



# **OPERATOR'S MANUAL**

## **KYODO WEST MODEL KG506**

### **FULL-DUPLEX MOBILE**

Preliminary



## 1.0 INTRODUCTION

Thank you for purchasing the KYODO WEST MODEL KG506 Full-Duplex Mobile Radio. This manual contains information to assist you in the application and operation of the radio.

The KG506 is a building block intended for use in systems requiring a compact radio for full duplex, repeater, link, etc. The radio is capable of both analogue and digital modulation.

The KG506 is designed to operate with an external, custom designed, control system, which may be supplied by Kyodo West or by the customer. Kyodo West will provide engineering assistance and technical information to assist in the design of the control system by the customer.

Use of the many features available in the radio will depend on the complexity of the control system.

## 2.0 FEATURES & PRODUCT DESCRIPTION

### 2.1 Standard Inclusions

The KG506 transceiver is supplied complete with the following items:

- KG506 transceiver
- DC Supply Cable with Fuse and Plug
- Operators Manual
- Spare Fuse
- Two Magnetic Keys
- Mounting Plate with Hardware

### 2.2 Features

- Designed for use with external control system
- Simplex or two frequency Duplex operation
- EEPROM programmable with a PC computer
- Up to 64 Channels
- Optional Internal Duplexer
- All FM Frequency Bands from 66 to 520 MHz
- Transmit Time Limiter to prevent channel jamming
- TX and RX Encryption
- All-Scan and Program Scan Scanning Modes
- 5 Tone Encoder & Decoder plus DTMF Encoder & Decoder
- 22, 26, or 35 MHz switching bandwidth (model dependant)
- Two-Stage Front End allows mixed Simplex and Duplex operation
- Channel selectable Wide or Narrow channel spacing
- Channel selectable High / Low power
- CTCSS/DCS on a per channel basis
- Rugged Housing
- Heavy gauge mounting plate with key lock
- Step-Up VCO Voltage for Superior Selectivity
- Low Stand-by Current is ideal for Solar Installations
- Watch Dog Timer

### 2.3 Product Description

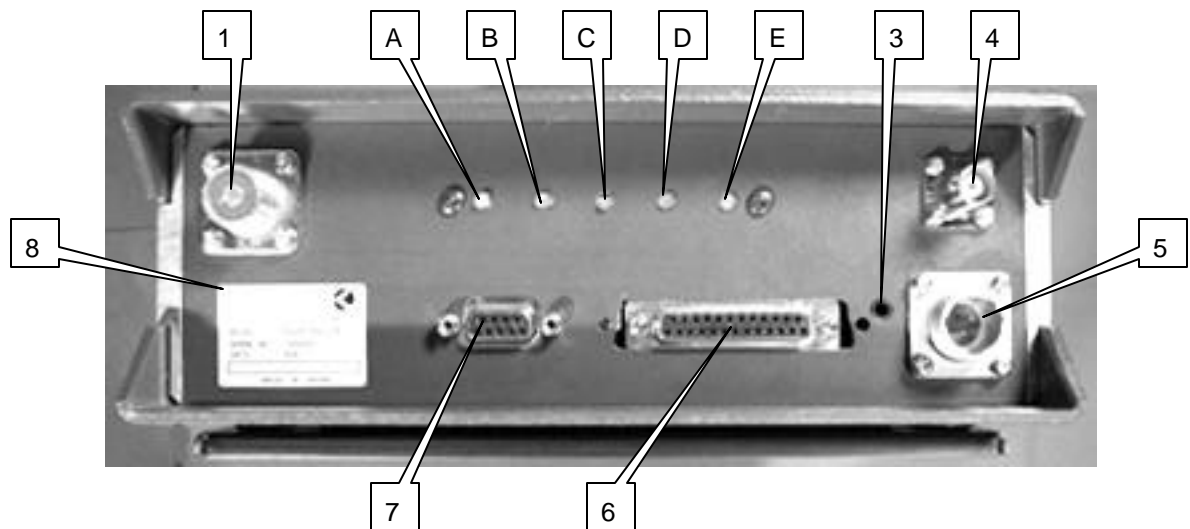
The **Kyodo West KG506** transceivers represent a great advance on the previous rugged & time proven KG106 transceiver. They consist of separate modules all housed within one rugged, compact mobile cabinet. The receiver, the transmitter, and the PA Unit are each enclosed within their own diecast housings that are directly mounted to the main chassis. A full-featured logic module controls all parameters of the radio under the control of a microprocessor. The RF Power Output is 1 - 30 Watts on a continuous duty basis. The CTCSS module supports all EIA tones, which may be set on a per channel basis during radio programming.

The **KG506** is supplied with TX and RX antenna ports to allow connection to an external duplexer or feeder cables. Space is provided inside the housing for an antenna relay or mobile type 6-cavity duplexer.

## 2.4 Front Panel Features

The front panel includes the following:

1. UHF Type connector for the Transmitter (optional type "N")
2. LEDs to indicate: **A**=POWER, **B**=BUSY, **C**=TRANSMIT, **D**=ALARM, and **E**=REPEAT
3. Miniature jack for speaker audio output
4. BNC Connector for the Receiver
5. DC Power Connector
6. 25 position D sub connector for interface to the external control system
7. 9 position D sub connector for connection to a PC for programming
8. Model Number / FCC Label



## 2.5 Indicator Functions

### **A** POWER On Indicator LED

The Power ON Indicator LED will illuminate in Green (Blue on FCC sample) color whenever the Power ON/OFF switch is switched to the "ON" position.

### **B** BUSY Mode Indicator LED

The Busy Mode Indicator LED will illuminate in Green color whenever the KG506 receives a carrier signal on the selected channel that is greater than the Squelch setting.

### **C** TRANSMIT Mode Indicator LED

The Transmit Mode Indicator LED will illuminate in Red color whenever the KG506 is transmitting.

### **D** ALARM Mode Indicator LED

The Alarm Mode Indicator LED will illuminate (Flashing) in Amber color whenever the transceiver detects a fault in the receiver module, the transmitter module, or the PA module on the selected channel.

### **E** REPEATER Mode Indicator LED

The Repeater Mode Indicator LED will illuminate in Yellow color when the selected channel has been programmed for Repeater operation. This LED will NOT illuminate on any channel that is programmed to operate in Base Station mode.

## 3.0 OPERATION

### 3.1 Installation and Programming

KG506 can be installed to operate as a Transportable, Mobile or a Fixed Station in any mode of operation.

The KG506 must be programmed before it will operate correctly. This is best done by the equipment supplier or a competent radio engineer. They will require the correct programming kit and a computer. Complete programming instructions are provided with the kit. If a duplexer is used, please observe the maximum frequency range permitted by the duplexer notches.

It is important that the KG506 be correctly installed at its working location. It is recommended that this be done by a competent radio engineer.

As a minimum, it is necessary to:

**The antenna(s) used for this transmitter must be fixed-mounted on outdoor permanent structures. RF exposure compliance is addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co-location requirements of 1.1307(b)(3).**

- Securely attach the mounting plate to the desired location.
- Connect the DC Input power lead to a suitable 13.8 Volt Regulated DC Power supply that has sufficient capacity. (Ensure that the DC Polarity is correct, otherwise the fuse will blow).
- Connect the antenna feed line(s). (Check that the VSWR of the antenna is acceptable).
- Connect the Control System to the 25 position sub D connector.

### 3.2 Basic Operation

Note that controls and functions will vary with different control systems and with programming.

- 3.2.1 Switch On  
Switch the KG506 "ON" , the POWER indicator should illuminate.
- 3.2.2 Adjust the Volume Setting  
Rotate the Volume Knob clockwise until the audio level from the speaker is suitable.
- 3.2.3 Adjust the Squelch Setting  
Rotate the Squelch Knob clockwise (from the fully counter clockwise position) slowly until the background noise can no longer be heard. It is wise to slightly rotate the knob further in the clockwise direction so that variations in the background noise level do not "break" the squelch setting and cause annoying noises to be heard from the speaker.
- 3.2.4 Select the Channel  
Select the desired channel.
- 3.2.5 Receiving  
You should now be able to hear any radio traffic that occurs on channel. It may be necessary to further slightly adjust the Volume setting to suit your listening requirements.
- 3.2.6 Transmitting  
Depending on the legal requirements in your country and the operating requirements within your organization, it may be necessary to announce your Call Sign, and will

probably be necessary to announce the Call Sign of the party you are calling at the start of your transmission.

Press the PTT switch before beginning to speak. When transmitting, it is necessary to hold the microphone about 75mm (3") from your mouth and speak clearly into the grill of the microphone.

## 4. CIRCUIT DESCRIPTION

### 4.1 Receiver

#### 1) RF section

An incoming signal is fed to pre-selector, BPF-101/103, and amplified by Q101/Q102, and then fed to post-selector BPF-102/104. The outputs of the RF section(s) feed the balanced mixer, consisting of T101, T102, D107 and D108, which produces 48.5MHz by injection from the 1<sup>st</sup> local oscillator signal provided by the RX VCO.

#### 2) IF & Audio Sections

The output signal from the balanced mixer is fed to the crystal filters XF101, and then amplified by Q103. This signal is fed to crystal filters XF102 A & B and amplified by Q113. The signal is fed to 2<sup>nd</sup> processor IC (IC106). The 2<sup>nd</sup> local crystal oscillator signal is fed to IC106 to produce the 2<sup>nd</sup> (Low IF) signal of 455 KHz. IC106 amplifies and detects the 455 Low IF 2<sup>nd</sup> local signal to produce an audio signal. Then, the audio signal is fed to the low-pass filter inclusive in IC107, and fed to audio processor IC (IC3) located on the Logic Unit. IC3 provides band-pass and de-emphasis functions and passes the processed audio to IC16, line amplifier and IC22, Audio PA. IC16 provides internal repeat audio and external "0 dBm" audio for interfacing external devices. IC22 provides audio to the speaker jack.

#### 3) RX VCO Section

The oscillator circuit formed by Q301 and associated components produces the 1<sup>st</sup> local signal (Rx frequency minus 48.5MHz). The frequency of the oscillator is controlled by a signal input from the PLL, (see below) which is applied to varactors D303/304. The 1<sup>st</sup> local signal is amplified by buffer amplifier Q302, and again IC301 and Q303. The output signal is fed to the balanced mixer in the receiver RF section. A sample of the frequency is also sent to the PLL.

#### 4) RX PLL Section

The PLL IC101 contains a pre-scaler and frequency dividers to divide both the VCO frequency and the local TCVXO, 12.0 MHz to a common reference frequency. These signals are compared by a phase detector to produce a VCO control signal. This control signal is fed to the charge pump, consisting of Q108, Q109 and Q110, and fed to the LPF IC103 and on to the VCO. The supply voltage of the charge pump is multiplied by IC102 (approx. 15V) to achieve greater C/N ratio. The frequency dividers are controlled by data from the Logic Unit to determine receiver operating frequency.

### 4.2 Transmitter

#### 1) TX VCO section

The oscillator circuit formed by Q301 and associated components produces the final carrier signal. The frequency of the oscillator is controlled by a signal input from the PLL, (see below) which is applied to varactors D303/304. The oscillator signal is amplified by buffer amplifier Q302, and again IC301 and Q303. The output signal is fed to the TX (driver) Unit for further amplification. A sample of the frequency is also sent to the PLL. The modulation is applied to varactors D301 and D302.

#### 2) TX PLL section

The PLL IC101 contains a pre-scaler and frequency dividers to divide both the VCO frequency and the local TCVXO, 12.0 MHz to a common reference frequency (5 to 15 KHz.). These signals

are compared by a phase detector to produce a VCO control signal. This control signal is fed to the charge pump, consisting of Q206, Q207 and Q208, and fed to the LPF IC207 and on to the VCO. The supply voltage of the charge pump is multiplied by IC208 (approx. 15V) to achieve greater C/N ratio. The frequency dividers are controlled by data from the Logic Unit to determine transmitter operating frequency

3) Modulator Section

The modulation signal is fed to both VCO and the reference oscillator (TCVXO). This permits a very flat modulation characteristic against low frequency (DC). This permits operation with digital signals such as Digital Coded Squelch and POCSAG Paging Terminals.

4) TX Unit (Driver) Section

The VCO signal is amplified by Q215 to the proper level to drive the PA Module.

5) PA Section

The signal from driver stage is fed to PM501 to achieve 30W output power. The signal is then fed to a balanced line to detect forward and reverse power, then on to the LPF to eliminate harmonics spurious frequencies. An APC (Automatic Power Control) circuit stabilizes the output power at the set level. The circuit also protects the PA from excess reverse power caused by mis-match of the antenna. An alarm circuit signals if output power drops below a preset level or when SWR exceeds a preset level. All parameters are adjustable.

#### 4.3 Logic Unit

1) Microcomputer (CPU)

CPU, IC1, uPD78F0058, an 8-bit processor, has 60K flash memory and 2K RAM inside. This CPU controls all functions of KG506. A flash memory permits ON-BOARD-UP-GRADE when new software is released.

2) EE ROM section

IC7 is the 64kbit EEROM. This IC contains all channel parameters.

3) Audio processor section

An IC2 is for TX and IC3 is for RX audio processor. These IC's control all audio processing and encode/decode CTCSS tones commanded by the CPU. These IC's are also contain a 2400bps MODEM to enable use of MPT1327 trunking protocols by using external MPT control software.

4) LED display section (front panel of radio)

The LED's indicate each mode of operation of the KG506 as follows:  
POWER, BUSY, TRANSMIT, ALARM, REPEATER.

5) Audio amplifier section

An IC22 provides 5 W audio power to drive 8 ohm external speaker.

#### 4.4 Control Interface Connector

A 25 position D-sub connector for remote control is provided on the front panel of KG506.

The functions of each pin are as follows;

1	CH 0,	1	apply 1 to 6 bits of binary input to pins 1 thru 6 to select 64 channels,
2	CH 1,	2	Pin 1 is LSB.
3	CH 2,	4	
4	CH 3,	8	
5	CH 4,	16	
6	CH 5,	32	
7	GROUND		Ground

8	RSSI	Receive Signal Strength Indication, 0 to 5 V DC
9	DISC. OUT	Discriminator audio output, low level
10	SQ. CONT.	To external Squelch control, 10K pot to ground
11	BUSY	Goes to 5V logic high when squelch is opened by signal
12	MUTE	When pulled low, mutes RX and Repeat audio
13	MOD-1	Microphone modulation input
14	GROUND	Ground
15	PTT	Pull low to transmit
16	MOD-2	Digital modulation input, DC sensitive
17	SIMPLEX	Provides logic output during simplex operation
18	ERROR	Provides "flashing" high/low if error/alarm is present
19	DECODE	Logic low upon decoding 5-tone or DTMF code
20	RX AUD-1	With pin 21, provides balanced "0 dBm" audio
21	RX AUD-2	With pin 20, provides balanced "0 dBm" audio
22	TX OUT	Indicates error in PA, low power or high SWR
23	EXT. POW SW	Connect to ground through external POWER switch
24	VOLUME	To external volume control, 10 K pot to ground
25	+12V (nom)	Switched 12 VDC to external accessories

CN1 Mini phone jack      Balanced Speaker output both sides above ground.

## 5. ALIGNMENT PROCEDURES

### 5.1 Receiver Unit

#### 1) BPF-101 and BPF-102, RF Alignment

Connect the signal generator to the Rx antenna connector of KG506. Align the BPF-101 and BPF-102 to obtain the maximum sensitivity. For better alignment, if you have spectrum analyzer and tracking generator, connect the tracking generator to the Rx antenna connector and pick up the output signal from J101 to connect spectrum analyser. Align the BPF-101 and BPF-102 to cover the desired bandwidth of receive frequencies. If receiver is equipped with the optional dual RF sections, adjust BPF-103 and BPF-104 as above.

#### 2) FVR101 alignment

This is to adjust the tight squelch level. Set to threshold with external squelch control set to 1/2 rotation.

#### 3) VCO alignment

The VCO has been aligned at the factory to cover full bandwidth. However, if you must re-adjust the VCO due to repair, set the VCO voltage at 10.5V by L303 at the highest sub-band frequency.

### 5.2 Transmitter Unit

Note: there are no tuning adjustments for the transmitter. It is a broadband circuit.

#### 1) FVR201 alignment

This potentiometer determines the modulation balance. Carefully align this potentiometer to obtain equal deviation on the lowest and the highest RF frequency programmed into the transmitter (not required for normal frequency spreads).

#### 2) FVR202 alignment

This potentiometer determines the low frequency (below 300Hz) deviation. When POCSAG, CTCSS or DCS are used, it is necessary to adjust to have enough deviation at low frequency. Adjusts for flat slope on low frequency square wave tests.

#### 3) FVR203 alignment

This potentiometer sets the maximum deviation, normally set below 5KHz. Programming automatically sets to below 2.5KHz deviation for narrow spacing.

4) FVR204 alignment

Adjust the transmitter output power to 30 W or less.

5) VCO alignment

The VCO has already been aligned at the factory; however if you need to re-adjust, set the VCO voltage at 10.5V at the highest sub band frequency.

### 5.3 Power Amplifier (PA Unit)

1) FVR501

Terminate KG506 with 50 ohm load, and adjust this potentiometer for the minimum level of reverse power.

2) FVR502

This potentiometer sets the SWR alarm threshold when the transmitter is terminated with 50 ohms load. Set just slightly past the alarm point.

3) FVR503

Adjust this potentiometer for the low power alarm threshold, usually -3dB. Turn power down to 12.5 watts (using FVR504) and adjust FVR503 for alarm to trigger.

4) FVR504

Adjust for maximum power output, but do not exceed 35W.

### 5.4 Logic Unit

Note: some adjustments are repeated here for clarity.

1) FVR1 adjustment

Not used.

2) FVR2 adjustment

Adjusts the deviation level when the KG506 used as a repeater. Set to 3.5 kHz modulation with receiver modulated at 3.5 KHz.

3) FVR3 adjustment

Adjusts the TX output power (hi power level), usually set to 25 W. Will not exceed level set in Step 5.3.4.

4) FVR4 adjustment

Adjusts Low Power level when program calls for low power. Usually set to 10 to 15 W.

5) FVR5 adjustment

Internal Squelch range control; if necessary, adjust for threshold with external control set to 1/2 rotation.

6) FVR6 adjustment

Adjusts 600 Ohm RX output level at pins 20 & 21 of 25 pin interface connector, usually set to 0 dBm balanced output.

7) FVR7 adjustment

Internal volume control, used to set maximum audio output power into the speaker. With external Volume Control set to maximum, adjust for 5 watts or less at speaker.



- 8) FVR8 adjustment  
Used for auxiliary audio input.

9) FVC1 adjustment

This is to shift the CPU clock frequency. This is to eliminate beat interference with certain carrier frequencies.

10) FVC2

This is to shift clock frequency for IC2 and IC3, also to eliminate beat interference with certain carrier frequencies.

## 6. SPECIFICATIONS

### 6.1 General

#### Frequency Range

Version SA	300 - 335MHz
Version A	335 - 370MHz
Version B	365 - 400MHz
Version C	400 - 435MHz
Version DS	420 - 455MHz
Version D	440 - 475MHz
Version E	465 - 500MHz
Version F	485 - 520MHz

Number of Channels	64 channels ( <u>observe duplexer limitations</u> )
Channel Spacing	12.5/20/25/30KHz
Operation Mode	Semi Duplex/Full Duplex
Antenna Impedance	50 ohm unbalanced
Power Supply	DC 13.6V negative ground only (external)
Consumption	8 amperes or less
Environmental Conditions	-30 to +60 degree C, 95% humidity @35C
Dimensions	220 (w) 82 (h) 347 (d) mm
Weight	6 kgs.

### 6.2 Transmitter

Output Power	25W continuous, 30W maximum
Switchable Bandwidth	Full sub-band
Frequency Deviation	5KHz(wide band) 2.5KHz(narrow band)
Frequency Stability	+/- 1KHz
Frequency Response	Within +1, -3dB, 300-3000Hz @1KHz ref.
Signal to Noise Ratio	50dB or more @1KHz 70% mod. (45dB at narrow)
Modulation Distortion	3% or less
Spurious & Harmonics	0.25uW or less

### 6.3 Receiver

Switchable Bandwidth	4MHz
IF Frequencies	1 <sup>st</sup> IF 48.5MHz, 2 <sup>nd</sup> IF 455KHz
Frequency Stability	+/- 1KHz
Sensitivity	0.4uV or less for 20dB N.Q. / 0.3uV for 12dB SINAD
Squelch Sensitivity	0.25uV or less
Selectivity	70dB or more at 25KHz
Blocking	90dB or more
Intermodulation	70dB or more
Spurious Response	70dB or more
AF Response	Within +1, -3dB, 300-3000Hz @1KHz ref.
AF Distortion	5% or less @1KHz 70% mod
Signal to Noise Ratio	50dB or more @1KHz 70% mod. (45dB at narrow)