Theory of Operation of Base Station

Theory of Operation, Magnetic Transmitter

Power supply.

Unregulated DC voltage is delivered to the magnetic transmitter PCB assembly via J2. Pin 2 delivers approximately 16 VDC. Voltage regulation is accomplished with U11 (+12VDC) and U12 (+5VDC). The +5VDC supply (VCC) is used by the audio amplifier, TVM modulator and all logic circuits. The +12VDC supply (VCC2) is used by the power amplifier.

Audio input amplifier.

The input amplifier consists of L1, C27-C29, R1-R5 and U5A. The system is designed to accept the line output signal from a computer sound board with an expected level of between 100 mV and 1V rms.
R5 can be adjusted for desired volume level. CR3 provides peak clipping to prevent over modulation of the TVM signal. The gain of the audio amplifier is set for a maximum of 1/5. This scales down the level of the input signal to that required by the TVM modulator chip U10.

TVM modulator.

Time variant modulation (TVM) is accomplished by U10 (JV242). This proprietary integrated circuit takes an audio input at pin 17, a 200kHz input at pin 24 and produces a TVM modulated signal at pin 14. For a complete explanation of the JV242 please refer to the attached chip specification.

200 kHz clock.

A 200 kHz square wave is produced by U6 (XC303). The output frequency of this IC can also be set to 400 kHz by setting a jumper at JP1.

Monitor sync circuit.

Magnetic fields from horizontal sync coils in computer monitors can cause heterodyne tones in the magnetic receivers recovered audio. To eliminate this undesirable tone, a circuit has been added to lock the TVM clock to a harmonic of the computer monitors horizontal sync signal. An external pickup coil L4 is plugged into J1. The external coil is placed on the side of the computer monitor and inductively picks up the horizontal sync signals from the control yoke of the monitor. A high gain amplifier consisting of U1B, R13-R17, C33-C37, CR1, L2 and L3 amplifies and squares the sync signal. A low pass filter consisting of U1A, R18-R21 and C37-C39 removes any undesired high frequency components. A one-shot consisting of U2A, R28 and C42 limits the detected sync frequency to around 40 kHz. A phase locked loop consisting of U3, U4, R29-R34, C44 and C45 then multiplies the detected frequency by 10 to between 150 kHz and 400 kHz. A detector consisting of CR2, C41 R25-R27 and U5B senses the presence of a signal induced at the pickup coil and switches the clock source via U7 to either the fixed 200 kHz clock or the phase locked monitor sync clock source.

Transmit coil power amp.

P and N channel FETs Q1-Q4 are arranged in an H-bridge configuration Each side of the bridge is driven with complimentary signal delivered from the JV242 TVM modulator IC. Low pass filter capacitors C47-C50 are placed between source and drain of each FET to lower harmonic content of output drive signal. Filters consisting of C21-C26 and H2-H3 are used to reduce switching noise on power supply lines.

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Theory of Operation, Base Station Receiver

Introduction:

The following theory of operation describes in detail how the Base Station Receiver functions. Please refer to the Base Station Receiver System Block Diagram when reading this document.

Antenna:

The antenna is a helical type wound on a 1/4 by 20 nylon thread stock. The helical antenna is operating in the normal mode and therefore has similar performance to a 1/2 lambda end fed dipole.

Input Match:

This circuit is used to match the antenna to the low noise amplifier. The match steps up the impedence from 50 ohms to 500 ohms by means of a capacitor tap. One of the capacitors is adjustable. The adjustment of this capacitor is usually performed in conjunction with the two adjustments in the preselector filter when setting the front end gain and filter response.

LNA:

The low noise amplifier is a dual gate MESFET manufactured by NEC. The amplifier configuration is common source. This device provides excellent gain and the noise figure is about 3dB.

Preselector Filter:

The preselector is a 2 pole coupled resonator type. There are two capacitor adjustments in the filter to optimize the band pass response. This filter, in conjunction with the input matching filter, provides a 3 pole band pass response for the front end of the receiver. The bandwidth of this filter is around 4 MHz (169 MHz to 173 MHz).

Local Oscillator:

The reciever local oscillator uses a Butler topology. This configuration was chosen because it works well with overtone cut cyrstals. The crystal used for this oscillator is cut for series resonance at the channel frequency minus 10.7 MHz.. There is an adjustable inductor which is used to trim the oscillator on the exact frequency.

Mixer:

The signal on the output of the preselector and the local oscillator are combined in the mixer to create the I.F. at 10.7 MHz. The mixer is part of the FM Receiver I.C. (Motorola MC13156). The mixer is a double balanced active type using the Gilbert Cell topology. The mixer also provides a small amount of I.F. gain

10.7 MHz I.F.:

The next four stages after the mixer provide all the IF filtering and gain functions before audio detection. The output of the mixer is connected to a two element ceramic filter centered at 10.7 MHz. The bandwidth of the filter is 110 kHz.. The output of the filter is connected to an IF Amplifier in the MC13156. This amplifier then feeds another ceramic filter for further IF shaping. The output of this filter is connected to the limiting amplifier inside the MC13156 where the signal is compressed before detection. The main function of the entire I.F. chain is to establish the receiver's operating bandwidth, system noise floor, and compress the signal to eliminate any AM components.

Quadrature Detector:

The MC13156 includes circuitry to perform FM detection of the signal using a quadrature detector. The bandwidth of the detector is determined by a RLC resonant tank connected to the quadrature arm of the detector. The bandwidth of the tank is directly related to the Q of the circuit. The lower the Q, the wider the bandwidth, but the recovered audio is lower. The inductor in the tank is a tunable coil which is adjusted to provide the best linearity across the bandwidth of the tank (lowest audio distortion).

RSSI / Carrier Detect:

The MC13156 contains circuitry to measure the received signal strength and a carrier detect which can be used for squelching the audio when the signal gets too weak. The signal strength is determined by monitoring the current in the I.F. and limiting amplifiers. The RSSI output is a current output proportional to the signal strength. To establish a voltage, a resistor is placed from the output to ground. This resistor is adjustable so the squelch point can be set in test to the desired level.

Audio Buffer:

The recovered audio output of the MC13156 is connected to an operational amplifier buffer. This circuit also contains a potentiometer to adjust the audio gain on the output of the receiver.

Squelch:

Audio squelch is accomplished by shorting the audio signal to ground through a 8.2 k resistor. The short circuit is supplied by using a MOSFET as an analog switch. The switch is controlled by the carrier detect circuit and an extra op amp which is used as an inverting comparator. The squelch point is adjustable.

Active Low Pass Filter:

The audio bandwidth for the receiver is established by a 4 pole active low pass filter. The filter uses two op-amps configured using multiple feed back. The bandwidth of the filter is from less than 50 Hz to greater than 8 kHz.

Audio Out:

The output from the low pass filter is fed to a resistive divider to attenuate the signal level to 10mV rms (mike level input). The impedance of the circuit is set at 600 ohms. The output connector is a 3.5mm jack.

Theory of Operation of Headset

Headset Transmitter Theory Of Operation

Introduction:

The following theory of operation describes in detail how the headset transmitter RF functions. Please refer to the K Head Set Transmitter System Block Diagram when reading this document.

Microphone Input:

The microphone input is a noise canceling type. It is intended that the microphone be positioned with-in 1 inch of the mouth or so.

Automatic Level Control:

This circuit is designed to provide a constant audio output when the input is variable (soft vs loud speech). The component used is a Philips Semi-conductor NE578 compartor I.C. configured to provide ALC. The compression point is set at 50mV rms and the gain is 25 V/V. With these settings, some amplitude variations will be present at normal speech levels.

Crystal Modulation:

The output of the ALC is fed to a varactor diode. The changing audio characteristics change the capacitance of the diode which is connected to the crystal. This changing capacitance pulls the resonant frequency of the crystal.

Crystal Oscillator / X5 Multiplier:

The crystal oscillator for this circuit uses a colpitts topology. Incorporated into the circuit is a high frequency fundamental mode crystal. The collector of the oscillator is tuned to the 5th harmonic of the crystal. There is a capacitor adjustment to trim the oscillator to with in 5 kHz of the actual transmit frequency.

Filter:

The output of the oscillator is connected to the main filter block for the transmitter. The filter type is a 3 pole coupled resonator centered at the transmit frequency. This filter is optimized to provide as much suppression of the 2nd, 3rd, and 4th harmonics of the oscillator as possible and no attenuation of the 5th harmonic which is the transmitter frequency.

Power Amplifier:

This is the final gain stage for the transmitter. The amplifier is operating in the class A mode and the collector is tuned to the transmitter output frequency to reduce the amount of filtering required on the output.

Filter:

The output filter is a 1 pole coupled resonator type with antenna match. This circuit provides further harmonic suppression and isolation of the PA from the antenna.

Antenna:

The antenna is a helical type wound on a 1/4 by 20 nylon thread stock. The helical antenna is operating in the normal mode and therefore has similar performance to a 1/2 lambda end fed dipole.