RS-232 to J1939 Converter CE
Model 1939STB
Documentation Number 1939STB4600

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Table of Contents

Introduction

SAE-J1939 is a communication protocol developed by SAE (Society of Automotive Engineers). The communication protocol is based on the CAN specification developed by Bosch 2.0 part B (September, 1991).

Before using the Model 1939STB the user should be familiar with the SAE publications listed below, and follow all the guidelines before attempting to connect to an active J1939 network.

The SAE-J1939 specifications are guidelines. Many manufacturers have proprietary data codes developed for their own use. The user must obtain these codes from the manufacturer of the vehicle. B&B Electronics does not have access to the SAE-J1939 codes, and cannot provide any assistance in obtaining these codes. It is the responsibility of the user to obtain and implement the specific J1939 codes for the vehicle(s) that the 1939STB is interfaced to.

SAE Publications

Surface Vehicle Recommended Practice

SAE-J1939/11	Physical Layer – 250k bits/s, Shielded Twisted Pair (issued DEC94)
SAE-J1939/21	Data Link Layer (issued JUL94)
SAE-J1939/31	Recommended Practice for Serial Control and Communications Vehicle Network – Part 31- Network Layer (issued DEC94)
SAE-J1939/71	Vehicle Application Layer (revised MAY96)
SAE-J1939/73	Application Layer –Diagnostics (issued FEB96)
SAE-J1939/81	Recommended Practice for Serial Control and Communications Vehicle Network – Park 81 – Network Management (issued JUL97)

You may order these documents from SAE at (412) 776-4970
FAX: (412) 776-0790
Or on the web at
http://www.sae.org

CAN Specification 2.0   Robert Bosch GmbH
Postfach 50
D-7000 Stuttgart 1, Germany

WARNING!

This Model 1939STB Converter Module allows you to connect to active SAE J-1939 networks. It is possible that your transmissions through this converter module could cause malfunction of the network operation, damage to the software or equipment, or bodily harm.

> ***Do Not Transmit Any Messages to The Network without a complete understanding of the operation of the network.***

B&B Electronics Mfg. Co. specifically disclaims any responsibility for damage or injury to software, hardware, equipment or persons as a result of using this product.

WARNING!

Description

The 1939STB is an interface device allowing the user to connect a PC to an SAE-1939 bus via a serial port. The 1939STB conforms to the Physical Layer specification as set forth in SAE-J1939/11. The 1939STB allows the reception and transmission of messages over an SAE-J1939 standard bus. This converter has 14 message "slots" that can be configured for either reception or transmission. A sample program is provided to aid in the setup of the interface. Source code is provided and can be found in a subdirectory under B&B Electronics/J1939/VB6. The Visual Basic program runs under Windows: however, setup and data transfers can be sent and received by any terminal capable of serial communications.

The power supply is a wide-range design and will accept a DC voltage between 10 and 42 volts. The 1939STB has reverse polarity protection. Power is connected to the 1939STB though a terminal block located under the snap cover. +DC is connected to the terminal marked "POWER". -DC is connected to the terminal marked "GND".

The serial port on the 1939STB is a 9-pin male connection, configured as DCE (pin 2 receive// pin 3 transmit). The serial baud rate is user selectable between 300 and 57600. The stop, parity, and word length can also be adjusted.

Two LED's are provided on the 1939STB. One indicates that DC power is connected to the converter and the power supply is working properly. This LED will be lit constantly. The second LED is labeled "DATA". This LED monitors the function of the converter. After the device is connected, the LED should flash approximately once every 2 seconds. The flashing LED confirms that the converter is operating properly and is ready to accept data.

Connection to the SAE-J1939 bus is made by a terminal connection. The terminal, located under the snap cover, is marked "CAN LOW and "CAN HIGH". In some applications it may be necessary to add a terminating resistor across the CAN high/low terminals. Consult the SAE-J1939/11 publication for details concerning terminating resistors.

The terminals marked " A" and "B" are not used.

Physical Description

Length:	5.25 in. (134mm)
Width:	2.75 in. (70mm)
Height:	1.00 in (25.4mm)
Serial Connection:	DB-9 female, DCE
SAE-J1939 Connection:	Terminal block, CAN HIGH/CAN LOW
Power Connection:	Terminal block, POWER/GND
Temperature:	0 to +70 degrees Centigrade

Electrical Specification

Input Power Requirement: 10 to 42 volts DC, 1 Watt max.
Meets Physical Layer SAE-J1939/11
Fully compatible with ISO 11898-24v standard
RS-232 driver meets EIA-232-E and V.28 specification
CAN transceiver meets ISO 11898-24 V standard

Communication directed to the device

Format:

Table 1. J1939STB Format

Message header				Message Information							Data Payload							
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B18	B19	B20
81	21	1F	05	95	E7	0c	80	00	40	8c	41	42	43	44	45	46	47	48

All communications to the device start with a message header (white area). This header is removed from any message sent to the J1939 bus. The header is four bytes long. Two bytes (B1& B2) are used to confirm start of frame. The next two bytes (B3 & B4) contain information controlling how the 1939STB functions. The remainder of the packet is the data payload and can contain from zero to sixteen bytes depending on function.

Table 2. Transmit Data Format

Byte 1	Byte 2	Byte 3	Byte 4	Message Information	Data Payload
Check 1	Check 2	Control 1	Control 2		

The first two bytes (Check 1 and Check 2) are always set to 81hex and 21hex. These bytes <u>must</u> precede all data sent to the device. If the Check bytes are not sent consecutively the message will be rejected. The entire message must be resent before data can be transmitted to the device. Control (byte 3 and byte 4) contain information that is used by the converter. This information is not passed to the J1939 bus. Both control bytes must contain data (cannot have a value of 00) or the transmission will be rejected.

Control Byte 3

Byte 3 directs the data packet to the proper destination. The setting of this byte will affect the rest of the message. That is to say changing this byte changes the meaning of the following data bytes.

Table 3. Bits of Byte 3

Nibble 2				Nibble 1			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Byte 3 has two parts, Nibble 1 and Nibble 2. Nibble 2 (bits 4 – 7) sets the control code as follows:

Table 4. Byte 3 Nibble 2

Bit Number	Value	Function
Bit 7	1	Reserved not used
	0	Reserved not used
Bit 6	1	Reserved not used
	0	Reserved not used
Bit 5	1	Internal commands (Baud rate, Version number)
	0	No function
Bit 4	1	External commands (Messages to J1939 bus)
	0	No function

Nibble 1 (bits 0 – 3) of control byte 3 defines the number of bytes in the data payload of the message. The byte count does NOT include the message header (bytes 1 through 4). The message payload is limited to 16 bytes. This limit allows a complete J1939 packet to be sent or received from the bus.

Table 5. Transmit Data Format

Byte 1	Byte 2	Byte 3	Byte 4	Message Information	Data Payload
Check 1	Check 2	Control 1	Control 2		
				<< Count Number of Bytes for byte 3 nibble 1 >>	

Nibble 1 of control byte 3 can be set to any value between 0 and 16 (0 to F hex).

Table 6. Byte 3 Nibble 1

Bit Number	Value	Function
Bit 3	1	Number of bytes in data payload (MSB)
	0	
Bit 2	1	Number of bytes in data payload
	0	
Bit 1	1	Number of bytes in data payload
	0	
Bit 0	1	Number of bytes in data payload (LSB)
	0	

1939STB4600 Manual

Control Byte 4

When control byte 3 is set to "external commands" (bit 4 set to 1), nibble 1 of control byte 4 is used to tell the J1939 in which message slot location (1 through 15) to place the message data. NOTE: Message location number 15 is receive only.

Table 7. Byte 4

Nibble 2				Nibble 1			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

When control byte 3 is set to " internal commands" (bit 5 set to 1), nibble 1 of control byte 4 has the following functions:

Table 8. Nibble 1 Bit Values

Nibble 1 Value	Function
0001	Display vender number & version
0010	Set baud rate, stop, start bits
0100	Not used
1000	Not used

Nibble 2 of control byte 4 is reserved for future use and is set to 0.

Internal Functions

While most of the information sent and received from the 1939STB will be transferred to the J1939 bus, the internal function codes allow the user to set up the serial port, and receive an identity string from the 1939STB. The identity string may be used to verify that the 1939STB is connected and working properly.

Vendor String

The vendor string function is sent to the 1939STB as shown in the table below. This function is strictly internal and can be sent to the 1939STB at any time whether or not the 1939STB is connected to an active J1939 bus. The shaded areas are to be set by the user.

Table 9. Vendor String Setup

Byte 1	Byte 2	Byte 3		Byte 4	
		Nibble 2	Nibble 1	Nibble 2	Nibble 1
81	21	0010	0000	0000	0001
81	21	20hex		01hex	

After this is sent to the 1939STB the device will respond with:

Table 10. Message Received from the SAE-J1939 Bus

ID	Function	J1939 Address				MC	Data								
4	28	0	0	0	0	00	A	xx	xx	xx	xx	xx	xx	xx	A
2		0	0	0	0		A								A

See "Reception of Data" for an explanation of codes.
The xx may change.

The included Visual Basic application has a script file, VENDN.CVS, that can be sent to the 1939STB to illustrate the vendor string function.

RS-232 Baud Change

Setting byte-3/nibble-2 to 2 and byte-4/nibble-1 to 2 causes the 1939STB to change baud. This function also requires 3 bytes of additional information bytes 5, 6, and 7. It is important to note that after a baud change the PC must have its baud changed to match the baud of the 1939STB for communication to exist. If communication is lost after a baud change and cannot be recovered, disconnecting the 1939STB from its power source will restore the 1939STB to its default baud rate of 9600 baud, 1 stop bit, 8 data bits, no parity.

Table 11. Baud Rate Setup

Byte 1	Byte 2	Byte 3		Byte 4		Byte 5	Byte 6	Byte 7
		Nibble 2	Nibble 1	Nibble 2	Nibble 1	UB3	Baud 1	Baud 2
81	21	0010	0011	0000	0010			
81	21	23 hex		02 hex		03 hex	00 hex	06 hex

Table 11 shows how an internal command is used to set the 1939STB to a baud rate of 300, 1 stop bit, 8 data words, and no parity. Byte 3 nibble 2 sets the internal command function. A nibble value of 2 sets the J1939STB into the Internal Function mode. Nibble 1 of byte 3 tells the 1939STB 3 bytes will follow Byte 4. Byte 4, nibble 1 is set to 2 telling the 1939STB to perform a baud change using the information contained in bytes 5, 6, and 7.

Table 12. Baud Rate Setup

Baud Rate	Decimal Divisor	Hex Divisor MSB (Baud 2)	Hex Divisor LSB (Baud 1)
300	1556	06 hex	00 hex
1200	384	01 hex	80 hex
2400	192	00 hex	C0 hex
9600	48	00 hex *	30 hex *
19200	24	00 hex	18 hex
38,400	12	00 hex	0C hex
57,600	8	00 hex	08 hex

* Setup default value.

RS-232 Baud Rate Change - cont'd.

All baud rates are entered as hex numbers. To determine the decimal divisor use the following formula. The decimal number must be converted to hexadecimal before entering the number into byte 6 and 7. Baud rates faster than 57,600 are not supported.

UART clock = 7,372,800 Hz

$$\text{Decimal Divisor} = \frac{\text{Clock frequency (7,372,800)}}{\text{Baud output } \times 16}$$

If you want a baud rate output of 300 baud:

$$\text{Decimal Divisor} = \frac{7,372,800}{300 \times 16}$$

Decimal Divisor = 1536 = 600 hex
    Baud 1 = 00
    Baud 2 = 06

Programming a baud rate change to 300 baud, 1 stop bit, 8 bit data, no parity.

Table 13. Baud Rate Setup

Byte 1	Byte 2	Byte 3		Byte 4		Byte 5	Byte 6	Byte 7
		Nibble 2	Nibble 1	Nibble 2	Nibble 1	UB3	Baud 1	Baud 2
81	21	0010	0011	0000	0010			
81	21	23 hex		02 hex		03 hex	00 hex	06 hex

Table 13 is set to produce a baud rate of 300, 1 stop bit, an 8 bit data word, and no parity.

RS-232 Baud Rate Change cont'd.

Baud Change; Parity, word length, stop bits.

Byte 5 (UB3)

UB3 sets the LCR register on the UART

Table 14. Byte 5 (UB3)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Divisor latch	Set break	Set parity	Even parity	Parity enable	Stop bits	Word length 1	Word length 0

Bit 7 =   1 allows baud rate divisor to be changed.
0 baud rate change is blocked.

Bit seven should not be set. The setting and resetting of this bit is handled internally.

Bit 6 =   1 forces the transmitter output to a logic 0 for alerting the remote receiver to a line break.
0 No break condition.

Bits 5, 4, 3 work together to set parity.

Table 15. Parity Setup

Bit 5	Bit 4	Bit 3	Parity Selection
X	X	0	No parity *
0	0	1	Odd parity
0	1	1	Even parity
1	0	1	Force parity "1"
1	1	1	Force parity "0"

* Setup Default Value.

RS-232 Baud Rate Change cont'd.

Bit 2 stop bit works in conjunction with bits 1 and bit 0.

Table 16. Stop Bit Setup

Bit 2	Word length (bits)	Stop bit length
0	5, 6, 7, 8	1*
1	5	1½
1	6, 7, 8	2

    * Setup default value.

Bits 1 and 0 set the word length.

Table 17. Word Length

Bit 1	Bit 2	Word length
0	0	5
0	1	6
1	0	7
1	1	8*

    * Setup default value.

External Commands

The SAE-J1939 format is based on the CAN extended data frame. A detailed breakdown of the data frame is shown in Appendix A.

The arbitration field is changed to conform to the SAE-J1939 message frame. The message frame must be broken down further before it can be sent to the 1939STB.

The format for transmitting data to the 1939STB is shown in the following table:

Table 18. J1939 Format

Message Header				Message Information							Data Payload							
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B18	B19	B20
81	21	1F	05	95	E7	0c	80	00	40	8c	41	42	43	44	45	46	47	48

The message sent to the converter is formatted as shown above. The format is divided into three sections. Each section performs a specific function as follows:

Bytes 1 through 4 (B1-B4) are internal commands for the converter. These bytes tell the converter if the following message is intended for the SAE-J1939 bus, the slot where the message should be stored on the 1939STB, and the length of the data payload.

Bytes 5 through 11 are for message control - if it is to be transmitted (data frame) or received (remote frame). This area contains the J1939 message information: priority, data page, PDU format, PDU specific, and source address. The last section is the data section. This is the data that will be sent to, or received from, the bus. It may contain 0 to 8 bytes.

Message Header Setup

Before a message can be sent to the SAE-J1939 bus, the message header must be configured to direct the data correctly. The following table shows the bytes that must be set to direct a message to the SAE-J1939 bus.

Table 19. J1939 Message Header

Message Header			
B1	B2	B3	B4
81	21	1F	05

The first two bytes are for the start of message. The third byte (B3) containing hex 1F,1 directs the message to the J1939 bus. (F) hex is the number of bytes in the payload. Byte four (B4) tells the converter in which message slot to put the message (slot 5). Valid slots are 1 through 15, but slot 15 is reserved for receive only.

Table 20. Valid Codes for Byte 3

Nibble 2	Value	Function
	1	Message directed to SAE-J1939 bus
	2	Internal commands, vender #, baud change
Nibble 1		
	0 to 15	Number of bytes to follow byte 4

Table 21. Valid Codes for Byte 4

Function	Nibble 2	Nibble 1
No function (reserved)	Value = 0	
Message slot number		Value = 1 to 15 (1 to F hex)

Each message must have a unique slot number. A message sent to the same slot number overwrites the previous message.

Message Information

Table 22. J1939 Message Information

Message Information						
B 5	B 6	B 7	B 8	B 9	B 10	B 11
95	E7	0C	80	00	40	8C

The message information controls the action of the message. It also contains the header information that will be sent out on the J1939 bus. The bytes that control the message and are not transmitted to the bus are grayed in. Byte 5 and 6 are the message control bytes. They work together to control the message. The bit fields are set up in a two bit configuration as follows: NOTE: Byte 11 covered on page 18.

Table 23. Two Bit Values for Byte 5 and 6

Value of 2 bit field		Function on write	Function on read
0	0	Reserved	Reserved
0	1	Reset element	Element is reset
1	0	Set element	Element is set
1	1	No change	Reserved

The bit values shown in gray are the only values valid for the setup of the 1939STB.

Byte 5

Table 24. Byte 5

Bit Function	Byte 5							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	MSGVAL		TXIE		RXIE		INTPND	
Sets the message valid	1	0						
Sets the message invalid	0	1						
Transmit interrupt set			1	0				
Transmit interrupt not set			0	1				
Receive interrupt set					1	0		
Receive not set					0	1		
Interrupt has occurred							1	0
No interrupt pending							0	1

NOTE: The dark gray (white letters) should be set to this value when sending a new message to the 1939STB.

MSGVAL Bits 6 and 7
Message Valid. The message must be valid before any operations can be preformed on it. Messages can be preloaded on the converter and activated / deactivated as needed. Note that all messages locations are set invalid at power up. Any time the converter is reset, all message information is lost.

TXIE Bits 5 and 4
Transmit Interrupt Enable. Set bit(s) INTPND after a message is successfully sent to the bus.

RXIE Bits 3 and 2
Receive Interrupt Enable. Set bit(s) INTPND after a message is received from the bus. NOTE: It is possible to send a remote frame by setting both the TXIE and RXIE. The controller will clear the TXIE after the message is sent or if the data is received before the message can be sent.

INTPND Bits 1 and 0
     Interrupt Pending. Indicates that a message object has generated an interrupt request. Be aware that when a message is being serviced by the controller, it is temporarily inactive. This prevents a message from being overwritten by the J1939 controller while the message is being loaded to the serial port. During the upload the message location cannot receive or transmit.

Byte 6

Table 25. Byte 6

Bit Function	Byte 6							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	RMTPND		TXRQ		MSGLIST/CPUUPD		NEWDAT	
Remote Pending	1	0						
	0	1						
Transmit Request			1	0				
			0	1				
Message lost/ CPU update					1	0		
					0	1		
New data in message slot							1	0
							0	1

NOTE: the dark gray (white letters) should be set to this value when sending a new message to the 1939STB.

RMTPND Bits 7 and 6

    Remote Pending (used for messages that are to be transmitted). Indicates that the transmission of this object has been requested by a remote node, but the data has not been sent yet. When RMTPND is set the controller also sets TXRQ. Both RMTPND and TXRQ are cleared when the message has been sent successfully.

TXRQ Bits 5 and 4

Transmit Request. This message is in the process of being transmitted and is not finished yet.

MSGLST/CPUUPD Bits 3 and 2

This pair of bits has a dual function based on its direction.

Receive

MSGLST. Message Lost indicates the J1939 controller has stored a new message into this location while NEWDAT was set. The previous message was overwritten. This can occur for several reasons. The MPU was busy doing other tasks, transmitting a serial message, error checking or servicing a message with a higher slot number.

Transmit

CPUUPD. CPU update inhibits the transmission of a message while the CPU updates the information. It can also be used to control the automatic transmission of a message.

NEWDAT Bits 1and 0
Indicates if new data has been written into this slot by either the bus
controller (receive messages) or the controller (transmit objects).

Byte 11

Table 26. Byte 11

Byte 11								
Bit Function	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DLC				DIR	XTD		
Number of data bytes (0 to 8)								
Message direction: Transmit					1			
Message direction: Receive					0			
Extended identifier must be 1						1		
Bit not used set to 0							X	
Bit not used set to 0								X

DLC Bits 7, 6, 5 and 4
    Data length code. The number of data bytes in the message.

DIR Bit 3
    Direction. Defines if a message is transmit or receive.

    Bit Set = 1
    Transmit on reception of a remote frame matching the identifier.

    Bit = 0
    Receive. When a message is received with an identifier that matches the
    identifier of the message stored in this slot the data is stored in this slot.

XTD Bit2
    Extended identifier. This bit should always be set to 1. Bits 1 and 0 are
not used. To send a remote frame to Request Data, set up the message slot to
Receive Mode, then set TXRQ (10). This will be cleared by the control once
the data is sent or if the data is received before the remote frame could be
transmitted.

SAE-J1939 Control Header

Bytes 7 though 10 are the bytes that set the header information ("Arbitration Field" in the following table) for the SAE-J1939 bus. The areas shown in Table 27 in dark gray are set by the CAN specification and are NOT modified by SAE-J1939.

Table 27. J1939 Message Frame

ARBITRATION FIELD						CONTROL			DATA	CRC	ACK	EOF
S O F	Identifier (11 Bits)	S R S	I D E	Identifier Extension (18 Bits)	R T R	R 1	R 0	D L C				
1	11 Bits	1	1	18 Bits	1	6 Bits			64 Bits	16 Bits	2 Bits	7 Bits

The frame above shows the entire J1939/CAN frame.

Table 28 on the following page shows the Arbitration field in detail. Dark gray areas are part of the CAN standard and are set by the controller. The double black lines separate the CAN message identifiers (upper part) from the SAE-J1939 message identifiers (lower part). The area between the black lines highlighted in dark gray/white letters shows the bytes that must be entered to set up the SAE-J1939 message header. In the back of the manual you will find a worksheet, (Appendix A) and an example (Appendix B) to help set up the message header.

Table 28. J1939 Message Frame (Expanded)

Arbitration Field

	SOF	Identifier (11 Bits)					SRS IDE	Identifier Extension (18 Bits)			RTR
Bit width	1	11 Bits					1 1	18 Bits			1
Byte bits		7 6 5 4 3 2 1 0	7 6 5 (Byte 8)					4 3 2 1 0 7 6 5 4 (Byte 8 / Byte 9)	3 2 1 0 7 6 5 4 (Byte 9)	3 2 1 0 7 6 5 4 5 (Byte 10)	
Byte label		Byte 7	Byte 8					Byte 8	Byte 9	Byte 10	
Sub-field		Priority (3 Bits)	R 1	D P	PDU Format (8 Bits)			PF cont	PDU Specific (8 Bits)	Source Address	
Frame bit #	1	2 3 4	5	6	7 8 9 10 11 12		13 14	15 16	17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32	33

Byte 7

(Shown in Table 29)

Bits 7, 6, and 5 of byte 7 set the J1939 priority bits. Bit 7 is the MSB. Bit 5 is the LSB. To code a priority value = 6 set bit 7 = 1 bit 6 = 1 bit 5 = 0.

Bit 4 is the reserved bit - the J1939 specification sets this bit to zero. It may be used in the future therefore it is NOT hard coded. The user must set this bit to zero for every transmitted J1939 message.

Bit 3 is the data page bit and select page 0 or page 1and is set by the user.

Bits 2, 1, 0, are the MSB's of the PDU format.

Table 29. JI939 Message Frame (Expanded)

Arbitration Field

Field	Bit count	Byte(s)	Sub-fields	Bit labels	Positions
SOF	1			1	1
Identifier (11 Bits)	11 Bits	Byte 7 / Byte 8	Priority (3 Bits); R = 1; DP; PDU Format (8 Bits)	7 6 5 4 3 2 1 0 7 6 5	2 3 4 5 6 7 8 9 10 11 12
SRR	1			1	13
IDE	1			1	14
Identifier Extension (18 Bits)	18 Bits	Byte 8 / Byte 9 / Byte 10	PF cont; PDU Specific (8 Bits); Source Address (8 Bits)	4 3 2 1 0 7 6 5 4 3 2 1 0 7 6 5 4 3	15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
RTR	1			1	33

Byte 8

(Shown in Table 30)

Bits 7, 6, 5, 4, and 3 of Byte 8 along with Bits 2, 1, and 0 of Byte 7 make up the first part of the PDU (Protocol Data Unit). The first 8 bits are the PDU format. The values for specific formats will have to be supplied by the user.

Bits 2, 1, and 0 of Byte 8 and bits 7, 6, 5, 4, and 3 of Byte 9 make up the second part of the PDU. The eight bits are the PDU specific. Values for the PDU specific will have to be supplied by the user .

NOTE: It is a common practice to combine the first and second parts of the PDU into a single number. When given the PDU as a single number, bit 2 of byte 7 is the MSB and bit 3 of byte 9 is the LSB.

Table 30. J1939 Message Frame (Expanded)

Arbitration Field

Bit Number	Frame Field	Sub-Field	Byte	Bit	Value
1	SOF				1
2	Identifier (11 Bits)	Priority (3 Bits)	Byte 7	7	
3	Identifier (11 Bits)	Priority (3 Bits)	Byte 7	6	
4	Identifier (11 Bits)	Priority (3 Bits)	Byte 7	5	
5	Identifier (11 Bits)	R	Byte 7	4	1
6	Identifier (11 Bits)	DP	Byte 7	3	
7	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 7	2	
8	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 7	1	
9	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 7	0	
10	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 8	7	
11	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 8	6	
12	Identifier (11 Bits)	PDU Format (8 Bits)	Byte 8	5	
13	SRR				1
14	IDE				1
15	Identifier Extension (18 Bits)	PF cont	Byte 8	4	
16	Identifier Extension (18 Bits)	PF cont	Byte 8	3	
17	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 8	2	
18	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 8	1	
19	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 8	0	
20	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 9	7	
21	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 9	6	
22	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 9	5	
23	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 9	4	
24	Identifier Extension (18 Bits)	PDU Specific (8 Bits)	Byte 9	3	
25	Identifier Extension (18 Bits)	Source Address	Byte 9	2	
26	Identifier Extension (18 Bits)	Source Address	Byte 9	1	
27	Identifier Extension (18 Bits)	Source Address	Byte 9	0	
28	Identifier Extension (18 Bits)	Source Address	Byte 10	7	
29	Identifier Extension (18 Bits)	Source Address	Byte 10	6	
30	Identifier Extension (18 Bits)	Source Address	Byte 10	5	
31	Identifier Extension (18 Bits)	Source Address	Byte 10	4	
32	Identifier Extension (18 Bits)	Source Address	Byte 10	3	
33	RTR				1

Bytes 9 and 10

(Shown in Table 31)

Bits 7, 6, 5, 4 and 3 complete the PDU.

Bits 2, 1, and 0 of byte 9 and bits 7, 6, 5,and 4 of byte 10 are the Source Address for the converter. Each Source Address MUST be unique. SAE J1939-81 describes address management and allocation in detail and should be consulted before connecting to a J1939 bus. Addresses 249 and 250 are designated for offboard diagnostic service tools. WARNING: These addresses are SUGGESTED. The procedure described in SAE J1939-81 should be followed when connecting to any unknown bus.

Table 31. JI939 Message Frame (Expanded)

Arbitration Field

Field	SOF	Identifier (11 Bits)				SRS	IDE	Identifier Extension (18 Bits)			RTR
		Priority (3 Bits)	R / 1 — D / P	PDU Format (8 Bits)				PF cont	PDU Specific (8 Bits)	Source Address	
Byte		Byte 7		Byte 7 / Byte 8				Byte 8	Byte 9	Byte 10	
Value	1					1	1				1

Bit labels:

SOF	7	6	5	R / 1	D / P	2	1	0	7	6	5	SRS / 1	IDE / 1	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	RTR
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

Byte 11

Table 32. J1939 Message Information

Message Information						
B 5	B 6	B 7	B 8	B 9	B 10	B 11
95	E7	0C	80	00	40	8C

Table 33. J1939 Message Control

Message Information						
B 5	B 6	B 7	B 8	B 9	B 10	B 11
95	E7	0C	80	00	40	8C

Byte 11

Byte 11 is not sent to the J1939 bus and is coded as follows:

Table 34.   Byte 11

DLC				DIR	XTD		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

DLC Data Length Code

Number of bytes 0 to 8 in the data payload.

DIR Message Direction

DIR = 1 transmit. The loaded message is transmitted.
DIR = 0 receive. A remote frame with a matching identifier.
The message is stored in this message location.

XTD Extended IdentifierXTD = 1 Extended frame
This bit should always be set to one.

XTD = 0 Standard frame
J1939 does not support standard frames.

Data Field

The next 8 bytes are the data field and can have from 0 to 8 bytes used. This is the data payload.

Table 35. J1939 Message Frame

Arbitration Field						Control			Data	CRC	ACK	EOF
S O F	Identifier (11 bits)	S R S	I D E	Identifier Extension (18 bits)	R T R	R 1	R 0	D L C				
1	11 bits	1	1	18 bits	1	6 bits			64 bits	16 bits	2 bits	7 bits

The remaining fields are handled by the controller and are not accessible through the converter.

Reception of Data

The 1939STB sends data to the RS-232 port and onto the PC using a 16 byte format. The first byte of the message is 42hex. The next byte is the Function byte. The next field displays the SAE-J1939 header. If an internal message is received then this field is filled with zero. The receive message header is detailed below.

Table 36. Message Received from the SAE-J1939 Bus

ID	Func	J1939 Address				MC	Data								
4 2	09	C	80	00	40	1 E	41	42	43	44	45	46	47	48	F F
4 2	28	0 0	00	00	00	0 0	A A								A A

Table 36 shows the receive message. The black line separates the two types of messages that the 1939STB produces. Each message is detailed separately below.

SAE-J1939 Bus

Referring to Table 36 this is a message received from the SAE-J1939 bus. The first byte (ID) is the start of frame byte and is fixed at 42hex. The next byte is a function code byte. This byte is broken into two nibbles and decoded as follows:

Table 37. Function

Nibble 2				Nibble 1			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

The gray area shown in Table 36 is information that was not received from the bus, but is needed to track the message.

ID Byte
This is a start of a message and will always be 42Hex.

Function

This is used to show where the message came from. Refer to Table 37. If the Nibble 2 is set to 0, then the message is from the J1939 bus. If Nibble 2 is set to 2, it is an internal message (for example, Vendor ID).

Table 38. MC

Nibble 2				Nibble 1			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

MC

This is a byte from the controller. Nibble 2 is the number of data bytes (0-8) in the message. Nibble 1, Bit 3 is the message direction. Bit 2 should always be set to 1. Bit 1 and 0 are not used.

Internal Messages

Table 39. Message Received from the SAE-J1939 Bus

ID	Func	J1939 Address				MC	Data								
42	09	C	80	00	40	1E	41	42	43	44	45	46	47	48	FF
42	28	00	00	00	00	00	AA								AA

Table 39 shows the data received from the J1939 bus highlighted in gray. The bytes (C,80,00,40) are the J1939 priority, reserve bit, data page, and PDU. The data field contains the data payload of the message and be from 0 to 8 bytes.

The message starts with 42 hex. The function code is 28 hex. This identifies the message as an internal message 2 and type 8. The J1938 Address field is set to 0. The Data field has an AA hex at either end. The data between is variable.

Software

The program included with the 1939STB is a Visual Basic program that allows the transmission and reception of simple messages from the SAE-J1939 bus. The source code for the program is included on the disk to aid in program development.

Installation

Two disks are provided with the 1939STB. Disk one is installed first.
Start Windows and insert the disk in A: drive.
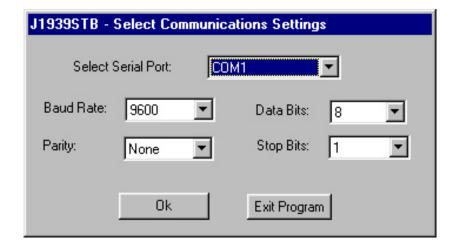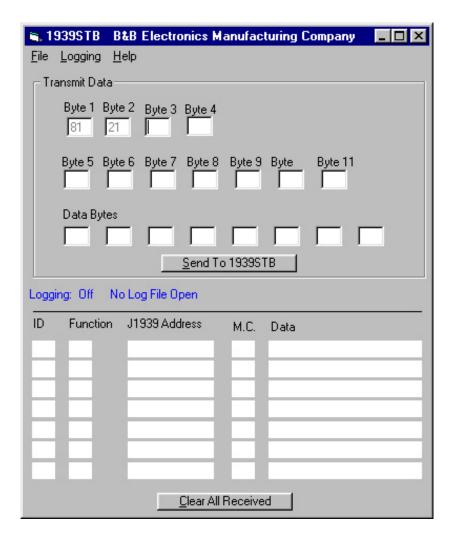Click on the Start icon.
Then click on the Run icon.
In the box type "a:setup".
Follow the screen instructions.

If you follow all the default settings the program will be under
Start/ Programs/ B&B Electronics / J1939stb.

After installing the program use the icon to start the program. The first screen sets the PC's com port. Choose the serial port where the 1939STB is connected. The default baud setting should be used. Click on enter to get to the next screen.

      This screen is divided into two parts. The upper half of the screen allows the user to fill out the individual bytes that configure the 1939STB. The lower part of the screen displays data received from the 1939STB.

Message Transmission
(sending data to the 1939STB)

The transmission window is divided into three rows. The first row is the internal header information. The second row contains message control information. The third row is the data payload sent with the information.

The first row has 4 bytes. Bytes 1 and 2 are set to 8 and 21 hex. All data is entered in hex. The next two bytes, 3 and 4, are set by the user. Refer to pages 6 and 7 of this manual for help setting theses two bytes. Setting a byte is done by clicking in the box under the label and entering the proper hex value. All values in this row must contain information or the message will be rejected.

The second row contains bytes 5 though 11. These bytes are set by the user. All values are entered in hex. All of the bytes in this row do NOT have to contain data for the message to be accepted.

The last row is the data payload that is transmitted with an SAE-J1939 message. This row may contain data or left blank.

Message Reception

To receive information from the SAE-J1939 bus, the user must program the 1939STB to receive a message. This is done by first sending a receive message to the 1939STB. Page 18 explains how to configure a message to receive data. After the proper byte codes are entered into the 1939STB, the device "listens" on the SAE-J1939 bus for a message that matches the identity code of the reception message. The message header information and data are displayed in the lower window. The incoming data will fill in the slots from top to bottom. Once the data moves off the page it is lost. If a permanent copy of the data is needed use "Data Logging".

NOTE: MicroSoft Visual Basic only allows a buffer of approximately 3K. You must manually clear the Receive Message buffer or you will get a buffer overflow error.

Saving Message Information

      To save a configuration: "the byte data"
Click on File at the top of the page. When the box opens click on Save.
When the next box opens select a directory where the file should be stored
and name the file. Click Save. The file is saved.

    To recall the information in a previously saved file use the File import
command. Select the name of the file you wish to use. Click on Open. The
data will be loaded into the Transmit window.

File Logging

    File logging allows the user to save the data from the receive window. To
start data logging, click on Logging at the top of the page. Use SelectFile to
set up the file to hold the information. Data logging is started/stopped by
clicking on Toggle located on the Logging tab.

Appendix A. The Extended CAN / SAE-J1939 Message Frame

Arbitration Field								Control Field		Data Field	CRC Field	Ack Field	EOF
	Identifier (11 bits)				Identifier Extension (18 Bits)				DLC				
S C F	1 2 3 4 5 6 7 8 9 10 11	S F S	I I E	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	F T F	F 1	F C	1 2 3 4	8 bytes 64 bits	2 bytes 16 bits		
	Priority (3 bits)	R1	DP	PDU Format (PF) (8 bits)	PF Cont	PDU Specific (PS) (8 Bits)	Source Address (8 Bits)						
1	2 3 4 5 6 7 8 9 10 11 12	13	14	15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	33	34	35	36 37 38 39				

The table above shows a comparison between the SAE-J1939 message frame and the extended CAN message frame.
The bold line separates the upper and lower parts of the table. The upper half of the table shows the CAN data frame labels and the lower part of the table contains the SAE-J1939 data labels. The areas that are in gray are controlled by the CAN controller and cannot be altered.

The CAN extended frame is made up of 6 fields: Arbitration, Control, Data, CRC, ACK, EOF. The arbitration field is subdivided into two fields of 11 and 18 bit identifiers. CAN uses these fields to determine both identification and priority.

The SAE-J1939 specification future subdivides the arbitration field as follows:

Priority   3 bits with a value of 0 to 7 - with 0 having the highest priority.

R1   1 bit. This bit is reserved by the SAE for future use and should be set to 0.

DP Data Page   1bit. Sets an auxiliary page of parameter groups.

PDU-Format   8 bit. One of the fields that makes up the Parameter Group Number.

PDU-Specific   8 bit. The second field the makes up the Parameter Group Number.

Source Address   8 bit. The address of the sending/receiving node.

The fields above are required to send a message on the SAE-J1939 bus. Additionally the 8 byte data field may or may not contain data.

An expanded view of the Arbitration field is shown on the following page.

Arbitration Field

SOF	Priority 3 Bits			R1 *	DP	PDU Format (PF) 8 Bits						SRS	IDE	PF Cont.		PDU Specific 8 Bits								Source Address 8 Bits (See note below.)								RTR
X	1	1	0	0	0	1	1	1	1	0	0	X	X	0	0	0	0	0	0	0	1	1	0									X
X	1	2	4	5	6	7	8	9	10	11	12	X	X	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	X
X	Byte 7								Byte 8			X	X	Byte E 8 cont.					Byte 9									Byte 10				X
X	7	6	5	4	3	2	1	0	7	6	5	X	X	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	X
X												X	X																			X
X												X	X																			X

* R1 is the reserved bit. ALL messages should set the SAE reserved bit to 0 on transmit.

The frame above represents the J1939 frame and shows how the data is coded, to be entered into the frame.
The bits marked with an X are set by the controller and are NOT settable by the user and can be ignored.

The easiest way to fill this out is to start at SOF bit, fill in the priority bits (3), the R1 bit, the data page DP bit and so on.
After all 30 bits are set, break apart the bits in bytes following the separation highlighted in gray.
The bytes are converted to hex and can be entered into the communication program provided by B&B as follows:

NOTE: The bytes in the rest of the message (bytes 3, 4, 5, 6, and 11) must be filled out for the message to operate properly.

Appendix B. Example

This example uses the SAE "Electronic Axle Controller #1" (EAC#1). The specifications are as follows:

Transmission Repetition Rate:	500 ms
Data Length:	8 bytes
Data Page:	0
PDU Format:	240
PDU Specific:	5
Default Priority:	6
Parameter Group Number:	61,446 (00F006) hex
Source Address:	249 (off-board diagnostic / service tool #1). See note below.

S O F	Priority 3 Bits			R 1 *	D P	PDU Format (PF) 8 Bits							S R S	I D E	PF Cont.		PDU Specific 8 Bits								Source Address 8 Bits (See note below.)								R T R
X	1	2	3	1	1	1	2	3	4	5	6	X	X	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	X
X	1	2	4	5	6	7	8	9	10	11	12	X	X	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	X
X	Byte 7							Byte 8			X	X	Byte 8 cont.				Byte 9								Byte 10							X
X	7	6	5	4	3	2	1	0	7	6	5	X	X	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	X
X	1	1	0	0	0	1	1	1	1	0	0	X	X	0	0	0	0	0	0	0	1	0	1									X
X												X	X																			X

* R1 is the reserved bit. ALL messages should set the SAE reserved bit to 0 on Transmit.

Byte 7 Binary								Convert to Hex	Convert to Decimal
7	6	5	4	3	2	1	0		
1	1	0	0	0	1	1	1	C7	199

The hex number is the value sent to the 1939STB.

NOTE: See SAE J1939–81 for Source Address management.