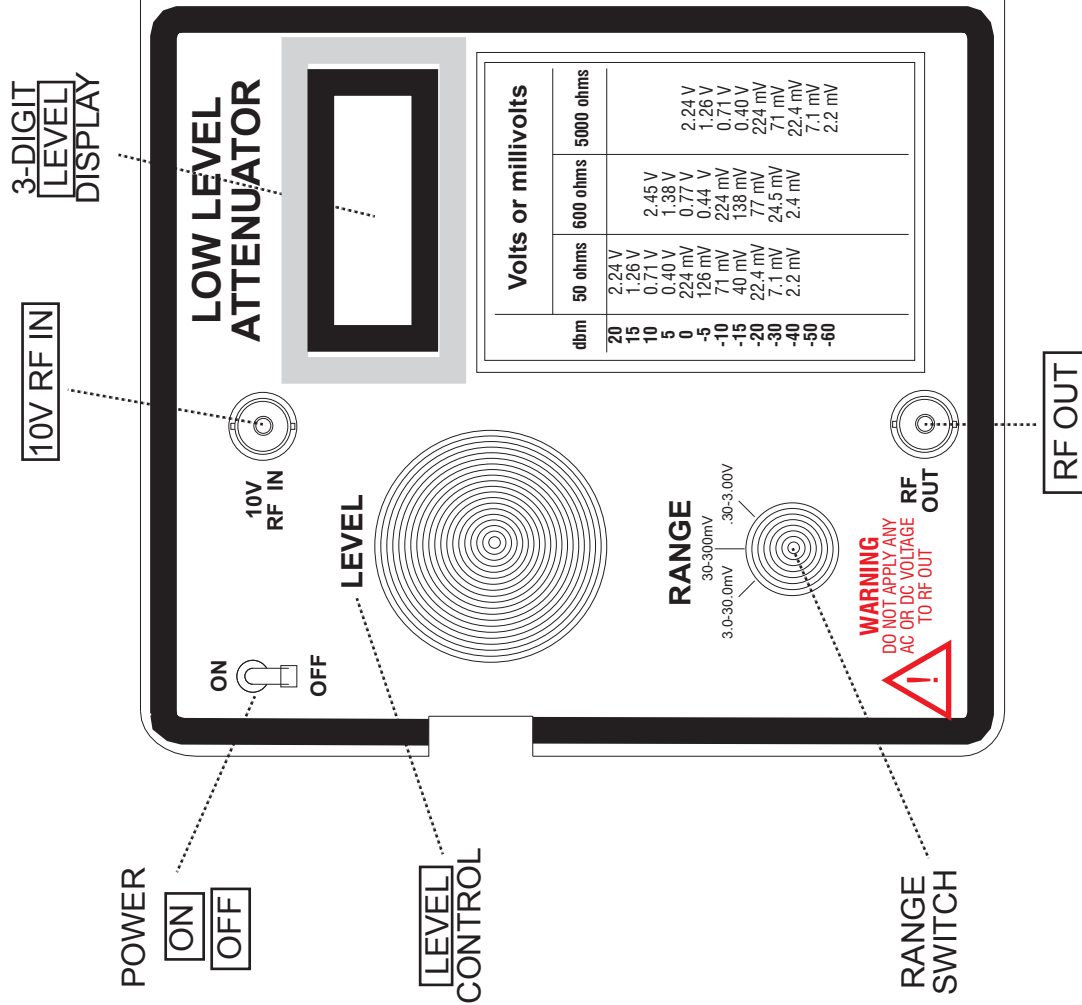


Figure 7. Model 90.04A Low Level Attenuator front panel.

## **LEVEL Control**

The output level within any of the selected ranges is set by this 1-1/2-turn vernier potentiometer. The vernier, as well as the large knob, make setting a desired value easily done. It should be noted that the display is updated about three times per second and therefore adjustment should be made slowly as the exact desired output level is approached. If adjustment is attempted too rapidly, the desired level will be overrun and seen a moment later when the display catches up.” There is a small amount of backlash in the vernier control. Thus, for greatest convenience, try to approach the desired level from one direction and more slowly as the desired level is neared.

A slip clutch is provided on the LEVEL control vernier. When either extreme of control adjustment is reached further rotation in the same direction produces a clicking sound. When this occurs, simply change the RANGE switch and reserve direction of the control rotation to resume level adjustment.

## **10 VOLT RF IN Connector**

The Attenuator input signal is supplied to this BNC connector via the provided coaxial cable from the Model 90A RF OUT connector. The input signal level should be set to 10 VRMS by setting the Model 90A output on the HI range and adjusting its LEVEL control for 10 volts indicated on the Model 90A OUTPUT VOLTS meter. Attenuator output levels can be adjusted outside their nominal ranges by changing the Attenuator input levels to any value between 5 and 15 volts. The Attenuator display may NOT read correctly if the input levels are less than 5 volts nor greater than 15 volts. Input impedance varies between 100 and 150 ohms dependent in the Attenuator load and LEVEL and range adjustment.

## **RF OUT Connector**

The test load is driven from this BNC connector. The LEVEL display shows the RMS voltage appearing

directly across the RF OUT connector terminals. Thus, when this output voltage level is maintained constant the effective output impedance is zero ohms. The physical source impedance varies with the level and range adjustment. On the lower two ranges where transformer voltage step down is used, the source impedance becomes a fraction of an ohm.

An internal 1A fuse protects the Attenuator from accidental connection to a current source.

## **LEVEL Display**

This is a 3-digit liquid crystal display that shows the output level as the RMS voltage appearing directly across the RF OUT connector. On the two lower ranges it displays the level in terms of millivolts ( 3.0 to 30.0 mV and 30 to 300 mV) and on the high range in terms of volts (0.30 to 3.00V). The circuitry driving the display employs a linear averaging detector and integrating digital voltmeter calibrated to read in RMS volts.

The display also has a LO BAT annunciator. When the positive rail battery voltage falls to 7.0 volts the LO BAT message will appear on the left side of the display. The LO BAT message will disappear when the voltage falls below 6.0 volts. Therefore it is important to change BOTH batteries as soon as this message appears.

## **Using the Low Level Attenuator**

### **The Proper Hookup**

All that is required to use the Attenuator is to insert it between the Model 90A RF OUT connector and the test load. To do this attaches one end of the provided coaxial cable to the Model 90A RF OUT BNC connector and the other end to the 10V RF IN connector on the attenuator. Then, attach the test load, such as a receiver, to the Attenuator RF OUT BNC Connector by any convenient cable.

Like the Model 90A itself, the Attenuator source impedance should be regarded as near zero ohms. This will always be true when the displayed output level is maintained constant, despite changes in the load. If a specific source impedance is required (to drive calibrated attenuators, terminated filters or

other input impedance-sensitive loads), simply place a resistor, R of a value equal to the desired source impedance, in series between the load and the center terminal of the RF OUT connector. The displayed output level is the read as the output behind R ohms.

### **Operation**

When connections are complete, turn the Model 90A power on, set its level to the HI range, and adjust its level to 10 volts, as seen on the OUTPUT VOLTS meter. Switch the Attenuator power ON to see the Attenuator output level present across its RF OUT connector. The desired output level can then be set by adjusting the Attenuator RANGE switch and LEVEL vernier potentiometer. Tune the Model 90A to the desired frequency in the normal manner.

The Attenuator is functional when its power switch is turned off; simply the display is not operating. Thus, if independent means are used to monitor the Attenuator output level then it is not necessary to turn the Attenuator power on. Or, if a given signal level is to be used for a prolonged period, with no readjustments of either the Model 90A or the Attenuator, the Attenuator power switch can be turned off to extend the battery life. Only turn the power on when necessary to display a new level.

All regular functions of the Model 90A may be used with the Attenuator.

Since the Attenuator adds extra weight to the lid, a pair of chain lid supports are supplied. The chains are attached to clips mounted under the upper Model 90A front panel screws.

### **Maintaining the Low Level Attenuator Batteries**

Two 9-volt batteries are used to power the Attenuator display circuits. The average current drain is 130 milliamperes. A typical battery life will be about 4 hours. The LO BAT annunciator message will appear on the LEVEL display when the positive rail battery voltage falls to 7 volts. This message will continue until this battery voltage falls to 6 volts. The display will continue to function normally within this interval. As the battery voltage falls below 6 volts the display numbers will begin to fade, the LO BAT message will disappear, and the indicated level will be inaccurate. Therefore it is important to change BOTH batteries as soon as the LO BAT message appears or when the display appears faint with low contrast.

To change the batteries, the Attenuator panel must be removed from the lid. To do this, release the 6 black “nylatches” on the panel and the 2-latches on the hinged door and lift the panel and door out of the lid. The batteries will be found in the clips on the back of the large circuit board. Gently disconnect each battery and remove them from their clips. Replace each with fresh batteries. To check that the new batteries have been properly installed and are really fresh, turn on the power switch. A high contrast display of one or two zeroes should be seen and the LO BAT message should NOT appear. When the battery installation check is successful, turn the power switch off and carefully replace the panel and the mounting brackets. Secure the panel and door in place by pressing the nylatches down until they snap.



position of the RANGE switch and LEVEL control. A very high reading indicates that the fuse is open and must be replaced.

To replace the fuse remove the panel as described under the Battery replacement above. The fuse is of the smt variety and is found on the small Attenuator circuit board. Remove the old fuse by heating the turret terminals with a small smoldering iron and pull each lead out with long nose pliers. With a little rosin-core solder reheat the turrets and insert the leads of a new fuse. Dress the fuse and its leads in the same position you found the original fuse. Check that the fuse replacement corrected the lack of output signal by connecting an oscilloscope or RF voltmeter to the RF OUT connector and the Model 90A signal into the 10 V RF IN connector. Presence of the RF OUT signal shows the replacement was successful. Install the panel back into the lid as describe previously.

### **Cleaning**

The panel may require cleaning to maintain appearance and readability. When cleaning is required, first remove loose debris with a soft cloth or brush. More stubborn soil and stains may be removed with a soft cloth dampened with a mild water and soap or detergent solution. When doing this, do not allow solution to flow through the panel holes into the connectors, switches, the LEVEL Control or interior of the Attenuator. Always work with only a slightly dampened cloth. Avoid the use of harsh or abrasive cleaners or any form of organic solvent.

### **Repairs**

The low Level Attenuator should be returned to the factory for repairs beyond the replacement of batteries Please telephone the factory (973) 781-0880 for a Return Authorization Number and return the instrument shipping prepaid. Be sure to include a short description of the trouble. If it is certain that the problem is only the Model 90.04 Attenuator, only needs to be returned (it is suggested that you ship it in the Model 90 lid). If there is some uncertainty as to whether the problem is in the Attenuator or the Model 90A itself, the return the complete Model 90A and Low Level Attenuator unit.

## **6.0 Addendum**

### **6.1 Lead acid battery replacement**

To remove the battery pack first make sure the power cord is disconnected from the Model 90A. Remove the four black mounting screws from the front panel. Lift the front panel from the lower case assembly. The cable connecting the front panel assembly to the lower case assembly is the battery charger cable. Disconnect the cable by unplugging it from the panel assembly. To remove the two (2) #10 screws holding the battery pack to the lower case assembly. Lift the free end of the battery pack and locate the plug that connects to the battery charger board. Disconnect the plug and life the battery pack from the lower case assembly.

To remove the batteries first disconnect the battery cable and the battery wires from the battery spade terminals. The batteries should slide out the open end off the pack.

Insert the new batteries into the pack . Connect the black wire of the battery cable to the negative terminal. Connect the white wire of the battery cable to the last positive terminal (red). Connect the battery jumper wire from the positive terminal of a battery to the negative terminal of the next battery. When all wiring has been installed the voltage measured between the black and white wires of the battery cable should be approximately 13 volts.

Position the battery pack so that the battery cable may be connected to the battery charger board located in the lower case assembly. Make sure the locking sides of the connectors are facing each other and the pins are properly aligned before connecting the battery pack to the battery charger board. Connect the cable from the battery charger to the front panel assembly.

Verify the connections by pressing the 'BAT' switch on the front panel. The meter on the front panel should read in the 'BAT OK' range.



The battery pack is now ready to install into the lower case assembly. Slide the tab protruding from the bottom of the battery pack into the lower case assembly and secure using two (2) #10 screws. Do not over-tighten. The threads in the aluminum base plate will strip if over-tightened.

Place the front panel assembly in the lower case assembly and secure with the four black mounting screws. Perform another battery check to verify successful battery replacement. The Model 90A should be allowed to charge overnight prior to field use.

# SIGNALCRAFTERS 1 YEAR LIMITED WARRANTY

Signalcrafters Tech, Inc. warrants this product to be free from defects in material and workmanship under normal use and service for a period of 1 year after shipment to the original user and, at Signalcrafters option, will replace or repair any product, at no charge which has become defective while under warranty, and which is still under warranty.

This warranty shall not apply to any Signalcrafters product which has been (a) subjected to misuse, neglect, accident, incorrect wiring not of our own installation, or (b) subjected to use in violation of instructions furnished by Signalcrafters Tech, Inc., or (c) repaired or altered outside of our factory or without our express authorization.

The warranty registration card must be on file at Signalcrafters to validate the date of purchase, and shipment to Signalcrafters Tech, Inc., must be prepaid. Factory shipment after in-warranty service will be prepaid to the customer.

Incidental or consequential damages, such as loss of use, loss of time, inconvenience, expenses for transportation, travel, telephone, or lodging, loss of or damage to personal property, commercial loss, loss of revenue or profits, or other matters not specifically included by the express terms of this warranty, are not covered.

THIS WARRANTY IS THE ONLY EXPRESS WARRANTY MADE BY SIGNALCRAFTERS TECH, INC., APPLICABLE TO THIS PRODUCT. ANY IMPLIED WARRANTY APPLICABLE TO THIS PRODUCT IS LIMITED IN DURATION TO THE DURATION OF THIS WRITTEN WARRANTY. NO REPRESENTATIVE OR PERSON IS AUTHORIZED TO ASSUME FOR US ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF OUR PRODUCTS.

Some states or provinces do not allow the exclusion or limitation of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary by state or province.

Should you desire warranty service, you may contact Signalcrafters Tech, Inc. 57 Eagle Rock Avenue, East Hanover, NJ 07936-3144,  
Telephone: 973-781-0880 or 800-523-5815