SCADAMETRICS®

Smart Bell202 Modem™

Model SB.202

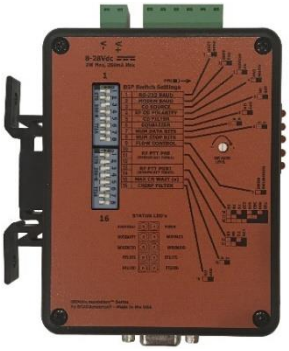
The Industry's First Bell-202 Modem That Works with a Simple 3-Wire Serial Port Connection!

Introducing the **Smart Bell202 Modem™!** – another member of SCADAmetrics® DINstrumentation™ series!

The **Model SB.202** Modem delivers non-proprietary, Bell-202 data modulation and demodulation for many popular analog telemetry radios. Its rugged design is optimized for use with industrial serial communication protocols, such as Modbus/RTU, Allen-Bradley DF1, and DNP3.

Bell-202 modem technology offers significant advantages when applied to certain difficult system integration projects: **1.** When combined with licensed VHF and UHF FM radios, it offers unsurpassed ability to punch through dense foliage and communicate across long distances with imperfect line-of-sight. **2.** It permits interoperability of a mix of various makes and models of compatible FM radios within a telemetry system.

However, the setup of legacy Bell-202 modems have traditionally presented two challenges: 1. implementation of radio "push-to-talk" pre-transmit and post-transmit timings; and 2. implementation of a delay in the transmit data stream until a sufficient duration of pre-transmit "push-to-talk" has completed.



In the past, system integrators have implemented proper push-to-talk timing by setting up sensitive serial port handshaking behaviors within both the modem and the RTU/PLC. Sound a little tricky? Until now, it used to be!

SCADAmetrics' Model SB.202 delivers all the benefits of Bell-202 modem technology – yet without the hassles. At the heart of the SB.202 is an intelligent microcontroller that supervises the timing of the radio's transmit data stream, thereby allowing your RTU/PLC to offload its Modbus requests and responses immediately – without RTS/CTS delays. In fact, you may even set up your PLC for simple 3-wire serial communication with RTS/CTS flow control disabled. The SB.202 then intelligently handles the keying/unkeying of the radio using dip-switch-selectable timings.

It is important to note that the Model SB.202 does ***not*** modify the content of the messages, and it does ***not*** add proprietary framing layers to the transmissions. Therefore, you may be assured that it will be over-the-air compatible with other-brand modems that adhere to the Bell-202 standard.

For example, if your SCADA network's communication system is built around the Schneider Electric™ SCADAPack 5902 Bell-202 modem and FM radio, then you can be assured that the SB.202 will **interoperate** seamlessly.

Are you interested in how SCADAmetrics modem technology can help your SCADA system communicate more effectively through rugged terrain? Give us a call! We'll be glad to discuss the details!

SCADAmetrics
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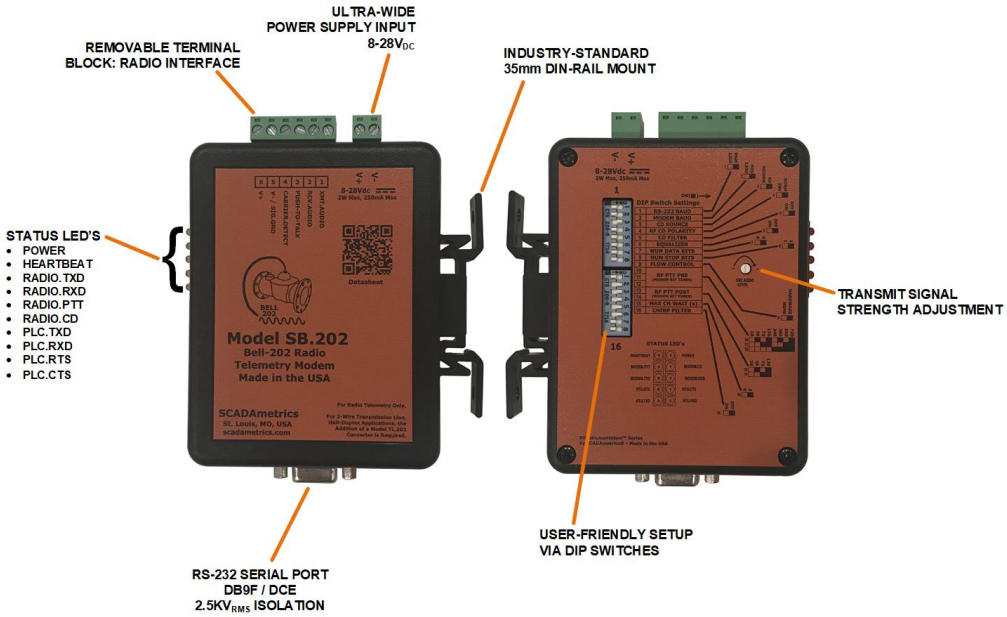
636.405.7101



Engineering Specifications –

Dimensions:	4.25" x 5.25" x 1.275"
Weight:	6.2 Ounces
Supply Voltage:	9-36V_{DC} (… and should always be powered from radio's power source!)
Supply Current:	42mA @ 12V_{DC}, 23mA @ 24V_{DC}
Supply Power:	0.65W Approx.
Internal Power Efficiency:	87%, Typical
Circuit Protection:	Fused 1000mA, TVSS Diode, Reverse-Protection Diode
Temperature:	-30C to +85C
Relative Humidity:	5% to 95%, Non-Condensing
Enclosure Rating:	Built to IP40 Specifications, Not Rated for Submersion/Outdoor Use
Panel Mounts:	Universal Din-Rail Clip
Environmental:	ROHS-Compliant, Lead-Free
Modem Speed:	1200, 600 bps (selectable)
Serial Port Speed:	1200, 9600 bps (selectable)
Modulation Type:	AFSK (Audio Frequency Shift Key), Bell-202
Protocol Compatibility:	MODBUS, DF1, Custom Binary & ASCII Protocols
Programming Method:	Integrated DIP Switches, 16-Poles
Source:	Designed & Manufactured at our Facility in Wildwood, Missouri from a combination of domestic and imported components.
Warranty:	2 Years (see www.scadametrics.com for details)

Port Pinouts –

DB9F (DCE) Comm Port to PLC (DTE) Serial Port:

1: DCD	to PLC DCD	optional
2: TxD	**to PLC RxD**	**required**
3: RxD	**to PLC TxD**	**required**
4: DSR	to PLC DTR	optional
5: GND	**to PLC GND**	**required**
6: DTR	to PLC DSR	optional
7: CTS	to PLC RTS	optional
8: RTS	to PLC CTS	optional
9: RI	<N/C>	

Power Port:

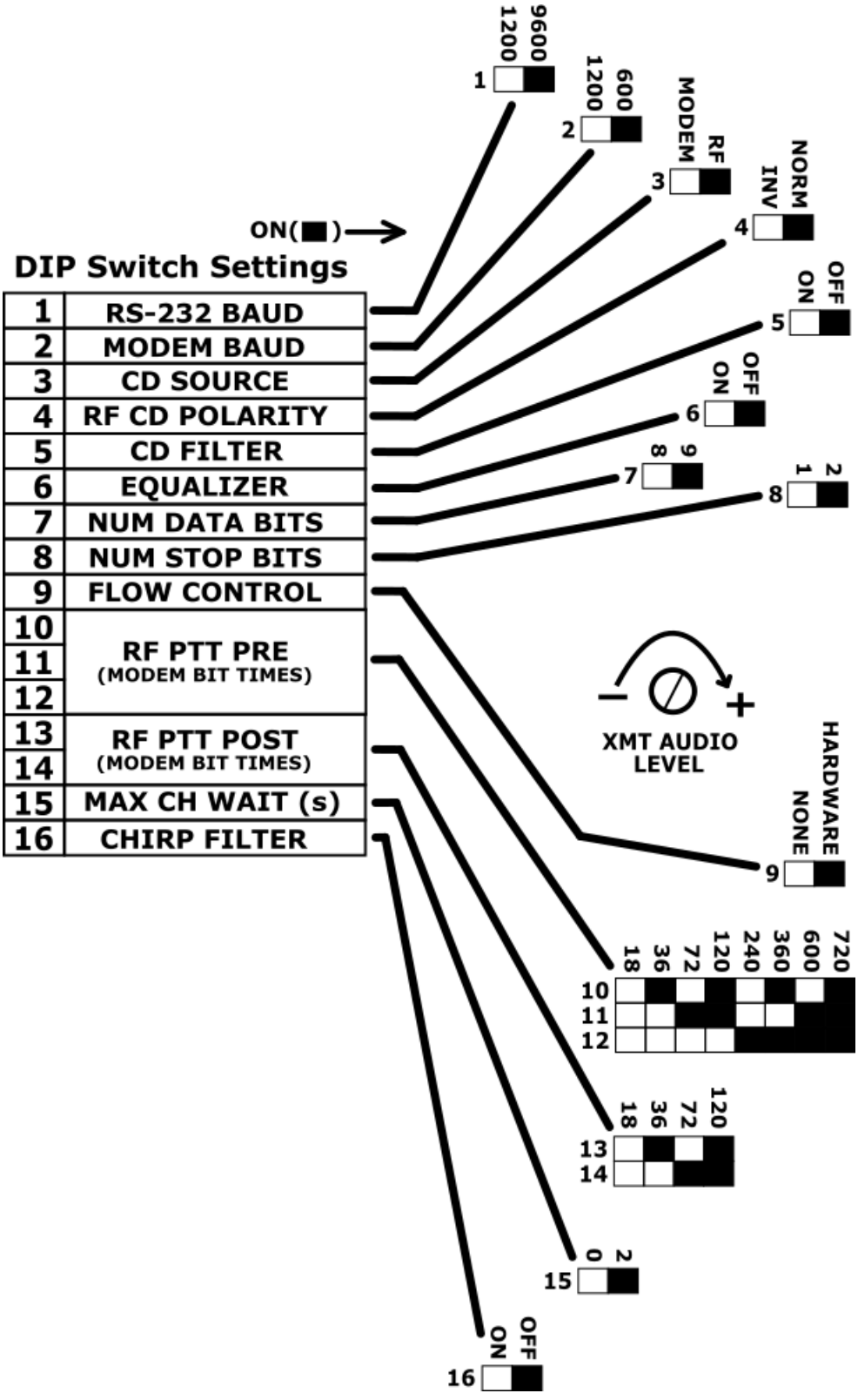
V+	V_{DC}+	8 to 28V_{DC}
V–	V_{DC}–	GND

Radio Interface Port:

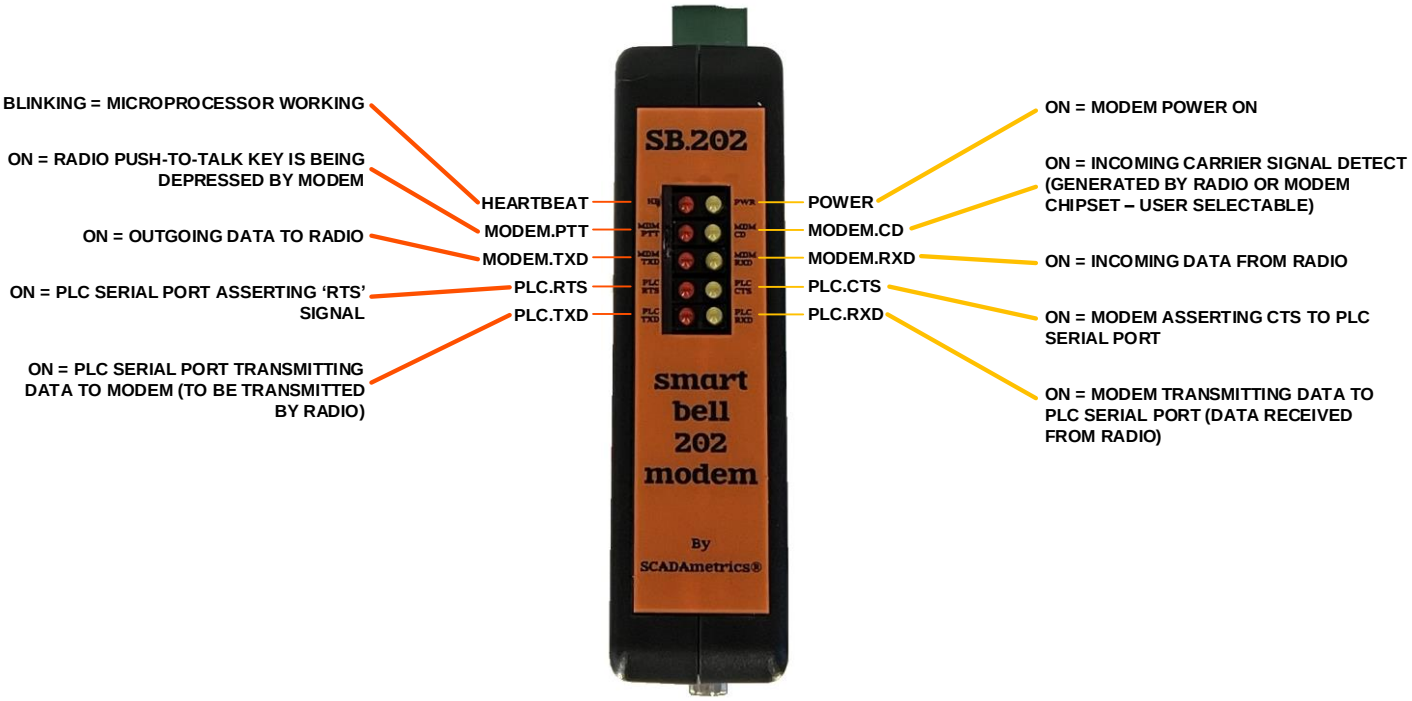
1: XMT.AUDIO (to radio)
2: RCV.AUDIO (from radio)
3: PUSH-TO-TALK (ground to transmit)
4: CARRIER.DETECT
5: V_{DC}–/GND, SIGNAL.GROUND
6: V_{DC}+

Engineering Dimensions (Inches) –

DIP Switch Definitions –



LED Definitions –



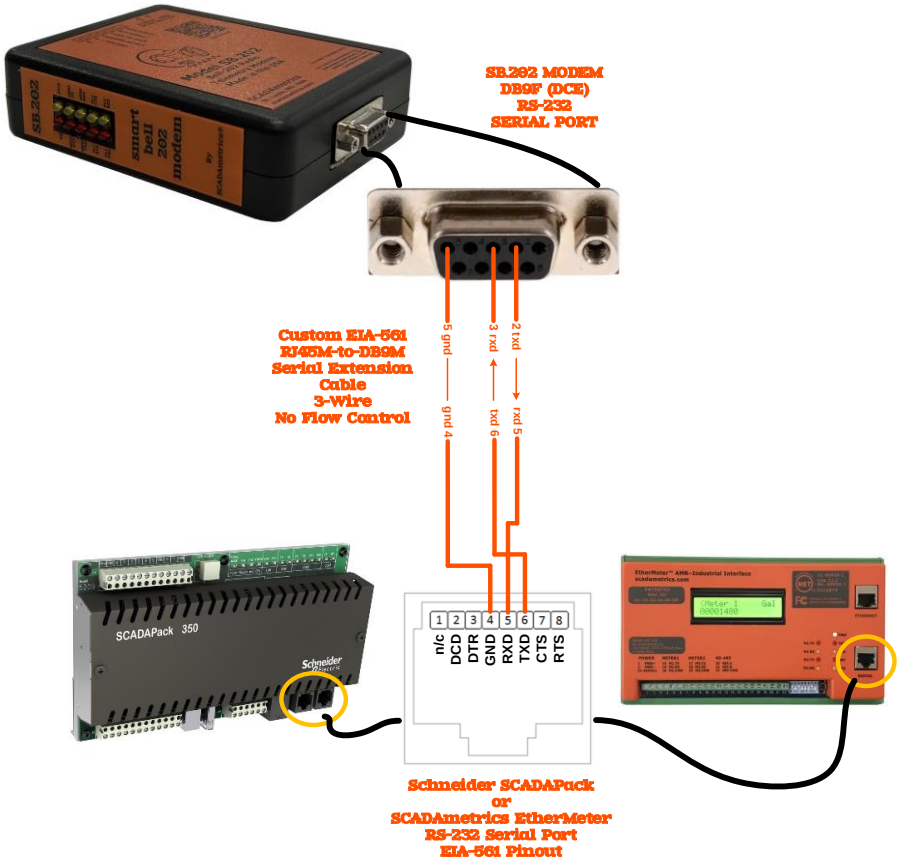
DIP Switches, Detailed Descriptions –

DIP Switches	Title	Description
1	RS-232 BAUD	OFF:1200 bps (default) ON:9600 bps
2	MODEM BAUD	OFF:1200 bps (default) ON:600 bps
3	CD SOURCE	OFF:From Modem (default) ON:From Radio
4	RF CD POLARITY	OFF:0V from Radio=CD (default) ON:0V from Radio=NotCD (only applies when CD SOURCE=Radio)
5	CD FILTER	OFF:Filter ON (Only Keep Bytes Received When CD Asserted) (default) ON:Disable Filter
6	EQUALIZER	OFF:Equalizer Enabled (default) ON: Equalizer Disabled (see MX614 datasheet for details)
7	NUM DATA BITS	OFF:8 (8 no parity, 7 even parity, 7 odd parity) (default) ON:9 (8 even parity, 8 odd parity – future. not yet available.)
8	NUM STOP BITS	OFF:1 Stop Bit (default) ON:2 Stop Bits
9	FLOW CONTROL	OFF:None (default) ON: Hardware (RTS/CTS)
10,11,12	RF PTT PRE	PTT Duration in Modem Bit Times – Before Data Transmission e.g. @1200 bps, 1 bit time = 0.833ms @600 bps, 1 bit time = 1.667ms Options: 18, 36, 72, 120, 240 (default), 360, 600, 720
13,14	RF PTT POST	PTT Duration in Modem Bit Times – After Data Transmission Options:18, 36 (default), 72, 120
15	MAX CH WAIT (s)	OFF:0 sec (Disable) (default) ON:2 sec (Enable) (maximum wait time for clear channel before transmission) (only recommended when using Radio as the CD source)
16	CHIRP FILTER	OFF:Enable (default) ON:Disable (Chirp Filter attempts to detect and discard noise bytes that are inadvertently generated by a radio transmitter when PTT is unkeyed.)

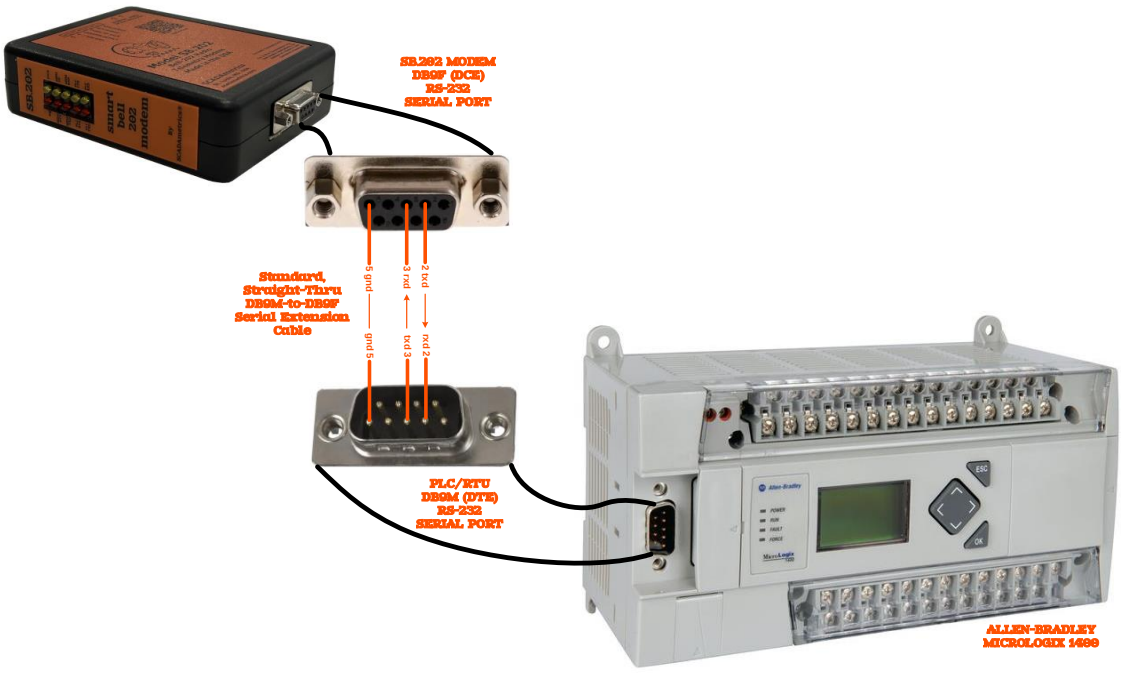
*In accordance with FCC CFR 47 Part 15.103(a,b,c) – the SB.202 is intended to be used as a control system component at public utility facilities, industrial plants, and within commercial transportation vehicles. It is also intended to be used within industrial, commercial, & medical test equipment. Not intended for consumer applications.

Serial Interface Examples -

Schneider Electric SCADAPack



Allen Bradley MicroLogix, CompactLogix, ControlLogix



Radio Interface Examples -

Ritron DTX+ / DTX-LS
VHF/UHF Telemetry Radios

Ritron DTX+
Telemetry Radio

DTX+ Notes:
Radio.Pin.13 (Carrier Detect) can be user-programmed as either "Active-High" or "Active-Low".

Requirement: The user MUST program the Carrier Detect pin as "Active-Low"!

DTX+ DB15F Pinout:
6: $12V_{DC}$
7: XmtAudio
8: RcvAudio
13: Carrier.Detect
14: Push-to-Talk
15: Ground

6-Conductor,
22 AWG
Shielded w/ Drain Wire
Red,Blk,Wht,Grn,Blu,Brn

Connect Drain Wire to:
SB.202 Terminal 5
..or..
Earth Ground

General Cable
E2006S

$12V_{DC}$
Gnd

SB.202 Pinout:
1: XmtAudio
2: RcvAudio
3: Push-to-Talk
4: Carrier.Detect
5: Ground
6: $12V_{DC}$

Ritron DTX+
Telemetry Radio
With
Terminal Block
Adapter for SB.202

6-Conductor,
22 AWG
Shielded w/ Drain Wire
Red,Blk,Wht,Grn,Blu,Brn

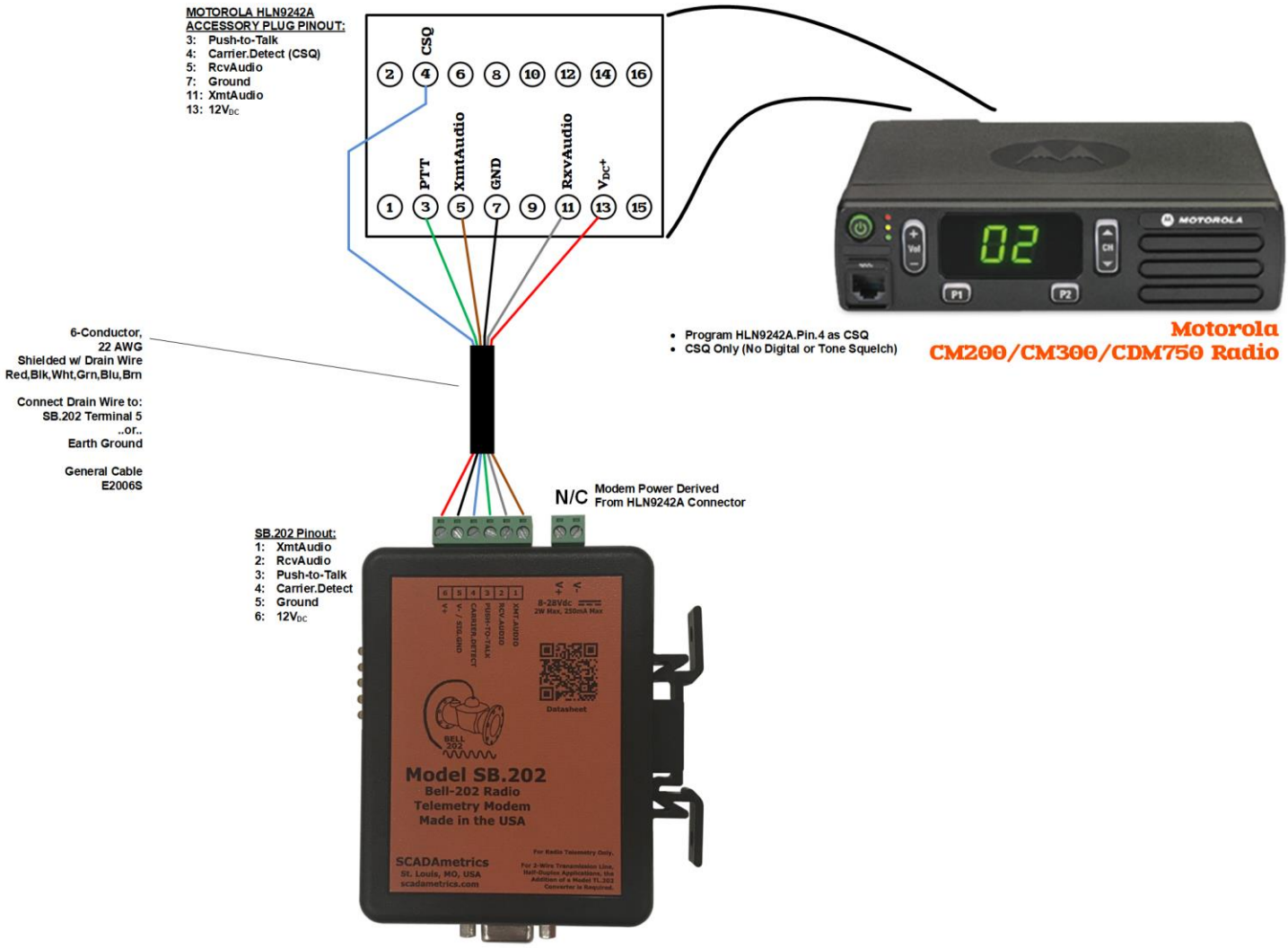
Connect Drain Wire to:
SB.202 Terminal 5
..or..
Earth Ground

General Cable
E2006S

$12V_{DC}$
Gnd

SB.202 Pinout:
1: XmtAudio
2: RcvAudio
3: Push-to-Talk
4: Carrier.Detect
5: Ground
6: $12V_{DC}$

Motorola CM200/CM300/CDM750 VHF/UHF Radios



Maxon SD-171EX (VHF), SD-174EX (UHF) Telemetry Radios

SD-171EX, SD-174EX Telemetry Radio

SD171EX, SD-174EX DB9F Pinout:
1: XmtAudio
2: RcvAudio
3: Push-to-Talk
4: Ground
5: $12V_{DC}$
6: Carrier.Detect

6-Conductor, 22 AWG Shielded w/ Drain Wire Red,Blk,Wht,Grn,Blu,Brn

Connect Drain Wire to: SB.202 Terminal 5 ..or.. Earth Ground

General Cable E2006S

$12V_{DC}$
Gnd

SB.202 Pinout:
1: XmtAudio
2: RcvAudio
3: Push-to-Talk
4: Carrier.Detect
5: Ground
6: $12V_{DC}$

Calamp DL-3400
VHF/UHF Radios

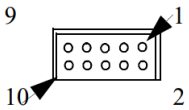
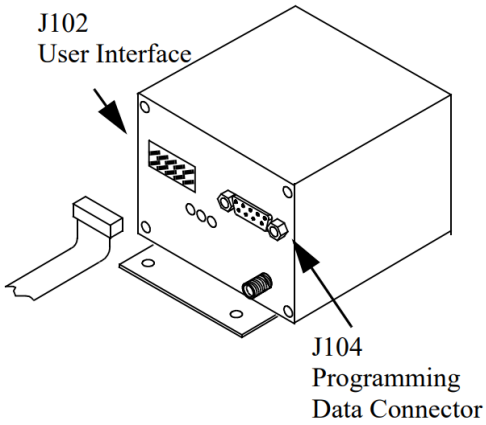


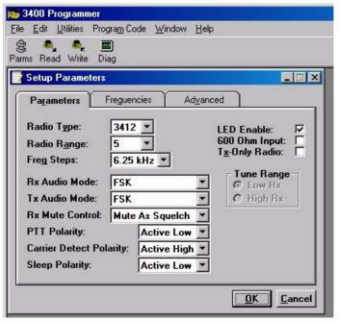
TABLE 2-1 J102 CONNECTOR PIN ASSIGNMENTS

Interface Cable Wire Color (023-3410-109)	Pin	Function
Brown	1	Tx Wideband Data In
Blue	2	Rx Wideband Data Out
Violet	3	Frequency Select In
Green	4	RSSI Out
Red	5	+13.3 V DC In
Orange	6	Tx Key (PTT) In
Gray	7	Carrier Detect Out
Yellow	8	Tx Data In
Black	9	Ground
White	10	Rx Data Out



DL 3400 Notes:
Program PTT Polarity as "Active Low" (Calamp default).
Program Carrier Detect Polarity as "Active High" (Calamp default).

On SB.202, set RF Carrier Detect Polarity Dip Switch to NORMAL



Calamp / Dataradio DL-3400 Telemetry Radio with Calamp Interface Cable 023-3410-109

Calamp Interface Ribbon Cable
PN 023-3410-109

$12V_{DC}$
Gnd

SB.202 Pinout:
1: XmtAudio
2: RcvAudio
3: Push-to-Talk
4: Carrier.Detect
5: Ground
6: $12V_{DC}$

Telemetry Leased Line Interface Instructions –

SB.202 and TL.202
Telemetry Leased Copper Line

Model SB.202 and Model TL.202

TL.202 Configuration for 2-Wire and 4-Wire Networks:

In order to convert the **Model SB.202** for use with 2-wire and 4-wire telemetry leased copper lines, the **Model TL.202** should be added by connecting the following five (5) jumper wires:

2-Wire Configuration			
	SB.202 **Smart Bell-202 Modem for Radio Telemetry**		**TL.202** **Telemetry Leased Line Adapter for Bell-202 Radio Modem**
1.	TRANSMIT AUDIO	↔	TRANSMIT AUDIO
2.	RECEIVE AUDIO	↔	RECEIVE AUDIO
3.	PTT (PUSH-TO-TALK)	↔	PTT (PUSH-TO-TALK)
4.	CARRIER DETECT (DO NOT CONNECT)	n/c	CARRIER DETECT (DO NOT CONNECT)
5.	V- / SIGNAL GROUND	↔	V- / SIGNAL GROUND
6.	V+	↔	V+

4-Wire Configuration				
	SB.202 **Smart Bell-202 Modem for Radio Telemetry**		**TL.202 #1 - Transmitter** **Telemetry Leased Line Adapter for Bell-202 Radio Modem**	**TL.202 #2 - Receiver** **Telemetry Leased Line Adapter for Bell-202 Radio Modem**
1.	TRANSMIT AUDIO	↔	TRANSMIT AUDIO	TRANSMIT AUDIO
2.	RECEIVE AUDIO	↔	RECEIVE AUDIO	RECEIVE AUDIO
3.	PTT (PUSH-TO-TALK)	↔	PTT (PUSH-TO-TALK)	PTT (PUSH-TO-TALK)
4.	CARRIER DETECT (DO NOT CONNECT)	n/c	CARRIER DETECT (DO NOT CONNECT)	CARRIER DETECT (DO NOT CONNECT)
5.	V- / SIGNAL GROUND	↔	V- / SIGNAL GROUND	V- / SIGNAL GROUND
6.	V+	↔	V+	V+

… and then the telemetry leased line(s) should be connected to the **Line.A** and **Line.B** terminals in the front of the TL.202(s). Please note that Line A and Line B are polarity-insensitive.

SB.202 Configuration for 2-Wire and 4-Wire Networks:

1. All SB.202 Modems on the network should have IDENTICAL DIP Switch settings, with the exception of DIP Switch #1, which sets the RS.232 baud rate. DIP Switch #1 should be set to the RS.232 baud rate of the connected RTU/PLC/Computer. Available settings are 1200 bps and 9600 bps.

2. All SB.202 modems on the network should be set for Carrier Detect Source=Modem (DIP Switch #3 = OFF)

QUICK-START TIPS –

Initial Setup:

1. **Connect the RS-232 Serial Port of the PLC/RTU to the Serial Port of the SB.202. Take special care to ensure that the pins are interconnected properly and according to the respective pinouts.**

2. **Connect the Radio Interface Port of the SB.202 to the FM Radio. Take special care to ensure that the pins are interconnected properly and according to the respective pinouts.**

3. **Connect the SB.202 to the DC Power Source. The DC Power Source *must* be the same DC Power Source that is used to power the radio.**

4. **Apply Power, and Observe…**

    - The 'Power' LED should be lit up continuously.

    - The 'Hearbeat' LED should be blinking slowly, signifying that the SB.202 microcontroller is working.

    - The RTU LED's should light up whenever serial port activity is detected.

    - The Modem LED's should light up whenever radio activity is detected.

5. **Perform Modbus (or DF1) test polls to validate performance.**

FAQ's –

• **Is the SB.202 a 'smart' modem?** Yes and No. The SB.202 is 'smart' in the sense that it contains an integral microcontroller that supervises the timing of the radio's transmitter and the data stream, thereby allowing your RTU/PLC to offload its Modbus requests and responses immediately – without RTS/CTS delays. In fact, you may even use a simple 3-wire serial cable with RTS/CTS flow control disabled. Additionally, you may even connect an RS-485 Modbus device to the SB.202 without an intermediary RTU/PLC – although an external RS-485 to RS-232 converter would be required.

On the other hand, the SB.202 is 'dumb' in the sense that it does ***not*** try to out-smart the systems integrator! The SB.202 does ***not*** modify the content of the messages, and it does ***not*** add proprietary framing layers to the transmissions. For these reasons, you may be assured that it will be over-the-air compatible with other-brand modems that adhere to the pure Bell-202 standard.

• **What are the power requirements of the SB.202?** The SB.202 provides the user with a great deal of flexibility in that it will operate on any voltage between 9-36V_{DC}. However, it is **required** that the user power the modem with the same voltage source that is used to power the radio – which will generally be ~12VDC. Radio Interface Terminal 6 provides a direct connection back to the V_{DC}+ terminal block.

• **Does the SB.202 require programming?** No, the unit features 16 DIP switches for tailoring the modem to your radio and application, and one trim pot for adjusting the transmit audio level.

• **What are the Bell-202 modulation tones?** The Bell-202 standard uses 1200 Hz for 'MARK' (Binary '1'), and 2200 Hz for 'SPACE' (Binary '0').

• **Will the SB.202 work over leased lines?** No, not by itself, as the SB.202 is designed for use with radios only. However, the combination of the **Model SB.202** and the **Model TL.202 Telemetry Line Interface** does enable usage over 2-wire and 4-wire leased lines.