KP ELECTRONICS SYSTEMS
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BSR100

VHF Base-Station Radio Transceiver

Service Manual

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FCC INFORMATION TO USER

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

UNPACKING THE BSR100

Carefully unpack the BSR100 and inspect for external damage that might have been caused during shipment. If there is any apparent damage, replace the unit in its original packing and contact KP ELECTRONIC SYSTEMS LTD. for damage claim instructions.

PLEASE NOTE: The antenna's used for this transmitter must be fixed-mounted on outdoor permanent structures with a separation distance of at least 6 meters from all persons during normal operation. Users and installers must be provided with appropriate antenna installation instructions and transmitter operating conditions, including antenna co-location requirements of §1.1307(b)(3), for satisfying RF exposure compliance.

Table of Contents

1 Introduction

This document is intended for experienced technical personnel, and it explains the theory of operation, software and programming guide description, testing, adjusting, and tuning procedures for the BSR100™ transceiver in manufacturing and laboratory conditions. It contains the following chapters:

- Introduction
- General Description
- Theory of Operation
- Software Description
- Programming Guide
- Manufacture Testing Setup Diagram
- Testing, Adjusting, and Tuning
- Technical Specifications

2 General Description

The BSR100 transceiver receives and transmits FSK (frequency shift keying) and DF (direct frequency) modulated signals in VHF bands. It operates as a two-way base-station radio at remote central stations and repeaters in half duplex mode of communication. The following is a description of:

- Functions
- Appearance and Connectors

2.1 Functions

- Receives and transmits:
  - FSK (frequency shift keying) modulated signals
  - DF (direct frequency) modulation
- Performs receiving and transmitting frequency programming changes
- RSSI output
- Measurement analog output
- Visual control:
  - Channel monitor control
  - PTT control
  - ON/OFF indicator

2.2 Appearance and Connectors

BSR100 has five sets of connectors: **J1**, **J2**, **J3**, **J4**, **J5** (see Figure 1: BSR100 connectors).

- **J1:** BNC connector connects an Rx VHF antenna (usually it is connect to Ground; optionally it can be connected to Rx).
- **J2:** BNC connector connects an Rx\Tx VHF antenna. (Optional BNC connector connects a Tx antenna only.)
- **J3:** 12.5 VDC power supply.

- **J4:** A 10-pin contact connector connects the following:

Connector	Pin
+VB	1
GND	2, 8, 10
RS232 IN	3
RS232 OUT	4
PTT	5
AUDIO IN	6
DIAGNOSTIC MODE	7
AUDIO OUT*	9

*Optional

- J5: A D-type 15-pin rear panel connector connects the following:

Connector	Pin
PTT	1
PTT2 OUT	2
RS232 IN	3
RS232 OUT	4
GND	5, 6, 10, 13, 15
AUDIO OUT	7
AUDIO IN	8
CHANNEL MONITOR	9
RSSI OUT	11
RSSI TO AI	12
DATAOUT	4

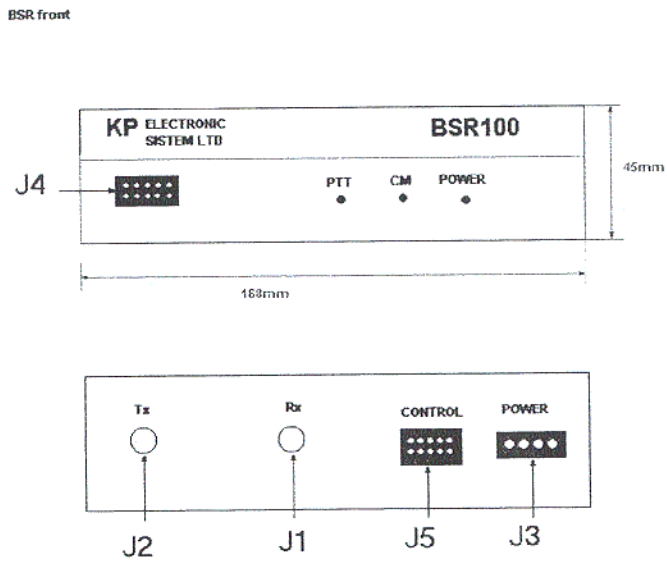

Figure 1: BSR100 connectors

3 Theory of Operation

The BSR100 transceiver consists of five major blocks:

- Receiver
- Transmitter
- Synthesizer
- Microcomputer
- Power supplies

The following is a description of operation for the five major blocks and their modules.

3.1 Receiver

The Receiver consists of four major blocks:

- VHF Front-end Circuits
- Double-Balanced Mixer
- 45 MHz IF Section and Back-end IF IC with RSSI meter and channel monitor functions.

3.1.1 VHF Front-end Circuits

The VHF Front-end circuits consists of tree blocks of circuitry: Pre-selector, RF amplifier, and Post-selector filter. The Pre-selector and Post-selector filters are fixed tuned designs and provide wide-band operation.

The pre-selector is a 3-pole, .01 dB Chebyshev band pass filter with capacitive coupled resonators .The 3 dB bandwidth is 19 MHz, centered at 164.5 MHz and the insertion loss is -1.5 dB. The pre-selector filter's output termination is connected to the RF amplifier that follows it.

The RF amplifier is a class A common-emitter amplifier with an active bias network. It has approximately +16 dB gain with 3 dB NF and is supplied by a +8V supply (+8 Vr).

The post-selector is a 4-pole, .01 dB Chebyshev band pass filter with capacitive coupled resonators .The 3 dB bandwidth is 19 MHz, centered at 164.5 MHz and the insertion loss is -2.5 dB. The post-selector filter operates with a 50 Ohm output termination. The input termination is connected to the RF amplifier. The output transmission is connected to the mixer that follows.

3.1.2 Double-Balanced Mixer

The Double-Balanced Mixer is JMS-1. DBM configuration consists of four diodes and two balanced mixers connected in a "ring" configuration. The Double-Balanced mixer uses two hybrids, which improve both the L-R and R-I ports. Because of its highly balanced and symmetrical configuration, this type of mixer theoretically suppresses 75% of possible IM products. The level mixer is +7 dBm and its conversion loss is -7 dB max.

3.1.3 45 MHz IF Section and Back-end IF IC

The Intermediate Frequency (IF) Section consists of: 45 MHz IF and back-end IF IC blocks. The first LO signal and RF signal mix with the IF frequency of 45 MHz and then enter the IF portion of the radio.

The signal passes through a diplexer network (DN) to optimize intercept point performance by not allowing any signals, especially local oscillator (LO) harmonics, to be reflected back into the mixer. It is then passed through a number of filters. The first crystal filter, TE 9420, provides selectivity; the second, TE9420, image and intermodulation protection.

The TE 9420 filter is a 2-pole filter with a 1 dB ripple, -3 dB insertion loss, -3dB bandwidth of ±3.75 kHz, -18 dB bandwidth of ±16 kHz, and ultimate rejection of -40 dB. The IF 45 MHz signal is amplified by the IF amplifier, MAR-6SM. The amplifier provides a +18dB gain with a 3 dB noise figure, draws 16mA of current, and is supplied by the +8 Vr.

The signal then passes through the second crystal filter, TE9420, which provides further selectivity and second image rejection.

The filtered and amplified IF signal is then mixed with the second local oscillator at 44.545 MHz. The second LO is internal to the narrowband FM IF chip, an external crystal, and some external chip parts. The MC3372D chip consists of an oscillator, mixer, and limiting IF Amplifier, Quadrature Discriminator and Squelch Switch

The output mixing of the IF signal and the section LO produce a signal at 455 kHz. This signal is then filtered by external ceramic filters, CFWS455G and CFU455G2, and amplified. The CFWS455GY filter is a ceramic filter for communication equipment on 455.0 kHz ±1 kHz center frequency, with a 1 dB ripple, -11 dB insertion loss, -6dB bandwidth of ±4.5 kHz, and stop band att. of -40 dB.

The CFU455G2 filter is a ceramic filter for communication equipment on 455.0 kHz ±1 kHz center frequency, with a 1dB ripple, -6 dB insertion loss, -6 dB bandwidth of ±4.5 kHz and stop band att. of -25 dB.

The CDBC455CX16 Ceramic Discriminator is used in the circuit of the demodulator. The resulting detected audio output is then sent to the external connector through the audio low-pass filter.

3.2 Transmitter

The VHF transmitter contains:

- Antenna switch
- Harmonic filter
- Power amplifier
- Synthesizer

3.2.1 Antenna Switch

The Antenna Switch circuit consists of two PIN diodes and lumped elements to simulate the λ/4 section. When D1 and D2 are both ON, transmit mode is active. When D1and D2 are both OFF, receive mode is active. To activate receive isolation while transmitting, use D2 as a short-circuit termination for the λ/4 section.

PIN diode UM9401F provides high isolation, low loss, and low distortion, and can handle over 100W of transmitter power in VHF and UHF bands.

3.2.2 Harmonic Filter

The purpose of the low-pass filter is to attenuate the harmonics of the transmitted signal, but low-pass filter is reflective. This means that the undesired harmonics are reflected back into the device and remix. This effectively increases the level of harmonic output from the active device, and therefore, the low-pass filter should provide about 20 dB more rejection then appears to be required. The low-pass filter is of a Chebyshev design.

3.2.3 Power Amplifier

The power amplifier consists of an output power amplifier, drive, and predrive. The Output power amplifier contains one transistor stages: n-p-n silicon RF VHF power transistor 2SC2539.

The 2SC2539 transistor, purchased from Mitsubishi, has Pout = 14 Watt, Pin=0.5Watt, Vcc = 13.5V, power gain ≥8 dB/F = 150 MHz, and is designed for RF power amplifiers on VHF band mobile radio applications.

The drive is class C amplifier and it use the MRF4427 transistor, purchased from Motorola, has Pout =1.0 Watt,Pin=30mW and is designed for VHF large-signal class C amplifier applications.

The predrive is a MMBR 5179(7H) high frequency transistor with high gain 15 dB/200 MHz and low noise NF=4.5/200MHz .

3.3 Synthesizer

The serial input PLL frequency synthesizer consists of the following blocks:

- MB1501 chip (Fujitsu Microelectronics Inc.)
- TXO 225B
- VCO/ Rx
- VCO/Tx
- Tx/buffer amplifier: MAR7SM
- Rx/buffer amplifier: MAR8SM
- Feedback buffer amplifier: MAR7SM