



SERIES 1250 TRANSMITTER
TECHNICAL MANUAL

produced by:

APPLIED TECHNOLOGY SOLUTIONS, INC.

4200-F Technology Court
Chantilly, VA 22021

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SECTION ONE INTRODUCTION

1.0 INTRODUCTION

This document is the Operating Manual for the Series 1250 Transmitters, produced by Applied Technology Solutions, Inc. The Series 1250 includes the Models 1252 and 1253. Functionally and mechanically, both are identical with the exception being their transmit frequency assignment. As such, the use in this document of the terminology Series 1250, refers to both models in the series.

The Series 1250 is part of the Voice Privacy Low Probability of Detection (VPLPD) System 1200. The System 1200 includes the Model 1245 Monitor Station and the Model 1225 Hand Held Transceiver.

The System 1200 uses spread spectrum modulation to provide secure, low probability of detection and interception communications to the user. The transmitted voice data is scrambled with a user selected key, to provide voice privacy and an additional level of security. The System 1200 design incorporates an ATS proprietary self synchronizing design. This design provides nearly instantaneous receiver synchronization and provides improved performance over other spread spectrum designs in a rapid fade, multi-path environment.

The Series 1250 Transmitter is a transmit-only device. It has been designed for concealment on the body although the unit can be concealed on other objects. The transmit frequency channel is factory set. The Models 1252, and 1253 designate the channel assignment. In their basic physical configuration, the Series 1250 devices include an internal microphone and are provided with connectors for antenna, power and external microphone. This configuration is referred to as the Naked configuration. Optionally, the device can be provided with a battery holder and integral antenna. Two such holders are currently available. The Model 1250-04 allows the use of a J battery and uses a custom antenna mounted along the side. The J-battery supports an operating time of approximately 1 hour and 45 minutes. The Model 1250-45 Extended Service Case permits the use of AAA batteries and includes a custom patch antenna. The AAA batteries support an operating time of 6 ½ hours. The patch antenna provides an improved performance when compared with other available antennas. (These configurations are referred to as the Stand Alone configuration). Additionally, the battery(ies) can be replaced with an optional Power Converter to allow the use of DC automobile power.

1.1 SPECIFICATIONS

The specifications for the Series 1250 Body Worn Transmitters follow. Unless otherwise noted, all specifications are at 25°C and a supply voltage of 6.0 VDC.

RF CHARACTERISTICS

Channels: One (1), Factory set
Channel Options Compatibility
Channel A: Direct and repeater
Channel B: Direct
RF Power Output: 25 mW
Frequency Stability: ± 100 ppm @ -25° C to $+68^{\circ}$ C
Spurious and Harmonic
Attenuation: 25 dBc
Modulation: Direct sequence spread spectrum
PN Sequence Length: 33,554,401 bits

ANTENNA

Naked Flatpack: External, 50 Ω
Stand Alone: Integral

AUDIO CHARACTERISTICS

Frequency Response: ± 6 dB, 300-5800 Hz
Mic Audio Processing: Dual Time Constant AGC
Dynamic Range: 55 dB, minimum
Audio Encoding: CVSD
Sampling Rate: 62.9 KHz
Data Scrambling: 13 bit linear auto key

Microphone

Internal: Knowles EK series
External: input compatible with Knowles electret, such as EA or EK series

CONNECTIONS

Ext. Mic/Power: Microtech DR-4S-4-PC
Shorting Plug: Tibbets SP-1
Antenna: MMCX Jack

POWER

Naked Flatpack
Power Source: External, 5.0 to 7.5 VDC @ 115 mA

Stand Alone
Power Source: One Mallory 7K-6V alkaline battery
Operating Time: 1.5 hours, typical

Power Source: 4 AAA alkaline battery
Operating Time: 6.5 hours, typical

With Model 1250-09 Power Converter
Power Source: External, 6 to 15 VDC, 65 mA @ 12 VDC, typical

SIZE

Naked Flatpack: 2.4" X 1.4" X 0.35"
Model 1250-05: 4.5" X 1.75" X 0.4"
Model 1250-45: 4" X 2.6" X 0.65"

ENVIRONMENTAL

Operating Temp.: -25° C to $+68^{\circ}$ C
Storage Temp.: -40° C to $+85^{\circ}$ C

SECTION TWO INSTALLATION

2.0 GENERAL

The Series 1250 Transmitters are designed for body worn or concealment applications. The Series 1250 Transmitters include an internal microphone and have connectors for antenna and power as well an external microphone. In its basic, or Naked, configuration, the user must connect antenna and power to the unit using the connectors.

2.1 CHANNEL SELECTION

Channel Selection for the Series 1250 Transmitters are factory pre-set. The Series 1250 Transmitters can be provided for operation on Channel A or B. Channels A and B are the standard System 1200 channel assignments. Operating on these channels permits the other System 1200 devices, i.e. the Models 12454 and 1225 to receive Series 1250 transmissions directly. The Series 1250 channel assignments are:

Model 1252	Channel A	Center Frequency: 906.75 MHz
Model 1253	Channel B	Center Frequency: 923.25 MHz

2.2 POWER

The Model 1250-04 J- Battery Holder or Model Extended Service case 1250-45 can be ordered for the Series 1250 Transmitters. The Model 1250-04 battery uses a standard J size, 7K-6V alkaline battery. The Model 1250-45 Extended Service Case uses 4 AAA batteries. The Model 1250-09 Power Converter can be used with the J-Battery Holder. This permits the user to connect the unit to DC power sources, ie DC automobile power.

2.2.1 Model 1250-04

The Model 1250 transmitter slides into the Model 1250-04 Battery Holder. While applying slight pressure, the antenna is snapped into the mating connector on the 1250 and the captive screw tightened. To remove the transmitter, again apply slight inward pressure, loosen captive screw on antenna and remove antenna. Model 1250 should slide out of battery holder. J-Battery should be inserted at slight angle. Battery can only be inserted in one direction.

2.2.2 Model 1250-45

The Model 1250 slides into the Model 1250-45 Extended Service Case. The connector from the case lid is snapped into the Model 1250 RF connector and screwed in. This holds the assembly in place. After batteries are loaded into the battery holder, the holder is locked in place by pressing the clips inward, towards the middle and sliding the holder into place.

2.2.3 Activation

With the shorting plug installed, and when using the J battery holder, the Model 1250 is powered on when the J battery is installed. When using the Model 1250-45 Extended Service Case, the On/Off switch located on the underside of the case must be moved to the ON position. Alternatively, the shorting plug can be removed and an external On/Off switch connected.

2.3 ANTENNA

ATS has developed two antennas for use with the Series 1250 Transmitters and the Model 1250-04 J Battery Holder. The Model 1250-02 Antenna was developed for use with Models 1252 and 1253. The antennae are low profile and incorporate a connector to mate with the transmitter connector. The antenna also contains a captured screw which fastens into the transmitter. Use of these antennas provides a compact, integral unit. ATS has also developed a patch antenna that is integral to the Model 1250-45 Extended Service Case. This antenna provides improved performance when compared to the 1250-01 and 1250-02 antenna's.

2.4 MICROPHONE

The Series 1250 Transmitters are equipped with a built-in microphone. The microphone is mounted facing a hole in the flat side of the case. The microphone must be faced away from the body. To use the microphone, a shorting plug must be installed in the microphone connector on the edge of the transmitter case.

The Series 1250 Transmitters will accept an external microphone. To use an external microphone, the shorting plug must be removed, thereby disabling the internal microphone, and a compatible microphone connected in its place. The microphone connector is a Microtech DR-4S-4PC.

2.5 CODE SELECT

Access to the Code Select rotary switch is provided through a hole in the flat side of the Series 1250 Transmitters. A screwdriver must be used. The Private (P) or Common (C) code can be selected by turning the code select switch to the appropriate stop.

2.6 EXTERNAL ACCESSORIES

The Model 1250 normally uses its internal microphone. Optionally, the shorting plug may be removed and an external microphone connected.

Normally, the Model 1250 is powered on following the procedures stated in paragraph 2.2.1. Optionally, the shorting plug may be removed and an external On/Off Switch connected.

An external microphone and an external On/Off switch may be used by removing the shorting plug and uses a Y-cable to connect to the microphone and switch. The Model 1250-05 Surveillance Kit contains an external microphone, an external on/off switch and the Y-cable.

The Private Keys can be changed using the Model 1260 Key Loader and Model 1250-03 Key Load Adapter. This equipment is only required to change the factory loaded, Private Key. The Common Key cannot be changed by the user.

SECTION THREE OPERATION

3.0 GENERAL

The Series 1250 Transmitters are one device in a family of devices designed to provide secure communications and surveillance capabilities to law enforcement agencies. This section describes the operation of the Series 1250 Transmitters with the other units in the VPLPD System 1200.

3.1 SYSTEM 1200 COMPONENTS

The System 1200 components include the Model 1245 Monitor Station and the Model 1225 Hand-Held Transceiver.

3.1.1 System Operation

The Series 1250 Transmitters are low power, LPI/LPD devices intended for body worn applications. The overall system design provides for direct reception by the other System 1200 devices. Extended operating ranges can be attained by using the Model 1240 Portable Repeater.

The Model 1245 Monitor Station is used to monitor and record all VPLPD transmissions including those from the Series 1250 devices. The Model 1245 is a self contained unit including re-chargeable battery, recorder and integral receive antennas. The unit is designed for unattended operation and is capable of receiving and recording with the case lid closed. The Model 1245 is also equipped with speaker, line out and headphone capability to support active monitoring. With fully charged battery, the Model 1245 supports an operating time (receiving and recording) in excess of 8 hours. The Model 1245 may also be powered and/or charged from AC mains or DC automobile power. An external receive antenna can be used for improved performance.

The Model 1225 Hand Held Transceiver is similar in operation and use to typical walkie talkie style, PTT transceivers. It provides user controls for channel selection, code selection, volume control and PTT.

3.2 PRIVACY CODES

The Series 1250 Transmitters contains non-volatile memory for the storage of the privacy keys. The keys are loaded into memory using the Model 1260 key loader. If a keyed unit is lost or stolen, the keys in the remaining units can be changed quickly to maintain the overall security. Code selection is made by turning the code select switch on the front of the Series 1250 device.

Two code selections are available, Common (C) and Private (P). The C code is factory set on all units and provides a common scrambler code for use during inter-agency operations. The P code is intended to be agency or group specific. This code can be changed by the user. In operation, the System 1200 uses different codes for Channel A and Channel B operation.

To load a P code into a Series 1200 device, first install the 1250 into the receptacle on the Series 1250-03 Key Load Adapter and slip the retaining clip over the top of the 1250. Attach the Key Loader to the Key Load Adapter. Place the On/Off Slide control on the adapter to the On position. The POWER indicator on the Model 1260 should light. Select a code by rotating the KEY NUMBER thumb wheel switches on the Model 1260. (Selecting a code number above 300 will result in an error indication on the Model 1260.) Depress the LOAD KEY button on the Model 1260 to download the selected key. The KEY LOADED indicator should light, indicating that the new keys were successfully loaded into the

Model 1240. If the LOAD FAIL indicator lights, the key load sequence did not succeed. If this occurs, check the setting of the KEY NUMBER switches to ensure that it is not set above 300. Verify that the interface plug on the Model 1260 cable is fully seated into the KEY LOADER connector on the Key Load Adapter. Continuing LOAD FAIL indications mean that either the Model 1260 or the Series 1250 is defective and should be returned for repair. If a Model 1260 is suspected of failure, it should be tried with another System 1200 device. If failures still occur, the Model 1260 is defective.

SECTION FOUR THEORY OF OPERATION

4.0 GENERAL

The Series 1250 devices are miniaturized, transmit-only devices. They use spread spectrum modulation and low power output to provide LPI/LPD characteristics. The devices were designed for body worn applications but may also be planted or hidden in other objects. The devices can be equipped with a power converters allowing the use of alternative power sources, such as a high capacity battery or DC automobile power, for long duration, fixed location surveillance applications.

The standard antennas for the units are miniature designs that snap into the RF output connectors. These antennas were custom designed for use with the transmitters. For special applications, the standard antenna can be replaced with a user supplied antenna having better directional characteristics.

4.1 FUNCTIONAL DESCRIPTION

Figure 4-1 shows the block diagram of the Series 1250 transmitters. Each of the three transmitters (Models 1251, 1252 and 1253) have the same block diagram.

4.1.1 Audio/Digital Section

The Series 1250 is equipped with an internal microphone. It is supplied with an external shorting plug that connects the internal microphone to the microphone pre-amplifier, and at the same time connects the battery to the power supply. Whenever the shorting plug is installed, the Series 1250 transmits continuously, using the internal microphone. To use an external microphone, the shorting plug can be replaced with a compatible microphone connected by a cable to the Series 1250. The cable plug then makes the connection between the battery and the power supply in the Series 1250, and connects the external microphone to the microphone pre-amplifier input. The internal microphone is not used in this application. DC Power for the external microphone is available at the microphone connector via the connection to the DC power input in the Series 1250.

The microphone pre-amplifier section includes an audio AGC (Automatic Gain Control) function that produces a constant audio signal level for the CVSD (Continuously Variable Slope Delta-modulation) encoder. A lowpass filter is used between the pre-amplifier and the CVSD encoder, to limit the audio bandwidth to the encoder to prevent aliasing.

CVSD encoding converts the analog audio into a serial data stream. The bit rate of this data stream is set by the CVSD clock signal.

Once the audio signal is digitized by the CVSD encoder, the FPGA (Field Programmable Gate Array) handles the processing of this signal. The FPGA performs all of the digital data processing in the Series 1250. Figure 4-1 also details the major functional sections in the FPGA.

Serial data from the encoder is combined with a pseudo-random key stream in the data scrambler. The key stream is generated from the scrambler key that is stored in the key memory. The scrambler key manager reads the status of the key select switch, and reads the appropriate key from the key memory, and sends it to the data scrambler. Programming access to the key memory is provided through the Key Loader input, which connects to the Series 1250-3 Key Loader Adapter.

Once the data stream from the CVSD encoder is scrambled, it is ready to be spread spectrum modulated. The PN (Pseudo-Noise) sequence generator produces a long digital sequence, at a clock rate that is much greater than the signal from the data scrambler. This signal is combined with data scrambler signal by the spread spectrum modulator. This produces

the spread data signal, which along with the PN sequence, is biphase modulated by the clock signal from the modulator clock generator. Further processing of these signals occurs outside the FPGA.

Two clock generator circuits are included in the FPGA, both being driven from the same crystal oscillator stage. The data clock generator has three outputs, the PN clock, the scrambler clock and the CVSD clock. The modulator clock generator has two outputs, one being twice the frequency of the other, driving the biphase modulators.

4.1.2 IF/RF Section

The two biphase modulated signals from the FPGA are individually bandpass filtered, and then added together, to produce the baseband composite spread spectrum signal. This signal is up-converted at the first IF (Intermediate Frequency) mixer. The output from the first IF mixer is bandpass filtered to remove mixer image products.

The first IF signal is up-converted to the final transmit frequency by the second IF mixer. The output of the second IF mixer is also bandpass filtered and drives the RF power amplifier. Prior to going to the antenna, the output signal from the RF power amplifier is lowpass filtered, to remove any harmonics generated by the RF power amplifier.

4.2 RF CHARACTERISTICS

The Series 1250 Transmitter is a low power, transmit only device, therefore its operating range is more sensitive to the physical and electrical environment. The transmit range from a 1250 to a receiver should approximate 200 feet for a fixed installation and 100 feet if placed on a body. The actual range is dependent on many factors and ATS recommends the installation be verified before deployment. Placing the Model 1240 Portable Repeater to the Repeater/Transceiver functional mode and using a PTT transmitter is the easiest way to verify receive and transmit capability. When this is not possible, the repeater should be placed within 100 feet of a Series 1250 Transmitter.

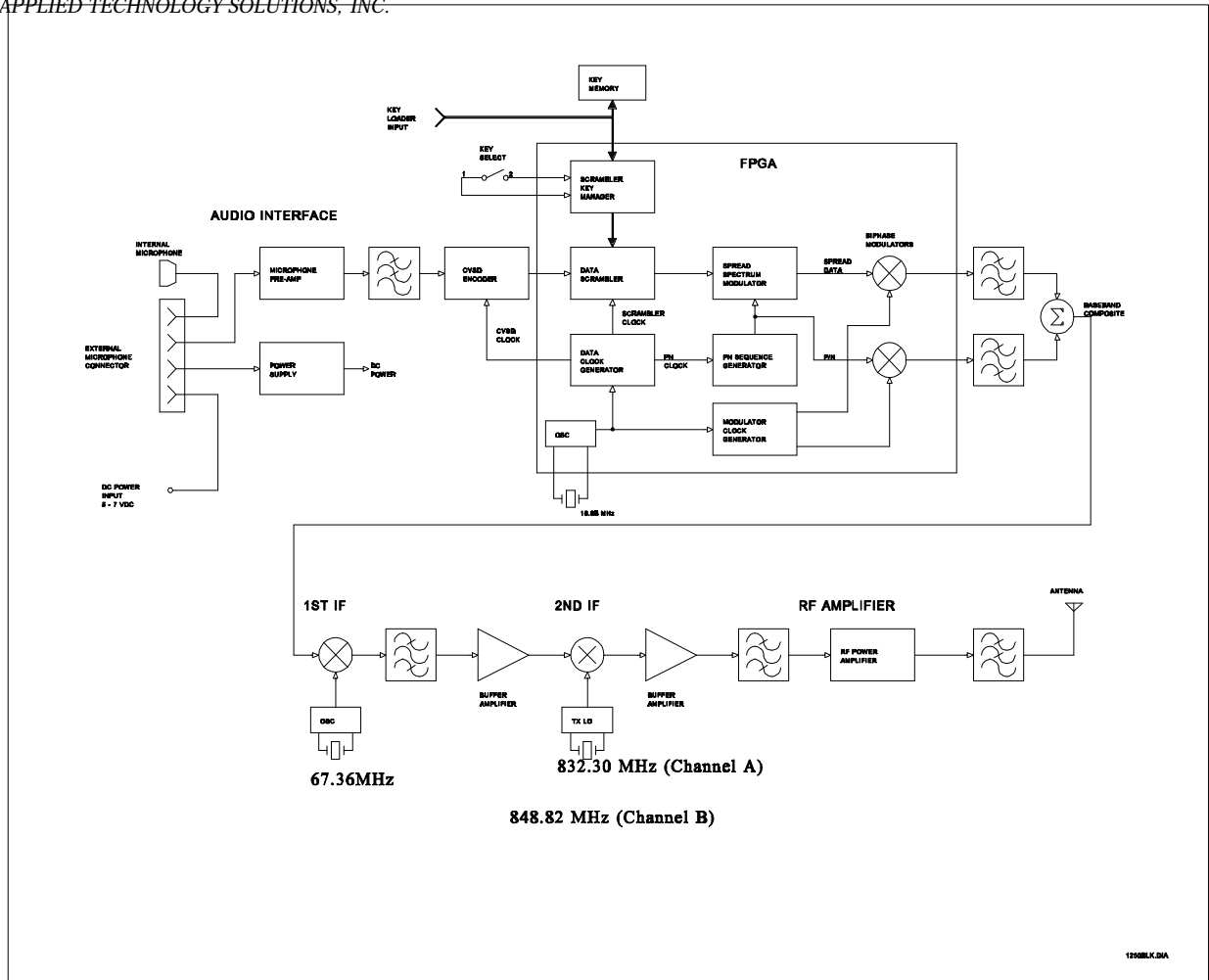
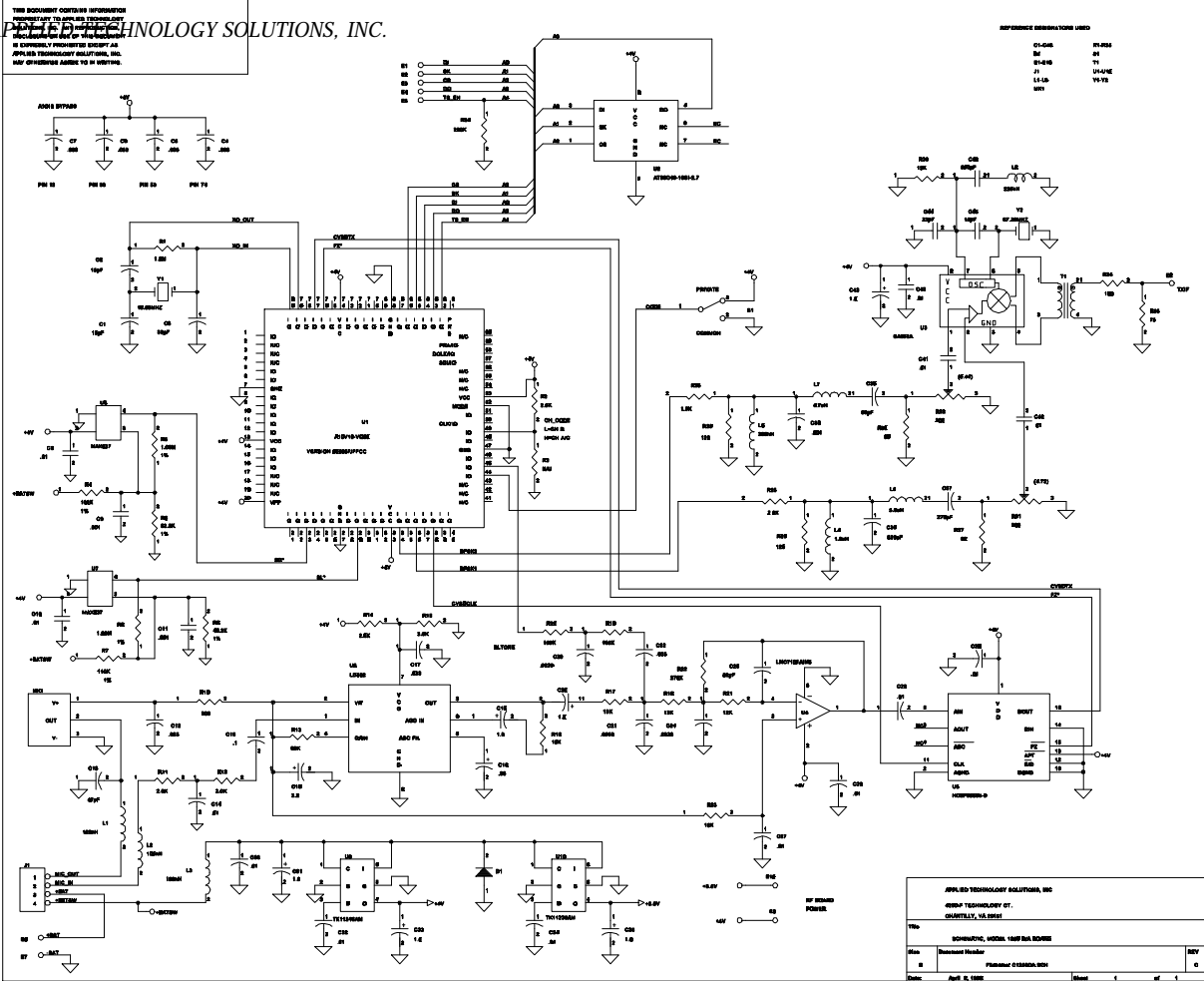
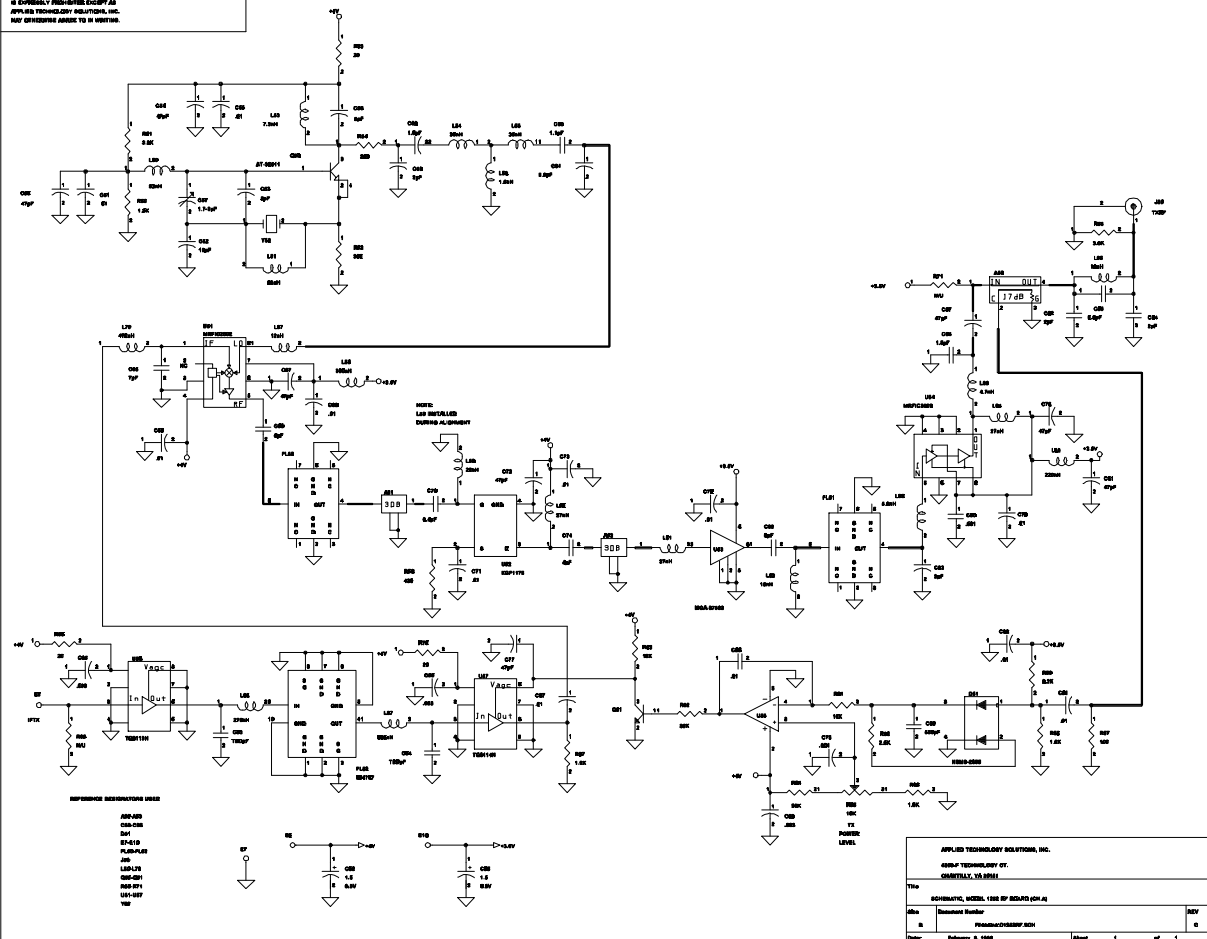


Figure 4-1 Series 1250 Block Diagram



Digital Board Schematic

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RF Board Schematic

SECTION FIVE
MAINTENANCE

5.0 TROUBLESHOOTING

When supplied with power, the Series 1250 devices should be actively transmitting. This can be verified using one of the other System 1200 devices to receive the transmitted signal.

- a. Verify that the antenna is properly connected to the antenna jack.
- b. Verify the shorting plug, or external microphone, is firmly in place.
- c. If a signal is not received and a battery is being used:
 - Verify the battery is firmly in place.
 - Verify the battery is fresh.
- d. If a Power Converter is being used:
 - Verify appropriate power is applied to the converter.
 - If the applied power is within specifications replace the Power Converter with a battery. If the unit now works, the Power Converter is not functioning and should be returned for repair.
- e. If the unit will not de-scramble the signal or achieve lock:
 - Insure that both the transmit and receive units are set to the same channel operation.
 - Insure that both transmit and receive units are set to the same code setting.

NOTE:

Both units must be operating with the same code to achieve communications. Field personnel will not be able to verify the actual codes associated with common or private operation. If necessary, the issuing office should verify the codes, re-load the codes, or return the units to ATS.

- f. Do not attempt repairs. Return the unit to the factory for repair.

5.1 MAINTENANCE

The Series 1250 Transmitters are designed for simple operation. There are no user maintenance requirements.

5.2 REPAIRS

If repairs are required, the Series 1250 Transmitters should be returned to ATS.