
STN1100

Multiprotocol OBD-II to UART Interpreter

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1.0 Overview

On-Board Diagnostics, Second Generation (OBD-II) is a set of standards for implementing a computer based system to control emissions from vehicles. It was first introduced in the United States in 1994, and became a requirement on all 1996 and newer US vehicles. Other countries, including Canada, parts of the European Union, Japan, Australia, and Brazil adopted similar legislation. A large portion of the modern vehicle fleet supports OBD-II or one of its regional flavors.

Among other things, OBD-II requires that each compliant vehicle be equipped with a standard diagnostic connector (DLC) and describes a standard way of communicating with the vehicle's computer, also known as the ECU (Electronic Control Unit). A

wealth of information can be obtained by tapping into the OBD bus, including the status of the malfunction indicator light, diagnostic trouble codes, Inspection and Maintenance (I/M) information, freeze frames, VIN, hundreds of real-time parameters, and more.

The STN1100 is an OBD to UART interpreter that can be used to convert messages between any of the OBD-II protocols currently in use, and UART. It is fully compatible with the *de facto* industry standard ELM327 command set. Based on a 16-bit processor core running at 40 millions instructions per second, with 128 Kbytes of ROM and 8 Kbytes of RAM, the STN1100 offers more features and better performance than any other ELM327 compatible IC.

2.0 Feature Highlights

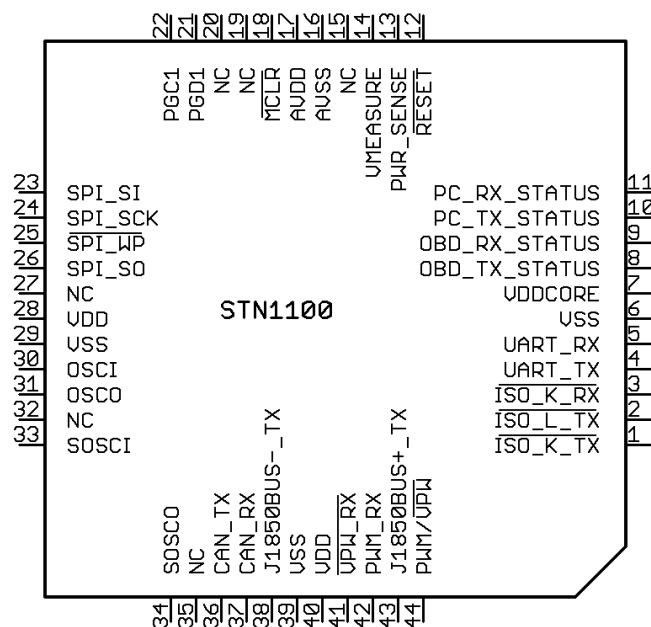
- Fully **compatible with the ELM327** "AT" command set
- **Extended "ST" command set**
- **UART interface** (baud rates up to 10 Mbps⁽¹⁾)
- Secure **bootloader** for easy firmware updates
- Support for **all legislated OBD protocols**:
 - ISO15765-4 (CAN)
 - ISO14230-4 (Keyword Protocol 2000)
 - ISO9141-2 (Asian, European, Chrysler vehicles)
 - J1850 VPW (GM vehicles)
 - J1850 PWM (Ford vehicles)
- Support for **non-legislated OBD protocols**:
 - ISO 11898 (raw CAN)
- Superior **automatic protocol detection** algorithm
- **Large memory buffer**
- Voltage input for **battery monitoring**
- Available in **TQFP-44** and **QFN-44** packages

Note 1: Maximum theoretical baud rate. Actual maximum baud rate is application dependent and may be limited by driver hardware.

3.0 Typical Applications

- Academic projects
- Automotive diagnostic scan tools and code readers
- Digital dashboards
- Fleet management and tracking applications
- OBD data loggers

4.0 Pinout



5.0 Pin descriptions

Pin #	Pin Name	Pin Type	Pin Description
1	ISO_K_TX	O	Active low K-line transmit for ISO9141/ISO14230.
2	ISO_L_TX	O	Active low L-line transmit for ISO9141/ISO14230.
3	ISO_RX	I	Active low receive for ISO9141/ISO14230.
4	UART_TX	O	UART transmit.
5	UART_RX	I	UART receive.
6	VSS	P	Ground.
7	VDDCORE	P	3.3V.
8	OBD_TX_STATUS	O	OBD transmit activity status pin.
9	OBD_RX_STATUS	O	OBD receive activity status pin.
10	PC_TX_STATUS	O	UART transmit activity status pin.
11	PC_RX_STATUS	O	UART receive activity status pin.
12	RESET	I	Not implemented in this version, do not connect.
13	PWR_SENSE	I	Not implemented in this version, do not connect.

14	VMEASURE	A	Measures battery voltage.
15	NC	—	Do not connect.
16	AVSS	P	Analog ground.
17	AVDD	P	Analog positive supply.
18	MCLR	I/P	Active low Master Clear.
19	NC	—	Do not connect.
20	NC	—	Do not connect.
21	PGD1	I/O	ICSP programming data.
22	PGC1	I	ICSP programming clock.
23	SPI_SI	I	Not implemented in this version, do not connect.
24	SPI_SCK	O	Not implemented in this version, do not connect.
25	SPI_WP	O	Not implemented in this version, do not connect.
26	SPI_SO	O	Not implemented in this version, do not connect.
27	NC	—	Do not connect.
28	VDD	P	+3.3V.
29	VSS	P	Ground.
30	OSCI	I	Oscillator crystal input.
31	OSCO	O	Oscillator crystal output.
32	NC	—	Do not connect.
33	SOSCI	I	Not implemented in this version, do not connect.
34	SOSCO	O	Not implemented in this version, do not connect.
35	NC	—	Do not connect.
36	CAN_TX	O	CAN transmit for ISO15765-4.
37	CAN_RX	I	CAN receive for ISO15765-4.
38	J1850BUS-_TX	O	J1850 Bus- transmit.
39	VSS	P	Ground.
40	VDD	P	+3.3V.
41	VPW_RX	I	Active low J1850 VPW receive.
42	PWM_RX	I	J1850 PWM receive.
43	J1850BUS+_TX	O	J1850 Bus+ transmit.

44	PWM/VPW	O	J1850 PWM/VPW mode select.
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Legend

—	Unused pin	I/O	Input/output
A	Analog input	O	Output
I	Input	P	Power

6.0 Absolute Maximum Ratings

Reference Microchip PIC24HJ128GPX04 datasheet.

7.0 Electric Characteristics

Reference Microchip PIC24HJ128GPX04 datasheet.

8.0 Communicating with the STN1100

The STN1100 uses a three-wire UART connection that is CMOS/TTL compatible. The UART settings are:

- 38400 baud (default)
- 8 data bits
- No parity bit
- One stop bit
- No handshaking

The baud rate is software-selectable (see AT BRD).

Note: The UART Tx pin is configured as an open drain output and requires a 10 k Ω pull-up resistor. Maximum pull-up voltage is 5 volts.

Once powered and connected, the STN1100 will display the welcome prompt:

```
ELM327 v1.3a
```

```
>
```

The STN1100 sends the '>' ("prompt") character, to signal that it is ready for more input. By default, the prompt character is preceded by a carriage return (0x0D). The user software should always wait for the prompt before sending the next command.

There are three types of commands recognized by the STN1100: **AT commands**, **ST commands**, and **OBD requests**.

The STN1100 is designed to fully emulate the ELM327 **AT command set** supported by many existing software applications. AT commands begin with "AT" and are intended for the IC. They cause the STN1100 to carry out some action – change or display settings, perform a reset, and so on. A list of supported "AT" commands can be found in section 9.

In order to provide additional functionality while maintaining compatibility with the ELM327 command set, the STN1100 supports an alternative **ST command set**, described in section 10.

OBD requests are messages that are sent to the OBD bus. Only ASCII hexadecimal digits (0-9 and A-F) are allowed in OBD requests.

Only ASCII alpha characters, numbers, backspaces, and the carriage return are accepted on the UART, spaces are ignored. All commands must terminate with a carriage return (0x0D).

By default, responses from the STN1100 are terminated with a carriage return (0x0D). AT L1 command can be used to have the STN1100 append linefeeds (0x0A) to the carriage returns.

Sending a single carriage return character repeats the last command.

9.0 AT Commands

This section lists the AT commands supported by the STN1100. Every effort was made to maintain compatibility with legacy ELM327 software, and for most purposes, these commands work exactly as

described in the ELM327 datasheet. Please refer to the "AT Commands" section of the ELM327 datasheet for the complete description of the AT command set.

General Commands		
Command	Description	Status
<CR>	Repeat last command	supported
BRD hh	Try baud rate divisor hh	supported
BRT hh	Set baud rate timeout	supported
D	Set all settings to defaults	supported
E0/1	Echo off, or on*	supported
FE	Forget events	not applicable
I	Print ELM327 version ID string	supported ⁽¹⁾
L0/1	Linefeeds off*, or on	supported
M0/1	Memory off, or on*	supported
WS	Warm start	supported
Z	Reset device	supported
@1	Print manufacturer string	supported
@2	Display device identifier	supported ⁽²⁾
@3	Store device identifier	not supported

Programmable Parameter Commands		
Command	Description	Status
PP xx OFF	Disable PP xx	supported
PP FF OFF	All PPs off	supported
PP xx ON	Enable PP xx	supported
PP FF ON	All PPs on	supported
PP xx SV yy	For PP xx, set value to yy	supported
PPS	Print PP summary	supported

Voltage Reading Commands		
Command	Description	Status
CV dddd	Calibrate voltage to dd.dd volts	supported
RV	Read voltage	supported

OBD Commands		
Command	Description	Status
AL	Allow long (>7 byte) messages	supported
AR	Automatically receive	supported
AT0/1/ 2	Adaptive timing off, auto1*, auto2	supported

BD	Buffer dump	not applicable
BI	Bypass initialization sequence	supported
DP	Describe current protocol	supported
DPN	Describe current protocol by number	supported
H0, H1	Headers off*, or on	supported
MA	Monitor all	supported
MR hh	Monitor for receiver hh	supported
MT hh	Monitor for transmitter hh	supported
NL	Normal length messages* (7 bytes max)	supported
PC	Protocol close	supported
R0/1	Responses off, or on*	supported
RA hh	Set the receive address to hh	supported
S0/1	Print spaces off/on*	supported
SH hhh	Set header to hhh	supported
SH hh hh hh	Set header to hh hh hh	supported
SP h	Set protocol to h and save it	supported ⁽³⁾
SP Ah	Set protocol to h with auto search and save it	supported ⁽³⁾
SR hh	Set receive address to hh	supported
ST hh	Set timeout to hh x 4 msec	supported
TP h	Try protocol h	supported ⁽³⁾
TP Ah	Try protocol h with auto search	supported ⁽³⁾

J1850 Specific Commands (protocols 1 and 2)

Command	Description	Status
IFR0/1/2	IFRs off, auto*, or on	supported
IFR h/S	IFR value from header* or source	supported

ISO Specific Commands (protocols 3 to 5)

Command	Description	Status
IB 10	Set ISO baud rate to 10400*	supported
IB 96	Set ISO baud rate to 9600	not supported
IIA hh	Set the ISO (slow) init address to hh	supported
KW	Display ISO key word	supported
KW0/1	Key word checking off, or on*	supported
SW hh	Set wakeup interval to hh x 20 msec	supported
WM [1-6 bytes]	Set wakeup message	supported

CAN Specific Commands

Command	Description	Status
CAF0/1	Automatic formatting off, or on*	supported
CF hhh	Set ID filter to hhh	supported

CF hh hh hh hh	Set ID filter to hh hh hh hh	supported
CFC0/1	Flow control off/on	supported
CM hhh	Set ID mask to hhh	supported
CM hh hh hh hh	Set ID mask to hh hh hh hh	supported
CP hh	Set CAN priority to hh (29 bit only)	supported
CRA hhh	Set CAN receive address to hhh	supported
CRA hh hh hh hh	Set CAN receive address to hh hh hh hh	supported
CS	Show CAN status counts	supported
D0/1	Display of the DLC off*, or on	supported
FC SM h	Flow control, set mode to h	supported
FC SH hhh	Flow control, set header to hhh	supported
FC SH hh hh hh hh	Flow control, set header to hh hh hh hh	supported
FC SD [1-5 bytes]	Flow control, set data to [...]	supported
RTR	Send an RTR message	supported
V0/1	Use of variable DLC off*, or on	supported

J1939 CAN Specific Commands (protocols A to C)

Command	Description	Status
DM1	Monitor for DM1 messages	not supported
JE	Use J1939 ELM data format*	not supported
JS	Use J1939 SAE data format	not supported
MP hh hh	Monitor for PGN 0hhhh	not supported
MP hh hh hh	Monitor for PGN hhhhhh	not supported

Note 1: ID string corresponds to the version of the ELM327 IC that OBDLink CI is designed to be compatible with (e.g., "ELM327 v1.3a")

Note 2: Each OBDLink CI device comes preprogrammed with a unique 12 digit device identifier. The AT @2 command responds with:

ddddsssssss

where *ddd* is the device ID and *sssssss* is the device serial number.

Note 3: The STN1100 only supports protocols 1 through 9. However, to maintain compatibility, setting protocol number to any valid ELM327 protocol causes OBDLink to print "OK". Attempts to send messages on unsupported protocols will result in NO DATA being returned by the scan tool.

9.1 Supported ELM327 Programmable Parameters

Programmable parameters are configuration values stored in non-volatile memory. Please refer to the “Programmable Parameters” section of the

ELM327 datasheet for a full description of this functionality.

Programmable Parameters				
PP	Description	Values	Default	Type
00	Perform AT MA after power up or reset	00 = ON FF = OFF	FF (OFF)	R
01	Printing of header bytes (AT H default setting)	00 = ON FF = OFF	FF (OFF)	D
02	Allow long messages (AT AL default setting)	00 = ON FF = OFF	FF (OFF)	D
03	NO DATA timeout time (AT ST default setting) setting = value x 4.096 msec	00 to FF	32 (205 msec)	D
04	Default adaptive timing mode (AT AT setting)	00 to 02	01	D
06	OBD Source (Tester) Address.	00 to FF	F1	R
07	Last protocol to try during automatic searches	01 to 0C	09	I
09	Character echo (AT E default setting)	00 = ON FF = OFF	00 (ON)	R
0A	Line feed character	00 to FF	0A	R
0D	Carriage return character	00 to FF	0D	R
10	J1850 voltage settling time Setting = value x 4.096 msec	00 to FF	0D (53 msec)	I
13	Auto search time delay between protocols 1 & 2 Setting = value x 4.096 msec	00 to FF	32 (205 msec)	I
17	ISO wakeup message rate (AT SW default setting) setting = value x 20.48	00 to FF	92 (2.99 sec)	D
18	Auto search time delay between protocols 4 & 5 setting = value x 4.096 msec	00 to FF	00 (no delay)	I
24	CAN auto formatting (AT CAF default setting)	00 = ON FF = OFF	00 (ON)	D
25	CAN auto flow control (AT CFC default setting)	00 = ON FF = OFF	00 (ON)	D
26	CAN filler byte (used to pad out messages)	00 to FF	00	D
29	Printing of CAN data length (DLC) when printing header bytes (AT D0/1 default setting)	00 = ON FF = OFF	FF (OFF)	D

10.0 ST Commands

ST commands are designed to provide extended functionality, without breaking compatibility with the

ELM327 AT command set. Both command sets are available simultaneously.

General	
Command	Description
I	Print OBDLink version ID string (e.g., "OBLink v1.2.3")

Filtering	
Command	Description
CAFCP [ttt] ,[rrr]	Add flow control 11-bit ID pair.
CCFCP	Clear all Flow Control 11-bit ID Pairs.
FAP [pattern] , [mask]	Add pass filter.
FAB [pattern] , [mask]	Add block filter.
FAFC [pattern] , [mask]	Add flow control filter.
FCP	Clear all Pass filters.
FCB	Clear all Block filters.
CFC	Clear all Flow Control filters.

10.1 General ST commands

I
Prints OBDLink version ID string (currently "OBLink v1.0.0").

10.2 Filtering ST commands

STN1100 supports pass, block, and flow control filters. Each of the Add commands dynamically allocates a block of RAM to store the filter, and can return OUT OF MEMORY error if there is not enough memory to add the filter. If this occurs, OBD requests may start returning the same error because the OBD memory buffer is located in the same RAM.

CAFCP [ttt], [rrr]

Add a flow control 11-bit CAN ID pair. Takes two three-digit parameters: [ttt] is transmitter ID, and [rrr] is receiver ID. For example, STCAFCP 7E0,7E8.

FAP [pattern], [mask]

Add a pass filter. Takes two parameters: pattern and mask. Pattern and mask can be any length from 0 to 5 bytes (0 to 10 ASCII characters), but both have to be the same length. The messages are matched MSB first, up to the filter length. Messages shorter than the filter length, will not match that filter.

If an odd number of ASCII characters is specified, a leading 0 will be added to the first byte. In other words,

STFAP 7E8,FFF
..is the same as
STFAP 07E8,0FFF

For 29-bit CAN, the first four bytes are CAN ID; for 11-bit CAN, the first two bytes are CAN ID.

The first 3 bits for 29-bit CAN or the first 5 bits for 11-bit CAN should be don't care (0s in mask) and/or 0s in pattern.

FAB [pattern], [mask]

Add block filter. Same syntax as STFAP.

FAFC [pattern], [mask]

Add flow control filter. Same syntax as STFAP.

FCP

Clear all pass filters.

FCB

Clear all block filters.

CFC

Clear all flow control filters.

11.0 OBD Requests

The STN1100 uses the same format for OBD requests as the ELM327. Please refer to the "OBD Commands" section of the ELM327 datasheet for information.

See the following standards for more information about legislated On-Board Diagnostics:

SAE J1979: E/E Diagnostic Test Modes. This document describes data reporting requirements of On-Board Diagnostic regulations in the United States and Europe, and any other region that may adopt similar requirements in the future. The ISO equivalent of this standard is ISO15031-5.

SAE J2190: Enhanced E/E Diagnostic Test Modes. This document describes the implementation

of Enhanced Diagnostic Test Modes, which are intended to supplement the legislated Diagnostic Test Modes defined in SAE J1979 standard. Modes are defined for access to emission related test data beyond what is included in SAE J1979, and for non-emission related data.

SAE J2178: Class B Data Communication Network Messages. This document describes the information contained in the header and data fields of non-diagnostic messages for automotive serial communications based on SAE J1850 Class B networks.

12.0 Error Messages

When hardware problems or transmission errors are encountered, the STN1100 will display an error message.

OUT OF MEMORY

This error message is displayed when there is not enough available RAM to complete the requested operation. For example, this may happen if too many filters are set.

For a list of other possible error messages and their descriptions, please refer to the "Error Messages" section of the ELM327 datasheet.

Appendix A: Revision History

Revision A (September 11, 2009)

Initial release of this document.

Appendix B: Contact Information

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