From RomRaider - Open Source ECU Tools

RomRaider: Ssm Protocol

This will only be of interest to people reverse engineering ECUs or working on software that communicates with ECUs. I don't know who originally wrote this document, but it's floating around various forums in plain text and PDF format. Both are kind of hard to read, so I've pasted it here and added some formatting to help readability.

- NSFW

Serial Settings

The subaru select monitor protocol uses an ISO9141 interface and uses UART settings: 4800 bps n, 8, 1 all data is sent and recieved using small packets that all share a common header.

Packet Structure

Maximum packet size is ~250 bytes. This includes the echoed request and response data.

Packets all follow this structure:

- 0×80
- Destination byte
- Source byte
- Data Size byte
- Command/Response byte
- data…
- Checksum byte

The known Source and Destination bytes are:

- `0x10` Subaru ECU
- `0x18` Subaru TCU/DCCD
- `0xf0` Diagnostic tool

The Data Size byte specifies the number of data bytes in the packet the Checksum byte is the 8 least significant bits of the sum of every packet byte (including the header). For example, if you send this packet:

```
0x80 0x10 0xF0 0x01 0xBF 0x40
```

…the ecu might respond with:

```
0x80 0xF0 0x10 0x39 0xFF 0xA2 0x10 0x0F 0x1B 0x14 0x40 0x05 0x05 0x73 0xFA 0xEB
0x80 0x2B 0xC1 0x02 0xAA 0x00 0x10 0x00 0x60 0xCE 0x54 0xF8 0xB0 0x60 0x00 0x00
0xE0 0x00 0x00 0x00 0x00 0x00 0xDC 0x00 0x00 0x55 0x10 0x00 0x00 0x02 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x1F
```

When sending a packet to the ECU it expects a command byte. These are the known commands:

- 0xA0 Read memory
- 0xA8 Read single address

- 0xB0 Write memory
- 0xB8 Write single address
- 0xBF ECU init

Command Types

A0 Block Read Request

A0 PP AA AA AA CC

PP == 0×00 (single response), 0×01 (respond until interrupted)

AA AA AA = address

CC == byte count - 1

A8 Address Read Request

A8 PP A1 A1 A1 A2 A2 A2 A3 A3 A3…

PP == 0×00 (single response), 0×01 (respond until interrupted)

A1 A1 A1 == address

A2 A2 A2 … == optional addresses

B0 Write Block Request

B0 AA AA AA DD DD DD DD DD …

AA AA AA == address

DD DD … == data of desired length

B8 Address Write Request

B8 AA AA AA DD

AA AA AA == address

DD == data byte

BF ECU Init Request

BF

Command Examples

Block Read: Read 128 bytes from address 0×200000 (ecu returned all zeros)

Sent:
```
0x80 0x10 0xF0 0x06 0xA0 0x00 0x20 0x00 0x00 0x7F 0xC5
```

Received:
```
0x80 0xF0 0x10 0x81 0xE0
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xE1
```

Address Read: Read Address 0×000008 and 0×00001C (ecu returns values 0×7D and 0xB1)

Sent:
```
0x80 0x10 0xF0 0x08 0xA8 0x00 0x00 0x00 0x08 0x00 0x00 0x1C 0x54
```

Received:
```
0x80 0xF0 0x10 0x03 0xE8 0x7D 0xB1 0x99
```

Block Write: Write 4 bytes to address 0×200000 (ecu returns written data)

Sent:
```
0x80 0x10 0xF0 0x08 0xB0 0x20 0x00 0x00 0x01 0x02 0x03 0x04 0x62
```

Received:
```
0x80 0xF0 0x10 0x05 0xF0 0x01 0x02 0x03 0x04 0x7F
```

Write single address: Write value 0×02 to address 0×00006F

Sent:
```
0x80 0x10 0xF0 0x05 0xB8 0x00 0x00 0x6F 0x02 0xAE
```

Received:
```
0x80 0xF0 0x10 0x02 0xF8 0x02 0x7C
```

Capability Bits

Certain bytes in the ECU Init string (returned from request 0xBF) can be examined to determine which parameters the ECU will support. The individual bits are flags that will be set to one if the parameter can be read from the ECU

(byte 9 is immediately after the 5 byte ECU ID value)

```
********** BYTE 9 **********
7 Engine Load
6 Coolant Temperature
5 Air/Fuel Correction #1
```

```
4 Air/Fuel Learning #1
3 Air/Fuel Correction #2
2 Air/Fuel Learning #2
1 Manifold Absolute Pressure
0 Engine Speed

********** BYTE 10 *********
7 Vehicle Speed
6 Ignition Timing
5 Intake Air Temperature
4 Mass Air Flow
3 Throttle Opening Angle
2 Front O2 Sensor #1
1 Rear O2 Sensor
0 Front O2 Sensor #2

********** BYTE 11 *********
7 Battery Voltage
6 Air Flow Sensor Voltage
5 Throttle Sensor Voltage
4 Differential Pressure Sensor Voltage
3 Fuel Injection #1 Pulse Width
2 Fuel Injection #2 Pulse Width
1 Knock Correction
0 Atmospheric Pressure

********** BYTE 12 **********
7 Manifold Relative Pressure
6 Pressure Differential Sensor
5 Fuel Tank Pressure
4 CO Adjustment
3 Learned Ignition Timing
2 Accelerator Opening Angle
1 Fuel Temperature
0 Front O2 Heater #1

********** BYTE 13 *********
7 Rear O2 Heater Current
6 Front O2 Heater #2
5 Fuel Level
4 -------------------------
3 Primary Wastegate Duty Cycle
2 Secondary Wastegate Duty Cycle
1 CPC Valve Duty Ratio
0 Tumble Valve Position Sensor Right

********** BYTE 14 *********
7 Tumble Valve Position Sensor Left
6 Idle Speed Control Valve Duty Ratio
5 Air/Fuel Lean Correction
4 Air/Fuel Heater Duty
3 Idle Speed Control Valve Step
2 Number of Ex. Gas Recirc Steps
1 Alternator Duty
0 Fuel Pump Duty

********** BYTE 15 *********
7 VVT Advance Angle Right
6 VVT Advance Angle Left
5 OCV Duty Right
4 OCV Duty Left
3 OCV Current Right
2 OCV Current Left
1 Air/Fuel Sensor #1 Current
```

```
0 Air/Fuel Sensor #2 Current

********** BYTE 16 **********
7 Air/Fuel Sensor #1 Resistance
6 Air/Fuel Sensor #2 Resistance
5 Air/Fuel Sensor #1
4 Air/Fuel Sensor #2
3 Air/Fuel Correction #3
2 Air/Fuel Learning #3
1 Rear O2 Heater Voltage
0 Air/Fuel Adjustment Voltage

********** BYTE 17 **********
7 -------------------------
6 -------------------------
5 Gear Position
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 18 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 Air/Fuel Sensor #1 Heater Current
3 Air/Fuel Sensor #2 Heater Current
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 19 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 20 **********
7 -------------------------
6 AT Vehicle ID
5 Test Mode Connector
4 Read Memory Connector
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------
********** BYTE 21 **********
7 Neutral Position Switch
6 Idle Switch
5 -------------------------
4 Intercooler AutoWash Switch
3 Ignition Switch
2 Power Steering Switch
1 Air Conditioning Switch
0 -------------------------
********** BYTE 22 **********
7 Handle Switchv
6 Starter Switch
```

```
5 Front O2 Rich Signal
4 Rear O2 Rich Signal

3 Front O2 #2 Rich Signal
2 Knock Signal 1
1 Knock Signal 2
0 Electrical Load Signal
********** BYTE 23 **********
7 Crank Position Sensor
6 Cam Position Senso
5 Defogger Switch
4 Blower Switch
3 Interior Light Switch
2 Wiper Switch
1 Air-Con Lock Signal
0 Air-Con Mid Pressure Switch

********** BYTE 24 **********
7 Air-Con Compressor Signal
6 Radiator Fan Relay #3
5 Radiator Fan Relay #1
4 Radiator Fan Relay #2
3 Fuel Pump Relay
2 Intercooler Auto-Wash Relay
1 CPC Solenoid Valve
0 Blow-By Leak Connector

********** BYTE 25 **********
7 PCV Solenoid Valve
6 TGV Output
5 TGV Drive
4 Variable Intake Air Solenoid
3 Pressure Sources Change
2 Vent Solenoid Valve
1 P/S Solenoid Valve
0 Assist Air Solenoid Valve

********** BYTE 26 **********
7 Tank Sensor Control Valve
6 Relief Valve Solenoid 1
5 Relief Valve Solenoid 2
4 TCS Relief Valve Solenoid
3 Ex. Gas Positive Pressure
2 Ex. Gas Negative Pressure
1 Intake Air Solenoid
0 Muffler Control

********** BYTE 27 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 Retard Signal from AT
2 Fuel Cut Signal from AT
1 Ban of Torque Down
0 Request Torque Down VDC

********** BYTE 28 **********
7 Torque Control Signal #1
6 Torque Control Signal #2
5 Torque Permission Signal
4 EAM signal
3 AT coop. lock up signal
2 AT coop. lean burn signal
```

```
1 AT coop. rich spike signal
0 AET Signal

********** BYTE 29 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 30 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 31 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 32 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 33 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 34 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 35 **********
```

```
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 36 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 37 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 38 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 39 **********
7 -------------------------
6 -------------------------
5 Throttle Motor Duty
4 Throttle Motor Voltage
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 40 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 41 **********
7 Sub Throttle Sensor
6 Main Throttle Sensor
5 Sub Accelerator Sensor
4 Main Accelerator Sensor
```

```
3 Brake Booster Pressure
2 Fuel Pressure (High)
1 Exhaust Gas Temperature
0 -------------------------

********** BYTE 42 **********
7 Cold Start Injector
6 SCV Step
5 Memorized Cruise Speed
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 43 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 44 **********
7 Exhaust VVT Advance Angle Right
6 Exhaust VVT Advance Angle Left
5 Exhaust OCV Duty Right
4 Exhaust OCV Duty Left
3 Exhaust OCV Current Right
2 Exhaust OCV Current Left
1 -------------------------
0 -------------------------

********** BYTE 45 **********
7 -------------------------
6 ETC Motor Relay
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 46 **********
7 Clutch Switch
6 Stop Light Switch
5 Set/Coast Switch
4 Resume/Accelerate Switch
3 Brake Switch
2 -------------------------
1 Accelerator Switch
0 -------------------------

********** BYTE 47 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------
```

```
********** BYTE 48 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 49 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 50 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 51 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 52 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 53 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 54 **********
7 -------------------------
6 -------------------------
```

```
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 55 **********
7 -------------------------
6 -------------------------
5 -------------------------
4 -------------------------
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------

********** BYTE 56 **********
7 Roughness Monitor Cylinder #1
6 Roughness Monitor Cylinder #2
5 Roughness Monitor Cylinder #3
4 Roughness Monitor Cylinder #4
3 -------------------------
2 -------------------------
1 -------------------------
0 -------------------------
```

Beyond this point has not been translated to wiki formatting yet.

```
Parameters are read by providing a 3 byte address for each parameter via command 0xA8
For example use address 0x000008 for Coolant temp and use addresses 0x00000E and 0x00000F for engine RPM

Parameters ************************************************************

- Engine Load ---------------------------------------------
8 bit value
P0x07 = low byte

Multiply value by 100.0 and divide by 255 to get percent
-------------------------------------------------------------
- Coolant Temperature -------------------------------------
8 bit value
P0x008 = low byte


Subtract 40 from value to get Degrees C
-------------------------------------------------------------
- Air/Fuel Correction #1 ----------------------------------
8 bit value
P0x009 = low byte

Subtract 128 from value and divide by 1.28 to get percent
-------------------------------------------------------------
- Air/Fuel Learning #1 ------------------------------------
8 bit value
P0x00A = low byte

Subtract 128 from value and divide by 1.28 to get percent
-------------------------------------------------------------
- Air/Fuel Correction #2 ----------------------------------
8 bit value
```

```
P0x00B = low byte

Subtract 128 from value and divide by 1.28 to get percent
------------------------------------------------------------
- Air/Fuel Learning #2 -------------------------------------
8 bit value
P0x00C = low byte

Subtract 128 from value and divide by 1.28 to get percent
------------------------------------------------------------
- Manifold Absolute Pressure -------------------------------
8 bit value
P0x0D = low byte

Multiply value by 37.0 and divide by 255 to get psig
------------------------------------------------------------
- Engine Speed ---------------------------------------------
16 bit value
P0x0E = high byte
P0x0F = low byte

Divide value by 4 to get RPM
------------------------------------------------------------
- Vehicle Speed --------------------------------------------
8 bit value
P0x010 = low byte

Value is in km/h
------------------------------------------------------------
- Ignition Timing ------------------------------------------
8 bit balue P0x11 = low byte

Subtract 128 from value and divide by 2 to get degrees
------------------------------------------------------------
- Intake Air Temperature -----------------------------------
8 bit value
P0x012 = low byte

Subtract 40 from value to get Degrees C
------------------------------------------------------------
- Mass Air Flow --------------------------------------------
16 bit value
P0x13 = high byte
P0x14 = low byte

Divide value by 100.0 to get grams/s
------------------------------------------------------------
- Throttle Opening Angle -----------------------------------
8 bit value
P0x15 = low byte

Multiply value by 100.0 and divide by 255 to get percent
------------------------------------------------------------
- Front O2 Sensor #1 ---------------------------------------
16 bit value
P0x016 = high byte
P0x017 = low byte

Multiply value by 0.005 to get voltage
------------------------------------------------------------
- Rear O2 Sensor -------------------------------------------
16 bit value
P0x018 = high byte
P0x019 = low byte
```

```
Multiply value by 0.005 to get voltage
------------------------------------------------------------
- Front O2 Sensor #2 ---------------------------------------
16 bit value
P0x01A = high byte
P0x01B = low byte

Multiply value by 0.005 to get voltage
------------------------------------------------------------
- Battery Voltage ------------------------------------------
8 bit value
P0x01C = low byte

Multiply value by 0.08 to get volts
------------------------------------------------------------
- Air Flow Sensor Voltage ----------------------------------
8 bit value
P0x01D = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Throttle Sensor Voltage ----------------------------------
8 bit value
P0x01E = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Differential Pressure Sensor Voltage ---------------------
8 bit value
P0x01F = low byte

Multiply value by 0.02 to get Volts
------------------------------------------------------------
- Fuel Injection #1 Pulse Width ----------------------------
8 bit value
P0x20 = low byte

Multiply value by 0.256 to get ms
------------------------------------------------------------
- Fuel Injection #2 Pulse Width ----------------------------
8 bit value
P0x21 = low byte

Multiply value by 0.256 to get ms
------------------------------------------------------------
- Knock Correction -----------------------------------------
8 bit value
P0x22 = low byte

Subtract 128 from value and divide by 2 to get degrees
------------------------------------------------------------
- Atmospheric Pressure -------------------------------------
8 bit value
P0x023 = low byte

Multiply value by 37.0 and divide by 255 to get psig
------------------------------------------------------------
- Manifold Relative Pressure -------------------------------
8 bit value
P0x24 = low byte

Subtract 128 from value, multiply by 37.0 and divide by 255 to get psig
------------------------------------------------------------
- Pressure Differential Sensor -----------------------------
```

```
8 bit value
P0x25 = low byte

Subtract 128 from value, multiply by 37.0 and divide by 255 to get psig
------------------------------------------------------------
- Fuel Tank Pressure ---------------------------------------
8 bit value
P0x026 = low byte

Subtract 128 from value and multiply by 0.0035 to get psig
------------------------------------------------------------
- CO Adjustment --------------------------------------------
8 bit value
P0x027 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Learned Ignition Timing ----------------------------------
8 bit value
P0x028 = low byte

Subtract 128 from value and divide by 2 to get degrees
------------------------------------------------------------
- Accelerator Opening Angle --------------------------------
8 bit valuev P0x029 = low byte

Divide value by 2.56 to get percent
------------------------------------------------------------
- Fuel Temperature -----------------------------------------
8 bit value
P0x02A = low byte

Subtract 40 from value to get Degrees C
------------------------------------------------------------
- Front O2 Heater #1 ---------------------------------------
8 bit value
P0x02B = low byte

Multiply value by 10.04 and divide by 256 to get Amps
------------------------------------------------------------
- Rear O2 Heater Current -----------------------------------
8 bit value
P0x02C = low byte

Multiply value by 10.04 and divide by 256 to get Amps
------------------------------------------------------------
- Front O2 Heater #2 ---------------------------------------
8 bit value
P0x02D = low byte

Multiply value by 10.04 and divide by 256 to get Amps
------------------------------------------------------------
- Fuel Level -----------------------------------------------
8 bit value
P0x02E = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Primary Wastegate Duty Cycle ----------------------------
8 bit value
P0x30 = low byte



Multiply value by 100.0 and divide by 255 to get percent
```

```
------------------------------------------------------------
- Secondary Wastegate Duty Cycle ---------------------------
8 bit value
P0x31 = low byte

Multiply value by 100.0 and divide by 255 to get percent
------------------------------------------------------------
- CPC Valve Duty Ratio -------------------------------------
8 bit value
P0x032 = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Tumble Valve Position Sensor Right -----------------------
8 bit value
P0x033 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Tumble Valve Position Sensor Left ------------------------
8 bit value
P0x034 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Idle Speed Control Valve Duty Ratio ----------------------
8 bit value
P0x035 = low byte

Divide value by 2 to get percent
------------------------------------------------------------
- Air/Fuel Lean Correction ---------------------------------
8 bit value
P0x036 = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Air/Fuel Heater Duty -------------------------------------
8 bit value
P0x037 = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Idle Speed Control Valve Step ----------------------------
8 bit value
P0x038 = low byte

Value is in steps
------------------------------------------------------------
- Number of Ex. Gas Recirc. Steps --------------------------
8 bit value
P0x039 = low byte

Value is in steps
------------------------------------------------------------
- Alternator Duty ------------------------------------------
8 bit value
P0x03A = low byte

Value is in percent
------------------------------------------------------------
- Fuel Pump Duty -------------------------------------------
8 bit value
P0x03B = low byte
```

```
Divide value by 2.55 to get percent
------------------------------------------------------------
- Intake VVT Advance Angle Right ---------------------------
8 bit value
P0x03C = low byte

Subtract 50 from value to get degrees
------------------------------------------------------------
- Intake VVT Advance Angle Left ----------------------------
8 bit value
P0x03D = low byte

Subtract 50 from value to get degrees
------------------------------------------------------------
- Intake OCV Duty Right ------------------------------------
8 bit value
P0x03E = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Intake OCV Duty Left -------------------------------------
8 bit value
P0x03F = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Intake OCV Current Right ---------------------------------
8 bit value
P0x040 = low byte

Multiply value by 32 to get mA
------------------------------------------------------------
- Intake OCV Current Left ----------------------------------
8 bit value
P0x041 = low byte

Multiply value by 32 to get mA
------------------------------------------------------------
- Air/Fuel Sensor #1 Current -------------------------------
8 bit value
P0x042 = low byte

Subtract 128 from value and multiply by .125 to get mA
------------------------------------------------------------
- Air/Fuel Sensor #2 Current -------------------------------
8 bit value
P0x043 = low byte

Subtract 128 from value and multiply by .125 to get mA
------------------------------------------------------------
- Air/Fuel Sensor #1 Resistance ----------------------------
8 bit value
P0x044 = low byte

Value is in ohms
------------------------------------------------------------
- Air/Fuel Sensor #2 Resistance ----------------------------
8 bit value
P0x045 = low byte

Value is in ohms
------------------------------------------------------------
- Air/Fuel Sensor #1 ---------------------------------------
8 bit value
```

```
P0x46 = low byte

Divide value by 128.0 to get Lambda
------------------------------------------------------------
- Air/Fuel Sensor #2 ---------------------------------------
8 bit value
P0x47 = low byte

Divide value by 128.0 to get Lambda
------------------------------------------------------------
- Gear Position --------------------------------------------
8 bit value
P0x04A = low byte

Add 1 to value to get gear
------------------------------------------------------------
- A/F Sensor #1 Heater Current -----------------------------
8 bit value
P0x053 = low byte

Divide value by 10 to get Amps
------------------------------------------------------------
- A/F Sensor #2 Heater Current -----------------------------
8 bit value
P0x054 = low byte


Divide value by 10 to get Amps
------------------------------------------------------------
- Roughness Monitor Cylinder #1 ----------------------------
8 bit value
P0x0CE = low byte

Value is in ?
------------------------------------------------------------
- Roughness Monitor Cylinder #2 ----------------------------
8 bit value
P0x0CF = low byte

Value is in ?
------------------------------------------------------------
- Air/Fuel Correction #3 -----------------------------------
8 bit value
P0x0D0 = low byte

Subtract 128 from value and divide by 1.28 to get percent
------------------------------------------------------------
- Air/Fuel Learning #3 -------------------------------------
8 bit value

P0x0D1 = low byte

Subtract 128 from value and divide by 1.28 to get percent
------------------------------------------------------------
- Rear O2 Heater Voltage -----------------------------------
8 bit value
P0x0D2 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Air/Fuel Adjustment Voltage ------------------------------
8 bit value
P0x0D3 = low byte
```

```
Multiply value by 0.02 to get voltage
------------------------------------------------------------
- Roughness Monitor Cylinder #3 ----------------------------
8 bit value
P0x0D8 = low byte

Value is in ?
------------------------------------------------------------
- Roughness Monitor Cylinder #4 ----------------------------
8 bit value
P0x0D9 = low byte

Value is in ?
------------------------------------------------------------
- Throttle Motor Duty --------------------------------------
8 bit value
P0x0fa = low byte

Subtract 128 from value and divide by 1.28 to get percent
------------------------------------------------------------
- Throttle Motor Voltage -----------------------------------
8 bit value
P0x0FB = low byte

Multiply value by 0.08 to get volts
------------------------------------------------------------
- Sub Throttle Sensor --------------------------------------
8 bit value
P0x100 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Main Throttle Sensor -------------------------------------
8 bit value
P0x101 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Sub Accelerator Sensor -----------------------------------
8 bit value
P0x102 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Main Accelerator Sensor ----------------------------------
8 bit value
P0x103 = low byte

Multiply value by 0.02 to get volts
------------------------------------------------------------
- Brake Booster Pressure -----------------------------------
8 bit value
P0x104 = low byte

Multiply value by 37.0 and divide by 255 to get psig
------------------------------------------------------------
- Fuel Pressure (High) -------------------------------------
8 bit value
P0x105 = low byte

Multiply value by 0.04 to get MPa
------------------------------------------------------------
- Exhaust Gas Temperature ----------------------------------
8 bit value
P0x106 = low byte
```

```
Add 40 to value and multiply by 5 to get Degrees C
------------------------------------------------------------
- Cold Start Injector ----------------------------------------
8 bit value
P0x108 = low byte

Multiply value by .256 to get ms
------------------------------------------------------------
- SCV Step ---------------------------------------------------
8 bit value
P0x109 = low byte

Value is in Steps
------------------------------------------------------------
- Memorised Cruise Speed -------------------------------------
8 bit value
P0x10a = low byte

Value is in km/h
------------------------------------------------------------
- Exhaust VVT Advance Angle Right ----------------------------
8 bit value
P0x118 = low byte

Subtract 50 from value to get degrees
------------------------------------------------------------
- Exhaust VVT Advance Angle Left -----------------------------
8 bit value
P0x119 = low byte

Subtract 50 from value to get degrees
------------------------------------------------------------
- Exhaust OCV Duty Right -------------------------------------
8 bit value
P0x11A = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Exhaust OCV Duty Left --------------------------------------
8 bit value
P0x11B = low byte

Divide value by 2.55 to get percent
------------------------------------------------------------
- Exhaust OCV Current Right ----------------------------------
8 bit value
P0x11C = low byte

Multiply value by 32 to get mA
------------------------------------------------------------
- Exhaust OCV Current Left -----------------------------------
8 bit value
P0x11D = low byte

Multiply value by 32 to get mA
------------------------------------------------------------



Switches are read in the same way a parameter is read except that it will
return up to
8 individual ON/OFF flags in the individual bits of the return byte
```

```
Switches ************************************************************

Switch P0x061
7 ------------------------
6 AT Vehicle ID
5 Test Mode Connector
4 Read Memory Connector
3 ------------------------
2 ------------------------
1 ------------------------
0 ------------------------

Switch P0x062
7 Neutral Position Switch
6 Idle Switch
5 ------------------------
4 Intercooler AutoWash Switch
3 Ignition Switch
2 Power Steering Switch
1 Air Conditioning Switch
0 ------------------------

Switch P0x063
7 Handle Switch
6 Starter Switch
5 Front O2 Rich Signal
4 Rear O2 Rich Signal
3 Front O2 #2 Rich Signal
2 Knock Signal 1
1 Knock Signal 2
0 Electrical Load Signal

Switch P0x064
7 Crank Position Sensor
6 Cam Position Sensor
5 Defogger Switch
4 Blower Switch
3 Interior Light Switch
2 Wiper Switch
1 Air-Con Lock Signal
0 Air-Con Mid Pressure Switch

Switch P0x065
7 Air-Con Compressor Signal
6 Radiator Fan Relay #3
5 Radiator Fan Relay #1
4 Radiator Fan Relay #2
3 Fuel Pump Relay
2 Intercooler Auto-Wash Relay
1 CPC Solenoid Valve
0 Blow-By Leak Connector

Switch P0x066
7 PCV Solenoid Valve
6 TGV Output
5 TGV Drive
4 Variable Intake Air Solenoid
3 Pressure Sources Change
2 Vent Solenoid Valve
1 P/S Solenoid Valve
0 Assist Air Solenoid Valve

Switch P0x067
7 Tank Sensor Control Valve
6 Relief Valve Solenoid 1
```

```
5 Relief Valve Solenoid 2
4 TCS Relief Valve Solenoid
3 Ex. Gas Positive Pressure
2 Ex. Gas Negative Pressure
1 Intake Air Solenoid
0 Muffler Control

Switch P0x068
7 ----------------------
6 ----------------------
5 ----------------------
4 ----------------------
3 Retard Signal from AT
2 Fuel Cut Signal from AT
1 Ban of Torque Down
0 Request Torque Down VDC

Switch P0x069
7 Torque Control Signal #1
6 Torque Control Signal #2
5 Torque Permission Signal
4 EAM Signal
3 AT coop. lock up signal
2 AT coop. lean burn signal
1 AT coop. rich spike signal
0 AET Signal

Switch P0x120
7 ----------------------
6 ETC Motor Relay
5 ----------------------
4 ----------------------
3 ----------------------
2 ----------------------
1 ----------------------
0 ----------------------

Switch P0x121
7 Clutch Switch
6 Stop Light Switch
5 Set/Coast Switch
4 Rsume/Accelerate Switch
3 Brake Switch
2 ----------------------
1 Accelerator Switch
0 ----------------------
```