Base Equipment Manual
For Access Taxi
Fort McMurray

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April 18, 2006	A4	Added BSU to PC Com port cable. Customer specific
December 18, 2008	A5	Customer Specific – Access Taxi

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1. INTRODUCTION

1.1 Overview

The Base Signalling Unit (BSU) interfaces the computer dispatch link and the voice dispatch link to the base radio. This allows the radio channel to be used in either mode of operation. In data mode, the BSU transmits and receives asynchronous message packets to and from the dispatch computer. A conditioned phone line carries the asynchronous message packets, using CSU/DSU units. The BSU also transmits and receives synchronous message packets to and from the fleet, using the base radio.
The BSU incorporates logic to control the base radio PTT keying, computer dispatch (data) or fallback (voice) mode, master/slave configuration, station identification and channel busy monitoring.

Communications takes the form of a fixed-length packet. The transmission rate between the dispatch computer and the BSU is 4800 bits per second (bps) asynchronously, and 3600 bps synchronously between the BSU and mobile data terminals. The communication system operates in a full-duplex mode, with the BSU transmitting a packet every 125 milliseconds (adjustable up to 312.5 ms).

The BSU buffers message packets in both directions to facilitate speed conversion and retransmission. The BSU achieves a high degree of transmission accuracy using error detection, single bit error correction and packet merging techniques.

The unit's flexible design allows it to interface to a wide variety of computers and radio types. The hardware, protocol and message structure have all been designed conservatively to permit the unit to adapt to a wide variety of taxi and transit applications and to ensure future upgrade capability.

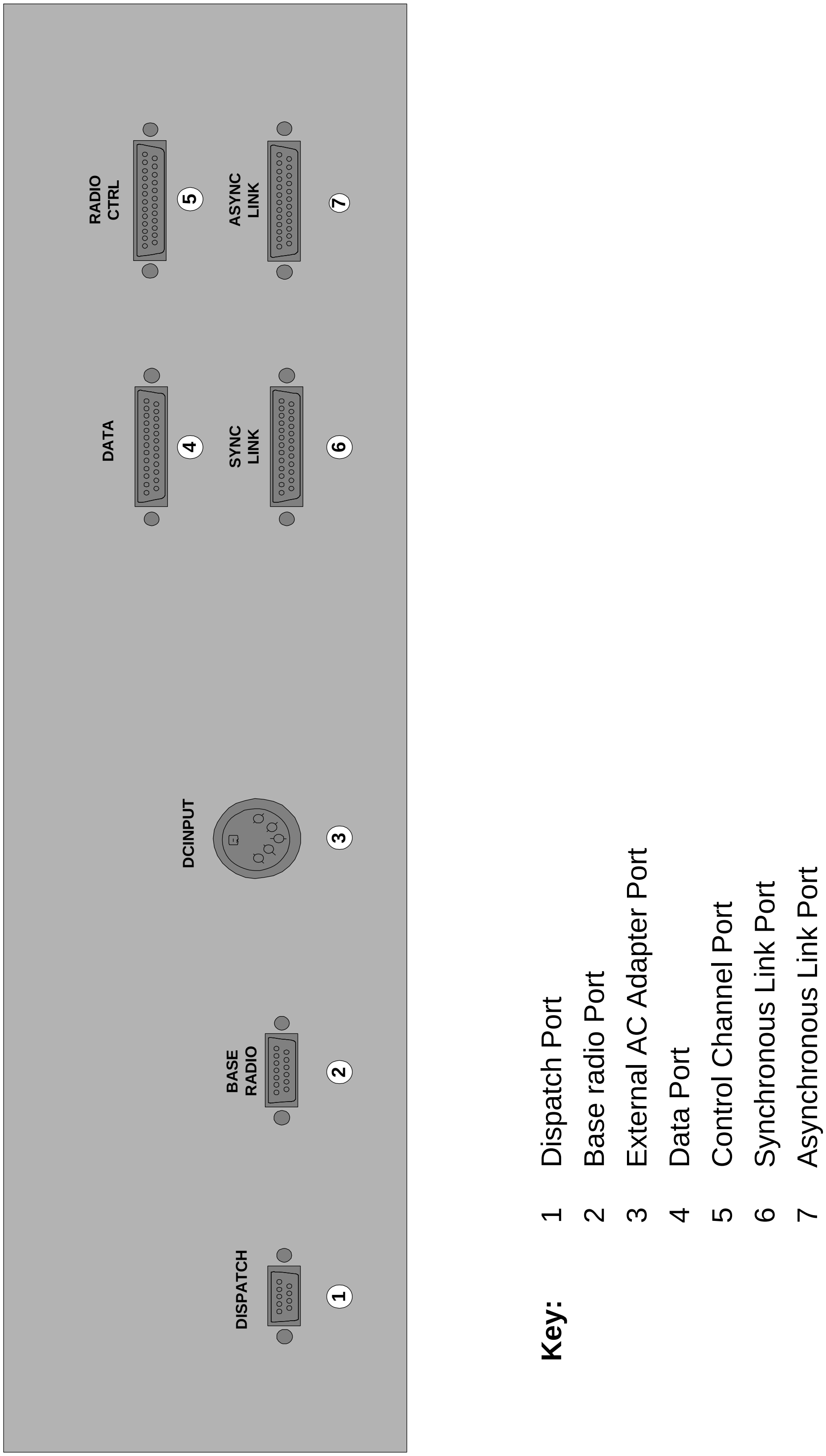
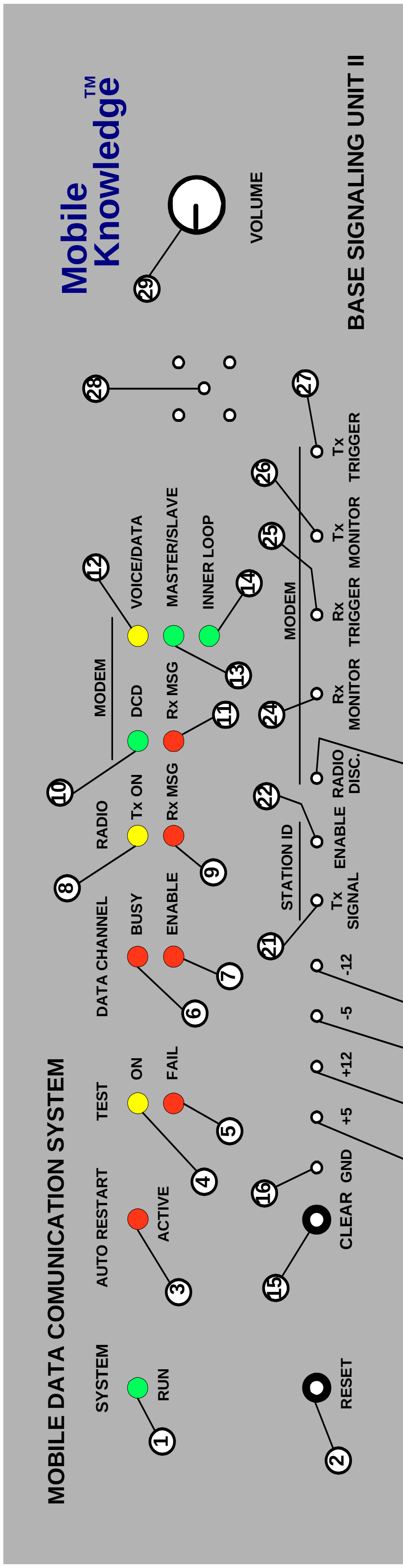


Figure 1: Rear View of BSU II



Key:

1 System Run LED
2 CPU Reset Switch
3 Auto Restart LED
4 Test On LED
5 Test Fail LED
6 Data Channel Busy LED
7 Data Channel Enable LED
8 Radio Tx On LED
9 Radio Rx MSG LED
10 Modem DCD LED
11 Modem Rx MSG LED
12 Voice/Data LED
13 Master/Slave LED
14 Inner Loop LED
15 Clear Switch
16 GND Test Point
17 +5V Test Point
18 +12V test Point
19 -5V Test Point
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21 Station ID Tx Signal LED
22 Station ID Enable LED
23 Radio Discriminator Test Point
24 Modem Rx Monitor test Point
25 Modem Rx Trigger Test Point
26 Modem Tx Monitor Point
27 Modem Tx Trigger Point
28 Speaker
29 Speaker Volume Control

Figure 2: Front View of BSU II

1.2 BSUII Front Panel Description

INDICATOR	FUNCTION
SYSTEM RUN	Indicates that the BSU microprocessor is executing program instructions
RESET	This switch resets the CPU.
AUTO RESTART ACTIVE	Indicates that the CPU Card watchdog timer has timed out and has caused an automatic restart of the BSU's CPU. The LED is on if the internal watchdog was triggered since last being cleared (by pushing the CLEAR button on the card).
TEST ON	Indicates that the CPU Card self-test is running. The self-test runs when you power-up the BSU or when you press the SYSTEM RESTART button. The self-test takes approximately 12 seconds to complete.
TEST FAIL	Indicates that one of the CPU Card self-tests has failed. The BSU may still be operational if the BSU fails a minor self-test.
DATA CHANNEL BUSY	This LED indicates detection of an RF signal on the base radio's receiver or transmitter frequencies. The base radio provides the channel busy detection signals to the BSU.
DATA CHANNEL ENABLE	Indicates the data channel is operating and is in the data mode.
RADIO Tx ON	Indicates that the BSU is trying to key the base radio transmitter and the BSU is generating data.
RADIO Rx MSG	Indicates that the BSU is receiving a message from the fleet. The LED flashes when the BSU detects a data packet from an MDT and it has been decoded correctly.
MODEM DCD	Indicates that the BSU is receiving Data Carrier Detect from the CSU/DSU unit (through MUX OUTPUT).
MODEM Rx MSG	Indicates that the BSU is receiving a message from the CSU/DSU unit. The LED flashes when the BSU detects a data packet.
VOICE/DATA	Indicates whether the BSU is in data mode or fallback mode (voice). The LED is on when the BSU is in data mode.
MASTER/SLAVE	Indicates whether the BSU is configured as a master or a slave unit. The LED is on when the BSU is configured as a master unit.
INNER LOOP	Indicates that the BSU's modem and I/O section are connected using the internal jumper.
CLEAR	This switch extinguishes the AUTO RESTART ACTIVE LED.
GND	Ground Test Point
+5	BSU +5 volt supply test point
+12	BSU +12 volt supply test point
-5	BSU –5 volt supply test point
-12	BSU -12 volt supply test point
STATION ID Tx SIGNAL	Station ID Tx signal test point
STATION ID ENABLE	Station ID enable test point
RADIO DISC	Test point for monitoring the discriminator output of the base radio
Rx MONITOR	Test point for monitoring the modem Rx signal
Rx TRIGGER	Reference signal used to trigger the Rx signal

Tx MONITOR	Test point for monitoring the modem Tx signal
Tx TRIGGER	Reference signal used to trigger the Tx signal
SPEAKER	Used to listen to the base radio discriminator
VOLUME	To adjust the volume of the speaker

1.3 Description

The BSU is an all in one single-board communication controller. It provides the interface between the computer dispatch link and the radio communications link, controlling all data communications and modes of operation to the radio link.
Test facilities such as self-test, loop backs and monitoring ports, are provided for system fault analysis. Thus, communication problems are diagnosed and resolved quickly.
The BSU is comprised of:

- An AC Power Adaptor (External)
- A CPU Section
- An I/O (Input/Output) Section
- A Modem Section
- A Audio Section

Various light emitting diodes (LEDs), switches and test points are front panel accessible. All cabling connections to the BSU are via rear panel D type connectors.
The BSU's microprocessor circuitry is centred on the Zilog Z80A family of components. Serial I/O channels are used for the computer dispatch link, the radio data channel link, the radio voice channel control links, and for the optional printer port. Parallel I/O is used for master/slave configuration and for local alarms. Voice/data switching and data push-to-talk (PTT) keying are relay controlled by the BSU.

1.4 Specifications

1.4.1 Dispatch Computer Communication Link

Transmission Speed	4800 bps.
Modem Type	CSU/DSU.
Link Protocol	Asynchronous, packetized, half duplex.
Packet Structure	Variable bit fields. Dispatch computer to BSU packet is 1104 bits maximum. BSU to dispatch computer packet is 104 bits maximum.
Error Detection	Block error check.
Link Control	Implied acknowledge. Retransmission on request. Dispatch computer has overall control, relinquishing it to the BSU for inbound packets. Timeout on relinquished control.

1.4.2 Radio Communication Link

Transmission Speed	3600 bps.
Modulation Technique	Delay modulation, proprietary coding. Spectral energy concentrated between 900 and 1800 Hz where radio impairments are minimal.
Link Protocol	Synchronous, packetized, controlled contention by message control.

Packet Structure	Fixed bit fields, all 8 bits per byte. BSU to MDT packet is 216 bits. MDT to BSU packet is 232 bits.
Error Control	Combination of byte parity, longitudinal redundancy checks, block checksum, and packet merging.
Retransmission Attempts	Failure to receive expected acknowledgement causes BSU to retransmit once after 12 seconds and MDT to retransmit up to four times with a 1-3 second variable delay between transmissions.
Mobile Radio Key-up Period	58 milliseconds to 250 milliseconds available.
Sensitivity	99% of data transmissions will be successful over a static radio link, with a received level sufficient to provide 18db SINAD, providing the radio has been interfaced for data according to MKN instructions.
Fallback	Radio communications link is switched from data to voice mode for Supervisor/Dispatcher to fleet voice communications.
Alarms	Accepts up to four local alarms. Optional opto-isolated inputs.
Station Identification	Morse code transmission of station identification. 1 kHz tone controlled. Interfaces to base radio modulator and PTT circuitry.
Channel Busy Monitor	Indicates detection of a radio frequency signal on the base radio receiver or transmitter frequencies.
Internal Controls	• Station ID signal level • Data transmit level • Transmit equalizer • Data receive level • Receive equalizer

1.4.3 Physical Requirements

Power Adaptor	Operating voltage 100-250 VAC, 50-60 Hz, 0.7-0.3A.
Operating Environment	Temperature 32 to 122 degrees F (0 to 50 degrees C). Relative humidity to 90%, non-condensing.
Case Dimensions	16.86"W x 3.15"H x 12.15"D (42.8cm x8.00cm x30.86cm)
Weight	15 lbs

2. POWER SUPPLY

2.1 Introduction

The external AC Adaptor is part of the BSU. It provides a +5V, a +12V and a –12V via a Din5 connector to the rear panel of the box. On board circuit generates –5V.
On normal operations, the current consumptions are,
+5V @ 390mA
+12V @ 90mA
-12V @ 60mA

3. CPU SECTION

3.1 Function

The CPU Section provides all the necessary functions to control synchronous communications with the mobile data terminals and asynchronous communications with the dispatch computer.

3.2 Theory of Operation

The Z80 microprocessor obtains program instructions from the on-board EPROM and performs the operations discussed below to control I/O device controllers and to process information within the system. The Z80 uses a 16-bit address bus and an 8-bit data bus. The Z80 is capable of handling one non-maskable interrupt and multiple maskable interrupts. The non-maskable interrupts are used by the on-board watchdog circuit while all other I/O devices use the maskable interrupts in a daisy chain arrangement.

3.3 CPU Section Devices

The CPU Section contains the following devices:

EPROM	A 32K x 8 device provides 16Kb of Electronically Programmable Read Only Memory (EPROM).
SRAM	A 32K x 8 device provides 32Kb of randomly read and write memory (RAM) for data storage.
DMA	Two Z80 Direct Memory Access (DMA) devices aid in full-duplex communications with the SIO on the PCB, which services the dispatch computer transmit and receive channels.
CTC	The Z80 Counter/Timer Circuit (CTC) device provides counting and timing functions to the microprocessor.
Watchdog	The watchdog provides a hard restart of the microprocessor if program instruction execution fails. This hard restart is implemented using a retriggerable one-shot device. During normal operation, the program will generate a watchdog select signal on a timely basis (shorter than the one-shot timeout) to retrigger the one-shot. However, if the program is not properly executed, the watchdog will timeout providing a restart (non-maskable) interrupt to the microprocessor.
SIO	The Serial Input/Output (SIO) device provides the asynchronous communications channel to the dispatch computer. The data rate is 4800 bps.

3.4 CPU Section Switches

The CPU Section provides the following switches:

Clear	
Restart	This switch resets the CPU.

3.5 CPU Section LED Indicators

The CPU Section provides the following LED indicators:

DCD	Indicates that the BSU is receiving Data Carrier Detect from the CSU/DSU unit (through MUX OUTPUT).
Rx MSG	Indicates that the BSU is receiving a message from the CSU/DSU unit. The LED flashes when the BSU detects a data packet.
VOICE/DATA	Indicates whether the BSU is in data mode or fallback mode (voice). The LED is on when the BSU is in data mode.
MASTER/SLAVE	Indicates whether the BSU is configured as a master or a slave unit. The LED is on when the BSU is configured as a master unit.
AUTO RESTART ACTIVE	Indicates that the CPU Card watchdog timer has timed out and has caused an automatic restart of the BSU's CPU. The LED is on if the internal watchdog was triggered since last being cleared (by pushing the CLEAR button on the card).
TEST ON	Indicates that the CPU Card self-test is running. The self-test runs when you power-up the BSU or when you press the SYSTEM RESTART button. The self-test takes approximately 12 seconds to complete.
TEST FAILED	Indicates that one of the CPU Card self-tests has failed. The BSU may still be operational if the BSU fails a minor self-test.
RADIO Tx ON	Indicates that the base radio transmitter is keyed on the data channel, and the BSU is sending data.
RADIO Rx MSG	Indicates that the BSU is receiving a message from the fleet.
RUN	Indicates that the BSU microprocessor is executing program instructions.

3.6 EPROM Alternative

3.7 Two jumpers are related with EPROM, JP8 called 27C256 and JP1 called coverage test.

JP1 2-3 indicates code start from 0000H, JP1 1-2 indicates code start from 4000H.
If the BSU is operating normally, JP8 1-2 is connected (default), indicating the chip is 27C256. JP1 2-3 is connected (default).
When using EEROM, JP1 MUST connect 1-2. Otherwise the code in EEROM would have been erased already.

3.8 Fault Indicators

If the BSU is operating normally, the DCD LED will light. Other CPU Section LEDs will also light, indicating activity. The following table identifies the LEDs that light when the BSU is operating normally.
If the CPU Section fails a self-test, the TEST FAIL LED will light. Other CPU Section LEDs will also light in a particular combination to help identify the device that failed the self-test. The following table identifies the LEDs that light when a particular CPU device fails the self-test.

LED Name	Normal	Failed Device					
		EPROM	RAM	CTC	DMA	CPU SIO	Data SIO
DCD	Lit						
Rx MSG	Flashing				Lit	Lit	Lit
VOICE/DATA	Lit		Lit	Lit			Lit
MASTER/ SLAVE	Lit	Lit		Lit		Lit	Lit
TEST ON		Lit	Lit	Lit	Lit	Lit	Lit
TEST FAIL		Lit	Lit	Lit	Lit	Lit	Lit
RADIO Tx ON	Lit						
RADIO Rx MSG	Flashing						

Table 1: CPU Card Fault Indicators

4. I/O SECTION

4.1 Introduction

This section describes the I/O section.

4.2 I/O Function

The I/O Section controls BSU communications for the following devices:

- Data channel for BSU communications with the base radio (via the Modem)
- Parallel I/O for BSU control of the base radio

4.3 I/O Connections

The I/O section connects to:

- The Modem Section via the Data Channel port in rear panel or via the header JP5 on board.
- The base radio via the Control Channel port in rear panel.

4.4 I/O Devices

The I/O Section contains the following devices:

SIO (Data Channel)	The SIO (serial I/O) device controls communications with the Modem Card at 3600 bps synchronous, via the Data Channel port.
Parallel I/O (Control Channel)	The BSU controls the base radio via the Control Channel port. Parallel I/O consists of an 8-bit input latch and an 8-bit output latch. The input latch processes the four local BSU alarms, radio channel status and master/slave inputs. The output latch controls the on-board station identifier. These station identifier control lines switch the Station Identifier relays to key-up the base radio and to gate the Station Identifier tone to the base radio modulator. An active low input is opto-coupled into the BSU. A zero volt level is required to activate each channel.
EIA Drivers and Receivers	These drivers and receivers level shift the TTL data and control signals to an EIA level and vice versa.

4.5 I/O LED Indicators

The I/O Section provides the following LED indicators:

DATA CHAN BUSY	This LED indicates detection of an RF signal on the base radio's receiver or transmitter frequencies. The base radio provides the channel busy detection signals to the BSU.
DATA CHAN ENABLE	Indicates the data channel is operating and is in the data mode.

4.6 I/O Test Points

The I/O Section contains test points for monitoring Station Identifier signals:

- Tx Signal
- Enable

4.7 Functional ports in real panel

To connect the following devices to the I/O Section:

- The Modem Section, via the Data Channel port labelled "DATA"

- The base radio, via the Control Channel port labelled “CTRL”. This allows the BSU to control the base radio, using parallel I/O.

4.8 Control Port

The Control port controls the following aspects of the BSU:

4.8.1 Station Identification

The BSU can be programmed to output the Station Identification in Morse code. The Station ID interface consists of a transformer isolated tone output and relay contacts to activate PTT. The interface includes four lines at the Control Channel port. Set the deviation of this output using VR1 on the I/O Section (40% $\pm$ 10% of maximum deviation).

4.8.2 Channel A Busy Monitor

Channel A busy monitor ensures that the BSU does not transmit if the channel is being used. The BSU will remove PTT from the base radio every 30 seconds for 2 seconds to monitor the channel. This feature is turned on and off by the dispatch computer software.

Channel A busy monitor interface consists of an opto-coupled input. The input is activated by a loop signal. Applying positive voltage to pin_11 and get return signal from pin_24 will activate this signal. The active signal normally comes from the Channel Busy Board, which monitors the receiving and transmitting frequencies being used for the data channel. When either signal is active, the BSU will not allow the base radio to transmit. The base radio will stay off the air for a maximum of 30 seconds before the BSU takes control of the channel.

VR20 adjusts the sensitivity and positive voltage range for this signal.
JP9 changes the polarity of Channel A Busy Monitor. JP9 default is 2-3.

4.8.3 Channel B Busy Monitor

The channel B busy monitor ensures that the BSU does not transmit if the channel is being used. The BSU will remove PTT from the base radio every 30 seconds for 2 seconds to monitor the channel. This feature is turned on and off by the dispatch computer software.

The channel B busy monitor interface consists of an opto-coupled input. The input is activated by a zero volt signal. The zero volt signal normally comes from the Channel Busy Board, which monitors the receiving and transmit frequencies being used for the data channel. When either signal is active, the BSU will not allow the base radio to transmit. The base radio will stay off the air for a maximum of 30 seconds before the BSU takes control of the channel.

4.8.4 Master/Slave Operation

The BSU can be configured for master or slave operation, using either of two methods.

The first method is to install a SPST switch between pin 14 (Master/Slave) and pin 7 (Signal GND) of the External Control Cable (850-0037-000). By leaving the switch open the BSU will enter Master operation. Closing the switch will put the BSU in Slave operation.

The second method is to use the internal jumper (JP7) to select master or slave operation. Placing the jumper on pins 2-3 will place the BSU in Master operation. Placing the jumper on pins 1-2 will place the BSU in Slave operation.

NOTE: When reconfiguring the BSU between master and slave, a BSU reset is required to enable the change.

Master Operation: The Station ID signal will be output in both data and fallback mode. The BSU transmits the fallback message "SYSTEM DOWN GO TO VOICE" when the BSU changes from data to fallback mode. The BSU transmits this message every three minutes while in fallback mode.
Slave Operation: The BSU transmits the Station ID signal only while the BSU is in data mode. The BSU transmits the fallback message "SYSTEM DOWN GO TO VOICE" when the BSU changes from data to fallback mode.

Typically Master operation is used when there is no back-up equipment on the same frequency. Therefore the MDTs will either work in voice mode or will be switched to another channel.

Slave operation is typically used when there is back-up equipment on the same frequency. MDTs will continue to operate on the same channel with the back-up equipment.

5. THE MODEM

5.1 Modem Function

To convert audio receive data from the base radio to serial receive data for the dispatch computer, and serial transmit data from the dispatch computer to audio transmit data for the base radio.

5.2 Modem Connections

The Modem Card connects to:

- The I/O Section via the Modem port in rear panel or via the header JP6 on board
- The base radio via the Base Radio port in rear panel
- The voice audio lines via the Dispatch port in rear panel

5.3 Modem Devices

The Modem Card contains the following devices:

EIA Drivers and Receivers	These drivers and receivers level shift the TTL data and control signals to an EIA level and vice versa, for communications between the Modem and I/O Cards.
Modulator	The modulator encodes and converts the serial transmit data from the I/O Card into an audio band signal with frequency components suitable for radio transmission.
Demodulator	The demodulator decodes and converts the audio receive data signal from the radio into serial receive data for the I/O Card.
Clock	The clock circuitry in this PCB provides transmit and receive clocks to the data channel to transfer data and to synchronize the modulator and demodulator to the appropriate data stream.
Receiver Level Adjust	An adjustable gain control (VR18) boosts the received signal to a working level, which the modem can use, to process received data.
Receive Equalizer	This eight-potentiometer equalizer (VR3, VR4, VR5, VR6, VR7, VR8, VR9 and VR10) compensates for radio channel phase delay distortion to assist in recovering the received data.
Receive Low Pass Filter	This filter provides the proper impedance matching to the base radio and filters all unwanted frequency components.
Transmit Equalizer	This seven-potentiometer equalizer (VR11, VR12, VR13, VR14, VR15, VR16 and VR17) pre-distorts the transmit audio signal to the radio's modulator to compensate for radio channel phase delay distortion.
Transmitter Level Adjust	An adjustable gain control (VR2) provides the proper signal level to modulate the base radio.
Transmit Low Pass Filter	This low pass filter ensures that only a clean audio band signal is modulating the base radio modulator.
Relay Control	The Modem Card has relay switching for voice/data. Relays cause the BSU to fallback to voice if the BSU malfunctions, the CPU section goes down, the BSU is powered off, or if the system is set to voice by the Supervisor. Relays K5 and K6 control the base radio PTT and PTT Ret lines while in data mode and relay K7 controls the switching of the base radio voice and data interface lines.

5.4 Modem LED Indicators

The Modem Card provides the following LED indicators:

DCD	Indicates that the BSU is receiving a signal with sufficient audio level from the base radio receiver. It is on whether the modulating signal is data, voice or noise.

5.5 Modem Test Points

The Modem Section has test points for measuring modem signals. The modem test points are used during the alignment of the modem's transmit and receive equalizers.

Test points in the Modem Section:

- Radio Disc.
- Rx Monitor
- Rx Trigger
- Tx Monitor
- Tx Trigger

5.6 Modem Function

To connect the following devices to the Modem Section:

- The I/O Section via the Modem port or via the header JP5 on board.
- The base radio via the Base Radio port
- The voice audio lines via the Dispatch port

5.7 Modem Devices

The Modem Section contains the following devices:

Modem Port	The Modem Section interfaces with the rest of the BSU via the Modem port. The Modem port is a serial I/O channel. The Modem and I/O Cards transfer data at 3600 bps synchronously on this channel. The signalling technique is a high-performance delay modulation with a proprietary MKN coding technique. The audio band signal is concentrated in the frequency range of 900 to 1800 Hz, which is optimal for transmission by the radio communications system.
Base Radio Port	The BSU uses the Base Radio port to transmit and receive data over the RF link.
Dispatch Port	The lines from the Supervisor's microphone and speaker connect to the Dispatch port. In voice mode, the BSU routes these lines from the port to the base radio.

6. AUDIO SECTION

6.1 Audio Amplifier

An independent audio amplifier has been implemented on board.
It amplifies transmission signals into a speaker when there is no receiving data coming into the BSU. When receiving, you can hear receiving sound as well.
This is supposed to be a good vision of the BSU status. You can even detect outside world conditions beyond the BSU, such as the radio's, or the leased line modem's, if your hearing is good enough.

7. General Message Sequence

7.1 Introduction

The following diagrams illustrate the basic message sequence for typical interactions between the dispatch computer, the BSU, and the MDTs. Note that all the MDTs receive all the packets sent by the BSU, but each MDT disregards packets intended for another MDT.

Symbol Definitions:

RTS	Request To Send information
CTS	Clear To Send Information
ACK	Acknowledge
EMB ACK	Embedded Acknowledge

Notes:

1. When the MDT receives a message from the BSU (other than an EMB ACK), it automatically sends an ACK to the BSU. This prevents the BSU from repeating the message.
2. When the BSU receives a message from an MDT, it automatically sends an EMB ACK to the MDT. This prevents the MDT from repeating the message. The EMB ACK is included in a packet usually intended for a different MDT. This helps conserve bandwidth by sending two messages at once (a data packet and an ack).
3. The following diagrams show an ideal case where there are no errors and hence no retransmissions.

7.1.1 Example 1 - Fleet or Zone Message

Computer		BSU		Fleet MDTs
RTS	------->			
	<-------	CTS		
Message	------->			
		Message	------->	

7.1.2 Example 2 - Individual Taxi Message

Computer		BSU		Taxi MDT
RTS	- - - - - - - >			
	< - - - - - - -	CTS		
Message	- - - - - - - >			
		Message	- - - - - - - >	
			< - - - - - - -	ACK
		EMB ACK	- - - - - - - >	
	< - - - - - - -	RTS		
CTS	- - - - - - - >			
	< - - - - - - -	ACK		

7.1.3 Example 3 - Message From a Taxi

Computer		BSU		Taxi MDT
			<-------	Message
		EMB ACK	------->	
	<-------	RTS		
CTS	------->			
	<-------	Message		

7.1.4 Example 4 - Taxi Books In and Accepts Fare

Computer		BSU		Taxi MDT
			<-------	Book 1
		EMB ACK	------->	
	<-------	RTS		
CTS	------->			
	<-------	Book 1		
RTS	------->			
	<-------	CTS		
Fare	------->			
		Fare	------->	
			<-------	ACK
		EMB ACK	------->	
	<-------	RTS		
CTS	------->			
	<-------	ACK		
			<-------	Accept
		EMB ACK	------->	
	<-------	RTS		
CTS	------->			
	<-------	Accept		

8. BSU ALIGNMENT PROCEDURE

8.1 Introduction

Aligning the BSU allows it to transmit and receive data from the MDTs in the fleet. This section describes how to equalize the receive and transmit circuitry of the BSU.

8.2 Equipment Checklist

The following equipment is required to align the BSU:

- Primary BSU interfaced with Base Radio
- MDT interfaced and aligned with Mobile Radio
- 1068A1 Monitor PCB
- Two 50 Ohm loads
- Communications Monitor
- Oscilloscope
- Scope probes
- 12 volt power supply

8.3 BSU Receive Equalization

Adjusting the BSU receive equalization allows it to properly receive data from the MDTs in the fleet. An MDT interfaced and aligned with a mobile radio provides a reference signal. You will adjust the BSU receive equalizer pots, level control pot and the gain strap on the BSU PCB to properly receive the reference signal from the MDT.
Figure 3 shows how to set up the system to perform the BSU receive equalization procedure:

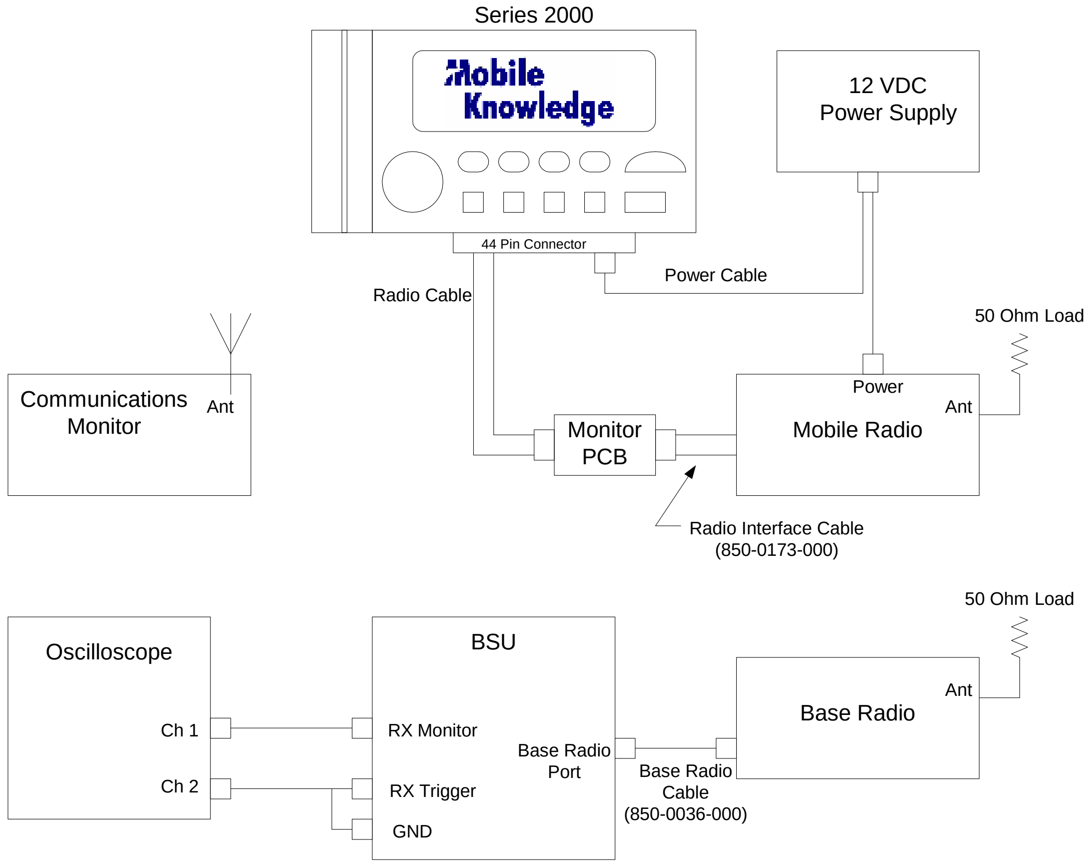

Figure 3: BSU Receive Equalization Setup

8.3.1 Equipment Setup

1. Connect the 12 VDC power supply to the Series 2000 MDT and the mobile radio. (Refer to *Series 2000 Installation Manual* for correct power connections).
2. Connect one side of the Monitor PCB to the Radio cable from the Series 2000 MDT. Connect the other side of the Monitor PCB to Radio Interface Cable (850-0173-00) from the mobile radio.
3. Connect a 50-Ohm load to the mobile radio antenna port.
4. Connect the Base Radio Cable (850-0036-00) from the Base Radio to the Base Radio port on the rear of the BSU.
5. Connect a different 50-Ohm load to the base radio antenna port.
6. Remove the top cover of the BSU to gain access to the receive level and equalizer pots.
7. Connect the Oscilloscope probes to the following BSU test points. You can attach the probes to the back of the test point plugs behind the BSU faceplate.
   - Channel 1- RX Monitor
   - Channel 2 - RX Trigger
   - Channel 2 Ground – Ground
8. Set Oscilloscope Channel 1 (RX Monitor) to 1 V/Division.
9. Set Oscilloscope Channel 2 (RX Trigger) to 5 V/Division.
10. Set the Communications Monitor's frequency to the Base Radio receive frequency.
11. Power up all equipment.

8.3.2 Placing the MDT in Transmit Mode.

1. Use the procedures described in the *Series 2000 MDT Installation Manual* to gain access to the MDT Radio Maintenance tests.
2. Enter the Modem Tap Settings test. Press the send button to put the MDT into the transmit mode.
3. Ensure that the MDT produces a ± 3.5 kHz (± 2.2 kHz for NB) deviation as viewed on the Communications Monitor, with a good eye pattern.

NOTE: The transmit mode will keep the mobile radio constantly keyed. Therefore the MDT should not be allowed to remain in this test for longer than one minute to prevent the mobile radio from over heating.

8.3.3 Adjusting the Equalization Pots

1. Adjust the VR18 gain control and the HI-LO gain strap (JP4, pin 2-3 LO, pin 1-2 HI) for a 2.0 Volt peak-to-peak signal at the RX Monitor point.
2. Adjust the receive equalization using pots VR3, VR4, VR5, VR6, VR7, VR8, VR9, and VR10 on the BSU PCB to produce a good eye pattern at the RX Monitor point as viewed on the Oscilloscope.

8.3.4 Compromising the Receive Equalization

1. Repeat the receive equalization procedures for all the mobile radio types.
2. Compromise the receive equalization so the BSU can receive all mobile radio types equally well.

8.3.5 Powering Down the Equipment

1. Power down all the equipment.

8.4 BSU Transmit Equalization

Adjusting the BSU transmit equalization allows it to properly send data to the MDTs in the fleet. An MDT interfaced and aligned with a mobile radio receives a test signal from the BSU. The Communications Monitor also receives the test signal. You will adjust the BSU transmit equalizer pots and the level control pot on the BSU PCB to send a quality signal to the MDT and the Communications Monitor.

Figure 4 shows how to set up the system to perform the BSU transmit equalization procedure:

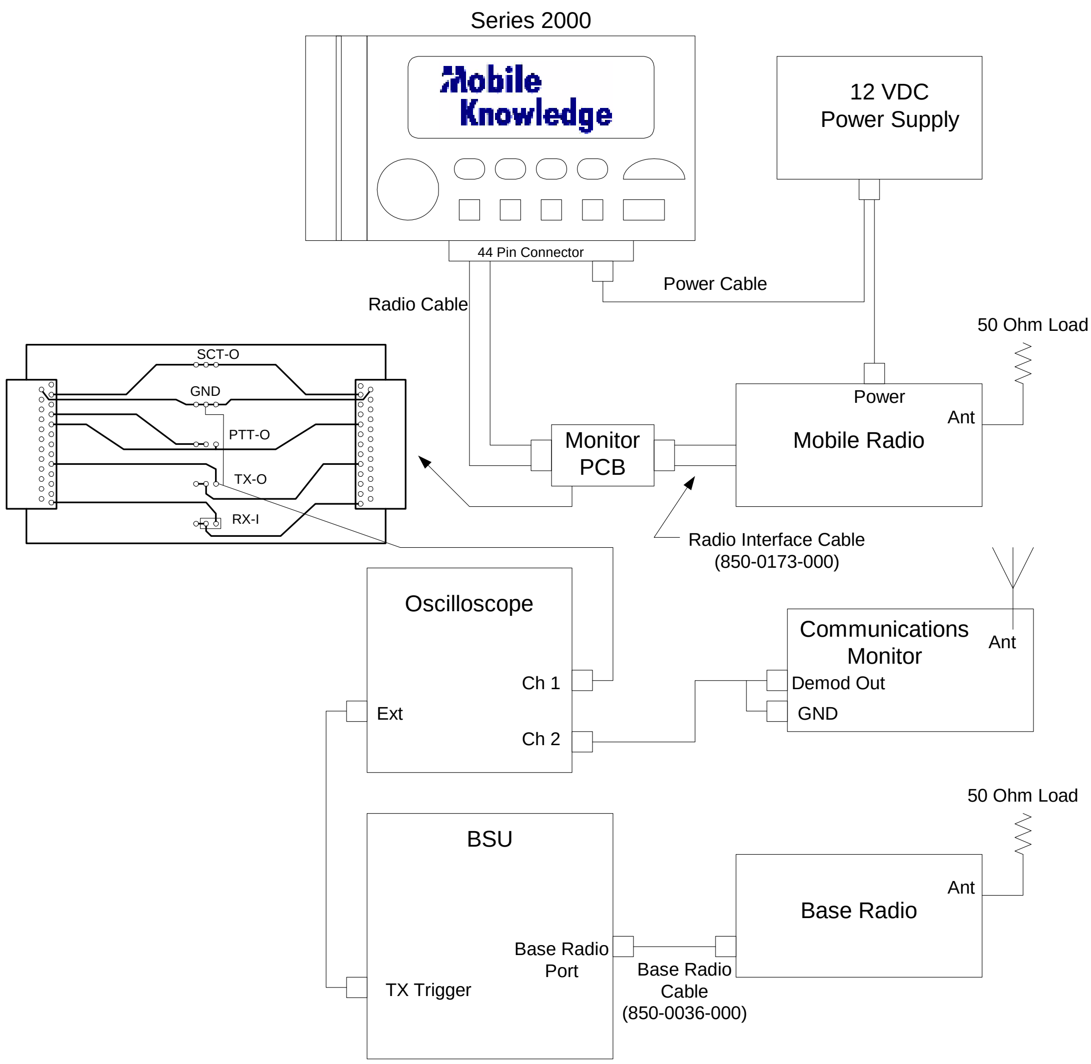

Figure 4: BSU Transmit Equalization Equipment Setup

8.4.1 Equipment Setup

1. Connect the 12 VDC power supply to the Series 2000 MDT and the mobile radio. (Refer to Series 2000 Installation Manual for correct power connections).
2. Connect one side of the Monitor PCB to the Radio cable from the Series 2000 MDT. Connect the other side of the Monitor PCB to the Radio Interface Cable (850-0173-000) from the mobile radio.
3. Connect a 50-Ohm load to the mobile radio antenna port.
4. Connect the Base Radio Cable (850-0036-00) from the Base Radio to the Base Radio port on the rear of the BSU.
5. Connect a different 50-Ohm load to the base radio antenna port.
6. Remove the top cover of the BSU to gain access to the transmit level and equalizer pots.
7. Connect the Oscilloscope probes to the following test points. You can attach the BSU Tx Trigger probe to the back of the test point plug behind the BSU faceplate.
   - Channel 1- Tx and GND points on Monitor PCB (Remove the jumper from the Tx line)
   - Channel 2 - Demod Out and GND points on Communications Monitor
   - External - TX Trigger on BSU Modem Card.

1. Set Oscilloscope Channel 1 (Monitor PCB) to 1 V/Division.
2. Set Oscilloscope Channel 2 (Communications Monitor) to .5 V/Division.
3. Set Oscilloscope External (BSU Modem Card) to 5 V/Division
4. Set the Communications Monitor's frequency to the Base Radio transmit frequency.
5. Power up all the equipment.

8.4.2 Adjusting the Equalization Pots

1. Set the transmit deviation level using VR2 on the BSU PCB to produce a ± 3.5 kHz (± 2.4 kHz for NB) signal as viewed on the Communications Monitor.
2. Adjust the transmit equalization using pots VR11, VR12, VR13, VR14, VR15, VR16 and VR17 on the BSU PCB to produce a good eye pattern as viewed on the Communications Monitor and the Oscilloscope.

8.4.3 Starting the MDT Loop back Test

1. Use the procedures described in the *Series 2000 MDT Installation Manual* to gain access to the MDT Radio Maintenance tests.
2. Enter the Modem Loop back Test.
3. Ensure that the MDT produces a good eye pattern as viewed on the oscilloscope.

8.4.4 Powering Down the Equipment

1. Power down all the equipment.

8.5 Setting the SID Level

The BSU can be programmed to output the Station Identification (SID) in Morse code. The section will describe how to set the SID transmit level.

8.5.1 Setting up the Equipment

1. Set the Communication Monitor’s frequency to the Base Radio transmit frequency.
2. Remove the BSU top cover.
3. Locate the SID level adjustment pot VR1 and JP3.
4. Ensure that the External Control cable from the base radio is connected to the External Control port on the rear of the BSU.
5. Ensure that the asynchronous Link cable is disconnected from the rear of the BSU.

8.5.2 Setting the Jumpers

1. Move the jumper from pins 4-6 on JP3 to pins 2-4. This will enable the SID PTT.
2. Move the jumper from pins 3-5 on JP3 to pins 1-3. This will enable the tone output.

8.5.3 Adjusting the SID Level

1. Adjust the SID level pot VR1 for 40% (±10%) of maximum deviation as observed on the Communication Monitor.
2. Reset jumpers on JP3 to be on pins 4-6 and 3-5.

9. BSU DIAGRAMS

9.1 Introduction

This section contains diagrams that illustrate the components of the Base Signalling Unit as well as the installation of the device and its accessories. Figure 8 shows the BSU board. Figure 9 shows a block diagram of the BSU. Figure 10 shows the BSU interconnections.

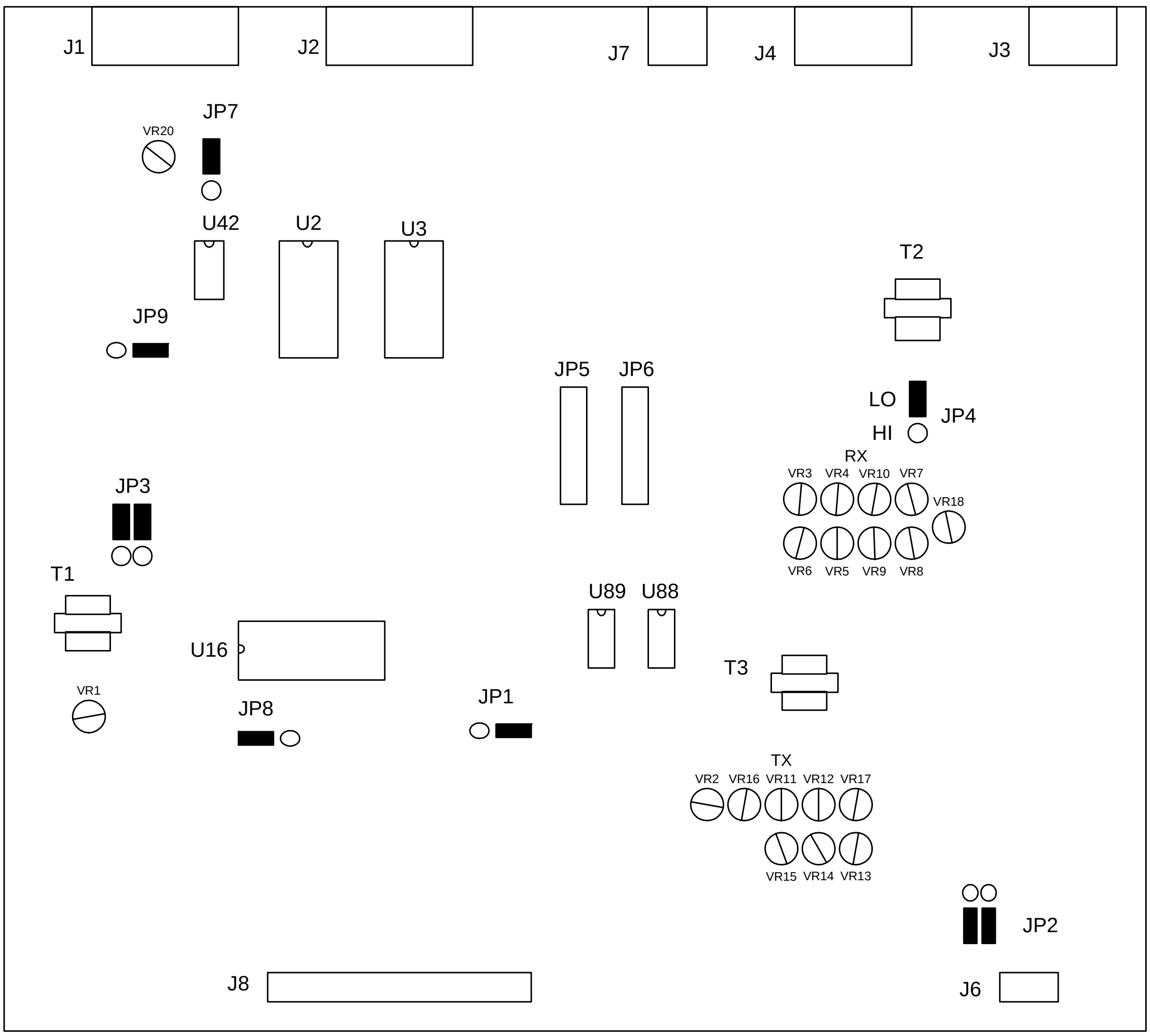

Figure 5: BSU II Board

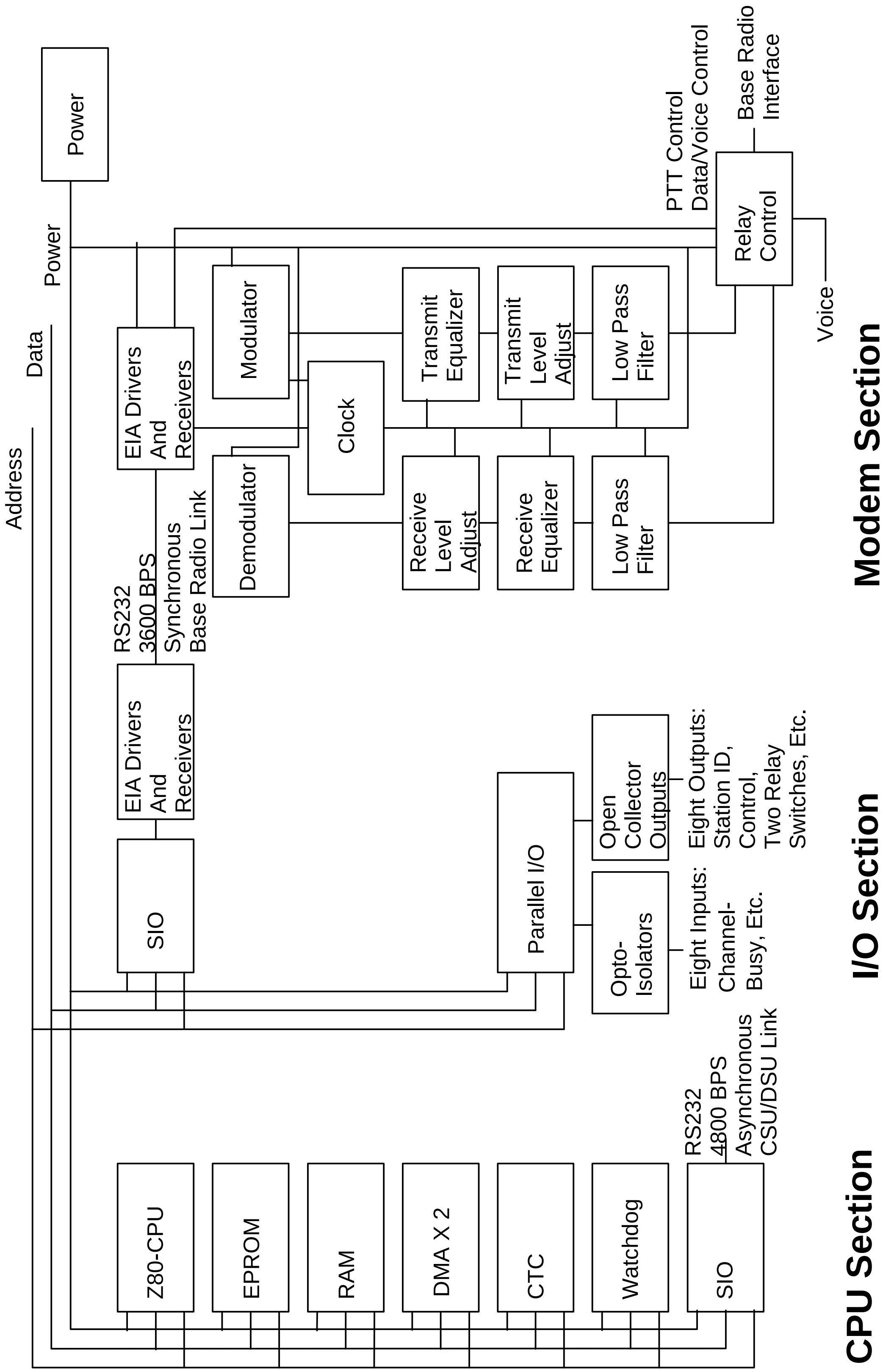

Figure 6: BSU II Block Diagram

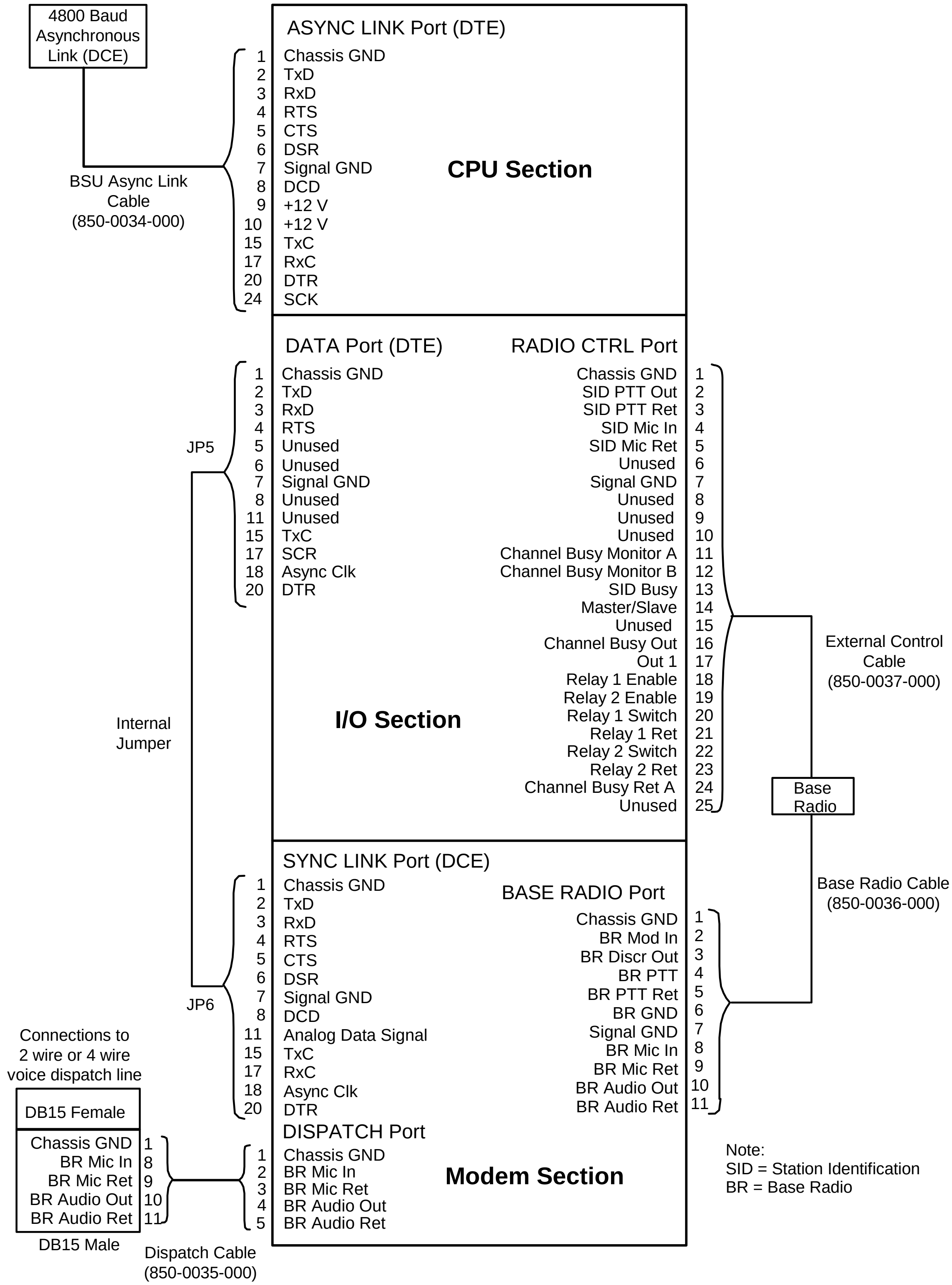

Figure 7: BSU II Interconnections

10. APPENDIX A – BSU CABLES

10.1 850-0034-000 BSU Async Link Cable (CSU/DSU to BSU)

The BSU Async Link Cable is a 1-to-1 EIA Cable that connects the CSU/DSU (DCE) unit to the Async Link Port (DTE) on the BSU.

PIN	SIGNAL NAME
1	Chassis Ground
2	TxD
3	RxD
4	RTS
5	CTS
6	DSR
7	Signal Ground
8	DCD
9	+12 V
10	+12 V
15	TxC
17	RxC
20	DTR
24	SCK

Table 2: Async Link Cable Pin Outs

10.2 Async Link Cable (Server Com Port directly to BSU)

<table>
<tr><th colspan="2">DB9 Com Port</th><th colspan="2">DB25 (A-sync port)</th></tr>
<tr><th>Pin #</th><th>Function</th><th>Pin #</th><th>Function</th></tr>
<tr><td>2</td><td>RX</td><td>2</td><td>TX</td></tr>
<tr><td>3</td><td>TX</td><td>3</td><td>RX</td></tr>
<tr><td>5</td><td>GND</td><td>7</td><td>GND</td></tr>
<tr><td colspan="2" rowspan="3">Jumper together →</td><td>5</td><td>CTS</td></tr>
<tr><td>8</td><td>DCD</td></tr>
<tr><td>9</td><td>+12V</td></tr>
</table>

Table 3: Async Link (Server Com Port directly to BSU) Pin Outs

10.3 850-0035-000 Dispatch Cable

The Dispatch Cable connects the dedicated voice line from the dispatch centre to the Dispatch port on the BSU. The DB9 connector connects to the BSU. The DB15 connector connects to a female DB15 connector, which is attached to the dedicated voice line.

DB15 Pin	DB9 Pin	SIGNAL NAME
1	1	Chassis Ground
8	2	BR Mic In
9	3	BR Mic Return
10	4	BR Audio Out
11	5	BR Audio Return

Table 4: Dispatch Cable Pin Outs

10.4 850-0036-000 Base Radio Cable

The Base Radio Cable connects the BSU Base Radio Port to the base radio. The table includes the wire colours, because the base radio end of the cable does not have a connector. The wires connect to interface points in the base radio. Note that BR stands for base radio.

PIN	WIRE COLOUR	SIGNAL NAME
1	Shield	Chassis Ground
2	Blue	BR Mod In
3	Orange	BR Discr Out
4	Red/White	BR PTT
5	Green	BR PTT Return
6	Green/Black	BR Ground
7	Black	Signal Ground
8	Red	BR Mic In
9	Red/Black	BR Mic Return
10	White	BR Audio Out
11	White/Black	BR Audio Return

Table 5: Base Radio Cable Pin Outs

10.5 850-0037-000 External Control Cable

The External Control Cable connects the BSU External Control Port to the base radio. The table includes the wire colours, because the base radio end of the cable does not have a connector. The wires connect to interface points in the base radio.

PIN	WIRE COLOUR	SIGNAL NAME
1	Shield	Chassis Ground
2	Red	SID PTT Out
3	Red/Black	SID PTT Return
4	Orange	SID Mic In
5	Orange/Black	SID Mic Return
6		Not Used
7	Black	Signal Ground
8		Not Used
9		Not Used
10		Not Used
11	Blue	Channel Busy Monitor A
12	Green	Channel Busy Monitor B
13		Not Used
14	Red/White	Master/Slave
15		Not Used
16		Not Used
17		Not Used
18		Not Used
19		Not Used
20		Not Used
21		Not Used
22		Not Used
23		Not Used
24	Blue/Black	Channel Busy Return A
25		Not Used

Table 6: External Control Cable Pin Outs

11. Appendix B – BSUII to TAIT TB8100 Base Radio interface instructions

11.1 Interface Preparation

The following instructions provide all the information needed to interface the RF Technology Eclipse Base Radio to the Mobile Knowledge BSU II. The instructions describe how to connect the Base Radio Cable and the External Control Cable to the base radio; and how set-up the Base Radio to accept the interface.

11.2 Equipment Checklist

The following equipment is required to interface a BSU to the Base Radio:

- Base Radio
- Base Radio Cable P/N 850-0036-000
- External Control Cable P/N 850-0037-000
- BSU Modem Cable P/N 850-0034-000
- Soldering iron, 25 Watt with small tip
- Solder, 60/40 resin core, 0.75 mm diameter
- Heat-shrink tubing
- Small work knife
- Long nose pliers
- Side cutters
- Wire strippers
- Assorted screwdrivers
- Channel Busy Interface Board [Included inside the Series II BSU]

11.3 Base Radio Information

Channel Number	1
Radio Type (Model Number)	TAIT TB8100
Operating Frequencies	TX = 452.500 MHz / RX = 457.500 MHz
Location	
Transmit Power	90 Watts out of PA
Receive Sensitivity	
TX Frequency Error	+650Hz
Data Circuit Number	NA
Remote Type	NA
Options	

Table 7: Radio Information Channel 1

11.4 Base Radio Programming Configurations

Please use the following programming information as a guide to configuring the Tait TB8100 for use with the Mobile Knowledge BSUII.

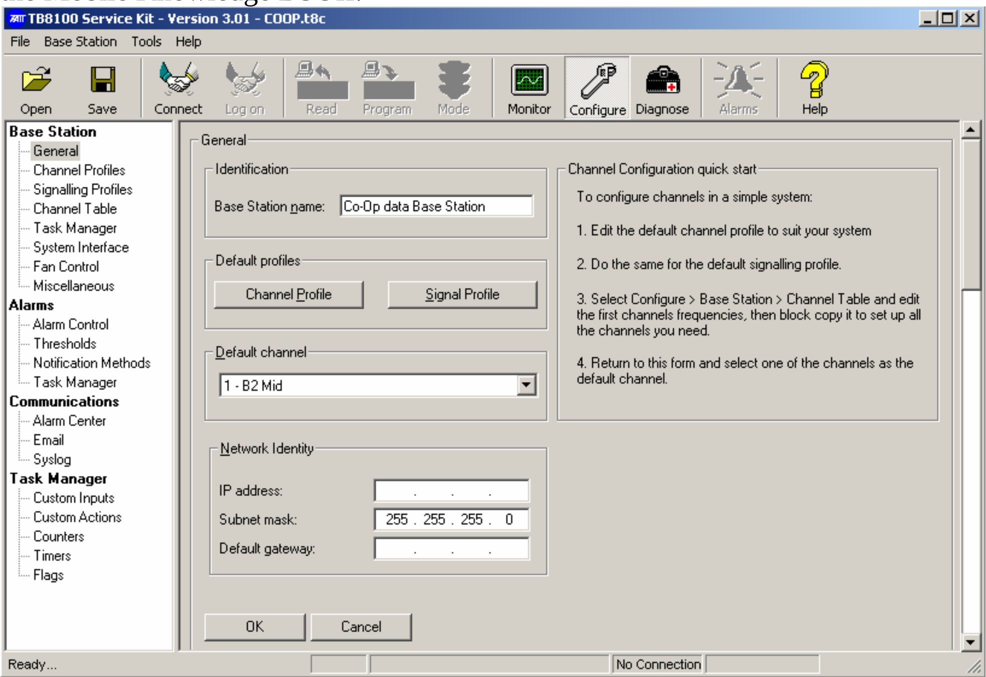

Figure 8: TB8100 General Settings

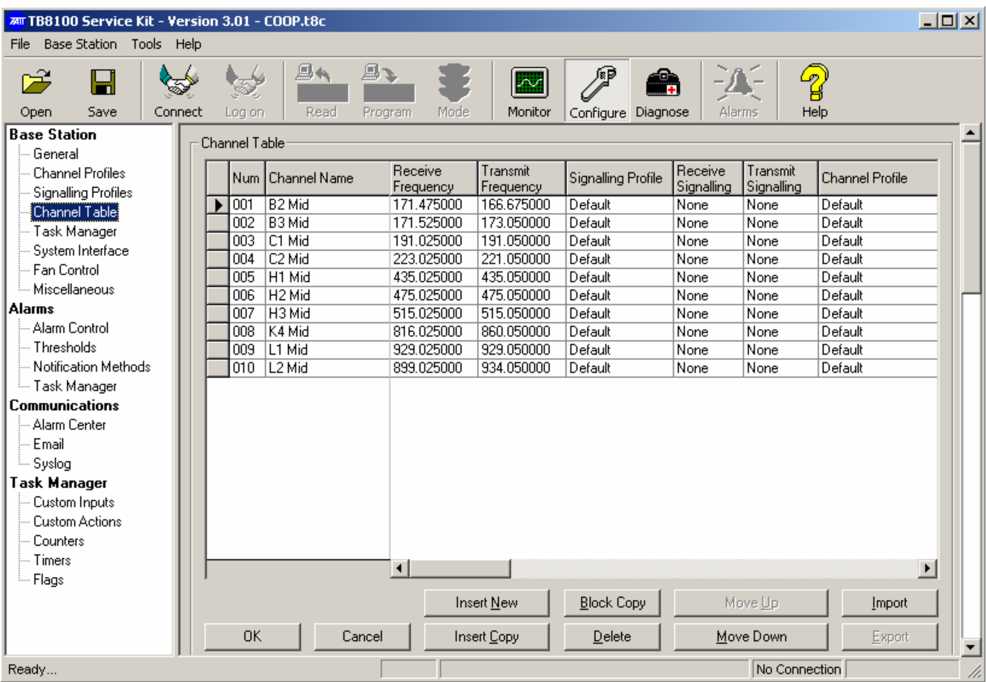

Figure 9: TB8100 Channel Table

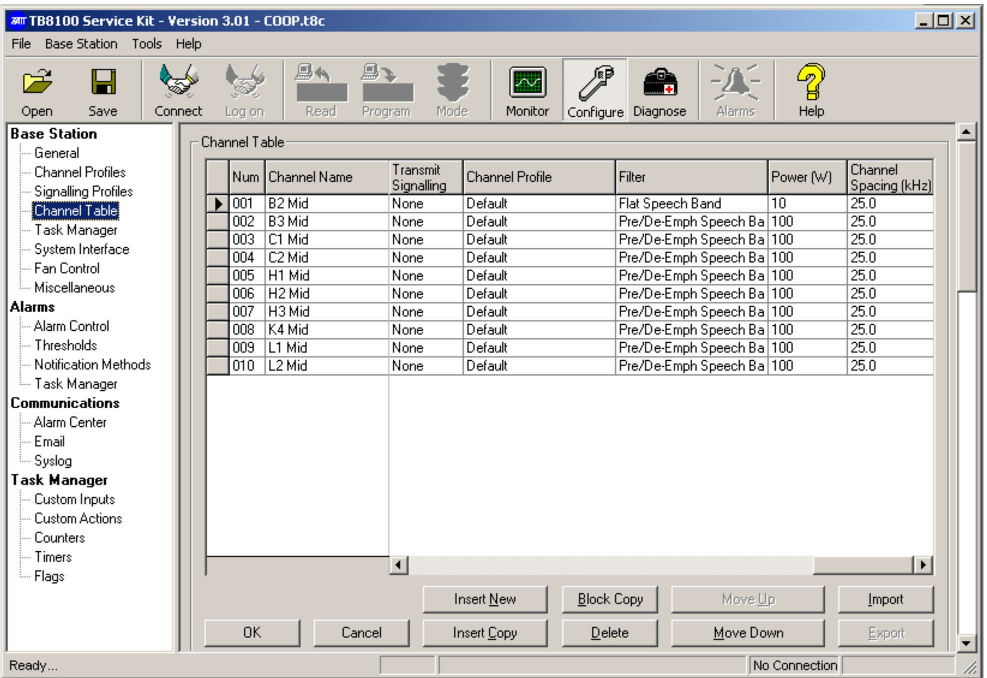

Figure 10: TB8100 Channel Table continued

It is important that the Audio routing be followed as show below to get proper data signal transmission.

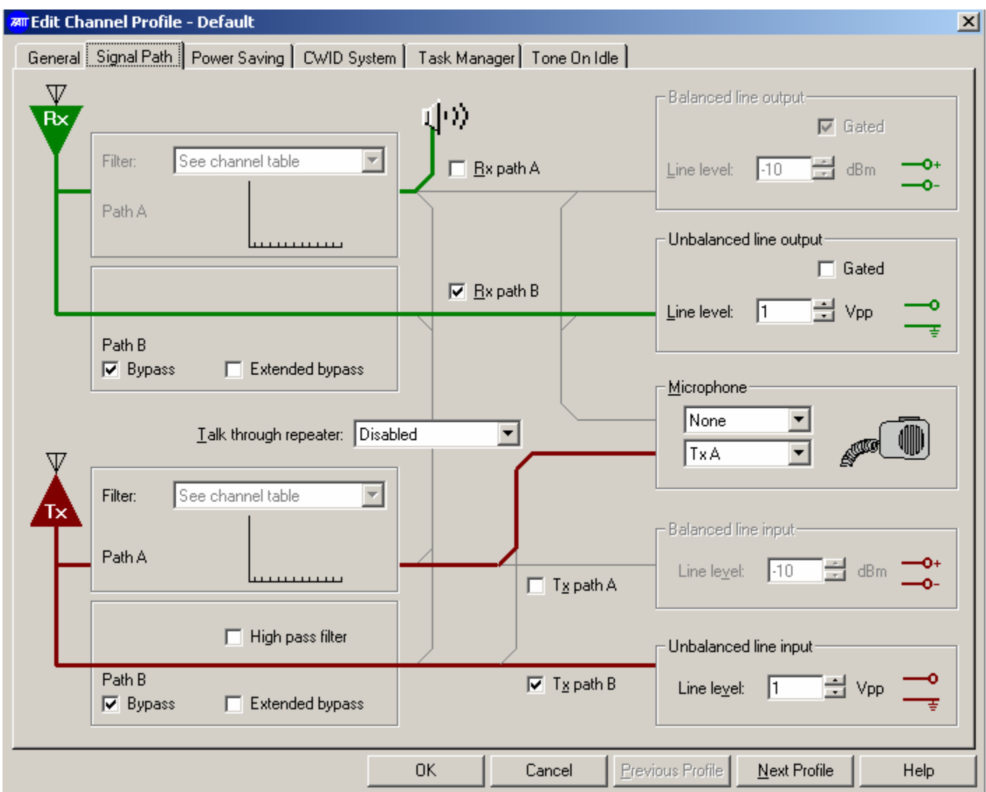

Figure 11: TB8100 Channel Profile Signal Path

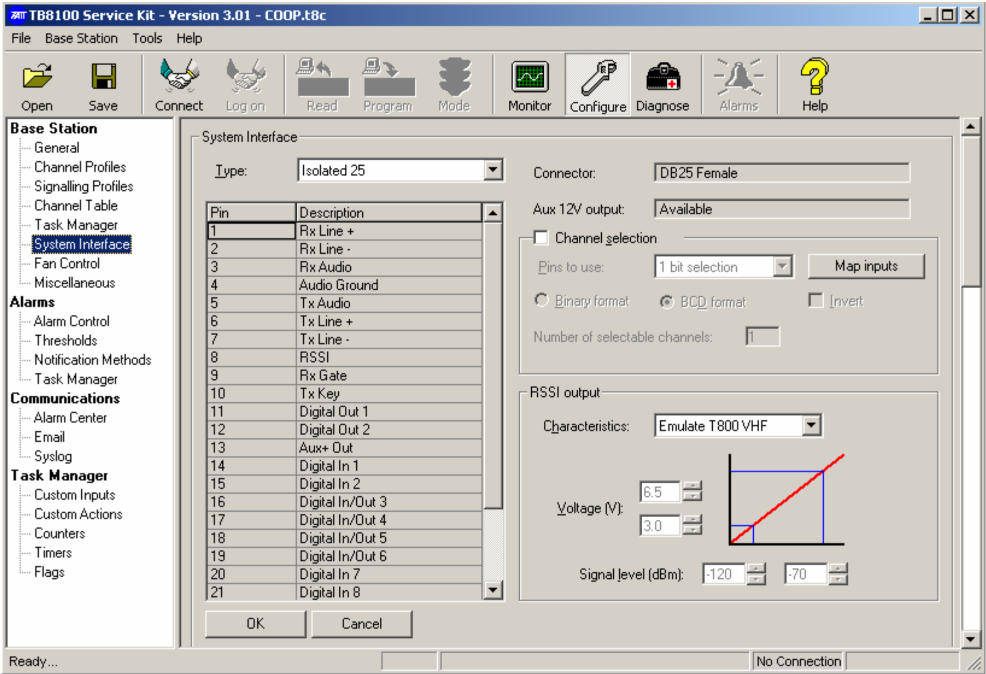

Figure 12: TB8100 System Information

11.5 Cable Assembly

All interface points to the TB8100 radio will be made through the 25-pin female D-range System Connector located on the radio back plane. This will require the purchase of a 25-pin male D-sub connector. The Mobile Knowledge Base Radio Cable (850-0036-000) and the External Control Cable (850-0037-000) will be terminated with the 25-pin male D-sub connector.
Referring to table 2 identify the wires needed from the Base Radio Cable (850-0036-000) and the External Control Cable (850-0037-000). Once you have identified these wires the remaining wires can be cut off or folded back and taped.

Radio Signal	Connector Pin	Base Radio Cable (850-0036-000)	External Control Cable (850-0037-000)
Tx Audio In	5	Blue [2-BR_MOD_IN]	Orange [4-SID_MIC_IN]
GND	4		Shield [1-CHASSIS GND] Red/Black [3-SID_PTT_RET] Orange/Black [5-SID_MIC_RET] Blue/Black [Channel Busy A RET]
Rx Audio Out	3	Orange [3-BR_DISC_OUT]	
	25	Shield [2-CHASSIS GND] Green [5-BR_PTT_RET] Green/Black [6-BR_GND]	
Tx Key	10	Red/White [4-BR_PTT]	Red [2-SID_PTT_OUT]
RSSI	8		Blue [Channel Busy Monitor A]

Table 8: Connections to 25-pin male D-sub connector.

11.6 Base Radio Cable [850-0036-000] Interface Points

The Base Radio Cable interfaces the PTT, Transmit, Receive and Dispatch Audio circuitry to the base radio. All Base Radio Cable connections to the TB8100 Base Radio will be made through the 25-pin female D-range System Connector.

11.6.1 Push To Talk Interface

1. Solder the Red/White wire (BR_PTT) of the Base Radio Cable (850-0036-000) to pin 10 on the 25-pin male D-sub connector.

11.6.2 Transmit Data Interface

1. Solder the Blue wire (BR_MOD_IN) of the Base Radio Cable (850-0036-000) to pin 5 on the 25-pin male D-sub connector.

11.6.3 Receive Data Interface

1. Solder the Orange wire (BR_DISC_OUT) of the Base Radio Cable (850-0036-000) to pin 3 on the 25-pin male D-sub connector.

11.6.4 Signal and Chassis GND Interface

1. Gather the Green (BR_PTT_RET), Green/Black wire (BR_GND), and the chassis braided shield of the Base Radio Cable (850-0036-000) together and solder to pin 25 on the 25-pin male D-sub connector.

11.6.5 Dispatcher Audio Interface

Not Interfaced

11.7 External Control Cable [850-0037-000] Interface Points

The External Control Cable interfaces the station identification circuitry, the master/slave circuitry and the channel busy circuitry to the base radio. All External Control Cable connections to the TB8100 Base Radio will be made through the 25-pin female D-range System Connector.

11.7.1 Station Identification (SID) Interface

1. Connect the Red wire (SID_PTT_Out) of the External Control Cable (850-0037-000) to pin 10 on the 25-pin male D-sub connector.
2. Connect the Orange wire (SID_Mic_In) of the External Control Cable (850-0037-000) to pin 5 on the 25-pin male D-sub connector.

11.7.2 Chassis Interface

1. Gather the Red/Black wire (SID_PTT_RET), Orange/Black wire (SID_Mic_Ret) and the chassis braided shield of the External Control Cable (850-0037-000) together and solder to pin 4 on the 25-pin male D-sub connector.

11.7.3 Channel Busy Interface

Not Interfaced

11.7.4 Master/Slave Interface

1. Set the BSU internal jumper (SLAVE ON) to the Master position. Jumper across pins 2 and 3 of JP7.

11.8 Base Radio Cable/External Control Cable connection to TB8100 Base Radio

After all Base Radio Cable and External Control Cable connections have been made to the 25-pin male D-sub connector cover the connections with a D-sub 25 pin connector hood.
Plug the connector into the 25 pin D-sub female System Connector on the back plane of the TB8100 base Radio.

11.9 Base Radio/External Control Cable to TAIT TB8100 Diagram

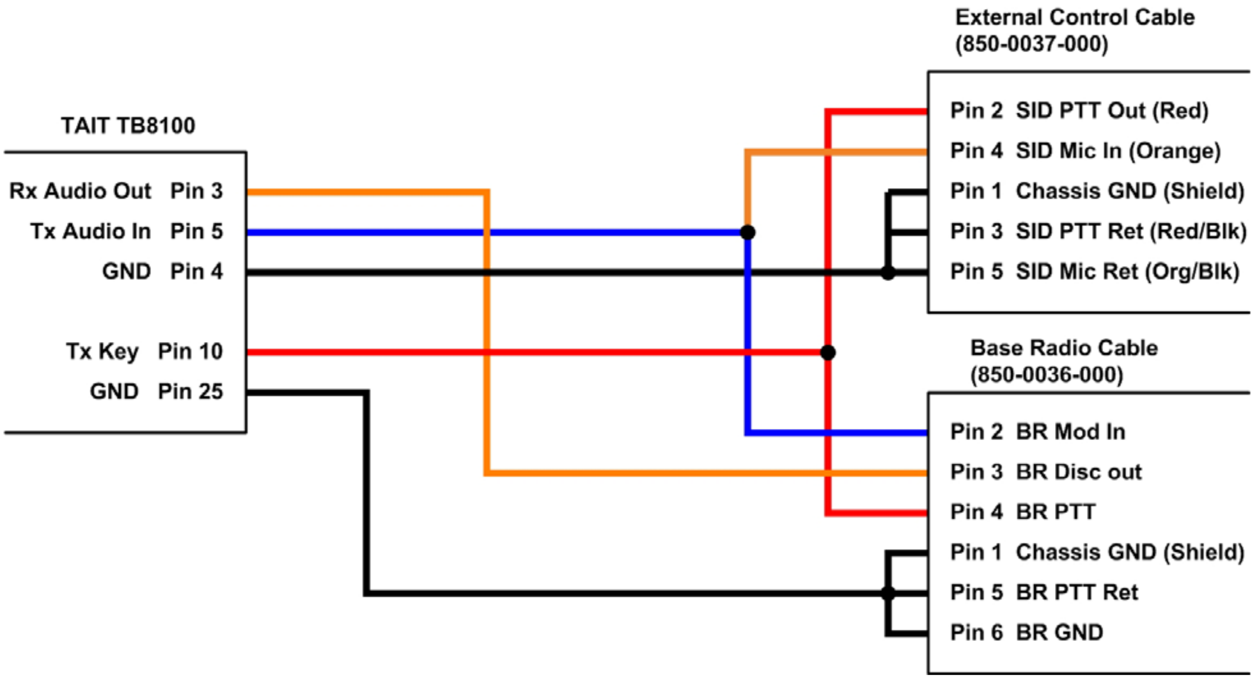

Figure 13: TAIT TB8100 Base Radio/External Control Interface Cable

11.10 Modem POT, SID Level and Jumper settings

The following diagrams outline the modem equalization, Station ID, and jumper settings for each data channel.

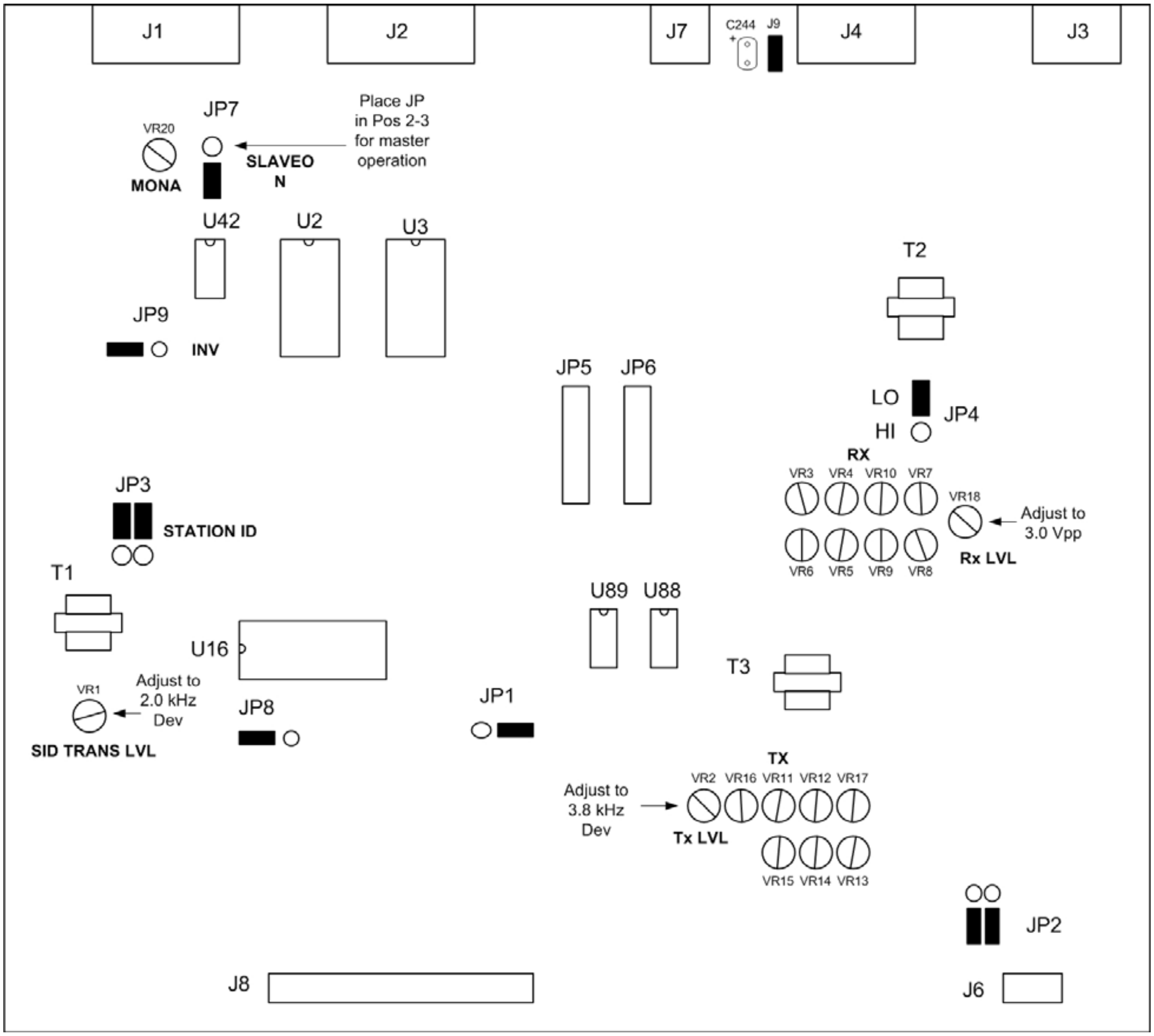

Figure 14: BSUII Modem POT, SID Level and Jumper Settings

Equalization POT Voltage Measurements								
TX	**VR16**	**VR11**	**VR12**	**VR17**	**VR15**	**VR14**	**VR13**	
	-0.611V	+0.244V	+0.336V	+0.069V	+0.111V	+0.099V	+0.333V	
RX	**VR3**	**VR4**	**VR10**	**VR7**	**VR6**	**VR5**	**VR9**	**VR8**

Table 9: Equalization POT Voltage Measurements for BSUII