Signalcrafters
TECH, INC

OWNERS MANUAL

MODEL 90

HIGH LEVEL VLF SIGNAL SOURCE

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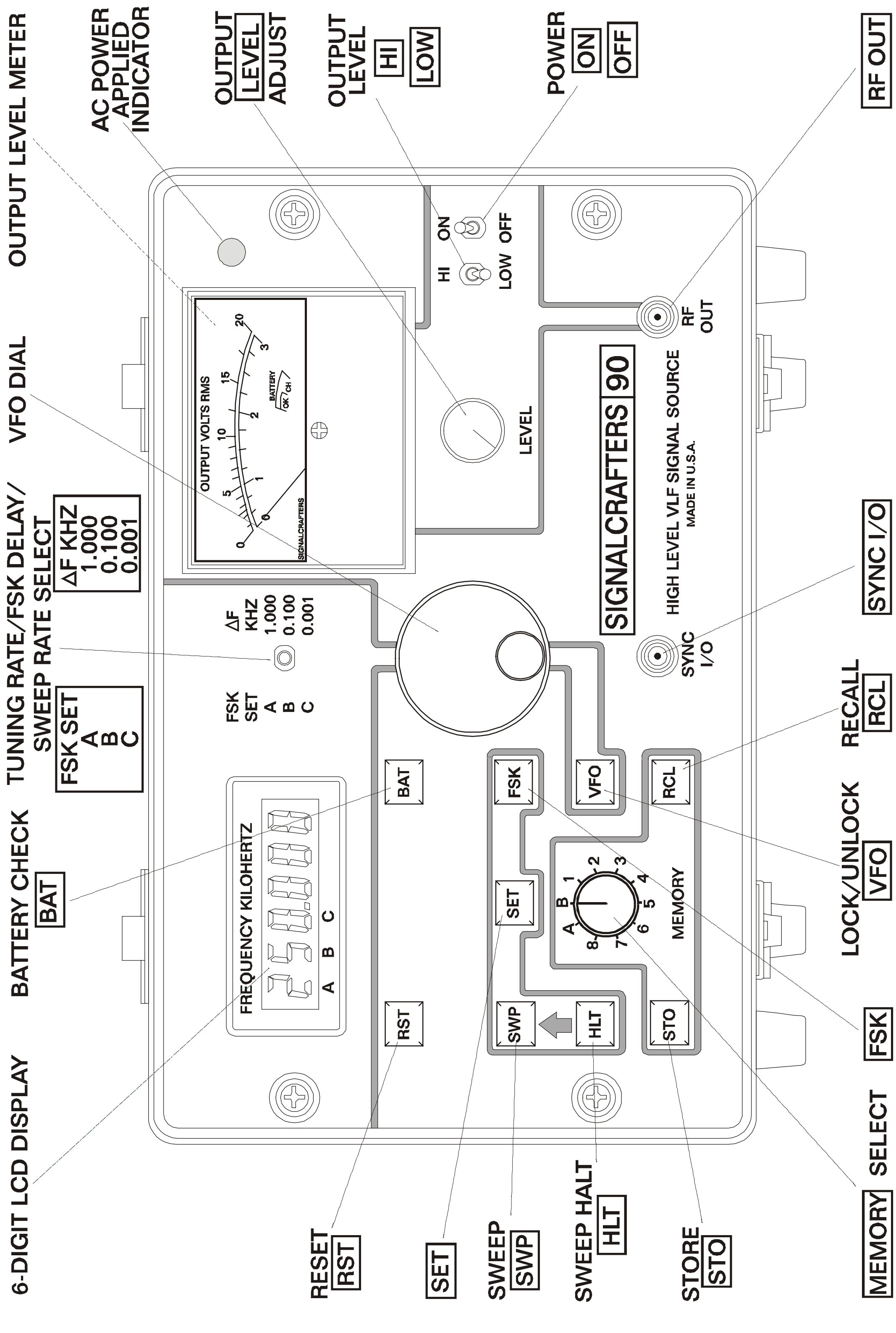

Figure 1 Model 90 High Level VLF Signal Source front panel

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

1.1 Overview

The Model 90 is directly synthesized, micro-processor-controlled signal source operating in the very low frequency (VLF) range of 0.100 kilohertz (kHz) TO 500 kHz. The output frequency may be adjusted in increments of 0.001; 0.100, or 1.000 kHz (1,100 or 1000 Hz) by manual "variable frequency oscillator" (VFO) DIAL tuning, selection from any of ten user-present MEMORY registers, sweeping from any present low frequency to any preset higher frequency, or frequency shift keying (FSK) between any two frequencies. When in the sweep mode, a synchronizing pulse is presented at the SYNC I/O connector at the start of each sweep. In the FSK mode the same synchronizing pulse is generated each time a frequency shift is initiated from the panel keypad. 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 90. When FSK is initiated the current output frequency is interrupted and the second frequency appears after a user –adjustable delay of from 0 to 999 milliseconds (ms). 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 0 to 40 degrees Celsius(C). Harmonics are at least 35 decibels (dB) below the fundamental signal level and other spurious frequencies are 50 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 frequency range of 4 kHz to 500 kHz and up to 70 milliwatts (mW) from 0.100 kHz to 500 kHz. Continuous output level adjustment is in two ranges, 0 to 1.9 (0.100 to 500 kHz) and 0 to 10 volts (4 to 500 kHz), root mean square (RMS), into 50 ohms or to 2.5 and 16 volts RMS, respectively, into an open circuit. The output voltage level indicated on the OUTPUT VOLTS panel meter and constantly shows the voltage appearing across the RF OUT connector

The Model 90 may be operated either from the 60 Hz power line or from its internal, rechargeable batteries. When the batteries are fully charged, the device can deliver 2 watts continuously for 6 hours at 25 degrees C. Longer operation per battery charge can be obtained at reduced power output. The batteries can be fully recharged by the internal charger in 14 to 16 hours. The Model 90 can be operated from 60 Hz line power while the batteries are recharging even if the batteries are completely discharged. Line operation can also be done with the batteries disconnected.

The Model 90 will operate normally over the temperature range 0 to 40 degrees C (32 degrees Fahrenheit (F) to 104 degrees F). But battery life will fall in a nearly linear fashion from 100% at 25 degrees C to 55% at 0 degrees C. Routine operation below 0 degrees C is not recommended, but the device will operate at reduced specifications down to –20 degrees C (-4 degrees F). Storage is permitted at temperatures –30 and 85 degrees C (-22 to 185 degrees F) but battery self-discharge increases at the higher temperature s (50% self-discharge in 9 months at 25 degrees C degreasing to 4 months at 40 degrees C).

Options are available as follows: Replacement of the slave FSK with a TTL-level logic drive of either frequency shift or on-off keying (Option 01); RF Output protection from accidental applications of voltages to the RF OUT connector (Option 03), standard in all units SN481 and later; and a Low Level Attenuator and digital level display mounted in the Model 90 lid (Option 04).

1.2 Function of the panel controls and indicators.

Please refer to Figure 1 (p.iii) for the following descriptions.

ON/OFF power switch

When the switch is in the "OFF" positions all memory functions are retained (and will be retained even if the internal rechargeable batteries are disconnected). If the power cord is connected to an active 60 Hz power source the internal batteries will be charged or maintained on a trickle charge.

When the switch is first placed in the "ON" position the instrument will be powered up, a firmware system-wide check performed, the output frequency set to the frequency shown on the LCD display when the instrument was previously turned off, and the VFO tuning dial (DIAL) locked. If the power cord is connected to an active 60 Hz powers source battery charging will continue as needed.

Closing the instrument lid will mechanically throw the switch to the "OFF" position.

AC Power Applied Indicator

The red indicator LCD lamp indicates the presence of DC voltage at the input of the battery charging circuit. The lamp will be lit when 60 Hz power is applied to the unit.

Frequency LCD Display

The 6-digit LCD display shows the output frequency in kilohertz with a resolution of .001 kHz (1 Hz). When programming sweep rates or FSK delays, it will display for user selection, 1 of 3 sweep increments (50, 100, or 200) per second or FSK second-frequency-onset delay in milliseconds (0 to 999). A low battery charge condition will be indicated by flashing dots between the 2nd and 3rd, and between the 4th and 5th digits.

Output Volts meter

The 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 03 volts RMS and is used when the HI/LOW switch is in the "LOW" position. The short bottom scale labeled "BAT OK" indicates the charge state of the batteries when the "BAT" keypad is pressed. The low mark indicates a minimum satisfactory charge state. The center mark indicates s full charge state under trickle charge conditions. The high mark indicates a near full charge state under high charging conditions. When the power cord is not connected and the internal charger not functioning, the battery charge level is satisfactory when the meter reads above the lowest mark.

Variable frequency oscillator (VFO) tuning DIAL

The VFO tuning DIAL allows manual tuning of the output frequency as well as presetting frequencies into 10 MEMORY registers. The DIAL is locked or unlocked by pressing the VFO keypad. The DIAL changes frequency in 64 increments per revolution. The size of the frequency increments is set by the position of the FSK SET/ΔF KHZ switch immediately above the DIAL and can be 0.001, 0.100, or 1.000 kHz (1,100, or 1000 Hz) per increment. When the Model 90 is first powered up with the OFF/ON switch the DIAL will be locked and the frequency will be that formerly sent when the instruments was turned off.

VFO VFO tuning DIAL lock/unlock key

The VFO tuning DIAL can be locked or unlocked by pressing the VFO keypad. When the DIAL is in the unlocked state the decimal point of the LCD display will blink. The DIAL must be locked in order to store or recall frequencies from the MEMORY registers and for FSK and sweep operations.

HI/LOW Output high/low level switch

When the switch is in the "HI" position the output level van be adjusted from 0 to 16 volts (open circuit) by the LEVEL control and the upper scale on the Output Level meter is used. This setting should only be used for frequencies of 4.000 kHz and higher. (The output waveform will be distorted if the switch is in the high position and the frequency becomes less than 4 KHz by any mode of operation.) 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 control and the middle scale of the OUTPUT VOLTS meter is used.

The RF Output Protection option (Option 03) has been installed, see Section 6.3 Option 03, paragraph f on disconnect trip and the following reset procedures.

LEVEL Output level adjustment

Output level can be set to any voltage level between 0 and that determined by the setting of the HI/LOW switch by positioning the LEVEL control. The voltage level of the output is read on the appropriate scale on the OUTPUT VOLTS meter.

A low-level attenuator and digital output level display is available as Option 04. If this is option has been installed, see Section 6.4 Option 04.

FSK SET/ΔF KHZ Tuning rate/FSK delay/ sweep rate select

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

Locked DIAL, FSK SET: 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 that shown on the LCD Display at positions "A", "B", and "C". Position A represents hundreds - , B represents tens -, and C represents units of milliseconds delay.

Locked DIAL, sweep mode: The switch sets the increment size in the sweep mode as 0.001, 0.100, or 1.000 kHz. 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.

MEMORY Memory select

This switch allows storing, or recalling, frequencies to, or from, 10 MEMORY registers.

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

Register B also serves as the source 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 keypad

When the DIAL is locked, pressing the STO keypad will store the displayed frequency into the MEMORY register selected by the MEMORY switch position. This action will replace any frequency formerly stored in the register.

When the DIAL is unlocked this keypad is in-operative.

RCL Recall keypad

When the DIAL is locked, pressing the RCL keypad will retrieve, and output, the frequency stored in the MEMORY register selected by the MEMORY switch position. This action will not alter the frequency stored in the register.

When the DIAL is unlocked this keypad is in-operative.

SET – Setting sweep, FSK delay, or Master / slave FSK

When the DIAL is locked, pressing the SET keypad 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. Normally, the FSK, SWP or HTL keypads will be pressed after the initial press of SET.

When the DIAL is unlocked this keypad is inoperative.

SET –SWP Setting the sweep rate in single or repetitive mode

Pressing the SWP keypad immediately after pressing the SET and obtaining a display of "---." Will bring up the LCD display of "50.", "50.P", "100.", "100.P", "200.", or "200.P". These represent the number of the frequency increments per second the frequency will increase during sweep operation and whether the sweep will be rePetitive ('-P), or not ('-."). The magnitude of the frequency increments is determined by the position of the FSK SET/ΔF KHZ switch. Pressing SWP again will advance the LCD display to the next choice, rolling over from "200.P" to "50", and continue for each SWP keypad press. When the desired increment rate and repetitive or single sweep mode is displayed, pressing SET again will place the selection into MEMEORY and take the instrument out of the SET mode.

SWP Sweep mode operation

Pressing SWP keypad 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 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 increase is determined by the product of the sweep increment rate determined by the product of the sweep increment rate stored in MEMORY and the position of the FSK SET/ΔF KHZ switch. The sweep will stop at that stored in MEMORY register B if a single sweep mode was stored in memory. If a repetitive mode was selected, upon reaching MEMORY B frequency, the frequency will instantly change to that stored in MEMORY register A and again sweep to B and 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.

When the DIAL is unlocked this keypad is inoperative.

HLT Sweep halt

Pressing the HLT keypad while in sweep mode will cause an immediate cessation of the sweep. The displayed and output frequency will remain at the frequency that was occurring when the keypad was pressed. Sweep may be resumed at the displayed frequency (if the DIAL is locked) by pressing the SWP keypad.

When the DIAL is unlocked, or if not in the sweep mode or the set mode, this keypad is inoperative.

SET - FSK Setting FSK second-frequency-onset delay

Pressing the FSK keypad immediately after pressing the SET and obtaining a display of "---." Will bring up to the LCD some 3-digit number. This number represents the milliseconds delay in the onset of the second-frequency output, stored in MEMORY register B, when frequency shift keying is activated. Each additional press of the keypad will advance the LCD display digit - A, B, or C selected by the position of the FSK SET/ΔF KHZ switch. Rollover, with no carry or borrow, will occur when advancing from "9" to "0". When all three digits have been selected for the desired delay in milliseconds, pressing SET again will place the delay in MEMORY and take the instrument out of the set mode.

FSK Frequency shift keying

When the DIAL is locked and the instrument is not in the set mode, pressing the FSK keypad will initiate frequency shift keying. Upon pressing the keypad the displayed output frequency 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 keypad again will interrupt the output of the register B frequency for the delay period and then the register B frequency output will resume.

When the DIAL is unlocked the keypad is inoperative.

SET-HLT-FSK Master Slave FSK Operation
Master-slave FSK operation of a pair of Model 90s can be done by interconnecting each SYNCH I/O connector. Each Model 90 may be programmed for it's own starting-frequency, second-frequency, and second-frequency-onset delay. The "slave" Model 90 must have the starting frequency stored in MEMORY register A. The starting-frequency for the "master" is that showing on its 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 SET on the "master will bring up to the LCD display "---." There will be no change in the output frequency of either instrument. Next, pressing the HLT keypad 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 90s will then be initiated by pressing the "master" FSK keypad. When the FSK keypad 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 90 may be the "master". This is simply determined by which one is activated by the SET, HLT, and FSK keypad-press 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.

RST Reset

Pressing the RST keypad restore the instrument to its initial power up state. The display and output frequency will be that currently present and the DIAL will be locked. MEMORY will not be altered.

This keypad is always operational when the instrument is powered up.

BAT Battery Check

Pressing the BAT keypad will display the charge state of the internal batteries on the lower scale of the OUTPUT VOLTS meter.

This keypad is always operational and independent of the setting of the OFF/ON switch.

SYNC I/O Synchronizing input and output

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

Application of a pair of pulses to this connector from a second 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 installed. If this option is installed, see section 6.1 Option 01.

RF OUT Signal output

The output signal appears at this connector of the frequency indicated on the LCD display and the voltage level indicated on the OUTPUT VOLTS meter. The source impedance of the signal between 30 and 40 ohms.

2. Using the Model 90

2.1 The proper hookup

RF OUT

The output from the Model 90 RF OUT connector may be connected to passive, reactive or resistive, loads of any impedance from 0 to open circuit. While the RF OUT connector is fuse protected (See Section 3 – Maintenance), connection to low impedance sources of greater that +/- 20 volts should be avoided.

An RF OUT protection circuit is available as Option 03. If this option has been installed, see Section 6.3 Option 03. This Option is standard in all units SN481 or later.

The source impedance of the Model 90 output is between 30 and 40 ohms. Since the OUTPUT VOLTS 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, R of a value equal to the desired source impedance, in series with the RF OUT center terminal. The OUTPUT VOLTS meter will then read the output voltage behind R ohms.

Because the actual source of impedance is grater 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 90 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 keypad (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 90.

Synchronized master-slave frequency shift keying may be produced by using a pair of Model 90s 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 installed. See Section 6 Options, Option 01.

POWER CORD

The Model 90 may be operated from either its internal rechargeable batteries or from the 50/60 Hz power line. When line operated or to charge or maintain the batteries, the power cord must be connected to the line voltage source. The source may be user-selected as either 115 volts or 230 volts by positioning the internal line voltage switch. This switch is located on the battery charger circuit board. IT is accessed by removing the front panel, see Figure 2. The switch is in the 115-volt position when the Model 90 is shipped from the factory.

If 230-volt operation is selected by the positioning A2A2S1 in the "230V" position, the fuse, A1A2F1, should be changed to a 3AG 3/8-ampere type (see Section 3.2 Fuse replacement). Since there are several types of 230-volt receptacles in common use, 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 90 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.

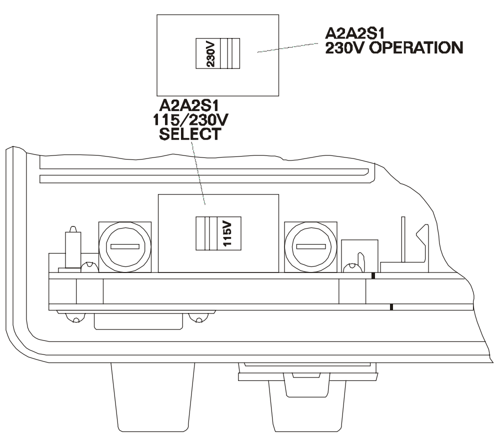

Figure 2. Line voltage select switch on the battery charger circuit board

2.2 Frequency limits

The Model 90 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. However there are some limitations as to the frequencies that can be achieved under certain settings and operations of the panel controls.

HI/LOW output level switch

The "HI" position of the HI/LOW switch should only be used for frequencies of 4.000 kHz and above. Attempting an output below 4.000 kHz when in the "HI" position, by any mode, will produce a severely distorted waveform of progressively decreasing level. Therefore, always place the switch in the "LOW" position when frequencies below 4.000 kHz will be used.

The instrument will NOT be damaged by any combination of HI/LOW switch position and output frequency.

See section 6.3 Options 03, paragraph, f. if Option 03 has been installed.

FSK SET/ΔF 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/ΔF 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/ΔF 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/ΔF 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 if 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/ΔF 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/ΔF 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/ΔF 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 90 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 store 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 MEMOERY 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/ΔF 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 90 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.

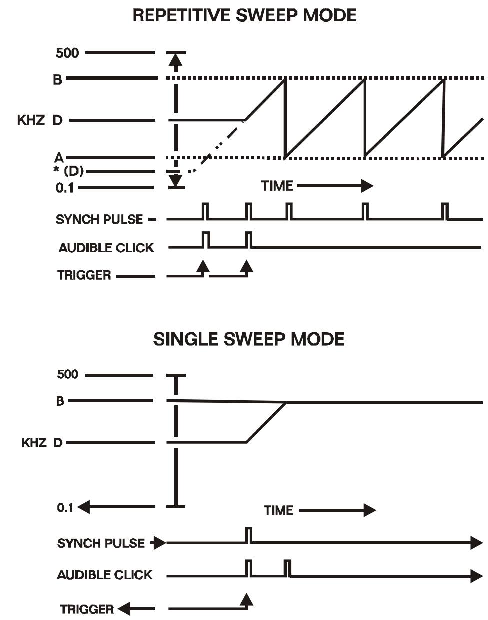

Figure 3. Output frequency, SYNC I/O pulses, and audible clicks verus time. A - Low frequency limit; B - High frequency limit; D - Indicated display frequency when SWP keypad pressed. If the indicated display frequency is lower than the MEMORY A frequency, the MEMORY A frequency is ignored on the first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

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 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 90 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 90 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 90 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 90'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 90s 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 installed. See Section 6.1 Option 01.

3. Maintenance

3.1 Batteries

The Model 90 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 1.70 volts or 15.3 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 15.8 volts. The LCD frequency display will indicate a low battery condition of less than 16.2 volts at the generator by flashing dots between the 2nd and 3rd and between the 4th and 5th 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 90 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 90 in three places and can be accessed by removing the front panel.

The AC Line Fuse, A2A2F1, affects operation of the instrument from the AC power lines as well as battery charging. The position of this fuse is shown is Figure 4. When necessary it should be replaced with a 3AG(1/4" X 1 ¼") ¾ A fuse for 115-volt operation or a 3/8 A fuse for 230-volt operation.

The battery pack is protected from overload by Fuse A2A2F2 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 1 ½ A fuse.

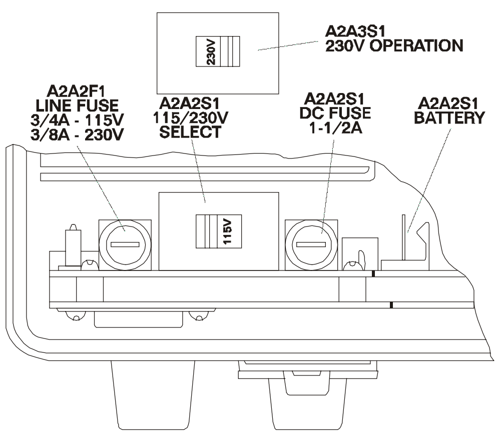

Figure 4. Line voltage fuse and battery fuse on the Battery Charger circuit board.

Both fuse-holders for A2A2F1 and –F2 require ¼ turn with a screwdriver for opening and closing.

The output circuit is protected from excessive accidental currents arising from active loads by fuse A1A4F1. If the instrument provides no output signal, but otherwise appears to be operating normally, this fuse may be open. This fuse is a miniature GFA2 1 A device. It is located near the center of the outer edge of the A1A4 Driver and Metering circuit assembly. This assembly is immediately behind the meter controls on the right side of the Front Panel.

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 or 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 90 consists of 9 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.

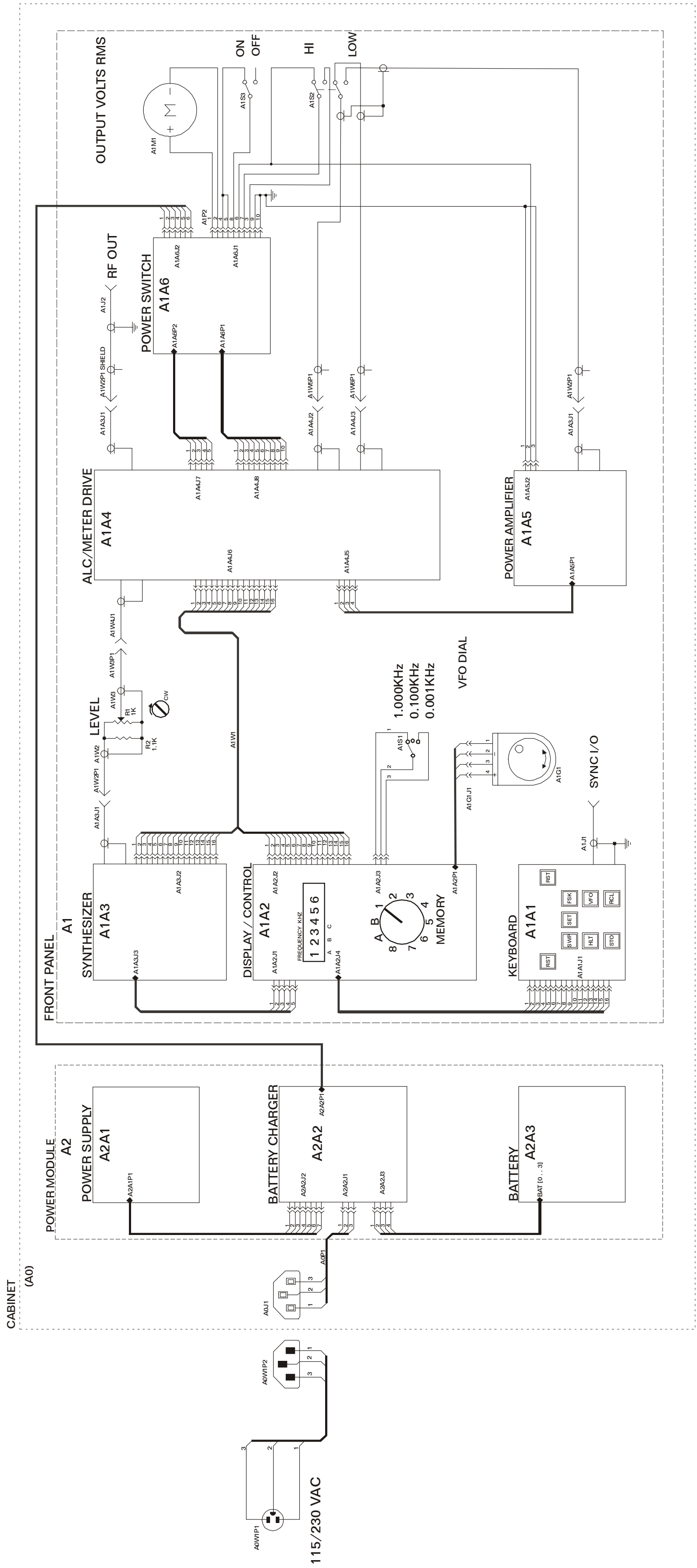

Figure 5. Subassemblies, circuit boards, and interconnecting cables.

4. Specifications

Frequency

Range .... 0.100 to 500kHz
Resolution .... 1 Hz
Accuracy .... 1 part per million, 0 to 40 C
Stability .... 1 part per million, 0 to 40 C
Aging .... 2 parts per million per year

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.

OUTPUT

	Low Level 0.100 – 500kHz	**High Level** 4 – 500 kHz
Max. Undistored power Into 50 Ohm load	0.05 W	2.0 W
Max undistorted voltage Into 50 Ohm load Into open circuit	1.60 VRMS 2.30 VRMS	10 VRMS 16 VRMS
Max undistorted current Unto short circuit	0.10 ARMS	0.5 ARMS

Output voltage accuracy .... +/-5%
Spurious output .... -50dBc
Harmonics .... -35dBc

SWEEP

	Sweep Rate		
Resolution	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
1kHz/incrm.	50 kHz/s	100 kHz/s	200 kHz/s

FREQUENCY SHIFT (FSK)

Shift range .... 0 to +/-499.9 kHz
Delay Range, accuracy .... 0 to 999 milliseconds, +/- 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 .... Internal sealed lead-acid
Capacity .... Approx. 6 hrs @ 2 W, 50 Ohms, 25C
Recharge Rate .... Approx 14-16 hrs, voltage sensing

A C OPERATION .... 115/230 VAC +/-10%; 50/60 Hz 50 VA

TEMPERATURE RANGE
Operating .... 0 to 40 C
Storage ....-30 to 85 C

SIZE .... 18x28x24cm (7x11x9.5 in)

WEIGHT .... 37.4 kg (17 lbs)

5. Principle of operation

Please refer to Figure 6 for assistance with the following description.

5.1 Microprocessor control

The keyboard and digital display operate under the control of a micro-controller, a device that is similar, in many ways, to the microprocessor in small computers. The micro-controller runs under the control of a program stored in a read-only-memory (ROM). When the instrument is first powered up, or when the Reset keypad is pressed, the program begins at a standard program setup; from that point on, the instrument is under complete firmware control by the ROM program. The micro-controller constantly scans the keypads and other panel devices, sends appropriate control signals to all parts of the instrument, and forwards the proper binary numbers to the digital frequency synthesizer. In addition to the binary numbers affecting the synthesizer, they also drive the LCD display after conversion into decimal form. The VFO DIAL operates an optical encoder, which generates 64 digits per revolution. The micro-controller counts these digits and converts them to new binary numbers for forwarding to the synthesizer. The result is that the DIAL "feels" like the conventional analog frequency-tuning knob used to tune many other types of signal generators. All of the actions initiated from all but one (BAT) panel keypads are the result of the firmware program stored in the ROM.

5.2 Digital frequency synthesizer

The digital frequency synthesizer (DFS) consists of both serial and parallel registers, binary adders, and a binary accumulator. The serial register receives the binary frequency data from the micro-controller and stores this data in a parallel register. The frequency data is then continuously summed with the contents of the accumulator at a clock rate determined by the 2.097152 MHz crystal-controlled time base. A new computation is rendered once every clock cycle or every 0.476837 microseconds. The accumulator output is taken as the address of data in the sine function ROM. The sine function data output from the sine ROM drives a high-speed digital-to-analog converter. The resulting analog voltages are samples of the proper amplitude and phase of the sine wave for the frequency data supplied by the micro-controller. The sine function ROM stores 512 amplitudes, one for each 0.703 degrees of phase angle. This data is stored as an 8-bit number and thus is accurate to one part in 256. Depending on the frequency output requested by the micro-controller, any where from about 4 to about 20,000 samples are generated for each output cycle. This stepwise approximation of the sine function is the converted to a low distortion sine wave by a loss-pass filter.

This type of frequency synthesis is particularly well suited for fast frequency shifting (FSK). The time required to shift from one frequency to another is, in general, far less than the period of the new output frequency.

The resolution of the synthesizer is one hertz and its accuracy is that of the frequency accuracy of the time base crystal. In the Model 90 the time base is established by a temperature compensated crystal oscillator (TCXO) with accuracy and stability of one part per million over a wide temperature range.

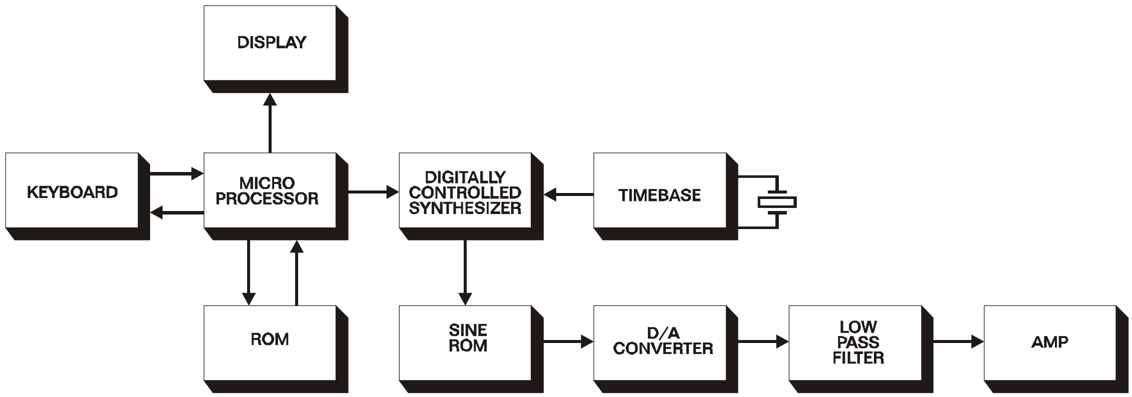

Figure 6. Functional block diagram.

5.3 High power amplifier

The output power amplifier is a low distortion, linear amplifier capable of two watts output (33dBm) into a 50-ohm load. It can supply an open-circuit output of 16 volts RMS. The frequency response of the final output stage is limited, at its low frequency end, to 4 kHz due to saturation characteristics of the output transformer. Any attempt to generate lower frequencies, at the 2-watt level much below 4 kHz will result in s distorted output waveform. Below 4 kHz only the lower power mode, which bypasses the high power amplifier, should be used.

5.4 Low power amplifier

The driver amplifier output is utilized by itself to supply the output in the low power mode. Since this circuit is entirely resistance-capacitance coupled, it has a broader low frequency response and can provide a nearly uniform output level over the entire range from 100 Hz to 500 Hz. Its maximum power output is about 50 milliwatts (17 dBm) into 50 ohms or 2.3 volts RMS into an open circuit.

6. Options

The following options are available for the Model 90. If any of these options have been installed in your instrument, appropriate labels will be found on the inside of the rear lip of the lid.

6.1 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 90 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 90 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 90 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'.

6.2 Option 02

This option is now standard with all instruments.

6.3 Option 03 RF OUT protection circuit (Standard effective SN 481)

This option protects the Model 90 output circuitry from damaging voltage levels that might be applied accidentally to the RF OUT connector. It operates by latching a disconnect between the amplifiers and the RF OUT connector voltage exceeds levels determined by the setting of the HI/LOW Levels switch. The OUTPUT VOLTS level meter will remain connected to the RF OUT connector after the disconnect is latched. The meter is protected from very high voltages by a fuse (A1A4F1 – 1 ampere) and an MOV as in the standard Model 90. Once the disconnect has been tripped, the instrument may be reset to normal operation by simply throwing the power switch to OFF and then back to ON.

The disconnect is tripped in the following conditions:

a. When the power switch is in the OFF position;
b. When the HI/LOW level switch is in the HI position and a voltage greater than 25 VRMS is being applied to the RF OUT connector (this will be evident by the OUTPUT VOLTS level meter showing a full scale deflection);
c. When the Hi/LOW level switch is in the LOW position and a voltage greater than 5 VRMS is being applied to the RF OUT connector (this will be evident by the OUTPUT VOLTS level meter showing a full scale deflection);

d. When either b. or c. above occurred but the excess voltages are no longer present (this will be made evident by the OUTPUT VOLTS level meter showing only a small deflection near its “O” position and NOT displaying any change despite rotation of the LEVEL control);

e. When the OUTPUT VOLTS level meter shows only a small deflection near its “O” position and will not show any change despite rotation of the LEVEL control;

f. Occasionally when the HI/LOW level switch is in the HI position and the LEVEL control is near its maximum clockwise position (this is evident by the OUTPUT VOLTS level meter showing only a small deflection near “O” that is unchanged by rotation of the LEVEL control).

The Model 90 is rest to normal operation, in any of the above conditions, by simply throwing the power switch to the OFF position and then back to the ON position. If the disconnect trip was triggered by an external voltage source, be sure to remove the source before attempting to reset the instrument. If the trip was triggered by an extremely high Model 90 output level (condition f. above), reduce the output LEVEL setting by turning the LEVEL control a few degrees counterclockwise and then carry out the reset procedure.

Under circumstances where a very high external voltage was applied to the RF OUT connector, the reset procedure may not completely restore output. This state will be made evident by the OUTPUT VOLTS level meter showing normal deflection changes, as the setting of the LEVEL control is changed, but there is no signal appearing at the RF OUT connector. This condition indicates that the output fuse, A1A4F1, has been blown and must be replaced as described in Section 3.2.

6.4 OPTION 04 Low-Level Attenuator

This option, installed in the lid of the Model 90, is a three-range attenuator using a combination of resistive and transformer voltage division. With a

Nominal Attenuator input of 10 Volts from the MODEL 90 RF OUT connector, the Attenuator output can be adjusted continuously from 3.0 to 30.0 millivolts, 30 to 300 millivolts, and .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 90 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 +/- 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 16 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 90 panel.

RANGE Switch

The range over which the output level can be adjusted by the LEVEL control is determined by the position of this switch. When the RF input level is at 10 VRMS the low range allows output level adjustment from 3.0 to 30.0 millivolts, the middle range from 30 to 300 millivolts, and the high range is from.30 to 3.00 volts RMS. The adjustable output level can be increased or decreased up to 50% by changing the RF input to any value between 15 and 5 volts.

It should be noted that, on the high range, limitations set by the Attenuator source impedance allow only a maximum output of about 1.8 VRMS with 10 VRMS RF input when the output is loaded by 50 ohms. However, by raising the RF input to 15 VRMS, 3.0 VRMS can be obtained as a maximum

Output level into 50 ohms. Loads as low as 27 ohms have a little effect on the maximum output levels of the lower two ranges since the additional transformer attenuation reduces the source impedance to extremely low values.

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 90 RF OUT connector. The input signal level should be set to 10 VRMS by setting the Model 90 output on the HI range and adjusting its LEVEL control for 10 volts indicated on the Model 90 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 high range (.30 to 3.00 volts) it varies from 3 ohms at minimum output to 40 ohms at maximum output. On the lower two ranges where transformer voltage step down is used, the source impedance becomes a fraction of an ohm.

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 m V and 30 to 200 mV) and on the high range in terms of volts (.30 to 3.00V). The circuitry driving the display employs a linear averaging detector and integrating digital voltmeter calibrated to read in RMS volts. It is updated about 3 times per second.

The display also has a LO BAT annunciator. When the positive rail battery voltage falls to 7.5 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 90 RF OUT connector and the test load. To do this attaches one end of the provided coaxial cable to the Model 90 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 90 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

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.

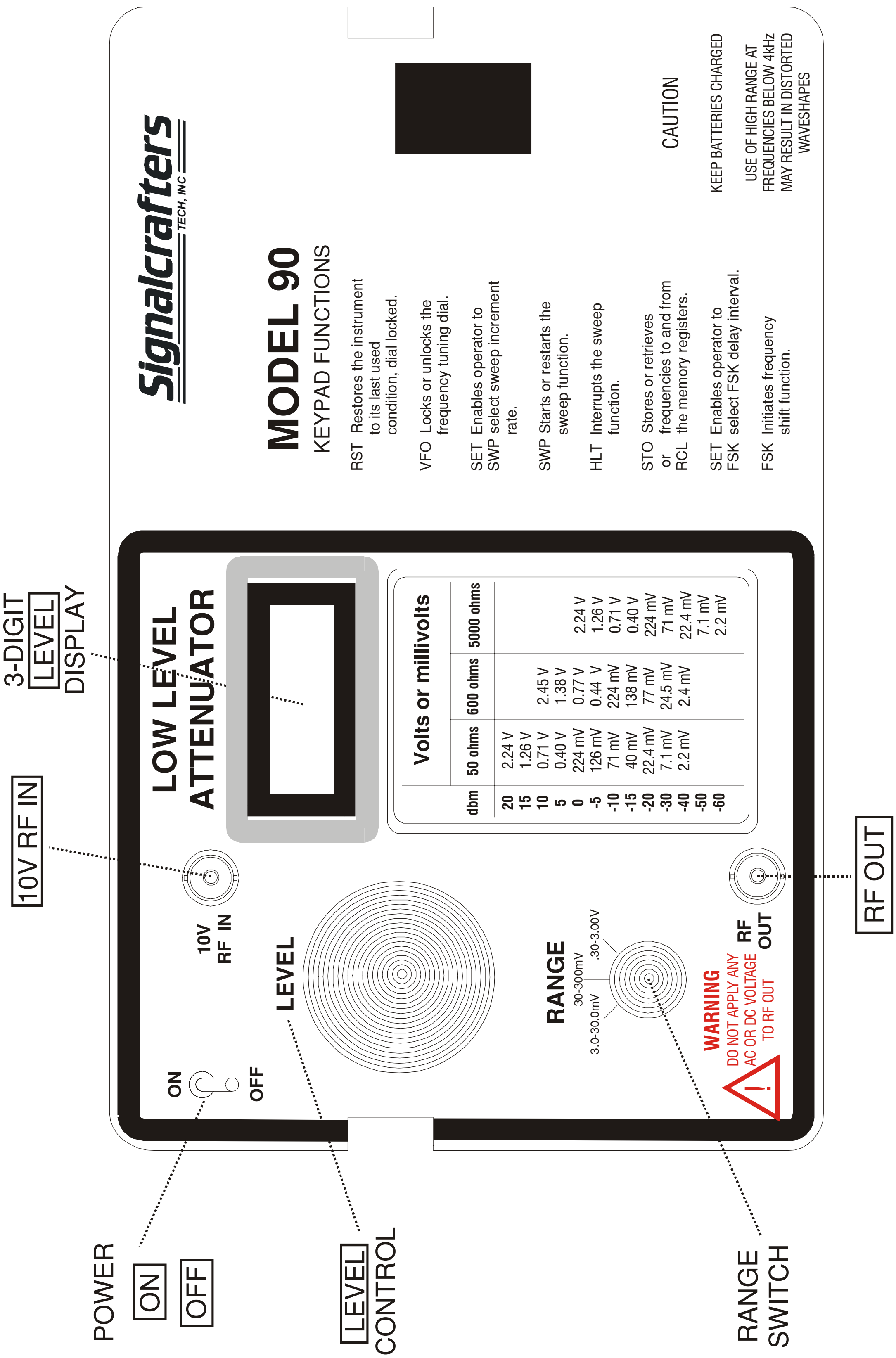

Figure 7. Model 90.04 Low Level Attenuator front panel.

Operation

When connections are complete, turn the Model 90 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 90 to the desired frequency in the normal manner. Since the Model 90 output level changes slightly with frequency change, this will appear as corresponding changes on the Attenuator LEVEL display. If necessary readjust either the Attenuator LEVEL control or the Model 90 LEVEL control to re-establish the desired Attenuator output signal level. It is perfectly acceptable to use either the Attenuator LEVEL control or the Model 90 LEVEL control to establish a desired signal level so long as the Model 90 output level is between 5 and 15 volts. Use the control that is most convenient.

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 90 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 90 may be used with the Attenuator.

A small-hinged door compartment is an available on the right side of the Attenuator for storage of the Model 90 power cord and the interconnecting coaxial cable. Be sure this door is securely closed and latched, and the cables disconnected before attempting to close the Model 90 lid.

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 90 front panel screws.

Maintaining the Low Level Attenuator Batteries

Two 9-volt NEDA 1604 batteries, such as Eveready Bo. 216 “transistor” batteries are used to power the Attenuatory display circuits. The average current drain is 11 milliamperes for the positive rail battery and 9 milliamperes for the negative rail battery. A typical battery life will be about 16 hours when the unit is powered for 2 hours per day. The LO BAT annunciator message will appear on the LEVEL display when the positive rail battery voltage falls to 7.5 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 4 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 immediately behind the LCD display. 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.

Output fuse

If the Attenuator LEVEL display indicates output but no signal is actually present at the RF OUT connector, the output fuse may be blown. This should be a very rare occurrence. Another check is to measure the resistance across the RF OUT connector with an ohmmeter. It should show a resistance between a fraction of an ohm up to 50 ohms depending on the 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 (Buss Type GFA, 2/10 ampere) Remove the panel as described under the Battery replacement above. The fuse is of the pigtail 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 90 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 and the RF OUT fuse. 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 90 itself, the return the complete Model 90 and Low Level Attenuator unit.

Addendum

3.1.1 Lead acid battery replacement

To remove the battery pack first make sure the power cord is disconnected from the Model 90. 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 are held in the pack by an end plate. Remove the two (2) #6 screws from the end plate and the #4 flat head screw at the other end of the pack. The batteries should slide out the open end off the pack.

Insert the new batteries into the pack with the negative terminal (black) first. All batteries must face the same direction before reconnecting the wiring. Connect the black wire of the battery cable to the first negative terminal. Connect the white wire of the battery cable to the last positive terminal (red). Connect the battery 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 19.5 volts. Replace the end plate and the screws while holding the end plate firmly against the batteries for a tight fit.

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 90 should be allowed to charge overnight prior to field use.

3.1.2 Lithium coin cell replacement

The lithium coin cell which provides backup voltage to the Model 90 memory may require replacement when frequent loss of stored frequencies occurs. The coin cell is contained in s holder mounted on the control and display board stack attached to the back of the front panel. The coin cell operates from a voltage of 3.2 volts down to 1.5 volts.

To measure or replace the coin cell disconnect the power cord from the Model 90. Remove the four black mounting screws from the front panel. Lift the front panel assembly out of the lower case assembly. Viewing from the LCD end of the front panel locates the coin cell holder mounted on the edge of the middle printed circuit board (approximately behind the 'RST' and 'SWP' buttons).

Using a DVM measure the coin cell voltage n=by probing the holder pins on the bottom side of the printed circuit board. If the coin cell has dropped below 1.5 volts is should be replaced. Remove the coin cell using a small screwdriver to lift the spring finger of the holder gently away from the cell and position the front panel assembly such that the cell will fall out of the holder. Memory settings will probably be lost when the coin cell is removed. A new coin cell may be inserted into the holder by sliding the cell with the positive side showing under the spring finger and into the holder. To test the installation turn on the Model 90 and store frequencies in some memory positions. Turn the unit off for 15 seconds or more then turn it back on. Recall the frequencies that were previously stored to verify the operation of the coin cell.

To reassemble the Model 90 place the front panel assembly into the lower case assembly and secure with the four black mounting screws.