



White Paper – July 2008

**BK Radio KNG-P150/P400/P500/P800**

## **Highest-Performance P25 Digital Radio, Class A Specifications**



The BK Radio KNG-P150/P400/P500/P800 from RELM Wireless Corporation meets or exceeds the highest performance specifications of all comparable digital two-way radios, providing clearest sound with least distortion.

The KNG-P150/P400/P500/P800 meets or exceeds requirements for APCO Project 25 (P25) and TIA Class A specifications including interoperability with other P25-compliant VHF radio products.

Smaller and lighter than any other P25 portable radios, the KNG-P150/P400/P500/P800 is infused with advanced features, yet designed for ease of use and custom-programming in the field.

RELM Wireless Corporation  
7100 Technology Drive  
West Melbourne, FL 32904  
USA: 800-821-2900 International: 321-984-1414  
Email: sales@ relm.com / Website: www.relm.com

## Summary

Having officially received equipment authorization from the Federal Communications Commission (FCC) in December 2007, the BK Radio KNG P150/KNG P400 portable radio from RELM Wireless Corporation now qualifies as the highest-performance digital portable two-way radio for national security, military, public safety and related applications, as compared with all other top-of-the-line P25 digital radios from U.S. manufacturers.

All KNG P150/KNG P400 specifications are in full compliance with the APCO Project 25 (P25) digital radio technical standard established by the Association of Public-Safety Communications Officials - International (APCO). In addition the KNG P150/KNG P400 not only qualifies in alignment with Class A specifications of the Telecommunications Industry Association (TIA), it also meets or exceeds the highest performance specifications of all other U.S. manufacturers' comparable P25 digital products in 10 of 11 key categories. The KNG P150/KNG P400 thereby provides superior audio quality resulting in clearest sound with least distortion (see pp. 5-8, p. 10) of any VHF (136-174 MHz) UHF (380-470 MHz) P25 radio.

The KNG P150/KNG P400 also offers certain practical advantages to radio users in the field. It is the smallest and lightest P25 digital portable radio among all comparable radios, making the radio less obvious to others. The KNG P150/KNG P400's lower current drain and power consumption give it significantly longer battery life (18+ hours) than any manufacturers' comparable radios. It provides up to 6 watts of RF output power for extended communications beyond the reach of most other manufacturers' comparable radios.

The KNG P150/KNG P400 shares interoperability with other manufacturers' VHF/UHF digital radio equipment also in compliance with P25 requirements.

Other advanced features and functionalities include:

- Enabling easier operation and custom-programming in the field are advanced features such as an enhanced multi-line dot-matrix display window and customizable keypad menu, OTAR (Over-The-Air Rekeying), cloning, USB (Universal Serial Bus) software to program the KNG P150/KNG P400 via PC or laptop, plus automatic digital/analog/mixed-mode detection/talkback.
- Design and construction provide maximum rugged reliability to withstand hazardous conditions. The KNG P150/KNG P400 meets MIL-STD 810 C/D/E/F specifications and has earned an IP67 submersible rating. There is also the option of a modified radio for IS (Intrinsically Safe) certification by FM Approvals.
- Embedded FIPSCOM cryptographic module provides secure encryption compliant with requirements of FIPS 140-2 for AES encryption/decryption of digital communications as well as enabling legacy DES encryption.

**[Summary continued]**

Radio features, functions, and upgrades are software-defined, thereby transferable via RELM's *FLASH* technology from PC to KNG P150/KNG P400 radios without the necessity of hardware changes or new radio replacements. In addition, cloning technology enables the radio user to transfer channel frequencies and group information from radio to radio in the field.

**Basic Practicalities**

Some of the qualities that distinguish the BK Radio KNG P150/KNG P400 from competing manufacturers' P25 digital radios also aligned with TIA Class A performance specifications are not simply better numbers, but rather factors that may have direct impact on the radio user.

These fundamental distinctions include:

- Superior audio quality, clearest sound with least distortion – This factor is the essence of TIA Class A performance specifications. The KNG P150/KNG P400 meeting or exceeding the best performance specifications as measured in 10 of 11 key categories (see pp. 5-8, p. 10) verifies this claim as related to other manufacturers' comparable top-of-the-line digital radio products.
- Lightest and smallest P25 digital radio meeting Class A specifications – total weight one pound, including battery, 2.5" x 1.8" x 5.5" – not a performance issue, but may be a significant factor for those who prefer being less conspicuous, such as officers and agents in plainclothes.
- Longer battery life than any comparable P25 digital radio meeting Class A specifications – More efficient processing design results in lower current drain that results in lower power consumption that in turn results in longer battery life between recharges or replacements. Using a high-capacity Lithium-ion battery, KNG P150/KNG P400 battery life is now estimated at 18+ hours based on a 5/5/90 duty cycle), two or three times the estimated battery life of some competing top-tier radios including those of the market leader.

### **[Basic Practicalities continued]**

- Easy to use, easy to custom-program – Enhanced five-line dot-matrix display window provides the radio user with more information at a glance. Intuitive menu-driven programming is facilitated with a customizable keypad menu and USB (Universal Serial Bus) port for programming from a PC or laptop computer. OTAR (Over-The-Air Rekeying) enables the radio user to re-key encryption while in the field. Automatic digital/analog/mixed-mode detection/talkback enables the KNG P150/KNG P400 digital radio user to both hear and talk back to older analog radios that also meet P25 requirements without adjusting the radio. Other P25 digital radios can hear calls from analog radios, but some are not able to send back voice signals in analog mode.
- P25 interoperability – The APCO Project 25 standard requires interoperability among all manufacturers' comparable P25 digital radios. Thus KNG P150/KNG P400 radios are capable of communicating with other manufacturers' P25 VHF/UHF radios and communicating within other manufacturers' P25 network infrastructures.
- Increased strength and protection, reliability, durability – The KNG P150/KNG P400 has qualified for an IP67 submersible rating, reinforcing waterproof and weatherproof qualities. The KNG P150/KNG P400 meets all MIL-STD 810 C/D/E/F military standard specifications. A modified version of the KNG P150/KNG P400 will provide rugged IS (Intrinsically Safe) protection with certification by FM Approvals.

### **Advanced Features and Functions**

- 1-6 watts RF power output – Three settings (1, 5, and 6 watts), 6 watts being higher power output than all but one of the direct competitors' comparable P25 digital radios (the other also 6 watts maximum), extra power to extend the radio's reach with signal clarity. High and low settings are programmable by channel for power efficiency (not all top-tier radios enable per-channel power settings).
- 512 channels, dynamic grouping – Custom-tailored user groups can be programmed into the KNG P150/KNG P400 by the radio user as well as changed or reprogrammed whenever needed. Channel spacing can be narrowband (12.5 kHz) or wideband (25 kHz).

**[Advanced Features and Functions continued]**

- TYPE 3/Level 1 encryption security – The FIPSCOM module from RELM Wireless Corp. is a multi-chip embedded cryptographic module assembled on a PC board and embedded in the BK Radio KNG P150/KNG P400. The FIPSCOM module meets the highest Level 1 specifications for Federal Information Processing Standards FIPS 140-2 in accordance with Derived Test Requirements for FIPS 140-2 and Security Requirements for Cryptographic Modules, certified by the National Institute of Standards and Technology (NIST) and by Canada's Communications Security Establishment for AES (Cert. #385 with ECB and OFB mode), RSA (Cert. #139), and SHS (Cert. #462) encryption/decryption tools for digital communications. The FIPSCOM module also enables legacy DES (in ECB and OFB mode) and NDRNG encryption algorithms.
- USB, *FLASH*, and cloning technologies transfer information, enabling future upgradeability. With today's radio functions being largely processor-based and software-defined, current functionality and future upgrades can be added by transferring programming from a PC to new radios. Software upgrades can be transferred via *FLASH* technology. Upgrading KNG P150/KNG P400 functionality need not require hardware redesign, so the KNG P150/KNG P400 can be current with new technology on a continuing basis. Cloning can transfer channel frequencies and group information from a KNG P150/KNG P400 radio in the field. The Clone Lockout Per Group function can prevent cloning of select group information.
- 100 programmable Quick Call IDs – Connect with select radio users ASAP through Quick Call function, programmed to reach up to 100 individual radios. The KNG P150/KNG P400 provides more Quick Call IDs than most comparable P25 radios that also meet TIA Class A specifications.
- Busy channel selections – Various methods and functions are designed to prevent other radio communications and interference on channels being used. The Qualify with NAC (Network Access Codes) function screens users on the same or a nearby channel but with different Network Access Codes. Allow/Inhibit NAC Mismatch can make adjustments to block or include radios with network access codes that don't match the user's NAC. Busy Channel Lockout prevents transmission via a busy channel already in use. Inhibit On Carrier sets the conditions for preventing competing signals on the same channels. For analog radio communications, the User-Selectable CTCSS/CDCSS (Continuous Tone-Coded Squelch System/Continuous Digital-Coded Squelch System) enables the radio user to squelch the voice communications of other users on the same channel so the radio user's conversation is uninterrupted by competing signals. Nuisance Channel Delete locks out channels with outside and unwanted users.

**[Advanced Features and Functions continued]**

- Channel/Priority/Group Scan – Find an available channel for communications: by channel, by priority channel, and by scanning groups one group at a time.
- Talk Around – This feature enables the radio user to bypass or “talk around” a repeater for a direct connection. Radio repeaters that extend the coverage area use two different frequencies to receive and transmit signals. When one radio is out of range for the repeater, the KNG P150/KNG P400 can transmit and receive on the same frequency in simplex mode with the flip of a switch, connecting the two radios.
- Problem-prevention features – The Keypad Lock prevents the radio user from accidentally hitting a button that may activate functions unintentionally. The built-in battery gauge may help avoid untimely surprises. The orange emergency button alerts the dispatch operator to an impending emergency confronting the radio user.

Programming and menus are designed to be relatively simple and intuitive so that implementing these options is easy for the radio user to accomplish even under difficult circumstances in the field.

**Class A Specifications and Performance Improvements**

The KNG P150/KNG P400 provides the clearest sound with the least distortion among comparable P25 radios. Utilizing radio performance measurements in accordance with applicable TIA/EIA 603A and TIA/EIA 102.CAA (Telecommunications Industry Association/Electronic Industries Alliance) standards, the BK Radio KNG P150/KNG P400 meets or exceeds the best performance numbers of all U.S. manufacturers’ comparable top-tier P25 digital radios in 10 of 11 key categories of TIA Class A specifications, as shown in the product comparison chart (p. 10) and the following list defining each category.

Receiver performance measurements for the KNG P150/KNG P400 include:

- Sensitivity (-121 dBm) – Indicating the radio’s sensitivity to receiving a signal using the least amount of power yet with an acceptable level of sound quality. The KNG P150/KNG P400 comes in at -121 dBm (decibels per millivolt). Only one of five comparable U.S. radios matches that number.

**[Class A Specifications and Performance Improvements continued]**

[Receiver performance measurements continued]

- P25 Sensitivity (-121 dBm) – A similar measurement of digital communications conforming to the APCO Project 25 (P25) public safety technical standard – also measured in dBm, with the KNG P150/KNG P400 again coming in at -121 dBm, also matched by only one other radio.
- Adjacent Channel (80 dB) – Refers to the radio’s ability to reject analog signals from adjacent channels – measured in decibels (dB), the KNG P150/KNG P400 ranks first at 80 dB, matched only by one other radio.
- P25 Adjacent Channel (60 dB) – Referring to the radio’s ability to reject signals from adjacent narrowband (12.5 kHz) channels – also measured in decibels (dB), the KNG P150/KNG P400 is at 60 dB along with three of the other five radios, the remaining two with no published specifications in this category.
- Intermodulation (78 dB) – Potential interference from multiple sources and nearby frequencies can be greater in urban areas, for example, where antennas of different systems are in the same locations – also measured in decibels (dB), in this category the KNG P150/KNG P400 is at 78 dB, matched by only two of the other five comparable radios.
- Spurious and Image Rejection (80 dB) – With radios rich in harmonics, unwanted image signals may be generated internally, perhaps interfering with and distorting the primary signal being received – also measured in decibels (dB), with the new KNG P150/KNG P400 radio at 80 dB, matched by three of the five other comparable radios, but an excellent number nonetheless.
- Audio Distortion (2%) – This refers to internal audio distortion generated by the radio, a measure of sound clarity at the rated audio power output. Measured as a percentage, the KNG P150/KNG P400 is rated at less than 2%, the one category in these TIA Class A specifications where the KNG P150/KNG P400 does not boast the industry-leading number on the chart. It is an excellent number, however, as the radio user is unlikely to notice or differentiate any such internal audio distortion of less than 5%. Improving from 2% down to 1% would not be a significant or noticeable change for the radio user.

**[Class A Specifications and Performance Improvements continued]**

Transmitter performance measurements for the KNG P150/KNG P400 include:

- **RF Power (1-6W)** – The BK Radio KNG P150/KNG P400 leads the pack with adjustable RF power output of 1, 5, and 6 watts. Only one other radio in this top-of-the-line group reaches up to 6 watts, and for some users that may be a vital measure.
- **Frequency Stability (1.5 ppm)** – This category is a measurement of frequency stability during radio transmission across a temperature range of -30°C to +60°C, in which the KNG P150/KNG P400 would not deviate more than 1.5 ppm (parts per million) in the transmission frequency. At 100 MHz VHF, for example, the KNG P150/KNG P400 would therefore not deviate more than 150 Hz from that transmission frequency. This is an excellent and exceptional rating, matched by only two of the other five comparable radios.
- **FM Hum and Noise (50 dB wideband, 45 dB narrowband)** – A measure of the clarity of the transmitted signal in regard to internally generated hum and noise distortion in decibels (dB) for both wideband and narrowband transmission. The KNG P150/KNG P400 is rated at 50 dB for wideband and 45 dB for narrowband transmission, numbers matched by only one of the other five comparable high-specification radios.
- **Spurious and Harmonics (75 dB)** – Instead of spurious signals generated in the radio while in receive mode, this category refers to unwanted radiated carrier emissions while in the transmit mode – also measured in decibels (dB), the KNG P150/KNG P400 is at 75 dB, matched only by two of the other five comparable radios.

These comparative measurements calculate the radio's adjacent channel, intermodulation, and spurious rejection characteristics. Across the board the BK Radio KNG P150/KNG P400 scored the best results and performance in 10 of 11 categories.

Design improvements in the synthesizer have contributed to the industry-leading performance specifications of the KNG P150/KNG P400, especially with transmitter FM hum and noise as well as spurious and harmonics distortion. The synthesizer also supports rapid channel scan and priority scan performance.

A complete overhaul of the VCO (Voltage Control Oscillator) used in previous BK Radio P25 digital radios led to the industry-leading adjacent channel performance numbers for the KNG P150/KNG P400. The VCO is also quite small and compact, requiring no manual tuning.

**[Class A Specifications and Performance Improvements continued]**

An innovative new strategy for the harmonic filter in the BK Radio KNG P150/KNG P400 led to its superior transmitter spurious and harmonic performance while maintaining the efficiency needed to provide the full 6 watts of transmitter RF output power.

A complete reworking of the receiver front end marked a major transition from the legacy BK Radio P25 radio design that resulted in the elimination of all manual adjustments for operation of the KNG P150/KNG P400, with the radio instead making such adjustments automatically. This transformation in design was responsible for industry-leading performance in receiver spurious and image rejection, intermodulation distortion, and sensitivity performance.

The receiver first IF (Intermediate Frequency) for the dual conversion receiver was adapted from the original BK Radio DMH P25 digital mobile radio design and was thereby responsible for helping the KNG P150/KNG P400 achieve industry-leading specifications in receiver adjacent channel, intermodulation distortion, and spurious and image rejection categories.

The digital IF (Intermediate Frequency) was also borrowed from the BK Radio DMH mobile radio design, although this is the first use of digital IF in a portable radio developed by RELM Wireless, and it is much smaller than previous versions. Unlike the previous version of the BK Radio portable radio design, no manual adjustments are required. The digital IF was also critical to the KNG P150/KNG P400 achieving the P25 receiver adjacent channel performance specifications.

State-of-the-science radio control and baseband signal processing design easily accommodates all BK Radio and P25 legacy features and functions, provides ample resources for P25 trunking (in development), supports sufficient processing speed and memory for current and foreseeable capabilities, and enables industry-leading battery life while fitting into reduced radio size.

The design of the BK Radio KNG P150/KNG P400 incorporates advanced microprocessors that utilize efficient development tools within the radio. These microprocessors can also provide sufficient surplus performance potential to allow and enable various future enhancements. There is room inside the KNG P150/KNG P400 to plant new features, innovations, and upgrades.

## **New Developments, Radio Products, Price/Performance Advantages**

The BK Radio KNG P150/KNG P400 and subsequent KNG products operating in different frequencies will enable P25 trunking capabilities to provide network expansion to more radio users in the field. The current hardware platform of the KNG P150/KNG P400 will support trunking functions compliant with the APCO Project 25 technical standard.

Also in development are additions to the new KNG digital P25 product line operating in 700/800 MHz frequency bands. The mechanical package and majority of circuitry from the KNG P150/KNG P400 will likewise serve as the foundation and core of the new KNG products.

In addition, new options and capabilities including GPS (Global Positioning System) components are in development.

What will be the deciding factors for agencies choosing among premier top-of-the-line P25 digital radios meeting highest-performance Class A specifications?

Such factors as smaller size and lighter weight may be of interest to some yet irrelevant to others. Reports from radio users in state forestry departments fighting wildfires seem to suggest they have no problem with carrying rugged radios, whereas plainclothes agents in security and related operations may prefer the smallest and lightest and least conspicuous option.

For P25 digital radios meeting Class A specifications, agencies will expect all the most critical capabilities, such as interoperability, encryption, trunking, OTAR, etc. Along with a robust and wide range of advanced features and functions, the KNG P150/KNG P400 also meets RELM's core requirements and competitive advantages: superior audio quality, ease of use and custom-programming, lowest power consumption and longest battery life, plus built-in cost and design efficiencies.

As a result, the BK Radio KNG P150/KNG P400 locks in its value proposition and price/performance advantages over its premier P25 radio competitors that will be sustainable over time, without any compromise in quality and performance

###

## Comparison Chart

Portable P25-Compliant Digital Radio  
TIA Class A Performance Specifications

### KNG P150/KNG P400 vs. U.S. Competitors' Highest-Performance P25 Digital Radios

[Note: Numbers in **boldface** indicate leading best-performance specifications.]

<u>Receiver</u>	<b>KNG P150/ P400</b>	Prod. A	Prod. B	Prod. C	Prod. D	Prod. E
Sensitivity (dBm)	<b>-121</b>	-119	-121	-119	-119	-119
P25 Sensitivity (dBm)	<b>-121</b>	-119	-121	-116	-119	-119
Adjacent Channel (dB, wide)	<b>80</b>	78	80	75	75	75
P25 Adjacent Channel (dB)	<b>60</b>	60		60		60
Intermodulation (dB)	<b>78</b>	75	78	75	78	75
Spurious and Image Rejection (dB)	<b>80</b>	80	80	75	75	80
Audio Distortion (%)	2	1.5, 2	<b>1</b>	3	2	3
<u>Transmitter</u>						
RF Power (Watts)	<b>1-6</b>	1, 5	1-6	1, 5	1, 5	5
Frequency Stability (ppm)	<b>1.5</b>	2	2	1.5	1.5	2
FM Hum and Noise (dB, w/n)	<b>50/45</b>	50/45	48/42	40/34	45/40	45/40
Spurious and Harmonics (dB)	<b>75</b>	70	75	73	75	70

<b>Specification</b>	<b>P-150</b>	<b>P-400</b>	<b>P-500</b>	<b>P-800</b>
<b>General</b>				
Channels w/ Variable Zone Size	512			
Zones (up to)	64			
Frequency Range (MHz)	136 - 174	380 - 470	440 - 520	763 - 870
Operating Voltage (V Nominal)	10			
Channel Spacing (kHz)	12.5 / 25			
Channel Increments (kHz)	2.5	12.5	12.5	TBD
Operating Temperature (°C)	-30 to +60			
Dimensions (W in x D in x H in)	2.5 x 1.8 x 5.5			
Weight w/Battery (oz)	16	16	16	16
Standby Current Draw (mA) With Battery Save "On"	20	20	20	20
FCC ID	K95KNGP150	K95KNGP400	K95KNGP500	K95KNGP800
<b>Receiver</b>				
Sensitivity (dBm)	-121	-119	-121	-119
P25 Sensitivity (dBm)	-121	-119	-121	-119
Adjacent Channel Rejection (dB) Per TIA/EIA-603 2.1.6	80 (70)	80 (70)	79 (67)	72 (63)
P25 Adjacent Channel Rejection (dB)	60	60	60	60
Spurious and Images (dB)	80	80	85	75
Intermodulation Rejection (dB)	78	75	77	75
Audio Distortion at 500mW (%)	2	2	2	2
Current Draw (mA)	255	255	255	255
<b>Transmitter</b>				
RF Power (Watts)	6 / 5 / 1	5 / 4 / 1	5 / 4 / 1	3 / 1
Frequency Stability (ppm)	1.5	1.5	1.5	1.5
Audio Distortion (%)	3	3	3	3
FM Hum & Noise (dB)	50 (45)	50 (45)	50 (45)	50 (45)
Spurious and Harmonics (dB)	75	75	75	75
Current Draw (mA)	1500	1500	1500	1500

Narrowband specifications are denoted in parenthesis.

### Military Specifications

	MIL-STD 810C		MIL-STD 810D		MIL-STD 810E		MIL-STD 810F	
	Method	Proc. /Cat.	Method	Proc. /Cat.	Method	Proc. /Cat.	Method	Proc. /Cat.
<b>Low Pressure</b>	500.1	I	500.2	II	500.3	II	500.4	II
<b>High temperature</b>	501.1	I, II	501.2	I/A1, II/A1	501.3	I/A1, II/A1	501.4	I/Hot, II/Hot
<b>Low Temperature</b>	502.1	I	502.2	I/C3, II/C1	502.3	I/C3, II/C1	502.4	I/C3, II/C1
<b>Temperature Shock</b>	503.1	–	503.2	I/A1C3	503.3	I/A1C3	503.4	I
<b>Solar Radiation</b>	505.1	II	505.2	I	505.3	I	505.4	I
<b>Rain</b>	506.1	I, II	506.2	I, II	506.3	I, II	506.4	I, III
<b>Humidity</b>	507.1	II	507.2	II	507.3	II	507.4	–
<b>Salt Fog</b>	509.1	–	509.2	–	509.3	–	509.4	–
<b>Blowing Dust</b>	510.1	I	510.2	I	510.3	I	510.4	I
<b>Immersion</b>	512.1	I	512.2	I	512.3	I	512.4	I
<b>Vibration</b>	514.2	VIII/F, Curve-W	514.3	I/10, II/3	514.4	I/10, II/3	514.5	I/24
<b>Shock</b>	516.2	I, II	516.3	I, IV	516.4	I/IV	516.5	I, IV

Units must also meet the following standard:

IP67 – Dust tight/Immersion up to 1 meter of submersion 30 minutes