14 PRODUCT DESCRIPTION

1. CIRCUIT ANALYSIS

The UHF – High split PANTHER 300M (KRD 103 154/4) is a 6-channel, dual-conversion, super-heterodyne FM land mobile radio transceiver operating in the 470 – 512 MHz band. It is designed to meet FCC regulatory requirements and the land mobile radio industry standard TIA/EIA-603. Refer to the Logic and RF Diagrams in Figure 1, and Figure 2, respectively.

RECEIVER

Receiver Front End

The receiver front end comprises the following stages:

- The transmitter Low Pass Filter,
- A transmit/receive switch controlled by the switching of PIN diodes,
- The first Band Pass Filter,
- An RF low noise amplifier (LNA), and
- A second Band Pass Filter, and a double-balanced first mixer (DBM).

These filters, RF LNA, and DBM are designed to provide appropriate filtering to minimize reception of undesired receive signals and provide the appropriate noise figure to allow reception of desired results. Receiver spurious response, sensitivity, and intermodulation performance are greatly affected by the design of the RX front end.

The first Local Oscillator (L.O.) signal for the first mixer is generated in the Voltage Controlled Oscillator (VCO) module and amplified in a Local Oscillator amplifier to provide the optimum L.O. drive level to the first mixer. Since this L.O. drive signal is low side injection and the desired first IF frequency is 55.05 MHz, the frequency range of the first L.O. signals are 414.950 – 456.950 MHz.

Receiver Back End

The back end of the receiver is a dual-conversion receiver with a first IF frequency at 55.05 MHz and a second IF frequency at 450 kHz. The receiver back end has the following stages:

- The first IF crystal filter,
- A low noise IF amplifier,
- A second IF crystal filter, and
- A receiver IF/amplifier/limiter IC.

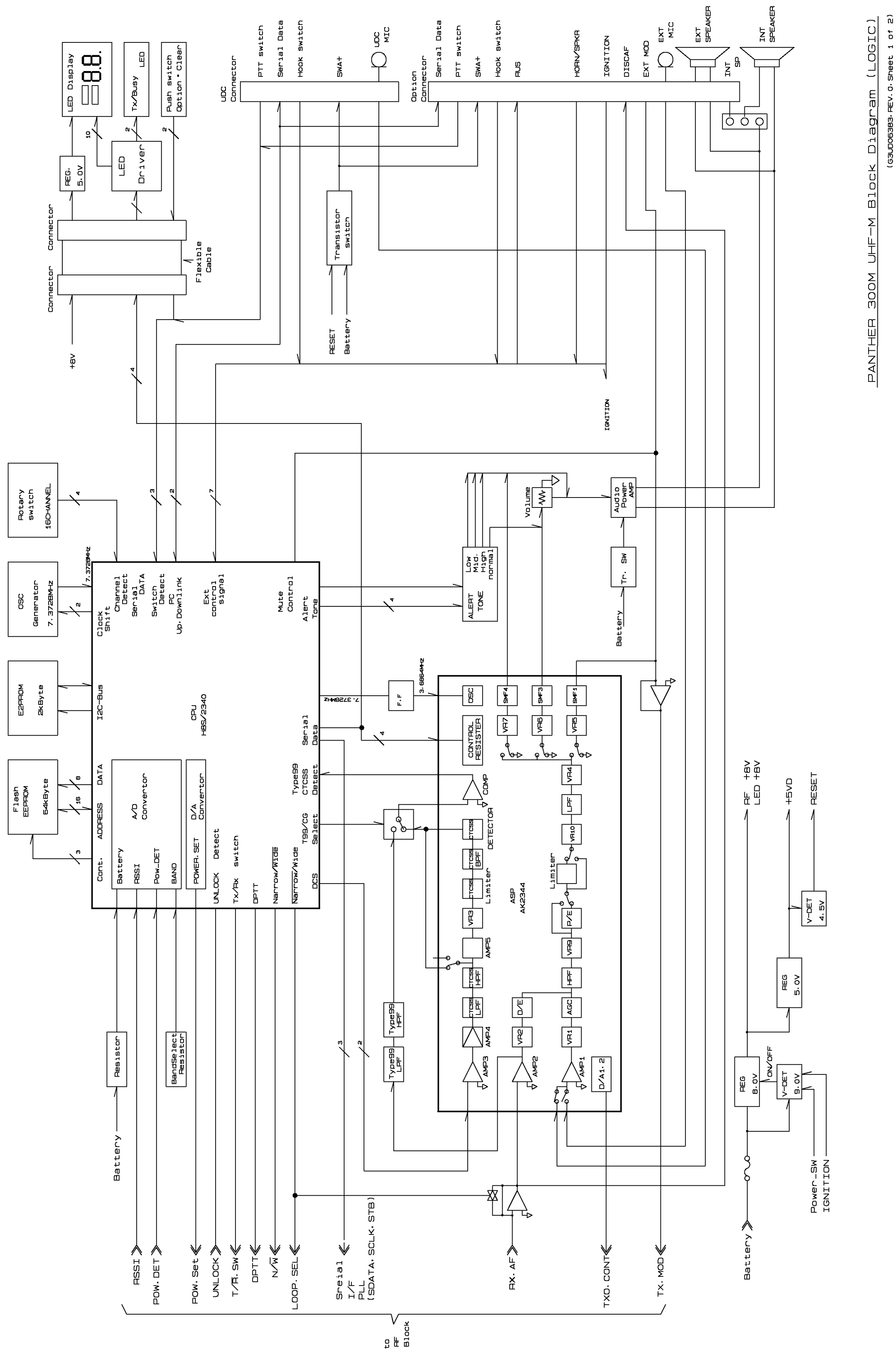

Figure 1 – PANTHER 300M Logic Block Diagram

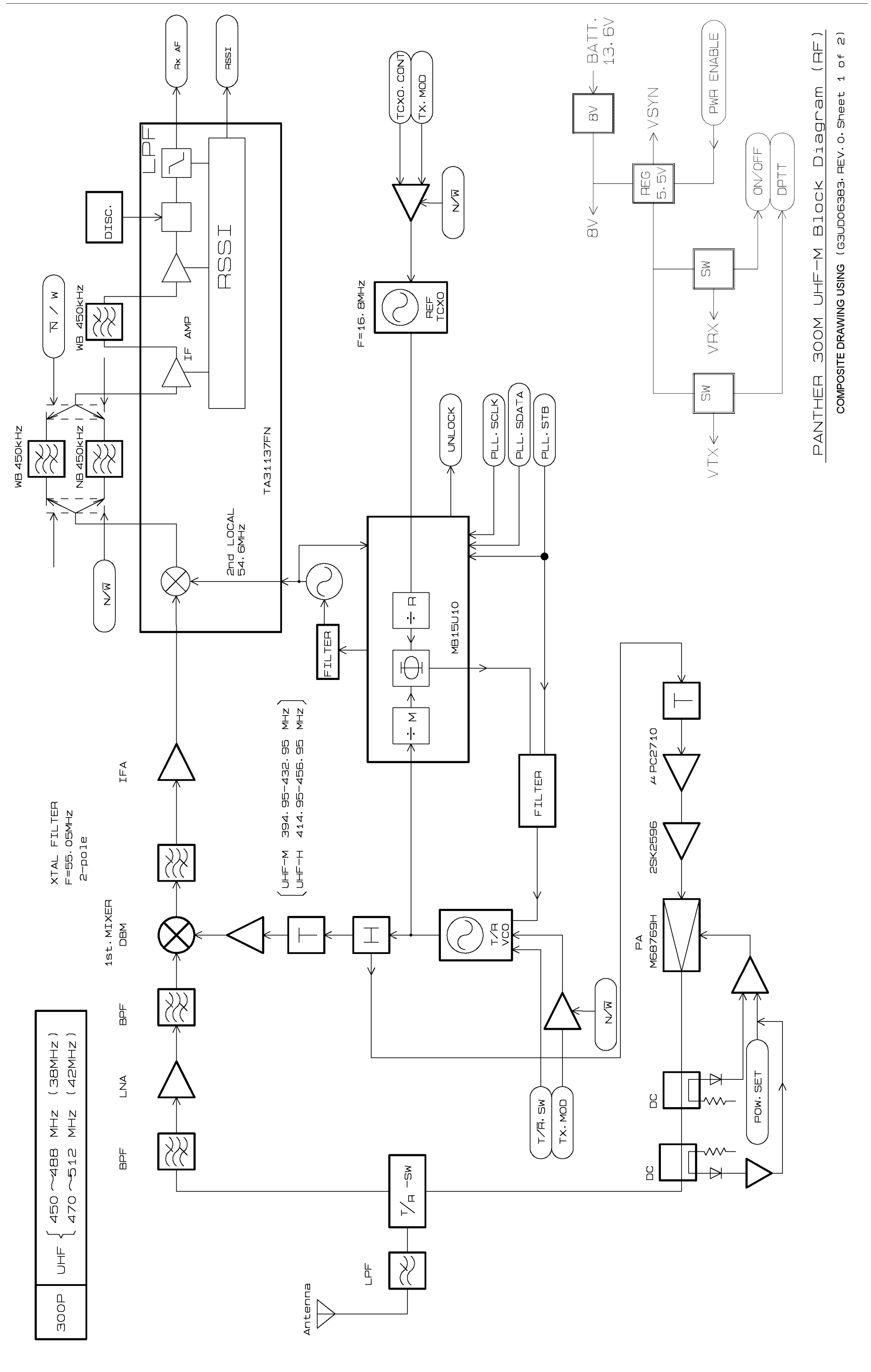

Figure 2 – PANTHER 300M RF Block Diagram

These stages provide the desired adjacent channel selectivity, receiver spurious response performance, and demodulation of the analog FM receive signals. The back end has been designed to provide switchable selectivity performance for either 12.5 kHz or 25 kHz channel spaced equipment. This is accomplished by selection of either a wide or narrow 450 kHz ceramic filter. Channel spacing is programmable on a per-channel basis.

The receiver IF/amplifier/limiter IC takes the incoming receive signal and mixes it down to the secondary IF frequency 450 kHz. The second L.O. drive signal is normally a low side injection 54.600 MHz signal derived from the synthesizer IC. (An optional 55.500 MHz high side injection signal can be synthesized for improved receiver self-quieting performance on certain frequencies). The FM detector is a quadrature detector that provides recovered receive audio.

TRANSMITTER

The transmitter is an FM, 40-watt rated transmitter. It can be programmed on a per-channel basis for either 40 or 20 watts.

The initial drive level for the transmitter is the VCO. The VCO frequency range is 470 – 512 MHz. The VCO output is amplified in a pre-driver and a driver stage and then input as the drive signal into the Power Amplifier (PA) module. The PA module amplifies the drive signal to approximately 50 watts. The PA output power then is transmitted through a directional coupler that is used for detecting forward and reverse power, the transmit/receive switch, and finally the TX Low Pass Filter.

The TX Low Pass Filter properly attenuates the harmonics of the desired carrier to meet FCC TX conducted spurious specifications of ≤20 dBm. The losses through the post-PA stages reduce the output power to a nominal 42 watts. This level is established by the setting of RF power tracking data in the Maintenance software application. (Note: RF power is set ONLY by qualified trained land mobile radio technicians.)

Regulating the voltage to the PA and PA driver section through pass transistor Q404 controls the transmitter output power. The pass transistor is controlled by forward and reverse power feedback loops and the microprocessor power set level. The forward power is sensed using a forward coupler in conjunction with an RF rectifier and a LPF. The reverse power circuitry is similar to the forward power circuit. The microprocessor power set level is determined by the power tracking data table stored in memory.

SYNTHESIZER

The heart of the synthesizer design is the use of a dual serial input Phase-Locked-Loop Frequency Synthesizer IC (similar to Fujitsu MB15U10). A Temperature Compensated Crystal Oscillator (TCXO) provides the reference frequency for the synthesizer. The TCXO is a 16.8 MHz oscillator, ±2.5 ppm from -30°C to +60°C. The TCXO and the output of the VCO are divided down and phase compared at 6.25 kHz.

The synthesizer hardware, along with the radio software, allows TX and RX frequencies to be synthesized every 12.5 kHz over the band split range. The error voltage provided at the output of the phase detector is filtered by a loop filter to provide a correction voltage to the VCO to set either transmit frequency or receiver L.O. frequency on channel. The loop filter also minimizes spurious input to the VCO. The microprocessor controls whether the loop filter is in a narrow or wide bandwidth. Wide bandwidth allows faster switching of synthesizer frequencies; narrow bandwidth optimizes transmit or receive Hum and Noise performance.

BASEBAND PROCESSING

Baseband processing is primarily controlled by an Audio Signal Processor (ASP) IC (similar to an AKM AK2344). Recovered receive audio from the FM demodulator is first sent to an amplifier. This amplifier's gain is dependent on whether the channel is programmed for wide or narrowband mode. If the channel is programmed for narrowband mode, the audio gain is adjusted to twice the gain for wideband mode. This is because in narrowband mode the incoming receive signal has its deviation cut in half, cutting the recovered audio out of the demodulator in half. Doubling the gain then increases the audio level back to the same level that could be found on a wideband channel (i.e., ½x 2 = 1).

Regardless of whether the receiver is in wideband or narrowband mode, the same audio levels are input to the remaining stages of the ASP. Receiver audio sensitivity at the speaker remains constant. The recovered receive audio is routed along two paths in the ASP. In one path the recovered receive audio is de-emphasized and then filtered by a 300 Hz high pass filter (HPF) and a 3kHz low pass filter (LPF) to improve signal-to-noise performance. The filtered audio is eventually routed to the audio amplifier. The audio amplifier can be used to either drive the internal speaker (an 16-ohm load) for a rated power of 0.5 watts or to drive an external speaker (a 16-ohm load) for a rated power of 0.5 watts.

In the second path, the recovered receive audio bypassed the de-emphasis filter and is run through a low pass filter to improve signal-to-noise performance for a sub-audible signal. The LPF's cutoff frequency is dependent on which Channel Guard (CG) [CTCSS] sub-audible frequency or Digital Channel Guard (DCG) [CDCSS] sub-audible signal is to be received. The sub-audible audio is then processed through a voltage comparator to "square" the waveform. The "squared" waveform is then sent to the microprocessor for processing/detection via a software algorithm.

Transmit voice audio is delivered to the ASP via either the internal or external microphone. The voice audio is then pre-emphasized and run through a limiter. The output level is established by the setting of peak voice deviation tracking data in the Maintenance software application. (Note: RF power is set ONLY by qualified trained land mobile radio technicians.) CG or DCG sub-audible encode tones are generated in the microprocessor and fed to the ASP. After being run through a low pass filter to reduce sub-audible encode distortion, the sub-audible audio is then combined with the voice audio at the output of the limiter.

This combined sub-audible audio and limited voice audio is then sent back to an inverting amplifier. If the channel is programmed for wideband mode, the audio gain at the inverting amplifier remains at its normal gain and the peak voice deviation tracking data is set to produce a nominal 3.75 kHz. With the 750 kHz nominal sub-audible deviation, the total deviation is approximately 4.5 kHz. (If no sub-audible deviation is present, the peak voice deviation is adjusted for 4.5 kHz.)

If the channel is programmed for narrowband mode, the inverting amplifier's gain is cut in half and the nominal peak voice deviation (and sub-audible deviation, if present) is reduced to 2.25 kHz. The inverting amplifier output is then used to modulate the VCO (voice audio) and the TCXO (sub-audible audio). The TCXO's reference frequency is adjusted by a DC voltage coming from a D/A converter in the ASP. The DC voltage level is established by the setting of TX carrier frequency tracking data in the Maintenance software application. (Note: TX carrier frequency is set ONLY by qualified trained land mobile radio technicians.)

LOGIC

The logic network is dominated by the use of a microcomputer (similar to Hitachi's H8S/2340-HD6412340). This controller is a true 16-bit microprocessor with a crystal clock frequency of 7.3728 MHz. The microprocessor interfaces with a variety of digital logic. The 64k Flash EEPROM stores the operational code. The 2k EEPROM stores all the personality and tracking data information. The microprocessor controls the following functions of radio performance:

- Loading the synthesizer IC,
- Switching and routing of transmit and receive audio in the ASP,
- Providing the drive signals to all control buttons and indicators.
- Using embedded algorithms to be able to decode CG, DCG, and Type 99 two-tone sequential receive signals, and
- Setting the RF output level.

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OPTIONS AND ACCESSORIES			
*** = CONSISTS OF FORIEGN PRODUCT NUMBERS**		**CONTENTS OF OPTION**	
DESCRIPTION	**OPTION**	**PART NUMBER**	**PART NUMBER**
ACCESSORIES			
POWER CABLE	KACJ7H	RPM 113 7674/10	
ANTENNA, 136-512MHz, ROOF MOUNT	KAAN1R	*19B209568P6	
MOBILE MIC	KAMC7J	KRY 101 1654/1	
DTMF MIC	KAMC7K	KRY 101 1654/10	
MIC HANGER	KAMN1A	*344A4678P1	
(A) OPTION CABLE	KACJ7G	RPM 113 7674/1	
(B) EXTERNAL SPEAKER	KALS1H	*19A149590P11	
(C) EXTERNAL RELAY KIT	KASU1C	*19A705499P1	
NOISE SUPPRESSION KIT	KAPD1A	*19A148539G1	