PC-16000A/E
HF Transceiver

Technical Manual

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Revision A

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PC-16000 SYSTEM OVERVIEW AND BOARD DESCRIPTION

The Receiver

The PC-16000 contains a dual up conversion receiver/transmitter design. The first IF is at 45 MHZ which allows continuous coverage of the HF spectrum from 1.5 to 29.7 MHZ. It also places the first mixer images 90 MHZ from the desired frequency allowing the front-end bandpass filters to remove them easily. Referring to the RF Section Block Diagram, a signal in the 1.5 to 30 MHZ HF range enters the system via one of the 3 Antenna ports (ANT A, ANT B or ANT C). The signal is routed through a fast T/R relay on the Low Pass Filter board and then via a coax cable to the main RX/TX RF board where it is passed through a second T/R relay and into a 20 db switchable front end attenuator. The signal is now passsed through one of 6 bandpass filters. These filters provide a degree of immunity to IMD products which would be produced by out of band signals. The filtered signal is then introduced to the first mixer. The mixer is driven by the first LO which is between 46.5 and 74.9 MHz. This LO is always 45 MHz higher than the desired input signal. The LO is developed in the Main Synthesizer which will be discussed later. This signal is capable of tuning in as little as 1 Hz steps and is the oscillator which is responsible for determining the frequency of operation of the radio.

The output of the first mixer is at 45 MHz. It is amplified by a 13 db gain amplifier and then passed through a 4 pole 45 MHz crystal filter which serves as the roofing filter for the system. The filter has a 3 db bandwidth of 7.5 KHz. The filter is followed by an amplifier providing an additional 20 db of gain. This amplifier is followed by an AGC controlled 45 MHz tuned amplifier which adjusts the signal level into the second mixer to keep IMD products to a minimum. The second mixer is an active mixer providing approximately 6 db of conversion gain. It takes the 45 MHz IF signal and mixes it with a 45.455 MHz second LO signal to produce a second IF at 455 Khz. This low level signal is passed through a diode switching arrangement that is used by the Noise Blanker circuit to open the signal path during a noise pulse an quiet the receiver for that period. The Noise Blanker amplifier is fed the same 455 Khz signal before the switch. The Noise Blanking pulse must be generated before the high selectivity filters have had a chance to widen the noise pulse an make it more difficult to remove.

After passing through the blanking switch the 455 Khz IF signal is passed through one of 3 filters. For SSB/CW or RTTY operation, either a 2.4 KHz or 500 Hz Collins Mechanical filter is used. For AM operation a 5 KHz wide ceramic filter is used. There is provision for installing a 1.8 Khz mechanical filter as an option. The output of the filter is routed to an IF amplifier chain which is AGC controlled and provides a maximum of 55 db of gain. The output of this amplifier is used as the pickoff point for the AGC amplifier. This AGC amplifier develops the control voltage for the 45 MHz amplifier as well as the 455 Khz IF amplifiers. This signal is also used to drive the AM detector circuit. The circuit used is known as an "infinite impedance detector". It provides very good AM recovery with very little drive power.

The output of the IF amplifier is now sent to a pair of balanced mixers which are configured as a Quadrature Phase Shift Detector. The mixers are driven on their LO ports by a pair of 455 Khz signals that are 90 degrees out of phase with each other. The outputs of the mixers are at audio and are again in quadrature phase. They are processed through audio phase shift networks whose outputs can be combined in a way

which will enhance one sideband and cancel the other. By making this arrangement switchable, the upper or lower sideband may be selected. This arrangement allows rejection of any unwanted sideband that may get through the mechanical filters when the IF shift function is being used to move the signal around within the filter passband.
Now that a baseband signal has been generated the audio filtering can be done in the Digital Signal Processor (DSP). The DSP filter is always engaged at some level of filtering except for when the AM mode is selected. In AM the Quadrature Detectors and the DSP filters are bypassed and the output of the AM detectors goes straight to audio power amplification. The PC-16000 has 5 filters selectable from the front panel. These are the overall bandwidths available for receiving. They are produced by combinations of IF and DSP filters. The combinations are as follows:

2.4 Khz : 2.4 Khz IF and 2.4 Khz DSP
1.8 Khz: 2.4 Khz IF and 1.8 Khz DSP
500 Hz: 500 Hz IF and 500 Hz DSP
250 Hz: 500 Hz IF and 250 Hz DSP
Digital: 2.4 Khz or 500 Hz IF and 200 Hz DSP.

The DSP also contains two special algorithms which can be switched in or out of the line. An "Autonotch" and a "Denoiser" function. The autonotch will find and lock onto a steady carrier or tone and reduce it by 40 to 50 db. It is capable of locking on to and rejecting multiple tones within milliseconds.

The DSP Board also contains some very tight analog filters which are used to separate the Mark and Space frequencies for RTTY and ASCII operation. A pickoff for a scope connection is also provided by this circuit. These filters are preceded by the DSP filters.

After passing through the DSP filtering the audio can now be switched to a manual notch circuit. The manual notch allows a single frequency to be notched about 45 db. The circuit works by creating a signal that is 180 degrees out of phase with the incoming signal and then adding both together so they cancel. The front panel "NOTCH" control adjusts the frequency where the 180 degree phase shift takes place. After all the audio processing is complete the signal is fed to the audio power amplifier IC, a TDA-1013B, which develops between 2 and 3 watts of audio to the speaker.

The Transmitter

The audio level from the microphone is adjusted by the front panel "MIC" control. This AF signal is amplified by an AGC controlled amplifier to keep the maximum audio to a preset level. This is necessary since the SSB signals in the PC-16000 are generated by the "Phasing" method and distorted audio would greatly reduce the amount of opposite sideband suppression available from this system. This AGC'd audio also acts as a type of compressor for the audio and increases the average power in the SSB signal without introducing distortion. Once the microphone signal has been amplified it is passed through two active phase shift networks. One shifts the phase of the signal +45 degrees while the other shifts it -45 degrees giving a total phase shift of 90 degrees between the two output signals. These "quadrature" signals are next applied to 2 balanced mixers. These mixers are driven with quadrature local oscillator signals at 455 Khz. The resultant phase shifted DSB signals are combined in a transformer and result in a Single Sideband signal. The actual sideband is selected by reversing the phase of the audio signals from the output of the AF

Phase shift networks to the mixers. This low level 455 Khz SSB signal goes to one side of a SPDT relay. The other side of the relay is connected to one phase of the 455 Khz LO signal. If the selected mode is SSB or AM the relay is set to pass the low level SSB signal from the output of the mixers. If the mode is set to be CW or RTTY/ASCII the relay is set to pass the constant level LO signal. This is done so that a CW mode signal does not have to be generated in the mixers with a sidetone signal. This results in a cleaner CW signal since there are no IMD products generated from a mixing process. The reason for using the mixer output for the AM mode is because AM is generated by adding a bias to one of the mixers. This low level AM signal appears at the output of the transformer as in the SSB case.

After the proper low level carrier/SSB signal is generated it is passed on to an amplifier. This amplifier raises the signal level to the point where it can be clipped by 4 back to back diodes. This clipping is actually a form of RF speech processing when applied to an SSB signal. It will raise the average speech power in the SSB waveform by approximately 10db. While clipping this waveform will increase the average power in the signal, it will also introduce considerable intermod products. To remove these products the signal is passed through a 455 Khz filter. This along with the AGC microphone audio results in a clean 455 Khz SSB signal with considerably higher "talk power" than a normal SSB signal without any processing. Since the processing is done at RF there is no distortion of the signal's audio as can sometimes happen with AF Speech Processing.

The cleaned up SSB/CW signal is now sent to a tuned amplifier with adjustable gain. The gain is controlled by the front panel "RF Power" control. This will be used to set the output power level of the transmitter by controlling the drive level to the final amplifier. This amplified signal goes to an active FET mixer where it is combined with the 45.455 MHz 2nd local oscillator signal. There are two major products produced by this mixing process; 45.0 MHz and 45.91 MHz. A 45 MHz crystal filter is used after the mixer to select the 45.0 MHz product. This is the transmitter IF frequency. The signal is passed through a fixed gain amplifier (approximately 13db) and then through a second 45 MHz crystal filter. These filters have a 3db bandwidth of 7.5 Khz so they clean up the transmitter signal quite nicely. The output of this filter is matched to a passive balanced mixer where it is mixed with a local oscillator signal from the main synthesizer in the range of 46.5 to 74.9 MHz. The main mixer output products fall into two ranges; 1.5 to 29.9 MHz and 91.5 to 119.9 MHz. The band of interest is the lower HF range (1.5 to 29.9 MHz). The output of the mixer is passed through a single section 30 MHz low pass filter which removes most of the VHF images. It is then amplified to a level of approximately 1.5 Vpp and sent to the bank of bandpass filters used at the receiver front end. Diodes are used to switch these filters between the transmit and receive paths. The filters will remove any residual image frequencies that made it through the 30 MHz LPF. The signal out of these filters is a clean .5 Vpp sine wave at the desired transmitter frequency. The signal is now passed through a diode T/R switch and sent to two gain block amplifiers. The output of these amplifiers is approximately 90 to 100 mW at full output (i.e. "RF Power" control at maximum). This signal is sent to the Power Amplifier assembly where it is amplified to the 100 Watt level. The output of the Power Amplifier is passed through a Low Pass

Filter board to remove the harmonic energy generated by the amplification process. The output from the filter is a clean signal with harmonic components greater than -45 dbc. This is the worse case value. Typically any spurious spectral components will be better than -55 dbc.

The Low Pass Filter board contains a directional coupler to sample the Forward and Reflected components of the output signal. These signals are passed back to the ALC circuit so that the amplifier will not exceed a maximum output power level. The Reflected component of the signal is used to limit or "foldback" the output power if a high VSWR condition is detected. Typically the power will foldback to 65 Watts at a 3:1 SWR value. This is done to protect the final amplifier transistors from damage due to high peak RF voltages that can be generated under these type of mis-match conditions. The maximum RF power and the foldback power level is controlled by throttling the gain of the 455 Khz adjustable gain amplifier before the 1st transmit mix to 45 MHz. The output from the filter goes to 3 relays which are used to connect the transceiver to 1 of three antennas (loads).

PC-16000 PC Board Architecture

The circuitry in the PC-16000 is divided between 9 Printed Circuit Boards. The circuit functions divide among the boards as follows:

FRONT PANEL PCB:
Contains the front panel controls and switches as well as the annunciator LED's. There are also several IC's to drive the LED's on this board. The S/Power Meter is also mounted on this board.

CPU BOARD:
Contains the Main microprocessor as well as the Communications Processor and all system EPROM and SRAM. A Real Time Clock and battery backed up SRAM are also on this board. Most of the system control logic and the RS-232 interfaces are on this board. The interface for the IBM keyboard can also be found here. In addition to these functions, the DDS (Direct Digital Synthesis) oscillator resides on this board. It is programmed by the Main processor in response to either encoder pulses from the main tuning knob or keypad/keyboard direct frequency information.

PLL BOARD:
This board contains the main synthesizer which generates the 46.5 to 74.9 MHz 1st Local Oscillator signal. This synthesizer is a DDS (Direct Digital Synthesis) driven PLL (Phase Locked Loop). It uses the 8.050 - 8.075 MHz DDS signal from the CPU board to mix in the loop and control the frequency. The DDS provides a very fine step size (1 Hz minimum) for the PLL so that the tuning has an "Analog feel" with digital stability and accuracy.

This board also contains the 200 Khz reference TCXO for all the PLL's in the radio. This reference can be trimmed for precise frequency calibration. The 4.91375 MHz IF Shift oscillator is also on the PLL board.

BFO BOARD:
Contains the 455 Khz Quadrature BFO PLL and the 45.455 MHz 2nd Local Oscillator PLL. These two synthesizers are phase locked to the IF Shift oscillator on the PLL board. This allows them to track for the IF Shift function.

RX/TX BOARD:
This board contains a majority of the

Receiver and Transmitter circuitry. The bandpass filters, 45 MHz Crystal filters and the narrow mechanical filters are all contained on this board. The entire receiver up to the 455 Khz IF output resides on the board. All of the low level transmit circuitry (including the 100 mW pre driver amplifier) is here except for the ALC control circuit.

AF PROCESSOR BOARD:
Contains the 455 Khz receiver quadrature detector and all audio amplification. The manual Notch and transmitter ALC circuitry is also on this board.

DSP BOARD:
This board contains the Digital Signal Processor and the Filters/Digitizing circuitry for the CW/RTTY/ASCII decoding function.

POWER AMPLIFIER:
Contains the Pre-driver, Driver and Final Amplifier stages. The final amplifier bias circuitry is also on this board.

LOW PASS FILTER BOARD:
Contains the 6 Transmit Low Pass Filters and the Directional Coupler circuitry. All contains the 3 antenna selection relays.

FREQUENCY SYNTHESIS SCHEME

1st Local Oscillator PLL:

The first LO tunes from 46.5 MHz to 74.9 MHz with a minimum step size of 1 Hz. The synthesizer spans this range by switching between 4 VCO's. The first VCO covers from 46.5 to 52.5 MHz, the second from 52.5 to 59.5 MHz, the third from 59.5 to 66.5 MHz and the fourth from 66.5 to 74.9 MHz. The output of the selected VCO is amplified and run through a bandpass filter before leaving the board. A sample of the output is also passed through a buffer whose output is used to drive a divide by 4 counter. The frequency at the counter output will be between 11.625 and 18.725 MHz. This signal is passed through a low pass filter and used as the LO for a mixer. The second input to the mixer is from a low pass filtered version of the 8.050 to 8.075 MHz DDS signal. Because of the divide by 4 in the loop, the DDS need only move one fourth of the frequency range that is required at the output of the VCO. This also means that in order to have the VCO move with a 1 Hz step, the DDS will need a .25 Hz step size for its resolution. The PLL is setup so that the programable divider (contained within the 145151 PLL IC) in the loop will cause the frequency to change in 100 Khz steps. The DDS will then move the frequency over a 100 Khz range in 1 Hz steps. Because of the fixed divide by 4, the DDS moves only 25 Khz to cover the 100 Khz range.
The output from the mixer varies from 3.575 to 10.625 MHz. This is filtered and used as the clocking signal for the programmable divider inside the PLL IC. The reference frequency for the loop comes from a very stable TCXO running at 200 Khz. There is a trimpot adjustment which is used to put the oscillator exactly on frequency. This reference frequency is divided down inside the PLL IC by 8 to yield a reference frequency of 25 Khz. With the loop in a locked state, the output of the programmable divider will be 25 Khz. This signal and the 25 Khz reference are applied to the PLL IC's internal phase detector. The phase detector will generate an error signal in the form of a pulse width modulated signal riding on a DC level. This error signal is passed through the active loop filter to produce a pure DC signal for use as a control voltage for the VCO's.
Digital control signals from the CPU Board are used to select the proper VCO and

bandpass filter to use depending upon the frequency of operation. The digital word to program the 100 Khz coarse frequency also comes from the CPU board.

2nd Local Oscillator and BFO:

The second LO (45.455 MHz) and the BFO (455 Khz) are phased locked to the 4.91375 MHz IF Shift VXO on the PLL Board in order to implement the IF Shift Function. The IF Shift function works by moving both the 45.455 MHz and 455 Khz by the same amount and in the same direction. This has the effect of moving the received signal within the passband of the selected mechanical filter. This allows adjacent interfering signals to be moved out of the filter passband and rejected by the out of band attenuation characteristics of the filter.

The 45.455 MHz loop is setup similar to the main (46.5 - 74.9 MHz) PLL. The difference is that instead of using the 8.05 MHz DDS output to fine tune the output frequency, the 4.91375 MHz VXO is mixed in the loop for that purpose. The VCO operates at 45.455 MHz and its output goes to a buffer amplifier and to a filter and higher power amplifier. The power amplifiers output is the LO output fed to the rest of the system. The output of the buffer is used by a divide by 4 stage to produce an output at 11.36375 MHz. This signal is used as the LO input to a mixer. The RF input of the mixer comes from the 4.91375 MHz IF Shift oscillator. The difference output of the mixer (6.45 MHz) is recovered through filtering and then amplified. This signal goes to the programmable divider in the 145151 PLL IC. This divider is fixed at a value of 258 to give an output at a frequency of 25 Khz. The 200 Khz reference signal from the PLL Board is brought into the PLL IC and internally divided by 8 to produce a 25 Khz reference. Both these 25 Khz reference signals are presented to the phase detector in the IC. The output of the phase detector is filtered and scaled so it may be used as the DC control voltage for the VCO.

Note that if the 4.91375 MHz signal changes frequency, the 45.455 MHz output will move by 4 times the frequency change. This is due to the divide by 4 in the loop. This means that to get a 4 Khz IF shift the VXO need only move 1 Khz.

The BFO (455 Khz) loop is very similar to the 45.455 MHz loop just described. The output of the 455 Khz VCO is buffered with a pair of CMOS inverters. The resulting signal is filtered to obtain the fundamental sine wave component and then passed to a passive Phase Shift Network where the "I" and "Q" quadrature components are developed for the rest of the system. The same buffered signal is also used to clock a dived by 4 circuit whose output (at 113.75 Khz) is used as the LO input to a mixer. The RF input to the mixer is the 4.91375 MHz IF Shift oscillator. The difference frequency of 4.800 MHz is recovered by passing the mixer output through a tuned amplifier at 4.8 MHz. This signal goes to the programmable divider in the PLL IC. The divide value is fixed at 192 so that the output is at the 25 Khz reference frequency. The reference and divider outputs are used by the internal phase detector to generate an error signal that is filtered and scaled to properly control the VCO frequency.

As in the 45.455 MHz PLL, if the IF Shift oscillator is moved by some amount, the 455 Khz output will move by 4 times that frequency change. The 45.455 MHz and 455 Khz signals therefore track the movement of the IF Shift oscillator and each other. This means that a signal will move within the passband of the IF filter but will not change pitch as the IF Shift oscillator is varied. The total shift available on the IF Shift oscillator is approximately 1.2 Khz which results in a passband shift of 4.8 Khz.

DIRECT DIGITAL SYNTHESIZER

The DDS is located on the Microprocessor PC Board. It generates the 8.050 - 8.075 MHz signal required for the Main PLL Synthesizer (46.5 - 74.9 MHz). The DDS system works by loading a value into a phase accumulator and continually adding that value to the subtotal on each cycle of the system clock. The binary value out of the phase accumulator is sent to a D/A converter. The converter outputs a voltage proportional to the binary input value which represents the value of the sine wave at the current phase angle. This repeats until the phase accumulator overflows (indicating 360 degrees has passed) and starts over for the next cycle. The frequency is changed by changing the value that gets added to the phase accumulator on each clock pulse. The resulting waveform out of the D/A is a "stepped" approximation of the sine wave. The amount of distortion that appears in the waveform will depend on the frequency being generated compared to the system clock "sampling" frequency. The closer the output frequency is to the sample rate the fewer steps per cycle there will be (i.e. there is a large value being added to the phase accumulator). The maximum frequency generated is limited by sampling theory to the Nyquist rate. The output frequency should be less than half of the sample clock for proper results.

The DDS in the PC-16000 uses a sample clock of 33.554433 MHz. This value, with the 32 bit phase accumulator in the DDS IC allows a minimum frequency resolution of 1/128th of a Hz. The software in the Control Microprocessor accounts for this and programs the DDS so that a minimum of 1 Hz steps will occur per Main Tuning knob encoder pulse. Since the output frequency is approximately 8 MHz the Nyquist criteria is satisfied and the resulting waveform has approximately 4 samples per cycle. The harmonic energy resulting from this non-sinusoidal waveform is filtered on the PLL board by a Low Pass Filter and the resulting sine wave is used to control the fine tuning of the PLL.

DIGITAL SIGNAL PROCESSOR

The Digital Signal Processing in the PC-16000 takes place at the baseband audio level in the receiver. The DSP Board contains the Signal Processor along with the CODEC required for A/D & D/A transformation. The DSP processor requires a boot PROM when it starts up so it can load the required code for the particular filter(s) being implemented. There is also a buffer on the same data bus which allows the processor to continually read the status byte which indicates what filters should be running. This byte is sent to the buffer by the main Control Computer in response to someone pushing a key on the front panel or the IBM keyboard. The processor runs at a 12.288 MHz clock rate which is internally divided down to give a sample rate of about 8 Khz which satisfies the Nyquist criteria for audio in the 3 Khz range.

The CODEC serves as an interface between the digital data to and from the processor and the analog signals before and after filtering. The CODEC takes the unfiltered analog waveform from the input amplifiers and converts it to a sampled serial data stream to which the processor can apply its filtering algorithms. After the signal has been filtered in the digital domain it is sent as a serial data stream back to the CODEC where it is converted back to an analog waveform for amplification by the rest of the system.

In addition to the DSP circuitry on this board, there is a "Digitizer" circuit which takes the audio after the DSP has filtered it and converts it to a digital data stream so that the main Control Computer can process and decode CW and RTTY/ASCII. The input signal is passed through narrow analog filters which are tuned to the proper frequencies for either CW or RTTY Mark and Space tones by switching in the proper resistors in the feedback networks. The output of these filters go to a positive and negative peak detector whose outputs are summed along with the detected envelope of the output of the filters. This allows the envelope zero reference to "track" the input signal amplitude variations. This "corrected" signal is passed through further amplification and filtering until it reaches a comparator where it is digitized into a serial data stream. This data stream is gated with an enable signal. This signal is derived from the output of the first set of filter/amplifiers and then passed through a detector/filter to form a DC voltage proportional to the input signal level. This level is placed on one input of a comparator. The second input (reference) is determined by the voltage divider formed by the Front Panel "SENSITIVITY" control. This control can then act as a "squelch" for low level background noise by keeping the gate on the digital data stream turned off. When a signal strong enough to generate a DC voltage at the output of the detector to override the reference voltage setting appears, the gate will open and the digital data will pass through to the Control computer for decoding.

AF PROCESSOR BOARD

The 455 Khz received IF signal from the RX/TX Board is introduced to the RF input port on two mixers with form the quadrature product detector. The LO ports of these mixers are driven with the "I" and "Q" outputs from the BFO PLL on the BFO board. Quadrature audio signals appear on the outputs of these mixers. The signals are amplified and then fed to the audio Phase Shift Networks. Each network is made up of 4 op-amps which will shift the voice band audio spectrum +/- 45 degrees respectively. These outputs are summed in a two resistive networks. The first sums the output of the two PSN's directly while the second inverts one output and then sums them. The result is that a USB signal appears on the output of the first network while a LSB signal appears on the output of the second. Note that it is important that the correct phasing of the 455 Khz "I" and "Q" signals is present to insure this relationship. Otherwise the USB & LSB outputs will be reversed. The networks are built with an adjustable resistor in them so that the opposite sideband rejection can be optimized.The individual USB and LSB signals now go to analog switches so that the control signals generated by the main Control Computer can select the proper sideband.

The output of these analog switches are connected to the input of the manual notch circuit. The signal can either be allowed to pass through the notch circuit or bypass the notch depending on which set of analog switches surrounding the notch circuit is enabled. The output of the analog switches now go to the DSP board for filtering. The output of the DSP filter comes back to this board to an op-amp buffer/combiner. This op-amp has two input channels. One from the DSP as was just mentioned and the second from the AM detector output on the RX/TX board. The AM detector input is gated onto this board with an analog switch when in the AM mode. It is then amplified and passed to the combiner amplifier. Note that this combiner amplifier only has a small amount of gain (between 1 & 2) and is just used to balance the levels between the product detector and AM detector outputs. When in the AM mode, the DSP processor mutes the output from its filter so only the AM signal will be present at the combiner.

The low level audio signal now goes to the audio power amplifier IC. This IC has two sections to it. The first is an adjustable gain pre-amp. The gain is controlled by a DC voltage which is derived from the Front Panel "AF Gain" control. The output of the pre-amp is coupled to the fixed gain power amplifier stage where approximately 2 watts of audio is developed. Since the second stage is a fixed gain unaffected by the volume control setting, the output of the sidetone oscillator is injected here. The sidetone volume is set by a pot adjustment at the output of the sidetone oscillator.

The remaining circuitry on this board deals with the transmitter functions. The connector that interfaces to the transmit Low Pass Filters resides on this board. This connector passes the 6 filter enable signals to the LPF board. These signals are used to switch the relays on/off for appropriate filter selection. There are also 3 antenna select signals to drive those relays. Coming back from the LPF board are the Forward and Reverse voltages from the directional coupler which indicate the transmitter output power and SWR condition. These signals are negative voltages which vary between 0 and -7 volts. There are zener diode clamps to insure that the voltage cannot exceed -7.5 volts. These voltages are used by the ALC circuit on the AF Processor board to limit the output power of the transmitter final amplifier for both maximum output under matched conditions (100 Watts) as well as reducing power under high VSWR conditions.

The ALC circuit functions by taking the FWD input voltage and running it to an inverting amplifier. The input to the amplifier has an adjustable DC offset bias that is summed with the FWD input signal. This is a positive voltage. With little or no output power from the final amplifier, the ALC amplifier will have a negative output due to the positive bias on the input. As the output power approaches 100 Watts the increasing negative FWD voltage will override the positive bias and cause the op-amps output to swing positive. There is an NPN transistor connected to the output of this ALC amplifier. The collector of this transistor is connected to the middle of a voltage divider. This divider provides a gate voltage for the adjustable gain 455 Khz FET amplifier in the transmit section of the RX/TX board. The actual voltage is determined by the setting of the Front Panel "RF Power" control since this is part of the voltage divider. The higher this voltage the higher the gain of the amplifier and the more drive the final amplifier gets. When the ALC amplifier's output starts to approach the turn on voltage of the transistor it will start to reduce the gate voltage which in turn will drop the final amplifier output power. This will also cause the FWD voltage from the directional coupler to fall back toward zero. If there were not certain time constants in this "loop" it is apparent that it could become unstable and oscillate. The time constants provided allow stable operation at full output power which is adjusted with the bias pots at the ALC amplifier input. Since there are slight differences in the response of the directional coupler from 1.8 to 29 MHz, the bias voltage is adjustable with 3 separate controls which are linked to the particular band in use. There is one for 1.8 MHz, another for 3.5 - 21.5 MHz and a third for 24.89 - 29.9 MHz. Each control can be used to set the maximum output power to 100 Watts for their respective bands.

The VSWR input to the ALC amplifier works in much the same way as the FWD power input. There is a pot which couples the REV voltage into the same summing node at the input to the ALC amplifier. By adjusting this pot under a given VSWR condition the power van be made to "foldback" to any given power. In general it is adjusted for 65 Watts of output power with a 3:1 condition.

In addition to controlling the final amplifier output power the signals from the directional coupler are buffered by a second set of adjustable gain amplifiers and sent to the A/D converter on the main Control Computer board. The computer can read these values, scale them appropriately, and display the output power and SWR on the front panel display.

POWER AMPLIFIER

The Power Amplifier Board consists of a three stage amplifier and a bias control circuit. The low level (~ 100 mW) TX signal from the RX/TX board passes through a 30 MHz LPF and then on to the pre-driver which has 13 db of power gain. This will deliver 2 Watts to the push pull driver stage which has approximately 7 db of power gain resulting in 10 Watts of drive to the Final Amplifier stage. This push pull stage has 10 db of gain to provide 100 Watts of output power. All interstage matching is done with broadband transformer coupling and feedback networks are used to flatten the response of the amplifier. Since the amplifier is used for SSB operation it must be used in a linear mode. An adjustable bias supply is used to bias the output transistors into their linear region. Since these are bipolar devices, they are subject to thermal runaway. To prevent this from occurring, a thermistor is thermally connected to the case of one of the transistors and is part of the bias power supply circuit. As the transistor heats up the thermistor causes the bias voltage to be turned down preventing the transistor from running away. Diodes are used to generate the bias voltages on the push pull driver stage. They are thermally connected to the devices so that the drops across the diodes will track the change in base-emitter voltage on the transistor with changes in temperature again preventing a thermal runaway condition.

Note that the bias supply for the amplifiers is switched off when not in transmit. This prevents noise from the idling amplifier from getting into the receiver and also prevents any spurious signals from being transmitted.

LOW PASS FILTER BOARD

The output of the Power Amplifier will contain harmonic energy which will be high enough not to comply with FCC spectral purity requirements (-40 dbc or better). In order to remove these unwanted signals the output of the amplifier is passed through a Low Pass Filter. There are 6 filters on the board which are selected by relays. The filters fall into the following bands of frequencies:

1.8 - 2.0 MHz
3.5 - 4.0 MHz
7.0 - 7.3 MHz
10.1 - 14.35 MHz
18.0 - 21.5 MHz
24.8 - 30.0 MHz

After passing through the filters, the worse case spurious should be -45 dbc or better.

Typically spurious will be -55 dbc or better.

In addition to the filters, there is a directional coupler which samples the output signal and generates negative voltages proportional to the forward and reverse power in the transmission line. These signals are used for the ALC control.

There are three antenna connections on the PC-16000. These are selected by relays on the LPF Board. Only one relay at a time is ever enabled. There is a small reed relay on this board which is used as a T/R switch. The receiver signal path is the only path that is switched. The transmitter is always in line via the LPF's. The reed switch will disconnect the receiver input from the antenna line and ground it. The receiver signal from the relay is routed to the receiver input on the RX/TX Board via a coax cable. The Control Computer software generates a 4 mS delay after switching the relay to transmit before turning the power amplifier on. This allows the relay to settle to the grounded position to insure no transmit power is applied to the RX input. There are back to back protection diodes on the receiver input on the RX/TX board to clamp any residual RF that might leak thru the relay down the cable.

MAIN CPU BOARD

This board coordinates and controls all the hardware in the PC-16000. It contains two microprocessors. The main Control Computer is responsible for reading the front panel switches, turning on/off the LED's on the front panel, communicating with the IBM keyboard, monitoring encoder pulses from the Main Tuning knob, programming the DDS and PLL synthesizers, generating all control signals for T/R, filter and mode select functions and for a good portion of the CW and RTTY/ASCII decoding and transmitting. Frequency and message memories as well as the Real Time Clock (RTC) are also handled by this processor. The second or Communications Processor is used to handle the RS-232 ports and do some of the processing and control for RTTY/ASCII transmitting and decoding.

The Control Computer can accommodate up to 64K bytes of EPROM program storage and the system contains 16K bytes of RAM storage. The RAM is divided into 2 IC's of 8K each. There is a "Smart Socket" on one of these RAM's which provides battery backup and the RTC function. The software is arranged so that the memories for both frequency and messages are always stored in this RAM. In order to communicate with the rest of the system a data bus needs to be routed to the various boards. Routing the standard data bus from the CPU through the radio circuitry would be disastrous. There would be so much RFI generated by the constant "bouncing" of the data lines, even when the control program is just idling in its main loop with nothing to do, it would completely destroy the receiver. To avoid this problem, a "Static Data Bus" (SBUS0-7) has been created. This bus only moves the data lines when an actual function needs to be performed otherwise it remains in a static state. This bus, along with certain control strobes, is responsible for routing the digital data through the radio. The EPROM's, static RAM's, A/D converter as well as various data latches and bus buffers are all on the local CPU dynamic buses. Even though these buses are local to the CPU board they can still cause RFI to the sensitive receiver. To reduce this problem further, there is a filter board which is "piggybacked" onto the Control Computer and EPROM IC's. This board provides enhanced power supply decoupling and removes some of the higher frequency components from the data/address busses.

The A/D converter requires a calibrated reference voltage for proper operation. There is an adjustable regulator which is set to exactly 5.12 VDC as the A/D reference.

Some of the devices in the PC-16000 are handled on an interrupt basis. These are the Encoder, the IBM Keyboard, the Front Panel pushbuttons and the internal heartbeat timer. The Encoder has two phases which run in quadrature. The computer reads both these phases to determine the direction the knob is being turned (CW or CCW). The IBM keyboard generates interrupts on its serial data clock so the computer can perform the necessary algorithm to clock in the serial data stream and decode a keypress. The IBM Keyboard and the Front Panel keys both share the same interrupt source on the processor. There is a port that has individual bits indicating a keyboard or keypad request. The computer must read this port when it receives an interrupt in order to identify the requesting device and use the appropriate service routine.

The front panel Liquid Crystal Display is controlled by the Control Computer via a bus transceiver on the local data bus. Data is written to and status information read from the display via this transceiver.

The Communications Processor handles the RS-232 ports in the system. It also must get information from the Control Computer in order to coordinate data transfer from the decoded data in the Control Computer to these ports. In addition, it does some of the character generation in the digital modes so it must communicate to the Control Computer for DDS shifting when in FSK and CW offset when it that mode. There are two ports setup between the Control Computer and the Communications Processor for this purpose. They allow the passing of data via a software protocol to smoothly accomplish these functions.

The last function on this board is the DDS. The basics of the DDS operation is described in the “DIRECT DIGITAL SYNTHESIZER” section under the “FREQUENCY SYNTHESIS SCHEME”. Frequency programming and control data is written to this IC by the Control Computer over the local data bus and via the SBUS. There are two frequency registers internal to the IC. One is setup with the receive frequency and the other the transmit frequency. The system T/R line is connected to the FSELECT pin on the IC. By moving this line the TX or RX frequency may be selected without reprogramming the frequency from the computer.

PC-16000A/E
HF Transceiver

Technical Manual

Patcomm Corporation
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Revision A

PC-16000 ALIGNMENT PROCEDURES

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CPU BOARD ALIGNMENT PROCEDURE

Required Equipment:

Frequency Counter
Digital Volt Meter
Plastic Alignment Tool

DDS Calibration:

The unit should be warmed up for at least 1 hour before performing this calibration procedure. The seven phillips screws in the cover should be removed. Gently slide back the cover until the DDS clock trimmer capacitor (C43) is visible on the left side of the unit. Attach the frequency counter probe to J1. Set the radio to USB Mode and enter a frequency of 14.000.00 MHz. Note the frequency of the DDS. It should be 8.050.00 MHz. If it is not then adjust C43 until this reading is obtained. After completing this procedure, the 200 Khz reference on the PLL should be checked for proper calibration.

A/D Reference Adjustment:

With power off, remove the top cover as described above. Gently lift the cover off the unit being careful not to rip the speaker cable. The cable may be unplugged and the cover placed aside. Unplug the 40 pin ribbon cable from the JP1 connector near the center of the CPU Board. Unplug the DDS Coax cable from J1 at the left side of the board. Remove the three screws on the bottom of the front panel plate. Carefully pull the front panel assembly toward you while twisting downward to release it from the main chassis. Swing the plate out far enough to gain access to R16 trimpot. Turn on the power and measure the voltage at C28 (+) or the top of R23. It should be 5.12 VDC. If this is not correct, adjust R16 until this voltage is obtained. Remove the power and re-assemble the unit in the reverse order.

PLL BOARD ALIGNMENT PROCEDURE

Required Equipment:

- Frequency Counter
- Oscilloscope with 10X probe
- Small Flat Blade Screwdriver
- Signal Generator - HP 8640B or equivalent
- Plastic Coil Alignment Tool (Patcomm P/N: 5400-TUNTOL-017)
- 100 Watt Dummy Load with RF Sample point

VCO Alignment Procedure:

Refer to the Section on "Access to RF Compartment" to gain access to the PLL Board. Power up the radio. Using TABLE I as a guide set the radio to the center of the frequency range for each VCO. With the scope set for a DC measurement and zeroed properly, monitor pin 1 of U6 and check that it matches the voltage in the Table for each VCO within 10%. If not, the coil turns on the toroidal inductor for the particular VCO being calibrated (L3, L18, L4 and L8) must be compressed or expanded to reach the proper control voltage.

IF Shift Oscillator Adjustment:

This adjustment can be made without gaining access to the RF Compartment. Remove the top cover as described in the "Top Cover Removal" Section. Make sure the RF Power control is turned fully CCW (Minimum output power). Connect the output of the Signal Generator to the ANT A input connector. Apply power to the PC-16000. Set the frequency to 14.035 MHz and select the CW Mode. Select the 250 Hz filter. Make sure the IF Shift Control is set to "0". Set the signal generator to 14.035 MHz with an output level of -100 dbm. Adjust the PC-16000 Main tuning for approximately an 800 Hz tone. Check to see if the IF Shift Oscillator is calibrated by tuning about 1.5 divisions + and - of "0" with the IF Shift control. The signal should virtually disappear at these positions of the control. If it does not do this or it is not symmetrical about the "0" mark then the IF Shift oscillator needs to be aligned. Proceed to the next section.

There is an access hole in the top cover of the RF Compartment near the front panel. Gently insert the coil alignment tool into this hole until it engages in the IF Shift oscillator coil. Place the IF Shift Control at the end of the range where the signal should just be audible (either + or - 1.5 divisions from "0"). Adjust the coil until the signal is audible. Run the control back and forth and make sure the signal is centered around "0". Adjust the coil until this condition occurs. This completes the IF Shift Alignment.

200 Khz Reference Calibration:

Before attempting this calibration, the 8.050 MHz DDS synthesizer should be calibrated. See the section on the CPU Board Alignment. Calibration should be checked before attempting alignment

VCO ADJUSTMENT VALUES

VCO 1

FREQ	CNTL VOLTAGE
100 kHz	1.2 V
1.500 MHz	1.6 V
3.550	2.8 V
3.950	3.0 V
7.030	6.0 V
7.490	6.8 V

VCO 2

FREQ	CNTL VOLTAGE
7.650 MHz	2.1 V
10.11	3.5 V
14.49	6.8 V

VCO 3

FREQ	CNTL VOLTAGE
14.65 MHz	2.0 V
18.10	3.9 V
21.03	6.5 V
21.49	7.0 V

VCO 4

FREQ	CNTL VOLTAGE
21.61 MHz	1.7 V
24.93	3.0 V
28.03	5.1 V
28.46	5.5 V
29.05	6.0 V
29.75	6.8 V
29.90	7.0 V

TABLE I

to be sure alignment is required. Connect the dummy load to the PC-16000. Apply power to the radio. Allow the radio to warm up for at least 1 hour. Place the unit on 14.035.00 MHz, CW mode. The TRANSMIT frequency on the display should indicate 14.035.00. Attach the frequency counter to the RF Sample point on the dummy load. Key the transmitter and set the output power to approximately 10 Watts. Read the frequency and verify it is 14.035.00 +/- 20 Hz.
Now switch to 1.815.00 MHz, CW mode. Again be sure the TRANSMIT frequency is 1.815.00. Key the transmitter and verify the frequency is correct to within 20 Hz. Repeat this procedure for a frequency of 28.010.00 MHz. If these 3 readings are correct the unit is calibrated and requires no alignment. If it is not calibrated proceed with the next step.

Remove the small ferrite block that is taped to the top of the RF Compartment with the 16 conductor ribbon cable passing through it. The tape must be ripped off and the cleaned from the block before fresh tape is applied after alignment. Under this block is an access hole. A small screwdriver can be placed thru the hole to adjust the trimpot on the PLL board to trim the 200 Khz reference oscillator. Set the PC-16000 to 14.035.00 MHz in CW mode again. Key the transmitter and note the frequency. Adjust the trimpot until the counter reads 14.035.00. Check the 1.815 and 28.010 frequencies. They should be within 20 Hz of the exact value. If this is not the case go to the alignment procedure for the 8.050 MHz DDS synthesizer then come back and repeat this procedure. After alignment replace the double sided tape on the ferrite block and re-attach to the RF Compartment top cover.

AM IF Shift Alignment:

Place the radio in the AM Mode. Place a frequency counter on the output of the 45.455 MHz PLL on the BFO board (J2 on the BFO). Adjust R98 (through the access hole in the BFO board) until the frequency reads 45.455.00. The signal is now centered in the filter passband for AM.

BFO BOARD ALIGNMENT PROCEDURE

Required Equipment:

Oscilloscope with 10X probe
Plastic Coil Alignment Tool (Patcomm P/N: 5400-TUNTOL-017)
Frequency Counter

455 Khz VCO Adjustment:

Gain access to the BFO Board as described in the "Access to RF Compartment" Section. This adjustment should be done with the unit cold. Connect the frequency counter to JP12 or JP13 to monitor the output frequency of the PLL. Apply power to the PC-16000. Be sure that the IF Shift control is set to "0". Using the scope DC coupled and properly zeroed monitor the voltage on pin 1 of U7. There should be a DC level of 4.0 volts. The frequency should be stable and within a couple of Khz of 455.0 Khz (depends on the sideband selected and the exact setting of the IF Shift oscillator). If this voltage is incorrect, adjust the slug in T1 until the correct voltage is obtained. Move the scope to pin 1 of U2. There should be a modulated RF waveform at 4.800 MHz. Adjust the slug in L1 to maximize the amplitude of the waveform and also minimize the modulation. Keep an eye on the output frequency while doing this since an incorrect setting could cause the loop to unlock. Only very small adjustments to this coil will be required. If the loop unlocks even though the waveform looks peaked, check the frequency of the waveform, it is probably over 5.1 MHz and is tuned to the image frequency of the mixer MX1. Turning the coil slug clockwise to increase the inductance will fix this.

45.455 MHz VCO Adjustment:

Gain access to the BFO Board as described in the "Access to RF Compartment" Section. This adjustment should be done with the unit cold. Connect the frequency counter to J2 to monitor the output frequency of the PLL. Apply power to the PC-16000. Be sure that the IF Shift control is set to "0". Using the scope DC coupled and properly zeroed monitor the voltage on pin 1 of U6. There should be a DC level of 3.0 volts. The frequency should be stable and within a couple of Khz of 45.455 MHz (depends on the sideband selected and the exact setting of the IF Shift oscillator). If this voltage is incorrect, adjust the slug in L5 until the correct voltage is obtained.

RX/TX BOARD ALIGNMENT PROCEDURE

Required Equipment:

Spectrum Analyzer (0 - 100 MHz Min) with Tracking Generator must also have a minimum scan rate of 1KHz/div or less with a 300Hz or less RBW.
1X - 10X Scope Probe (100 MHz BW Min)
Oscilloscope with 10X probe
Signal Generator - HP 8640B or equivalent
Audio Testset Generator - Single and Dual Tone adjustable output
100 Watt Dummy Load with RF Sample Point
RF Power and AF Gain Extension controls
(Patcomm P/N: 2900-16KEXT-024)
Coax jumper assembly to BNC Connection (Patcomm P/N: 6000-COAX01-028)

Note: The following procedure is intended to be followed in sequence. If a particular test is being performed out of order please read all sections preceding that test to insure the proper setup.

RECEIVER ALIGNMENT

Gain access to the board by following the "Access to RF Compartment" procedure. Attach the extension controls to the AF Processor Board. Set the RF Power output to minimum and the AF Gain to a 12 o'clock setting.
All measurements taken should be with 2 db for the Spectrum Analyzer and 10% for voltages.

Bandpass Filter Check:

Connect the Tracking Generator output to the ANT A connector. Carefully remove SMD capacitor C190. Attach the coax jumper assembly from D46 Anode to ground. Connect the other end of the cable to the Spectrum Analyzer input. Apply power to the PC-16000. Select the 160 meter band. Set the spectrum analyzer to display 0 - 5 MHz. Adjust the Tracking Generator output level to -20 dbm. Calibrate the Generator/Analyzer to establish a reference level. Verify that the filter plot breaks at 2.5 MHz with no more than a 4 db insertion loss. The ultimate attenuation should be 50 db or better. Follow the data in TABLE II for the rest of the filters.

After verifying the operation of all filters, turn off the PC-16000. Remove the test cable and replace the SMD capacitor C190.

First Mixer/Post Mixer Amplifier Check:

Remove the Tracking Generator from the ANT A connector and connect the Signal Generator. Set the generator for 14.035 MHz with an output level of -17 dbm. Attach a 1X probe to the input of the Spectrum Analyzer. Attach the 10X probe to the scope. Apply power to the PC-16000. Set the radio to 14.035 MHz, CW mode, 1.8 Khz bandwidth. Check the signal at jumper LP1 with the scope. A 100 mVpp 14.035 MHz sine wave should be present. Check the signal at C190, the same signal should be present with some first LO signal visible also. Place the probe from the Spectrum Analyzer on the input of U17 (Post Mixer Amplifier). A level of -48 dbm should be present. Check the level on the output of U17. It should be -26 dbm.

45 MHz Roofing Filter Alignment:

Check the level at the input of U25 (Post filter amplifier) it should be -46 dbm. If this is not the case the 45 MHz filter requires alignment. Place the probe on the output of the U25 Amplifier. The normal level here should be at -10 dbm. Adjust the Spectrum Analyzer for a center frequency of 45.0 MHz with a scan width of 200 Khz/division. The RBW should be adjusted for proper Analyzer calibration. Adjust C139 for a peak at 45.0 MHz. Next adjust L53 for a peak followed by L54. Note the 45.0 MHz signal level. It should be close to or above the -10 dbm level. Next the Signal generator should be moved to 13.125 MHz to generate an image signal at 45.910 MHz. Use C139 to minimize the image line. Then use L53 to bring the image line 55 db (or better) below the level that the 45.0 MHz signal was at. Now move the generator back to 14.035 MHz and check that the 45.0 MHz signal is within 2 db of the original value and that it is within 2 db of -10 dbm. The 45 MHz filter is now aligned properly.

AGC Adjustment:

Remove the signal generator input signal. Measure the voltage at U15 pin 14 with the DC coupled scope. It should measure 4.0 volts DC. If this is not the case, adjust R100 until that value is obtained. Next measure the IF output signal at the junction of C69 and J3 (or at the end of the IF signal coax cable on the AF Processor Board). There should be approximately 50 mVpp of noise present. If this is not the case, adjust R147 until this level is achieved. Be sure that the slug in T12 (in the IF amplifier) is turned fully CCW and at the top of its travel. Go back and check that the AGC voltage is still at 4.0 VDC. Repeat the process until the AGC voltage and the IF signal level are correct.

45 MHz IF Amplifier Alignment:

Turn the Signal Generator back on and check that the -17 dbm signal at 14.035 MHz is still being received by the PC-16000. Place the probe from the Spectrum Analyzer on the output side of C105 (side closest to Q35). The signal level should measure -17 dbm at 45.0 MHz. (There will also be IMD Products present). Using an plastic alignment screwdriver adjust C106 for this value. It is important to be sure that the signal is tuned properly within the receiver passband for an 800 Hz tone. Since this stage is AGC controlled the signal can actually appear larger when tuned outside the passband of the IF amplifiers. After peaking C106 the signal level should be at -17 dbm.

455 Khz IF Amplifier Alignment:

With the -17 dbm test signal present at the antenna input a 1.7 Vpp 455 Khz signal should be present at the anode of D25 (input to the noise blanker switch). The same signal should appear at the cathode of D24 (output of the noise blanker switch). The signal at the input to the mechanical filters (filter side of R211) should measure 1.2 Vpp. Make sure the receiver passband is set for 1.8 Khz bandwidth. Measure the signal at the output of the mechanical filter (G1 of Q31 or top of R173). It should be .2 Vpp. The signal at the drain of Q31 should measure 6Vpp. Adjust T13 for this value. The signal at the drain of Q29 should measure 5 Vpp. Adjust T14 for this value. The signal at the drain of Q28 should measure .8Vpp. Before adjusting this stage, check the G1 voltage on Q28. It should be 1Vpp. If it is not, then adjust R147 until this value is obtained. Be sure that the slug in T12 is backed out all the way to the top of the can. Re-check the drain of Q28 for the .8Vpp signal. Check the output of the IF strip at J3 (J3 side of C69). There should be a .3Vpp signal here. (This signal can also be seen on the other end of the IF Amp cable at the input to the AF Processor). The last check is to measure the AGC voltage at pin 14 of U15. It should be at .5 VDC.

S-Meter Calibration:

Set the signal generator to -72 dbm. Tune the PC-16000 and the generator to 14.035 MHz. With the output of the generator switched off, adjust R123 for a zero on the meter. Switch the signal generator output on and tune the receiver for an 800 Hz tone. Adjust R126 for an S9 meter reading.

Noise Blanker Check:

Set the signal generator to 14.035 MHz. Set the level to -50 dbm. Switch the internal pulse mode on. Set the pulse width to 50 uS and the Repetition rate to 25 mS. Turn on the signal generator output and pulse noise should be heard in the receiver. Switch the noise Blanker on and the noise should completely disappear. The signal at the anode of D25 should be a 2.3 V DC level with negative going pulses down to 1.3 V and a pulse width of about 1.5 mS. Adjust T10 and T11 if these values are not obtained.

This completes the receiver alignment on the RX/TX Board.

TRANSMITTER ALIGNMENT

Microphone AGC Adjustment:

Connect the output of the PC-16000 to the dummy load. Unplug the low level transmitter output cable from J4. Connect the microphone to the PC-16000. Apply power to the PC-16000. Set the Audio Testset Generator to the single tone (1 Khz) mode and set the output control to the 9 o'clock position. Connect the scope to the test point at pin 8 of U1. Set the scope to AC coupled, 1V/div and 2mS/div horizontal sweep rate. Set the front panel MIC GAIN control to the 2 o'clock position. Set the microphone in the testset, enable the tone and key the PTT on the microphone. The scope should show a 5 Vpp undistorted sine wave at 1 Khz. Adjust R23 until this value is obtained. Advance the output control on the testset and verify that the scope pattern remains constant and without distortion even with the control fully CW.

455 Khz IF Amp Gain Check:

Place the PC-16000 into the CW mode. Rotate the RF POWER control fully CW to full output power (be sure that the cable to J4 is unplugged). Place the scope probe at the drain of Q12. Key the transmitter using the T/R TUNE key or the PTT on the microphone. The scope should show a 455 Khz sinewave at 4.5 Vpp. Turning the RF POWER control CCW should make the amplitude smoothly drop down to zero at full CCW position. Unkey the transmitter and return the RF POWER control to the full CW (max power) position.

45 MHz Mixer Adjustment:

Place the probe from the Analyzer at the output of the transmit mixer (C218). Key the transmitter and note the level of the signal at 45.0 MHz. It should read -23 dbm. Using a plastic adjusting tool, adjust C45 until this level is reached.

45 MHz First Filter Alignment:

Place the Analyzer probe at the output of U18. Key the transmitter and note the signal level at 45.0 MHz. The signal should be at -14 dbm. With the analyzer set for a center frequency of 45.0 MHz and a sweep rate of 1 MHz/div all spurious signals should be at least -40 dbc. Adjust L8 and L17 until this is obtained.

45 MHz 2nd Filter Alignment:

Place the analyzer probe on the junction of C212 and R80. Key the transmitter and note that the level is -18 dbm and all spurious signals are at -50 dbc minimum. Adjust L55 and L56 for this response. Place the scope probe on the 30 MHz LPF output (L2 and C214). There should be 100 mVpp sine wave at 14.035 MHz. If observed with the analyzer probe, it should measure -30 dbm with no measurable spurious above -55 dbc.

Low Level TX Amplifier Check:

Place the scope probe at the output of U23. There should be a .9 Vpp sinewave at 14 MHz with the transmitter keyed. Move the probe to the output of the Bandpass Filters at the cathode of D29. There should be a .5 Vpp 14MHz sinewave present. Next look at the input of U21 and the level should be .3 Vpp. Move to the output of U21 and the level should measure .4 Vpp. The output of U22 should have a 6 Vpp signal which drops to 3 Vpp at the TX output connector J4.

Final TX Checkout:

Unkey the transmitter and plug the cable back into J4. Connect the Spectrum Analyzer to the RF sample point on the dummy load. Turn the RF POWER control down to minimum. Set the analyzer for a 0 to 100 MHz scan display. Key the transmitter and advance the RF POWER control until the output is at 100 Watts as indicated on the dummy load power meter. The spectrum analyzer should show a clean spectrum with all spurious and harmonics at least -45 dbc. Look for any close in spurious at the main carrier signal. If any exist they can be removed by careful touchup of the C45 adjustment at the first transmit mixer (use a plastic non-conductive tool). Unkey the transmitter. Set the Spectrum Analyzer to view the 14.035 MHz signal at a 1 Khz/div sweep rate. Set the PC-16000 to USB mode. Place the microphone on the testset and inject a 1KHz tone into the microphone. Key the transmitter using the PTT switch. Note the relative level of the

LSB signal to the USB line. It should be at least -40 dbc. Use R12 to adjust this level if required. Unkey the transmitter and set the mode to LSB. Repeat the procedure only use R44 to reduce the USB line to -40 dbc.

This completes the Transmitter alignment on the RX/TX board.

AF PROCESSOR BOARD ALIGNMENT PROCEDURE

Required Equipment:

Signal Generator - HP 8640B or equivalent
Oscilloscope with 10X probe
100 Watt Dummy Load with RF Sample point and SWR/Power Meter
Spectrum Analyzer (0 - 100 MHz Min) with Tracking Generator must also have a minimum scan rate of 1KHz/div or less with a 300Hz or less RBW.
13.8 VDC Power Supply with Current Metering

USB/LSB Opposite Sideband Reject Alignment:

Connect the Signal Generator to the ANT A connector on the PC-16000. Remove the top cover. Set the Generator to -100 dbm at a frequency of 14.035 MHz. Apply power to the PC-16000. Make sure ANT A is selected. Place the unit on 14.035 MHz, CW mode with the 1.8 Khz filter selected. Be sure the IF Shift Control is centered. Tune the receiver lower in frequency until it passes through zero beat. Contine lowering the frequency another 1 Khz. Adjust R21 to remove any residual signal. Switch the PC-16000 to USB and tune upward in frequency until passing through zero beat. Continue tuning another 1 Khz past zero beat. Adjust R20 to remove any residual signal. This completes the opposite sideband rejection adjustments.

Manual Notch Adjustment:

Setup the PC-16000 with the Signal Generator as in the previous opposite sideband rejection section. Adjust the frequency on the PC-16000 for approximately a 1 Khz tone. Turn on the Manual Notch and carefully rotate the NOTCH control to minimize the volume of the tone. Adjust R11 to maximize the notch depth. This completes the manual notch adjustment.

ALC Adjustment:

Gain access to the AF Processor Board by following the "Access to RF Compartment" procedure. Connect the dummy load to the ANT A connector on the PC-16000. Apply power to the PC-16000. Set the radio for 14.035 MHz, CW mode. Key the transmitter and adjust the output power to 100 Watts as shown on the dummy load wattmeter. If 100 Watts cannot be reached, turn R133 (MID BAND) to bring the unit out of ALC control. Unkey the transmitter and connect a scope to the junction of R18 and C45. Key the Transmitter and adjust C34 on the Transmit Low Pass Filter board until -6.8 VDC is obatined. Care should be taken around the LPF Board and C34. **C34 will have high RF Voltages present on it. Do not touch this part with your hands while transmitting.** Next advance the output power until 110 Watts of output power is obtained. Using R133 (MID BAND) bring the output power back to 105 Watts. Unkey the transmitter and change the band to 160 Meters (1.815 MHz). Key the transmitter and adjust the output power for 95 Watts on the dummy load power meter. Read the Power Supply current and be sure it does not exceed 22 Amps. Use R134 (LO BAND) to limit the current to 22 Amps maximum. Unkey the transmitter and change the band to 10 Meters (28.010 MHz). Key the transmitter and advance the RF POWER control until 105 watts is obtained. Use R61 (HI BAND) limit the power to 100 Watts. Unkey the transmitter. This completes the ALC adjustment.

Power / SWR Calibration:

Access to the RF Compartment is not required for this adjustment. Setup the unit as described in the previous ALC Adjustment section. Key the transmitter and adjust the output power to maximum as limited by the ALC. The power meter on the dummy load should read 105 Watts. Enable the Power Meter on the PC-16000. It should also read 105 Watts. If not, adjust R16 until this reading is obtained. Unkey the transmitter. Place the dummy load into the "Tuned Dummy" position. Key the transmitter and adjust the dummy load for a 3:1 SWR indication on the dummy load SWR meter. Adjust the SWR Foldback control, R59, for a forward power reading of 65 Watts on both the dummy load and PC-16000 power meters. Adjust R17 until the PC-16000 reads an SWR value of 3:1. Unkey the transmitter. This completes the Power / SWR Calibration.

Sidetone Level Adjustment:

Access to the RF Compartment is not required for this adjustment. Apply power to the PC-16000. Place the unit in the CW mode. Press the "SPOT" button. Adjust the level of the sidetone by turning R32. Press the "SPOT" button again to turn off the tone.

DSP BOARD ALIGNMENT PROCEDURE

Required Equipment:

Oscilloscope
Patcomm DSP Test Fixture (Patcomm P/N: 2900-DSPFIX-023)

RTTY Filter Calibration:

Disconnect the signal cables from the DSP Board and plug in the test fixture. Attach the scope to the fixture. Apply power to the PC-16000. Observe the lissajous pattern on the scope. Adjust R21 and R22 for a perfectly orthogonal pattern. This completes the procedure.

POWER AMPLIFIER BOARD ADJUSTMENT

Required Equipment:

100 Watt Dummy Load with RF Sample Point and Power Meter
Spectrum Analyzer (0-100 MHz)

Bias Adjustment:

Connect the dummy load to the antenna connector on the PC-16000. Connect the Spectrum Analyzer to the RF Sample Point on the dummy load. Locate the access hole for the bias adjust pot on the Power Amplifier board. It is located under the LPF board in the metal shield plate. Apply power to the PC-16000. Place the unit on 20 Meters (14 MHz) in the USB mode. Connect the microphone. Turn the microphone gain control all the way down (full CCW). Key the transmitter using the T/R TUNE function to obtain full output carrier and adjust the output power for 100 Watts. Set the Spectrum Analyzer for 6 boxes (60db) of deflection at 100 Watts. Unkey the transmitter. Key the PTT on the microphone. The Analyzer should show a level that is -50 dbc from the 100 Watt carrier level. Adjust the bias control until this level is obtained. **CARE SHOULD BE USED AROUND THE LPF BOARD...HIGH RF VOLTAGES ARE PRESENT ON THIS BOARD WHEN TRANSMITTING.**

Input LPF Adjustment:

Connect the dummy load to the antenna connector on the PC-16000. Apply power to the PC-16000. Set the PC-16000 to 28.010 MHz in the CW mode. Key the transmitter and set the output power to 50 Watts. Adjust the trimcap, C36 for maximum output power on the meter. Unkey the transmitter. This completes the adjustment.

Top Cover Removal

There are 7 screws holding the Top Cover in Place. There are 3 on each side and one in the top rear center of the cover. Remove these screws. Carefully lift the cover off the base being careful not to rip the cable connecting the speaker mounted in the cover to the base. Once the cover is clear of the base, the speaker cable may be unplugged and the cover placed aside. Take care not to lose the nylon washers under each of the cover screws. They are there to prevent chipping of the paint and should always be used when re-installing the cover. Audio can be picked up through the external speaker jack on the rear apron when the cover is removed.

Access to RF Compartment

Some of the testing and troubleshooting in the PC-16000 will require access to the PC Boards in the RF Compartment located on the right side of the unit. The boards contained in this enclosure are:

PLL Board
BFO Board
RX/TX Board
AF Processor Board

If access is required, use the following procedure:

1> Remove the Outside Top Cover
2> Remove the External Speaker jack from the rear apron
3> Unplug all cables from the connectors on the RF Compartment cover. It is not necessary to remove the white/blk cable from the Amp Bias control on JP17. Drape the cable harness over the Front Panel to prevent interference. Unplug the 16 pin ribbon that goes through the CPU shield plate. This cable is also passed through a Ferrite block taped to the RF Compartment top cover. This block must be snapped open to remove the red/black power lead to the PLL board.
4> Unsnap the two large ferrite blocks taped to the side of the compartment. Unplug the 40 pin ribbon cable from J15 and lift out of the blocks. Unplug the 26 pin ribbon cable from JP19 to the DSP Board.
5> Unscrew the center hold down nut in the center of the cover.
6> Remove the screw on the right side rear of the cover
7> Gently lift the cover off the compartment. Some cable ties may have to be cut to provide enough clearance. The cover cannot be completely removed, there are several cable assemblies between the AF Processor (Mounted on the cover) and the RX/TX board (Mounted on the bottom of the compartment).
8> The cover must now be tilted on a 45 degree angle and held up with a non metallic rod.
9> Once the cover is in place, the 40 pin ribbon cable from the CPU and the 26 pin ribbon from the DSP board may be plugged back in. Also plug the short 16 pin ribbon from the LPF board into its connector (closest to the front). The 16 ribbon to the CPU need not be plugged in if the external keyboard will not be used in testing. An extension cable must be used if required.
10> Plug the External Cables from the test fixture into the AF Gain and RF Output connectors on the AF Processor Board and the S-meter cable into the RX/TX board.
11> Plug the +12 V power cable from the LPF area into JP2 - **IMPORTANT - OBSERVE POLARITY ON THIS CABLE - DAMAGE TO THE UNIT CAN RESULT IF BACKWARD - CONSULT THE DRAWING OF THE COMPARTMENT COVER.**
12> Be sure to plug the 2 pin white/black cable from the Power Amplifier into JP17 to control the Amplifier bias properly.
13> When assembling, use the drawing of the compartment cover as a guide to cable connections, the color codes are on this drawing. Be sure to double check that all cables inside the

compartment are seated properly before closing.

PC-16000 AFPROC BOARD
Bill of Materials REV: D5

Item	Qty	Reference designation	Part	Part Number
1)	13	C1, C20, C27, C28, C32, C42, C63 C64, C65, C66, C67, C68, C80	22 UF	1500-22U-R-062
2)	5	C2, C4, C8, C61, C62	.1 UF	1500-.1U-R-035
3)	2	C3, C5	470 UF 16V	1500-470UR-102
4)	6	C6, C44, C69, C70, C75, C76	1 UF	1500-1U-R-063
5)	10	C9, C11, C12, C14 C24, C37 C60, C82, C85, C86	.1 UF	1500-.1U-A-125
6)	5	C10, C48, C88, CY, CZ (See Note #1 for CY and CZ)	.01 UF	1500-.01U-A-001
7)	7	C7, C13, C29, C46, C47, C54 C55	.1 UF SMD	1500-.1U-S-067
8)	3	C22, C78, C79	.22 UF	1500-.22U-A-152
9)	2	C16, C49	.47 UF	1500-.47U-R-064
10)	9	C18,C19,C21,C26,C31,C35,C36 C81, CX (See Note #2)	.68 UF	1500-.68U-R-049
11)	1	C23	100 UF	1500-100U-R-066
12)	2	C41, C84	10 UF 16V	1500-10U-R-109
13)	2	C33, C34	.015 UF	1500-.015UA-097
14)	1	C38	470 UF 6V	1500-470U-R-098
15)	3	C39, C40, C43	.022 UF	1500-.022UA-153
16)	3	C71, C72 C84A	4.7 UF	1500-4.7U-R-065

Item	Qty	Reference designation	Part	Part Number
17)	8	C50, C51, C52, C53, C56, C57 C58, C59	.001 UF	1500-.001UA-079
18)	2	C73, C74	33 UF	1500-33U-R-038
19)	1	C83	560 PF	1500-560P-A-013
20)	1	C77	3300 PF	1500-3300P-055
21)	14	D2, D3, D4, D7, D8, D9, D12 D13, D14, D15, D16, D17 D18, (D19 MOD #2)	1N4148	4800-1N4148-015
22)	2	D5, D11	1N4737A	4800-1N4737-033
23)	2	D6, D10	1N34A	4800-1N34A-019
24)	2	JP1, JP10	HEADER 3	2102-3P-MO-004
25)	9	JP3, JP7, JP13 JP2, JP4, JP6, JP11, JP12, JP17	HEADER 2	2102-2P-MO-004
26)	1	JP5	WIRE ASSY.	CABLE BAG-#10
27)	2	JP8, JP9	HEADER 16	2100-16MALE-019
28)	1	JP14	3 PIN BERG	2102-3PM-031_
29)	1	JP15	40 PIN HEADER	2100-40PSTM-053
30)	3	JP16, JP18 JP19	26 PIN HEADER	2100-26MALE-029
31)	3	J1, J2, J3	7 PIN DIN	2100-7P-DIN-036
32)	7	J4, J5, J6, J7, J8, J9, J10	RCA VERT JACK	2100-JK-VRT-024
33)	1	L1	3.9 MH	1800-3.9MH-015
34)	16	Q1, Q2, Q3, Q4, Q5, Q6, Q7	2N3904	4800-2N3904-013

Item	Qty	Reference designation	Part	Part Number
		Q8, Q9, Q10, Q11, Q12, Q13 Q15, Q16, Q17	2N3904	4800-2N3904-013
35)	1	Q14	TIP-122	4800-TIP122-020
36)	1	R1	3.3 OHM	4700-3.3-066
37)	15	R2, R5, R7, R22, R27, R28 R41, R42, R52, R64, R85 R111, R112, R121, R124	10 K	4700-10K-011
38)	1	R30	390 OHM	4700-390-082
39)	2	R36, R44	100 OHM	4700-100-009
40)	1	R6	8.2 K	4700-8.2K-034
41)	1	R51	5.6 K	4700-5.6K-089
42)	1	R66	1 MEG	4700-1MEG-080
43)	4	R12, R31, R53, R60	47 K	4700-47K-087
44)	1	R25	220 K	4700-220K-208
45)	9	R8, R14, R23, R40, R48, R49 R68, R69, R70	4.7 K	4700-4.7K-074
46)	4	R15, R45, R46, R102	2.2 K	4700-2.2K-075
47)	1	R128	2.2 K SMD	4700-2.2K-S-125
48)	5	R13, R18, R19, R33, R50	33 K	4700-33K-079
49)	12	R3, R24, R29, R34, R35, R56, R67, R125, R130, R131, R132, R135	22 K	4700-22K-068
50)	2	R105, R106	1 K	4700-1K-038
51)	1	R26	560 OHM	4700-560-085

Item	Qty	Reference designation	Part	Part Number
52)	1	R37	6.8 K	4700-6.8K-209
53)	6	R9, R38, R55, R58, R107, R108	100 K	4700-100K-078
,54)	3	R39, R113, R116	3.3 K	4700-3.3K-023
55)	1	R43	330 OHM	4700-330-192
56)	1	R54	150 K	4700-150K-088
57)	3	R57, R65, (R137 MOD #2)	330 K	4700-330K-090
58)	1	R63	82 K	4700-82K-111
59)	1	R71	18.2 K 1%	4700-18.2K1-073
60)	1	R126	1.8 K	4700-1.8K-083
61)	1	R72	47.5 K 1%	4700-47.5K1-030
62)	1	R73	200 K 1%	4700-200K-1-071
63)	16	R74, R75, R76, R77, R80, R81 R82, R83, R90, R91, R93, R94 R97, R98, R100, R101	10 K 1%	4700-10K-1-010
64)	1	R78	221K 1%	4700-221K1-022
65)	1	R79	332 K 1%	4700-332K-1-069
66)	1	R84	150 K 1%	4700-150K-1-015
67)	1	R86	499 K 1%	4700-499K-1-058
68)	1	R87	2.2 MEG	4700-2.2MEG-017
69)	1	R10, R88	68.1 K 1%	4700-68.1K1-059
70)	2	R89, R96	8.25 K 1%	4700-8.25K1-077

Item	Qty	Reference designation	Part	Part Number
71)	1	R92	12.1 K 1%	4700-12K-1-070
72)	1	R95	120 K 1%	4700-120K1-013
73)	1	R99	39.2 K 1%	4700-39.2K1-026
74)	2	R103, R104	4.75 K 1%	4700-4.7K1-027
75)	2	R109, R110	5.62 K 1%	4700-5.62K1-031
76)	2	R114, R115	2.7 K	4700-2.7K-018
77)	2	R117, R118	33.2 K OHM 1%	4700-33.2K1-113
78)	4	R119, R120, R122, R123	68 OHM	4700-68-063
79)	1	R127	10 MEG	4700-10MEG-012
80)	1	R62	220 OHM	4700-220-021
81)	1	R11	5 K POT	4750-5KPOT-008
82)	5	R16, R17, R20,R21, R32	10 K POT	4750-10KPOT-001
83)	1	R47	20 K POT	4750-20KPOT-005
84)	1	R59	500 K POT	4750-500KPT-006
85)	3	R61, R133, R134	1K POT	4750-1KPOT-017
86)	2	MX1, MX2	SBL-3	3130-SBL-3-091
87)	1	U1	TDA1013B	3130-1013BU-092
88)	1	U2	ULN2983	3130-2983A-051
89)	5	U3, U8, U11, U12, U13	TL074	3130-TL074C-031
90)	2	U4, U9	4066	3130-4066-059

Item	Qty	Reference designation	Part	Part Number
91)	1	U5	ICL7660	3130-7660-049
92)	2	U6, U18	74HC04	3130-HC04-005
93)	1	U7	ULN2803	3130-2803-034
94)	1	U10	74HC138	3130-HC138-040
95)	3	U14, U16, U17	74HC534	3130-HC534-009
96)	1	U15	74HC374	3130-HC374-008
97)	1	VR1	LM7805	3130-LM7805-053
98)	1	VR2	LM7808	3130-LM7808-093
99)	1	VR3	LM317L	3130-317LZ-018
100)	2	MISC 4-40 SS SCREW		2800-SCREW-005
101)	2	MISC #4 SS HEX NUT		2800-NUT-009
102)	2	MISC #4 SS STAR		2800-STAR#4-031
103)	1	PCB AFPROC PCB		1700-AFPROC-109

NOTE #1: Place CY across R12 and CZ across R55

NOTE #2: Place CX from Q1 Base to top of R124

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Item	Qty	Reference designation	Part	Part Number
1)	16	C1, C2, C4, C6, C8, C12, C18 C26, C32, C36, C40, C43, C44 C45, C47, C50	.1 UF SMD	1500-.1U-S-067
2)	2	C3, C41	330 PF SMD	1500-330P-S-119
3)	4	C5, C9, C51, C53	.01 UF SMD	1500-.01U-S-054
4)	1	C46	27 PF SMD	1500-27P-S-150
5)	7	C15, C17, C19, C33, C42, C48 C55	.001 UF SMD	1500-.001US-130
6)	2	C39, C60	.022 UF SMD	1500-.022US-124
7)	1	C10	390 PF SMD	1500-390P-S-058
8)	1	C11	100 PF SMD	1500-100P-S-056
9)	1	C13	.22 UF SMD	1500-.22U-S-149
10)	3	C14, C21, C49	10 PF SMD	1500-10P-S-138
11)	1	C16	4.7 PF SMD	1500-4.7P-S-113
12)	1	C20	2.2 PF SMD	1500-2.2P-S-111
13)	2	C22, C62	22 UF LEADED	1500-22U-R-062
14)	1	C23	33 PF SMD	1500-33P-S-115
15)	1	C24	15 PF SMD	1500-15P-S-137
16)	4	C25, C29, C34, C37	47 PF SMD	1500-47P-S-116
17)	1	C28	2200 PF SMD	1500-2200PS-141
18)	2	C59	51 OHM SMD	4700-51-S-145

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Item	Qty	Reference designation	Part	Part Number
19)	2	C7, C30	68 PF SMD	1500-68P-S-060
20)	1	C38	180 PF SMD	1500-180P-S-147
21)	2	C27, C31	12 PF SMD	1500-12P-S-114
22)	1	C35	120 PF SMD	1500-120P-S-057
23)	2	C52, C56	270 PF SMD	1500-270P-S-146
24)	1	C54	680 PF SMD	1500-680P-S-148
25)	2	C57, C58	6800 PF SMD	1500-.0068U-142
26)	1	C61	1500 PF SMD	1500-1500PS-121
27)	2	C63, C64	3900 PF SMD	1500-3900PS-162
28)	1	D4	MVAM104	4800-MV104-025
29)	1	D3	MVM108	4800-MVM108-003
30)	3	D1, D2, D5	1N4148 SMD	4800-4148SM-023
31)	1	JP1	26 PIN CONN.	2100-26MALE-029
32)	*	JP2, JP5, JP12, JP13	COAX JUMPERS (2)	
33)	2	J2 J3	VERT. JACK	2100-JK-VRT-024
34)	2	J1, J4	PLUG	2100-PLUG-034
35)	1	K1	RELAY SPDT	4500-RELAY-003
36)	1	L1	2.7 UH ADJ	1800-TK5135-025
37)	1	L2	10 UH SMD	1800-10U-S-045
38)	1	L3	4.7 UH SMD	1800-4.7U-S-038

Item	Qty	Reference designation	Part	Part Number
39)	1	L4	.18UH SMD	1800-.18U-S-039
40)	1	L5	T-37-6 (14T)	1800-T37-6-019
41)	2	L6, L7	1.8UH SMD	1800-1.8U-S-047
42)	1	L8	18 UH SMD	1800-18U-S-044
43)	4	Q1, Q2, Q6, Q10	3SK74 SMD	4800-3SK74-012
44)	1	Q7	2N3904 LEADED	4800-2N3904-013
45)	4	Q3, Q4, Q5, Q11	2N3904 SMD	4800-3904SM-004
46)	2	Q8, Q9	2N4416A LEADED	4800-2N4416-005
47)	1	R52	270 OHM SMD	4700-270-S-212
48)	2	R2, R42	15K SMD	4700-15K-S-161
49)	2	R55	121K 1% SMD	4700-120K1-S-154
50)	2	R28, R32	56 OHM SMD	4700-56-S-143
51)	9	R4, R6, R16, R34, R43, R51 R54, R64, R65	100K SMD	4700-100K-S-002
52)	6	R1, R8, R39, R48, R61, R63	68 OHM SMD	4700-68-S-072
53)	2	R5, R60	825 OHM 1% SMD	4700-825-1S-055
54)	7	R7, R22, R30, R31, R36, R56 R62	10K SMD	4700-10K-S-046
55)	3	R3, R23, R57	680 OHM SMD	4700-680-S-166
56)	2	R10, R12	2.7K SMD	4700-2.7K-S-149

Item	Qty	Reference designation	Part	Part Number
57)	2	R49, R59	47 OHM SMD	4700-47-S-043
58)	1	R9	20 OHM SMD	4700-220-S-138
59)	5	R11, R14, R38, R40, R53	47K SMD	4700-47K-S-135
60)	1	R15	27K SMD	4700-27K-S-162
61)	5	R13, R17, R18, R26,	100 OHM	4700-100-S-124
62)	4	R19, R20, R25, R27	470 OHM SMD	4700-470-S-144
63)	1	R21	18.2K SMD	4700-18.2K-S-178
64)	1	R24	2.2K SMD	4700-2.2K-S-125
65)	1	R50	47 UH SMD	1800-47U-S-067
66)	1	R29	10 OHM SMD	4700-10-S-167
67)	1	R33	787 OHM 1% SMD	4700-787-1S-196
68)	1	R35	22K SMD	4700-22K-S-048
69)	2	R41, R58	12K SMD	4700-12K-S-159
70)	2	R44, R46	1K SMD	4700-1K-S-047
71)	1	R45	120 OHM SMD	4700-120-S-181
72)	2	R47, R66	390 OHM SMD	4700-390-S-003
73)	2	T1, T3	IF301	5600-IF301-001
74)	1	T2	IF103	5600-IF103-008
75)	1	T4	16 T/BI F37 CORE	1800-F16B28-089
76)	1	U9	74AC74 SMD	3130-AC74-S-08[illegible]

PC-16000 45.455 BFO BOARD
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Item	Qty	Reference designation	Part	Part Number
77)	2	U2, U5	MC145151 SMD	3130-145151-079
78)	1	U3	74HC14 SMD	3130-HC14SM-089
79)	2	U6, U7	LM2904 SMD	3130-2904SM-100
80)	1	U1	74HC74 SMD	3130-HC74SM-068
81)	1	VR1	LM78L08	3130-78L08-094
82)	1	MX2	SBL-1	3130-SBL-1-037
83)	1	MX1	SBL-3	3130-SBL-3-091
84)	1	PCB	BFO	1700-BFOPLL-107

PC-16000 CPU/DDS BOARD
Bill of Materials REV: D

Item	Qty	Reference designation	Part	Part Number
1)	7	C3, C4, C6, C9, C26, C31, C32	22 UF SMD	1500-22U-R-062
2)	17	C2, C5, C7, C8, C11, C12, C13 C16, C17, C18, C22, C23, C24 C25, C27, C29, C33	.1 UF SMD	1500-.1U-S-067
3)	3	C10, C15, C20	22 PF SMD 0805	1500-22P-S-110
4)	1	C37	22 PF SMD 1206	1500-22P-S-068
5)	1	C38	22 PF LEADED	1500-22P-A-006
6)	1	C19	30 PF SMD	1500-30P-S-165
7)	1	C30	.01 UF SMD	1500-.01U-S-054
8)	1	C14	47 PF SMD	1500-47P-S-116
9)	2	C21, C45	6.8 PF SMD	1500-6.8P-S-166
10)	1	C36	560 PF SMD	1500-560P-S-156
11)	1	C35	.001 UF SMD	1500-.001US-130
12)	1	C34	.68 UF RADIAL	1500-.68U-R-049
13)	1	C28	2.2 UF RADIAL	1500-2.2U-R-037
14)	1	C39	330 PF SMD	1500-330P-S-119
15)	1	C40	.47 UF SMD	1500-.47U-S-131
16)	2	C41, C42	3.3 UF SMD	1500-3.3U-S-160
17)	1	C44	68 PF SMD	1500-68P-S-060
18)	1	C1	1 UF	1500-1U-R-063

Item	Qty	Reference designation	Part	Part Number
19)	1	C43	1.8-6PF VARI CAP	1500-1.8-6P-163
20)	1	D1 (See Note #1)	1N4148	4800-4148-015
21)	1	JP1	40 PIN CONN.	2100-40PSTM-053
22)	1	JP4	14 PIN BERG	2100-14PM-052
23)	1	JP3	2 PIN CONN	2100-2PM-MO-004
24)	1	JP2	16 PIN CONN	2100-16MALE-019
25)	1	JP5	5 PIN BERG	2102-5PM-031
26)	1	J1	VERT JACK	2100-JK-VRT-024
27)	1	L1	1 UH	1800-TK5130-026
28)	1	L2	32 T F37 CORE	1800-F32T28-092
29)	2	L3, L4	150 UH SMD	1800-150U-S-055
30)	1	L5	2.2 UH SMD	1800-2.2U-S-053
31)	1	P2	3 PIN MOLEX	2102-3P-MO-037
32)	1	P1	50 POS FEMALE	2102-50FE-021
33)	2	Q1, Q2	2N3904 SMD	4800-3904SM-004
34)	9	R13, R14, R15, R17, R18, R19, R20, R21, R22, R26 (SEE NOTE #2 for R26)	10 K SMD	4700-10K-S-046
35)	3	R3, R8, R23	220 OHM SMD	4700-220-S-138
36)	2	R1, R9	22 K SMD	4700-22K-S-048

Item	Qty	Reference designation	Part	Part Number
37)	1	R4	47 K SMD	4700-47K-S-135
38)	2	R2, R7	150 OHM SMD	4700-150-S-136
39)	1	R12	4.7 K SMD	4700-4.7K-S-137
40)	1	R16	1K/MT POT	4750-1K-POT-002
41)	3	R5, R6, R11	2.2 K SMD	4700-2.2K-S-125
42)	1	R10	390 OHM SMD	4700-390-S-003
43)	1	R24	1.5 K SMD	4700-1.5K-S-163
44)	1	R25	27 K SMD	4700-27K-S-162
45)	1	U34	74HC573 SMD	3130-573SMD-062
46)	1	U5	CLOCK/BATT	2100-1216B-051
47)	1	U5	6264 DIP	3130-6264-025
48)	1	U6	6264 SMD	3130-6264SMD-078
49)	3	U36, U37, U38	74HC32 SMD	3130-HC32SM-063
50)	4	U17, U26, U39, U41	74HC02 SMD	3130-HC02SM-064
51)	9	U8, U9, U10, U18, U19, U22 U25, U27, U29	74HC574 SMD	3130-574SMD-065
52)	2	U20, U24	74HC138 SMD	3130-138SMD-066
53)	2	U14, U30	74HC244 SMD	3130-244SMD-067
54)	2	U16, U40	74HC74	3130-HC74SM-068
55)	1	U35	4013 SMD	3130-4013SM-069

Item	Qty	Reference designation	Part	Part Number
56)	3	U21, U23, U42	74HC08 SMD	3130-HC08SM-070
57)	1	U32	74HC245 SMD	3130-245SMD-071
58)	1	U31	ADC0809 SMD	3130-0809SM-072
59)	1	U3	27C256 EPROM	3130-27C256-057
60)	1	U11	MAX 232 SMD	3130-232SMD-073
61)	2	U12, U15	74HC04 SMD	3130-HC04SM-074
62)	1	U7	87C51 MICRO	3130-87C51-054
63)	2	U1, U33	74HC132 SMD	3130-132SMD-075
64)	1	U2	80C31 MICRO	3130-80C31-046
65)	1	U28	AD7008 SMD	3130-7008SM-076
66)	1	U13	74HC534 SMD	3130-534SMD-080
67)	1	VR1	LM317Z SMD	3130-317SMD-077
68)	2	Y1, Y3	11.0592 MHZ	2300-11.059-020
69)	1	Y2	33.554432 MHZ	2300-33.554-017
70)	2	U4, U5	28 PIN SOCKET	2100-28-SKT-012
71)	1	U3	28 PIN 2 LVL SKT	2100-28LSKT-077
72)	1	U7	40 PIN SOCKET	2100-40-SKT-013
73)	1	U2	40 PIN 2 LVL SKT	2100-40LSKT-078
74)	2	U2, U7	WAFER CAP	1500-WAF-40-087

Item	Qty	Reference designation	Part	Part Number
75)	3	U3, U4, U5	WAFER CAP	1500-WAF-28-088
76)	1	DS1	DISPLAY	2450-DISPLY-005
77)	1	R501	10 OHM LEADED	4700-10-119
78)	1	MISC	CAP PCB	COMPLETED ASMBLY
79)	1	PCB	CPU/DDS	1700-CPUDDS-103

NOTE #1: D1 is placed across R1 with the cathode to +5 V

NOTE #2: R26 is placed on back of board from C35 to GND

Bill of Materials REV: D1 1/16/3

Item	Qty	Reference designation		ParPart Number	
_____ 1)	6	C1, C2, C11, C27, C29, C38	22 UF	1500-22U-R-062	_____
_____ 2)	18	C3, C5, C8, C9, C14, C16, C17 C18, C19, C20, C21, C22, C23 C28, C40, C41, C43, C51	.1 UF	1500-.1U-R-035	_____
_____ 3)	1	C4	4.7 UF	1500-4.7U-R-065	_____
_____ 4)	1	C6	100 UF	1500-100U-R-066	_____
_____ 5)	4	C10, C15, C30, C39	10 UF	1500-10U-R-036	_____
_____ 6)	2	C12, C13	22 PF	1500-22P-A-006	_____
_____ 7)	8	C24, C26, C32, C34, C35, C36 C47, C48	.01 UF 1%	1500-.01U-R-051	_____
_____ 8)	7	C7, C25, C31, C37, C45, C46 C58 ** ALL ON S/S	.1 UF SMD	1500-.1U-S-067	_____
_____ 9)	1	C33	2.2 UF	1500-2.2U-R-037	_____
_____ 10)	2	C42, C44	.047 UF 1%	1500-.047UR-053	_____
_____ 11)	1	C49	.0047 UF	1500-.0047U-076	_____
_____ 12)	1	C50	.001 UF	1500-.001UA-079	_____
_____ 13)	1	C52	47 UF	1500-47U-R-094	_____
_____ 14)	1	C53	.01 UF	1500-.01U-A-001	_____
_____ 15)	2	C54, (C55 ON S/S)	4700 PF SMD	1500-4700PS-154	_____
_____ 16)	2	C56, C57 ON S/S	150 PF	1500-150P-S-136	_____
_____ 17)	1	C59 MOD #1	1 UF	1500-1U-R-063	_____

Item	Qty	Reference designation		ParPart Number	
_____ 18)	4	D1, D2, D3, D4	1N34A	4800-1N34A-019	_____
_____ 19)	16	D5, D6, D7, D8, D9, D10, D11 D12, D13, D14, D15, D16, D17 D18, D19, (D20 MOD #1)	1N4148	4800-1N4148-015	_____
_____ 20)	1	JP1	HEADER 2	2102-2PM-MO-004	_____
_____ 21)	1	JP2	26 PIN HEADER	2100-26MALE-029	_____
_____ 22)	1	JP3	3 PIN HEADER	2102-3P-MO-037	_____
_____ 23)	3	R1, R53, R54	100 K	4700-100K-078	_____
_____ 24)	7	R2, R23, R24, R27, R28, R80, R94	4.7 K	4700-4.7K-074	_____
_____ 25)	8	R3, R4, R5, R6, R15, R18, R37 R87	10 K 1%	4700-10K-1-010	_____
_____ 26)	15	R8, R29, R33, R47, R49, R50 R55, R56, R57, R58, R60, R61 R71, R85, R91	10 K	4700-10K-011	_____
_____ 27)	5	R9, R10, R11, R12, R93	20 K 1%	4700-20K-1-191	_____
_____ 28)	2	R13, R30	22.1 K 1%	4700-22.1K1-104	_____
_____ 29)	4	R14, R20, R36, R88	23.2 K 1%	4700-23.2K1-100	_____
_____ 30)	1	R16	8.2 K	4700-8.2K-034	_____
_____ 31)	4	R17, R26, R38, R95	18.7 K 1%	4700-18.7K1-099	_____
_____ 32)	2	R19, R82	5.6 K	4700-5.6K-089	_____
_____ 33)	2	R21, R22	5 K POT	4750-5KST-018	_____
_____ 34)	4	R25, R45, R48, R76	220 OHM	4700-220-021	_____

	Item	Qty	Reference designation		ParPart Number	
_____	35)	2	R31, R77	470 K	4700-470K-105	_____
_____	36)	1	R32	47 K	4700-47K-087	_____
_____	37)	1	R34	1.8 K	4700-1.8K-083	_____
_____	38)	3	R35, R78, R83	1 K	4700-1K-038	_____
_____	39)	2	R39, R40	80.6 K 1%	4700-80.6K-035	_____
_____	40)	2	R41, R75	243 OHM 1%	4700-243-1-107	_____
_____	41)	1	R42	1.3 K 1%	4700-1.3K-1-106	_____
_____	42)	1	R43	2.21 K 1%	4700-2.21K1-108	_____
_____	43)	1	R44	11.3 K 1%	4700-11.3K1-109	_____
_____	44)	6	R46, R51, R72, R73, R74, R84	22 K	4700-22K-068	_____
_____	45)	1	R52	390 OHM	4700-390-082	_____
_____	46)	2	R59, R79	470 OHM	4700-470-057	_____
_____	47)	2	R62, R68	174 K 1%	4700-174K-1-098	_____
_____	48)	2	R63, R86	267 K 1%	4700-267K-1-097	_____
_____	49)	3	R7, R64, R92	2.2 K	4700-2.2K-075	_____
_____	50)	2	R65, R69	49.9 K 1%	4700-49.9K1-101	_____
_____	51)	2	R66, R70	7.5 K 1%	4700-7.5K-1-102	_____
_____	52)	1	R67	510 K	4700-510K-103	_____
_____	53)	1	R81	39 K	4700-39K-076	_____
_____	54)	2	R89, R90	33 K	4700-33K-079	_____

Item	Qty	Reference designation		ParPart Number	
_____ 55)	1	R97 MOD #1	1.5 K	4700-1.5K-134	_____
_____ 56)	1	R96 MOD #1	56 K	4700-56K-120	_____
_____ 57)	1	U1	74HC132	3130-HC132-012	_____
_____ 58)	1	U2	ADSP-2105	3130-AD2105-096	_____
_____ 59)	1	U3	27C512	3130-27C512-099	_____
_____ 60)	1	U4	74HC541	3130-HC541-095	_____
_____ 61)	1	U5	TLC320AC01	3130-TLC320-097	_____
_____ 62)	1	U6	ICL7660	3130-7660-049	_____
_____ 63)	6	U7, U9, U11, U12, U15, U17	TL074	3130-TL074C-031	_____
_____ 64)	3	U8, U10, U14	4066	3130-4066-059	_____
_____ 65)	1	U13	74ALS05	3130-ALS05A-060	_____
_____ 66)	1	U16	74HC08	3130-HC08-041	_____
_____ 67)	1	VR1	LM7805	3130-LM7805-053	_____
_____ 68)	1	VR2	LM7808	3130-LM7808-093	_____
_____ 69)	1	VR3	LM317	3130-317LZ-018	_____
_____ 70)	1	Y1	12.288 MHZ	2300-12.288-006	_____
_____ 71)	1	U2	SOCKET	2100-68-SKT-014	_____
_____ 72)	1	U5	SOCKET	2100-28-SKT-058	_____
_____ 73)	1	U3	SOCKET	2100-28-SKT-012	_____

Item	Qty	Reference designation		Part Number	
_____ 74)	2	L1, L2	32T / F37 CORE	1800-F32T28-092	_____
_____ 75)	2	MISC	4-40 SS SCREW	2800-SCREW-005	_____
_____ 76)	2	MISC	#4 SS HEX NUT	2800-NUT-009	_____
_____ 77)	2	MISC	#4 SS STAR	2800-STAR#4-031	_____
_____ 78)	1	PCB	DSP/DIGI	1700-DSPDIG-012	_____

MOD #1: REFER TO E.C.O. 16K0017 FOR COMPONENT PLACEMENT

PC-16000A/E FRONT PANEL BOARD
Bill of Materials REV: B

Item	Qty	Reference designation	Part	Part Number
1)	30	D1, D2, D3, D4, D5, D6, D8, D13, D14, D15 D16, D17, D18, D19, D20, D21 D22, D23, D26, D27 D28, D33, D34, D35 D36, D38, D39, D40, D41 D42	RED LED	2450-LEDRED-004
2)	3	D7, D31, D32	GREEN LED	2450-LEDGRN-002
3)	3	C1, CJ1, CJ2 (See Note #1)	.1 UF SMD	1500-.1U-S-067
3)	1	C2	330 PF SMD	1500-330P-S-119
5)	1	JP3	50 PIN CONN	2100-50STM-056
6)	1	JP4	8P MIKE PLUG	2100-8POSJK-071
7)	2	J2, J3	PHONE JACK	2100-PH-JAC-026
8)	1	J1	SPDT JACK	2100-JK-2SP-046
9)	1	J5	14 POS MALE	2100-14PM-052
10)	1	J6	CABLE ASSY	
11)	1	Q2	2N3904 SMD	4800-3904SM-004
12)	33	R1, R2, R3, R4, R5, R6, R7, R8 R15, R16 R17, R18, R19, R20 R23, R25, R27, R28 R29, R30, R31, R32, R33, R34, R35 R36, R38, R39, R41, R42 R43, R44, R46	390 OHM SMD	4700-390-S-003
13)	1	R40	22 K SMD	4700-22K-S-048
14)	2	R11, R12	100 OHM SMD	4700-100-S-124
15)	1	R33	2.2 K SMD	4700-2.2K-S-125
14)	2	RJ1, RJ2 (See Note #2)	2.2 K	4700-2.2K-075

Item	Qty	Reference designation	Part	Part Number
15)	1	RX	10 OHM 1/4W	4700-10-119
16)	30	S1 THRU S8 & S10 THRU S32	PB SWITCH	5100-PSHBUT-001
17)	4	U1, U2, U3, U4	74HC374	3130-HC374-008
18)	3	POS. #1 IF SHIFT POS. #2 NOTCH POS. #4 RF PWR	10 K PANEL	4750-10KPMT-020
19)	1	POS. #3 MIKE GAIN	50 K DETENT POT	4750-50KDPM-025
20)	1	POS. #5 SENS	10 K DUAL POT	4750-10K2PMT-032
21)	1	POS. #6 AF GAIN	1 K POT W/SWT	4750-1KSWCH-023
22)	1		ENCODER	3700-ENAIJ-003
23)	1		METER	2900-METER-001
24)	1		DISPLAY	2450-DISPLY-007
25)	1	MISC	#6 SS SCREW	2800-SCREW-032
26)	1	MISC	#6 SS STAR	2800-STAR#6-030
27)	1	MISC	1/2 STAND	2800-SDF1/2-001
28)	1	WIRES		FP CABLE KIT
29)	1	PCB	FRONT PANEL	1700-FRONT-104

NOTE #1: CJ1 AND CJ2 CONNECT FROM J3 PIN1 TO GND AND PIN 2 TO GND RESPECTIVELY

NOTE #2: RJ1 CONNECT FROM J3 PIN1 TO DOT CONNECTION ON PCB. RJ2 CONNECTS FROM J3 PIN2 TO DASH CONNECTION ON PCB

PC-16000A/E LOW PASS FILTER BOARD
Bill of Materials REV: E5

Item	Qty	Reference designation	Part	Part Number
1)	14	C1, C11, C13, C25, C26, C31 C32, C37, C38, C46, C58, C59 C60, C62 (Note: C59 & C60 HAVE .22 UF SMD IN PARALLEL (1500-.22U-S-149)	.1 UF SMD	1500-.1U-S-067
2)	6	C2, C3, C7, C8, C15, C22	470 PF 500V	1500-470P-R-075
3)	1	C6	1200 PF 2KV	1500-12002K-159
4)	2	C4, 2 PARTS IN PAR	470 PF 1KV	1500-470P1K-168
5)	1	C9A	1000 PF 500V	1500-.001UR-015
6)	3	C5, C9B, C47	680 PF 500V	1500-680P-R-031
7)	1	C19	820 PF 500V	1500-820P-R-033
8)	3	C29, C45, C30A	150 PF 500V	1500-150P-R-020
9)	2	C10, C61	.1 UF LEAD	1500-.1U-R-035
10)	1	C12	22 UF LEAD	1500-22U-R-062
11)	1	C14	270 PF 500V	1500-270P-R-025
12)	4	C17, C39, L7, C30B	120 PF 500V	1500-120P-R-018
13)	4	C16, C23, C65, C51A	33 PF 500V	1500-33P-R-027
14)	1	C51B	39 PF 500V	1500-39P-R-028
15)	1	C18	560 PF 500V	1500-560P-R-030
16)	1	C20	220 PF 500V	1500-220P-R-024
17)	1	C28	47 PF 500V	1500-47P-R-029
18)	3	C27, C52, C57	82 PF 500V	1500-82P-R-034
19)	2	C24, C49	390 PF 500V	1500-390P-R-073
20)	2	C33, C36	.01 UF SMD	1500-.01U-S-054

Item	Qty	Reference designation	Part	Part Number
21)	1	C34	3.5-20 PF TRIM	1500-3.5TRM-071
22)	1	C35	100 PF SMD	1500-100P-S-056
23)	5	C21, C40, C44, C48, C54	100 PF 500V	1500-100P-R-016
24)	2	C43, C56	22 PF 500V	1500-22P-R-078
25)	1	C41	180 PF 500V	1500-180P-R-022
26)	1	C66	1200 PF 1KV	1500-12001K-161
27)	16	D1, D2, D3, D4, D5, D6, D7 D8, D9, D10, D13, D14, D15 D16, D17, D18	1N4148	4800-1N4148-015
28)	2	D11, D12	1N34A	4800-1N34-019
29)	2	JMP1 @ C64	JUMPER	
30)	1	JP2	2 PIN HEADER	2102-2PM-MO-004
31)	1	P1	16 PIN CONN.	2100-16MALE-019
32)	15	K1, K2, K3, K4, K5, K6, K7 K8, K9, K10, K11, K12, K13 K15, K16	DPDT RELAY	4500-RELAY-002
33)	1	K14	SPDT RELAY	4500-RLEAY-003
34)	2	L21, L22	1 MH	1800-1MH-012
35)	1	L15	14 T/BI F37 CORE	1800-F14B28-090
36)	1	L17	5 T / AIR 5/16"	1800-A31518-106
37)	1	L18	7 T / AIR 5/16"	1800-A31718-098
38)	1	L1	22 T / T50-2	1800-T5222T-087
39)	1	L2	19 T / T50-2	1800-T5219T-108
40)	1	L3	24 T / T50-10	1800-T5124T-088

Item	Qty	Reference designation	Part	Part Number
41)	1	L4	18 T / T50-10	1800-T5118T-085
42)	2	L5, L9	11 T / T50-10	1800-T5111T-081
43)	1	L6	16 T / T50-10	1800-T5116T-083
44)	1	L8	17 T / T50-10	1800-T5117T-084
45)	2	L10, L16	13 T / T50-10	1800-T5113T-082
46)	1	L11	9 T / T50-10	1800-T5109T-080
47)	2	L12, L13	6 T / T50-2	1800-T5206T-105
48)	1	L20	9 T / T50-2	1800-T5209T-104
49)	1	L23	17 T / T50-2	1800-T5217T-XXX
50)	1	R1	3.3 K SMD	4700-3.3K-S-141
51)	1	R2	150 OHM .25W	4700-150-062
52)	1	R3	2.2 K	4700-2.2K-075
53)	1	Q1	2N3904	4800-2N3904-013
54)	1	PCB	LPF PCB	1700-LPFLTR-101

PC-16000 RF PA BOARD
Bill of Materials REV: F2

Item	Qty	Reference designation	Part	Part Number
1)	8	C16, C19, C24, C25, C27, C31 C33, C35	.1 UF	1500-.1U-R-035
2)	2	C3, C34	.1 UF SMD	1500-.1U-S-067
3)	2	C2, C15	.01 UF	1500-.01U-A-001
4)	1	C46	150 PF SMD	1500-150P-S-136
5)	3	C4, C5, C14	.001 UF	1500-.001UA-002
6)	2	C6, C7	.0068 UF	1500-.0068R-050
7)	1	C8	100 UF	1500-100U-R-066
8)	2	C9, C10	.047 UF	1500-.047UR-053
9)	2	C29, C30	.047 UF SMD	1500-.047US-140
10)	2	C11, C12	560 PF 500V	1500-560P-R-030
11)	1	C13	1200 PF 1KV	1500-12001K-161
12)	3	C20, C22, C32	22 UF	1500-22U-R-062
13)	2	C1, C23	100 PF SMD	1500-100P-S-056
14)	1	C28	470 PF	1500-470P-A-084
15)	1	C21	470 PF	1500-470P-S-132
16)	2	C26, C45	220 UF	1500-220U-R-093
17)	2	C18, C40	270 PF SMD	1500-270P-S-146
18)	1	C36	3.5 PF TRIM CAP	1500-3.5TRM-071
19)	1	C37	.47 UF	1500-.47U-R-064
20)	1	C17	680 PF 500V	1500-680P-R-031
21)	2	C38, C39	470 PF 1KV	1500-470-1K-168

Item	Qty	Reference designation	Part	Part Number
22)	1	C47	120 PF 500V	1500-120P-R-018
23)	1	D2	1N4148	4800-1N4148-015
24)	5	D1, D4, D5, D6, D7	1N4004	4800-1N4004-017
25)	1	D3	1N4728A	4800-1N4728-030
26)	1	JMP1	16 GA BLACK	6000-16-OTF-013
27)	2	J1, J2	RCA JACK	2100-JK-VRT-024
28)	1	J3	2 PIN DC PWR PLG	2100-2-PLUG-007
29)	1	K1	RELAY SPDT	4500-RELAY-004
30)	2	L1, L5	24T / F37 CORE	1800-F24T26-100
31)	3	L3, L6, L7	3.3 UH	1800-3.3UH-014
32)	1	L4	10T / F37 CORE	1800-F10T26-099
33)	1	L8	.12UH SMD	1800-.12U-S-046
34)	2	Q1, Q2	2SC2879 Matched	4800-SC2879-044
35)	1	Q3	2SC2166	4800-SC2166-028
36)	2	Q4, Q5	2N3904	4800-2N3904-013
37)	1	Q6	MJE-700	4800-MJE700-029
38)	2	Q7, Q8	2SC3133 Matched	4800-SC3133-027
39)	1	RT1	THERMISTOR	5300-THERM-003
40)	1	R1	470 OHM	4700-470-057
41)	2	R2, R3	1 K	4700-1K-038
42)	1	R4	10 K TRIMPOT	4750-10KPOT-001
43)	6	R5, R6, R9, R10, R27, R29	3.3 OHM 1/2 W	4700-3.3-217

Item	Qty	Reference designation	Part	Part Number
44)	4	R7, R8, R23, R24	22 OHM	4700-22-067
45)	2	R11, R12	24 OHM 5W	4700-24-5W-040
46)	2	R13, R14	330 OHM	4700-330-192
47)	1	R15	5.6 OHM	4700-5.6-211
48)	1	R16	10 K	4700-10K-011
49)	1	R28	470 OHM SMD	4700-470-S-144
50)	3	R17, R18, R19	2.2 K	4700-2.2K-075
51)	1	R20A	39 OHM 2W	4700-39-2W-189
52)	1	R20B	100 OHM 1/4W	4700-100-009
53)	1	R21	18 OHM 1/2W	4700-18-.5W-188
54)	2	R25, R26	82 OHM 1W	4700-82-1W-190
55)	1	T1	16:1 XFORMER	5600-1"CORE-004
56)	1	T2	9:1 XFORMER	5600-TRNCOR-012
57)	1	T3	4:1 XFORMER	5600-1/2COR-002
58)	1	VR1	LM317T	3130-LM317T-033
59)	1	VR2	LM7808	3130-LM7808-093
60)	3	MISC	4-40 SS SCREW	2800-SCREW-005
61)	1	MISC	4-40 SS SCREW	2800-SCREW-007
62)	4	MISC	#4 SS HEX NUT	2800-NUT-009
63)	4	MISC	#4 SS STAR	2800-STAR#4-031
64)	1	MISC	#4 SS FLAT	2800-WASHER-011
65)	1	PCB	PA	1700-RF-AMP-003

PC-16000A/E 45-75 Mhz PLL BOARD
Bill of Materials REV: D4

Item	Qty	Reference designation	Part	Part Number
1)	8	C2, C3, C11, C16 C26, C27, C44, C72	22 UF	1500-22U-R-062
2)	22	C1, C4, C6, C8, C13, C15, C17 C18, C23, C24, C25, C45, C52 C53, C54, C55, C73, C79, C98 C98, C99, C102, C103, C104	.1 UF SMD	1500-.1U-S-067
3)	5	C29, C30, C60, C69, C88	33 PF SMD	1500-33P-S-115
4)	3	C33, C34, C63	15 PF SMD	1500-15P-S-137
5)	4	C22, C58, C85, C92	100 PF SMD	1500-100P-S-056
6)	1	C70	4.7 PF SMD	1500-4.7P-S-113
7)	10	C48, C50, C51, C65, C66, C68 C77, C78, C87, C90	.001 UF SMD	1500-.001US-130
8)	1	C96	2200 PF SMD	1500-2200PS-141
9)	2	C81, C84	47 PF SMD	1500-47P-S-116
10)	1	C82	82 PF SMD	1500-82P-S-118
11)	6	C39, C46, C59, C71, C80, C91	68 PF SMD	1500-68P-S-060
12)	1	C21	390 PF SMD	1500-390P-S-058
13)	2	C49, C67	270 PF SMD	1500-270P-S-146
14)	1	C76	27 PF SMD	1500-27P-S-150
15)	1	C94	680 PF SMD	1500-680P-S-148
16)	6	C20, C31, C32, C36, C74, C86	.01 UF SMD	1500-.01U-S-054
17)	3	C56, C89, C93	330 PF SMD	1500-330P-S-119
18)	1	C9	470 PF SMD	1500-470P-S-132
19)	1	C19	220 PF SMD	1500-220P-S-134

Item	Qty	Reference designation	Part	Part Number
20)	3	C28, C47, C64	1200 PF SMD	1500-1200PS-143
21)	1	C57	180 PF SMD	1500-180P-S-147
22)	1	C83	2.2 PF SMD	1500-2.2P-S-111
23)	4	C35, C37, C61, C62	10 PF SMD	1500-10P-S-138
24)	1	C14	39 PF SMD	1500-39P-S-059
25)	2	C7, C95	.22 UF SMD	1500-.22U-S-149
26)	4	C40, C41, C42, C43, C44	10 UF 16V	1500-10U-R-109
27)	1	C12	560 PF SMD	1500-560P-S-156
28)	1	C75	5.1 PF SMD	1500-5.1P-S-157
29)	2	C5, C38	120 PF SMD	1500-120P-S-057
30)	14	D2, D3, D4, D5, D6, D9, D10 D11, D12	1N4148 SMD	4800-4148SM-023
31)	4	D7, D8, D13, D16	MV104	4800-MV104-025
32)	1	D4	MVAM108	4800-MVM108-003
33) 039	1	D1	BZX8476V2 SMD	4800-84C6-8-
34)	1	JP1	26P CONECTOR	2100-26MALE-029
35)	1	JP2	HEADER 2	2100-2PM-MO-004
36)	1	JP6	HEADER 3	2100-3PM-MO-004
37)	3	J2, J4, J5	VRT JACK	2100-JK-VRT-024
38)	1	L1	18 UH ADJ	1800-TK3129-103
39)	1	L18	T37 CORE / 9T	1800-T09T22-113
40)	1	L4	T37 CORE / 8T	1800-T08T22-112

Item	Qty	Reference designation	Part	Part Number
41)	1	L20	10 UH SMD	1800-10U-S-045
42)	1	L24	1 UH SMD	1800-1UH-S-050
43)	1	L8	T37 CORE / 7T	1800-T07T22-111
44)	2	L21, L22	.18 UH SMD	1800-.18U-S-039
45)	2	L23, L26	.12 UH SMD	1800-.12U-S-046
46)	2	L2, L19	100 UH SMD	1800-100U-S-056
47)	4	L6, L14, L27, L28	1.2 UH SMD	1800-1.2U-S-042
48)	2	L5, L15	.68 UH SMD	1800-.68U-S-069
49)	1	L3	T37 CORE / 10T	1800-T10T22-114
50)	2	L7, L17	.27 UH SMD	1800-.27U-S-070
51)	2	L9, L16	.33 UH SMD	1800-.33U-S-074
52)	2	L10, L12	4.7 UH SMD	1800-4.7U-S-038
53)	2	L11, L13	3.9 UH SMD	1800-3.9U-S-062
54)	1	L25	.39 UH SMD	1800-.39U-S-075
55)	1	L29	47 UH SMD	1800-47U-S-067
56)	4	Q11, Q12, Q18, Q23	2N3906 SMD	4800-3906SM-026
57)	19	Q1, Q3, Q4, Q5, Q7, Q8, Q9, Q10 Q13, Q14, Q15, Q16, Q17, Q19 Q20, Q21, Q22, Q45, Q25	2N3904 SMD	4800-3904SM-004
58)	1	Q26	MPS571	4800-MPS571-022
59)	25	R7, R12, R14, R18, R19, R22 R23, R25, R29, R38, R39, R44 R45, R49, R50, R53, R54, R67 R69, R70, R71, R73, R74, R76 R82	10K SMD	4700-10K-S-046

Item	Qty	Reference designation	Part	Part Number
60)	14	R3, R6, R9, R17, R26, R34, R40, R41, R51, R52, R68, R75, R77, R80	2.2K SMD	4700-2.2K-S-125
61)	1	R103	680 OHM SMD	4700-680-S-166
62)	1	R107	56 OHM SMD	4700-56-S-143
63)	10	R36, R37, R59, R60, R61, R64 R65, R83, R88, R100	100 OHM SMD	4700-100-S-124
64)	1	R11	.01 UF	1500-.01U-S-054
65)				
66)	4	R55, R56, R72, R78	22K SMD	4700-22K-S-048
67).	9	R30, R62, R63, R66, R81, R86 R89, R95, R99	100K SMD	4700-100K-S-002
68)	5	R8, R42, R92, R101, R105	10 OHM SMD	4700-10-S-167
69)	2	R24, R35	68 OHM SMD	4700-68-S-072
70)	1	R58	15K SMD	4700-15K-S-161
71)	1	R4	200 OHM 1% SMD	4700-200-1S-194
72)	1	R33	560 OHM SMD	4700-560-S-174
73)	1	R5	1.47K 1% SMD	4700-1.47KS-195
74)	1	R20	787 OHM 1% SMD	4700-787-1S-196
75)	1	R21	12K SMD	4700-12K-S-159
76)	2	R28, R106	47 OHM SMD	4700-47-S-043
77)	1	R46	1K SMD	4700-1K-S-047
78)	1	R32	120 OHM SMD	4700-120-S-181
79)	2	R13, R16	4.7K SMD	4700-4.7K-S-137
80)	1	R27	68K SMD	4700-68K-S-197

Item	Qty	Reference designation	Part	Part Number
81)	3	R1, R2, R108	68 OHM 1/4W	4700-68-063
82)	5	R31, R85, R87, R94, R96	470 OHM SMD	4700-470-S-144
83)	1	R43	330 OHM SMD	4700-330-S-182
84)	1	R47	51 OHM SMD	4700-51-S-145
85)	1	R48	5.1K SMD	4700-5.1K-S-204
86)	1	R57	270 OHM SMD	4700-270-S-212
87)	1	R79	390 OHM SMD	4700-390-S-003
88)	1	R84	22 OHM SMD	4700-22-S-213
89)	2	R90, R91	220 OHM SMD	4700-220-S-138
90)	3	R93, R97, R104	150 OHM SMD	4700-150-S-136
91)	1	R102	39 OHM SMD	4700-39-S-214
92)	1	R109	2.7K SMD	4700-2.7K-S-149
93)	2	R98, R110	10K ST POT	4750-10KPOT-001
94)	1	T1	T37 CORE - 23T/9T	1800-T36239-093
95)	1	MX1	JMS-1 SMD	3130-JMS-1-105
96)	1	U1	74HC138 SMD	3130-138SMD-066
97)	1	U2	MC145151 SMD	3130-145151-079
98)	1	U3	74HC08 SMD	3130-HC08SM-070
99)	1	U4	74HC04 SMD	3130-HC04SM-074
100)	1	U5	200 KHZ VCXO	3130-VCXO-112
101)	1	U6	LM2904 SMD	3130-2904SM-100
102)	1	U7	74HC4066 SMD	3130-4066-S-098

Item	Qty	Reference designation	Part	Part Number
103)	1	U8	74AC74 SMD	3130-AC74-S-086
104)	1	TP	TEST PIN	2100-TESTPN-073
105)	1	VR1	MC33269DT-5.0	3130-MC332-108
106)	1	VR2	LM317T	3130-LM317T-033
107)	1	VR3	LM78L08	3130-78L08-094
108)	1	Y1	4.9152 MHZ	2300-4.9MHZ-036
109)	1	PCB	CIRCUIT BOARD	1700-PLL45-106
110)	1	MISC	4-40 SS SCREW	2800-SCREW-005
111)	1	MISC	#4 SS HEX NUT	2800-NUT-009
112)	1	MISC	#4 SS STAR	2800-STAR#4-031

PC-16000A/E RX/TX BOARD
Bill of Materials REV: E4

Item	Qty	Reference designation	Part	Part Number
1)	10	C1, C5, C7, C8, C15, C18, C25 C26, C29, C226	.001 UF SMD	1500-.001US-130
2)	5	C2, C30, C39, C43, C123	22 UF	1500-22U-R-062
3)	49	C3, C9, C10, C16, C27, C28, C31 C35, C36, C41, C57, C64, C65 C68, C70, C71, C72, C78 C79, C83, C84, C86, C87, C88 C93, C95, C96, C97, C110, C113 C120, C122, C124, C126, C127 C130, C131, C137, C156, C178 C184, C190, C196, C202, C204 C216, C224, C228, C232	.1 UF SMD	1500-.1U-S-067
4)	3	C4, C22, C128	33 UF	1500-33U-R-038
5)	1	C92	2200 PF SMD	1500-2200PS-141
6)	8	C6, C59, C60, C91, C138 C141, C175, C183	220 PF SMD	1500-220P-S-134
7)	44	C12, C32, C33, C38, C40, C44, C49 C51, C52, C54, C56, C62, C66 C76, C81, C82, C85, C89, C90 C100, C101, C102, C103, C107 C109, C114, C115, C118, C121 C125, C133, C136, C142, C143 C144, C145, C146, C181, C185 C186, C187, C188, C189, C215	.01 UF SMD	1500-.01U-S-054
8)	5	C14, C17, C19, C21, C24	1 UF	1500-1U-R-063
9)	2	C20, C55	100 UF	1500-100U-R-066
10)	7	C34, C37, C104, C112, C212 C218, C219	12 PF SMD	1500-12P-S-114
11)	2	C42, C205	10 PF SMD	1500-10P-S-138
12)	3	C45, C106, C139	3.5-20 PF	1500-3.5TRM-071

Item	Qty	Reference designation	Part	Part Number
13)	1	C50	.0689 UF SMD	1500-.068US-144
14)	1	C164	22 PF SMD	1500-22P-S-068
15)	4	C58, C67, C206, C234	10 UF/16V	1500-10U-R-109
16)	2	C11, C61	3.3 UF SMD	1500-3.3U-S-160
17)	3	C63, C160, C169	39 PF SMD	1500-39P-S-059
18)	3	C13, C69, C75	.022 UF SMD	1500-.022US-124
19)	1	C77	680 PF SMD	1500-680P-S-148
20)	9	C80, C149, C161, C170, C173 C193, C213, C214, C229	120 PF SMD	1500-120P-S-057
21)	1	C203	82 PF SMD	1500-82P-S-118
22)	1	C94	390 PF SMD	1500-390P-S-058
23)	1	C105	1500 PF	1500-1500PA-085
24)	1	C108	3300 PF SMD	1500-3300PS-070
25)	2	C230, C231	4.7 PF SMD	1500-4.7P-S-113
26)	1	C147	8.2 PF SMD	1500-8.2P-S-107
27)	3	C148, C192, C217	33 PF SMD	1500-33P-S-115
28)	4	C150, C166, C182, C194	68 PF SMD	1500-68P-S-060
29)	3	C151, C180	150 PF SMD	1500-150P-S-136
30)	6	C154, C197, C198, C199 C200, C201	2.2 UF	1500-2.2U-R-037
31)	2	C158, C167	18 PF SMD	1500-18P-S-101
32)	2	C159, C168	27 PF SMD	1500-27P-S-150
33)	4	C53, C162, C171, C174	180 PF SMD	1500-180P-S-147

Item	Qty	Reference designation	Part	Part Number
34)	3	C163, C195, C223	470 PF SMD	1500-470P-S-132
35)	2	C172, C210	100 PF SMD	1500-100P-S-056
36)	1	C191	15 PF SMD	1500-15P-S-137
37)	1	C227	330 PF SMD	1500-330P-S-119
38)	1	C73	1500 PF SMD	1500-1500PS-121
39)	1	C176	510 PF SMD	1500-510P-S-164
40)	1	MISC	.68 UF	1500-.68U-R-049
40A)	1	C48	1200 PF	1500-1200P-S-143
40B)	2	C74, C74A	.47UF SMD	1500-.47U-S-131
41)	30	D1, D2, D3, D4, D5, D6, D7, D8 D9, D10, D11, D12, D13, D14 D15, D16, D17, D18, D19, D20 D21, D22, D23, D24, D25, D35 D36, D49, D50, D51	1N4148 SMD	4800-4148SM-023
42)	19	D26, D27, D28, D29, D30, D31 D32, D33, D34, D37, D38, D39 D40, D41, D42, D43, D44, D45 D46	1N4151 SMD	4800-4151SM-043
43)	2	D47, D48	1N4004	4800-1N4004-017
44)	4	FL1, FL7, FL8, FL9	TE9310	2300-TE9310-037
45)	2	FL2, FL3	455KHZ	2700-455KHZ-002
46)	1	FL10	TE9420	2300-TE9420-033
47)	1	FL4	500HZ MECH FIL	2700-500MHF-004
48)	1	FL6	2.5KHZ MECH FIL	2700-2.5KMF-003
49)	4	JP1, JP4, JP5, JP10	HEADER 2 PIN	2102-2PMMO-004
50)	1	JP2	HEADER 16 PIN	2100-16MALE-019

Item	Qty	Reference designation	Part	Part Number
51)	1	JP7	HEADER 26 PIN	2100-26MALE-029
52)	1	JP9	HEADER 5 PIN	2102-5PM-052
53)	2	JP11, JP14	BERG CONN.	2102-2PM-031
54)	8	J1, J2, J3, J4, J5, J6, J7, J8	RCA JACK	2100-JK-VRT-024
55)	5	K1, K3, K4, K5, K6	RELAY DPDT	4500-RELAY-002
56)	3	K2, K7, K8	RELAY SPDT	4500-RELAY-003
57)	1	LP1	JUMPER WIRE	
58)	10	L3, L4, L6, L7, L13, L14 L16, L24, L38, L52	1 mH	1800-1mH-012
59)	2	L2, L33	.47 UH SMD	1800-.47U-S-043
60)	2	L5, L34	.82 UH SMD	1800-.82U-S-066
61)	4	L8, L17, L55, L56	TK3105	1800-TK3105-036
62)	1	L9	100 UH SMD	1800-100U-S-056
63)	3	L1, L11, L60	3.3 UH SMD	1800-3.3U-S-076
64)	1	L15	8T / BIFIL / F37	1800-F08B28-091
65)	4	L18, L51, L58, L61	560 UH SMD	1800-560U-S-037
66)	4	L19, L21, L39, L41	1.8 UH SMD	1800-1.8U-S-047
67)	2	L20, L40	2.7 UH SMD	1800-2.7U-S-058
68)	1	L37	6.8 UH SMD	1800-6.8U-S-059
69)	2	L22, L42	12 UH SMD	1800-12U-S-060
70)	2	L23, L43	18 UH SMD	1800-18U-S-044
71)	2	L25, L46	2.2 UH SMD	1800-2.2U-S-053
72)	3	L26, L36, L47	3.9 UH SMD	1800-3.9U-S-062

Item	Qty	Reference designation	Part	Part Number
73)	2	L27, L48	5.6 UH SMD	1800-5.6U-S-057
74)	2	L28, L49	8.2 UH SMD	1800-8.2U-S-063
75)	2	L29, L50	15 UH SMD	1800-15U-S-064
76)	2	L30, L45	22 UH SMD	1800-22U-S-061
77)	1	L31	150 UH SMD	1800-150U-S-055
78)	1	L32	.22 UH SMD	1800-.22U-S-065
79)	1	L44	.18 UH SMD	1800-.18U-S-039
80)	1	L35	1.2 UH SMD	1800-1.2U-S-042
81)	2	L53, L54	TK3107	1800-TK3107-071
82)	1	L57	.56 UH LEADED	1800-.56UH-078
83)	2	MX1, MX2	SBL-3	3130-SBL-3-091
84)	2	MX3, MX4	SBL-1	3130-SBL-1-037
85	22	Q1, Q2, Q3, Q5, Q6, Q7, Q8, Q9 Q13, Q15, Q17, Q18, Q20, Q23 Q24, Q27, Q30, Q32, Q36, Q39 Q40, Q41	2N3904 SMD	4800-3904SM-004
86)	4	Q4, Q16, Q21, Q22	2N4416A	4800-2N4416-005
87)	3	Q11, Q14, Q35	2SK241	4800-2SK241-031
88)	6	Q12, Q25, Q28, Q29, Q31, Q33	3SK74	4800-3SK74-012
89)	2	R1, R40	8.25 K 1% SMD	4700-8.25KS-153
90)	16	R2, R3, R5, R14, R18, R27, R29 R30, R41, R42, R46, R51, R56 R62, R64, R65	10 K 1% SMD	4700-10K1-S-186
91)	1	R4	39.2 K 1% SMD	4700-39.2KS-152
92)	1	R6	360 OHM SMD	4700-360-S-049

Item	Qty	Reference designation	Part	Part Number
93)	16	R10, R34, R58, R76, R93, R95 R108, R119, R127, R132, R144 R145, R169, R205, R208, R211	2.2 K SMD	4700-2.2K-S-125
94)	1	R8	120 K 1% SMD	4700-120K1S-154
95)	15	R9, R38, R43, R50, R68, R73 R75, R87, R128, R148, R150 R168, R196, R207, R209	1 K SMD	4700-1K-S-047
96)	13	R11, R16, R24, R35, R36, R37 R69, R90, R141, R152, R171 R214, R215	10 K SMD	4700-10K-S-046
97)	1	R72	1.8 K SMD	4700-1.8K-S-142
98)	4	R15, R54, R154, R223	150 OHM SMD	4700-150-S-136
99)	2	R17, R106	1 MEG SMD	4700-1M-S-139
100)	3	R13, R19, R173	5.6 K SMD	4700-5.6K-S-044
101)	4	R21, R125, R151, R165	47 K SMD	4700-47K-S-135
102)	6	R22, R91, R94, R129, R155, R185	120 OHM SMD	4700-120-S-181
103)	1	R25	332 K 1% SMD	4700-332K1S-156
104)	1	R26	2.2 MEG 1% SMD	4700-2.2M-S-158
105)	1	R28	47.5 K 1% SMD	4700-47.5KS-155
106)	1	R31	150 K 1% SMD	4700-150K1S-157
107)	4	R32, R47, R89, R216	47 OHM SMD	4700-47-S-043
108)	2	R33, R113	3.3 K SMD	4700-3.3K-S-141
109)	1	R39	68.1 K 1%	4700-68.1KS-176
110)	1	R49	33 K SMD	4700-33K-S-140
111)	1	R45	12 K 1% SMD	4700-12K1-S-175

Item	Qty	Reference designation	Part	Part Number
112)	1	R118	6.8 K SMD	4700-6.8K-S-160
113)	25	R52, R70, R83, R88, R105 R114, R133, R135, R136 R142, R161, R162, R166 R180, R186, R187, R188 R189, R190, R197, R200 R201, R202, R203, R204	100 OHM SMD	4700-100-S-124
114)	11	R53, R59, R77, R79, R157 R158, R160, R170, R181 R194, R206	470 OHM SMD	4700-470-S-144
115)	2	R55, R120	22 K SMD	4700-22K-S-048
116)	5	R48, R57, R96, R99, R111	4.7 K SMD	4700-4.7K-S-137
117)	1	R60	200 K 1% SMD	4700-200K1S-177
118)	1	R61	499 K 1% SMD	4700-499K1S-179
119)	2	R7, R63	18.2 K 1% SMD	4700-18.2KS-178
120)	1	R66	220 K 1% SMD	4700-221K1S-180
121)	1	R67	560 OHM SMD	4700-560-S-174
122)	4	R84, R149, R159, R217	220 OHM SMD	4700-220-S-138
123)	1	R117	2.7 K SMD	4700-2.7K-S-149
124)	2	R78, R121	680 OHM SMD	4700-680-S-166
125)	1	R107	220 K SMD	4700-220K-S-168
126)	3	R98, R102, R115	82 K SMD	4700-82K-S-207
127)	2	R104, R175	27 K SMD	4700-27K-S-162
128)	1	R224	3.9 K	4700-3.9K-024
129)	1	R109	1.3 MEG SMD	4700-1.3M-S-198
130)	3	R80, R191, R220	10 OHM SMD	4700-10-S-167

Item	Qty	Reference designation	Part	Part Number
131)	2	R97, R143	180 K SMD	4700-180K-S-205
132)	2	R153, R167	100 K SMD	4700-100K-S-002
133)	3	R74, R101, R124	180 OHM SMD	4700-180-S-203
134)	3	R213, R218, R219	68 OHM SMD	4700-68-S-072
135)	3	R110, R130, R163	330 K SMD	4700-330K-S-185
136)	3	R178, R210, R222	390 OHM SMD	470-390-S-003
137)	1	R195	390 OHM	4700-390-082
138)	2	R122, R139	15 K SMD	4700-15K-S-161
139)	1	R225	330 K	4700-330K-090
140)	2	R177, R198	68 K SMD	4700-68K-S-197
141)	1	R137	15 OHM SMD	4700-15-S-210
142)	2	R156, R176	39 K SMD	4700-39K-S-206
143)	2	R172, R184	56 OHM SMD	4700-56-S-143
144)	1	R85	8.2 K SMD	4700-8.2K-S-173
145)	3	R12, R44, R126	20 K POT	4750-20KPOT-005
146)	3	R23, R100, R123	10 K POT	4750-10KPOT-001
147)	1	R147	5 K POT	4750-5KPOT-008
148)	3	R116, R212, R221	1.3 K SMD	4700-1.3K-S-199
149)	2	R103, R164	47 OHM 1/2W	4700-47HW-218
150)	1	TP1	TEST POINT	2100-TESTPN-073
151)	1	T3	12T / 4T T37 CORE	1800-T36124-095
152)	1	T15	12T / 8T T37 CORE	1800-T26128-094

Item	Qty	Reference designation	Part	Part Number
153)	1	T6	12T CT / 8T T37	1800-TCT128-096
154)	2	T16, T19	14T BIFI F37 CORE	1800-F14B28-090
155)	11	T1, T2, T4, T5, T7, T10, T11 T12, T13, T14, T18	IF301	5600-IF301-001
156)	4	U1, U2, U6, U15	TL074 SMD	3130-TL074S-083
157)	2	U3, U4	4066 SMD	3130-4066S-098
158)	1	U5	MC1350P SMD	3130-1350-S-081
159)	2	U7, U10	74HC534 SMD	3130-534SMD-080
160)	1	U8	74HC32 SMD	3130-HC32SM-063
161)	1	U9	74HC08 SMD	3130-HC08SM-070
162)	2	U11, U14	74HC04 SMD	3130-HC04SM-074
163)	1	U12	74HC374 SMD	3130-374SMD-087
164)	1	U13	74HC138 SMD	3130-138SMD-066
165)	1	U16	ULN2983	3130-2983A-051
166)	2	U17, U22	ERA-4 SMD	3130-ERA4SM-113
167)	3	U18, U21, U23	MAR-7 SMD	3130-MAR-7S-102
168)	1	U25	MAR-6 SMD	3130-MAR6S-106
169)	1	VR1	LM7805	3130-LM7805-053
170)	1	VR2	LM7808	3130-LM7808-093
171)	1	GS1	GND STRAP	1400-GNDSTP-024
172)	2	CABLE #1, & #2	COAX JUMPER	
173)	2	MISC	4-40 SS SCREW	2800-SCREW-005

Item	Qty	Reference designation	Part	Part Number
174)	2	MISC	#4 SS HEX NUT	2800-NUT-009
175)	2	MISC	#4 SS STAR	2800-STAR#4-031
176)	1	PCB	RXTX	1700-RXTX-108