Syvecs LTD

V1.3

X4 Expander

This document is intended for use by a technical audience and describes a number of procedures that are potentially hazardous. Installations should be carried out by competent persons only.

Syvecs and the author accept no liability for any damage caused by the incorrect installation or configuration of the equipment.

Please Note that due to frequent firmware changes certain windows might not be the same as the manual illustrates. If so please contact the Syvecs Tech Team for Assistance.

Support@Syvecs.com

The Syvecs X4 Expander is a compact but very powerful expansion unit for enhancing the Input and Output compliment of a powertrain electronics installation.

The X4 is fitted with four Half Bridges drivers which are capable of driving Low, High or joined in pairs as a full bridge motor driver. Each of the four H-Bridge Outputs is equipped with a current monitoring circuit which can be assigned in strategies on Syvecs Engine Controllers or as Current Limiting functions in other applications.

Four MagnetoResitive circuits make reading the ABS sensors found on most new automotive applications easier by just needing to connect one side of the sensor to the X4 and the other side to Ground.

The four 0-5v Analog inputs are not capable of frequency detection but are useful for monitoring of switches, pressure transducer or positional sensors.

Able to withstand the toughest of conditions and high temperatures the X4 is useful for many applications whether it's for external Drive By Wire support, Electronic Wastegates, Fuel Pump Controller and more.

Two canbus interfaces are fitted on the X4 which are setup out of the box for Slave Control with a S7,S8,S12 Ecu or XCan Support for other Ecu's.

Syvecs is also able to use the hardware for custom projects so if you have a requirement for a dedicated task please email support@syvecs.com

Specification

Outputs

4 Half Bridge Outputs (Support: Full Bridge, Lowside or HighSide Drive)

15Amp Peak (100ms) 8Amp Continuous Drive

Current Monitoring on each pin

Inputs

4 Analogue or switch inputs (0-5V)

4 MagnetoResistive Wheel Speed Sensor Inputs

Interfaces

USB For Updates and Config

2 x CAN 2.0B interface for communication with other controllers or logging systems

1 x Kline Interface

Power Supply

6 to 26V input voltage range

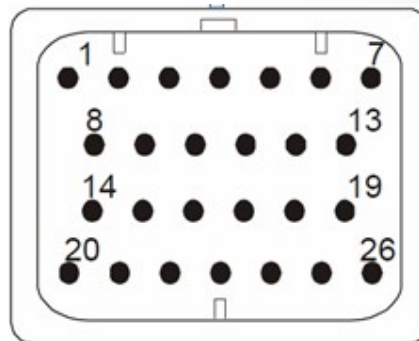Ignition Switch Logic with high current supply

Physical

Waterproof Sealed in Automotive Spec -40c to 125c

34 way Superseal 1.0

85mm x 70mm

Syvecs Description	iO4 Pinout	Function	Notes
PWRGND	A1	Ground	
PWRGND	A2	Ground	
H-Bridge1	A3	H Bridge with Current Sense	
H-Bridge2	A4	H Bridge with Current Sense	
H-Bridge3	A5	H Bridge with Current Sense	
H-Bridge4	A6	H Bridge with Current Sense	
12V HC	A7	12v Supply - High Current	
Kline/LinBus	A8	Kline/LinBus	
MagnetoResistive 1	A9	Connects to ABS +Wire	Other side of Sensor Gnd
MagnetoResistive 2	A10	Connects to ABS +Wire	Other side of Sensor Gnd
MagnetoResistive 3	A11	Connects to ABS +Wire	Other side of Sensor Gnd
MagnetoResistive 4	A12	Connects to ABS +Wire	Other side of Sensor Gnd
12V HC	A13	12v Supply - High Current	
Can0 H (1.33mb)	A14	Slave CanBus	1.33MB
Can0 L (1.33mb)	A15	Slave CanBus	1.33MB
12v IGSW	A16	12v - Ignition Switch	Wakes up Unit
Can1 H (500kb)	A17	XCan H	XCan Protocol
Can1 L (500kb)	A18	XCan L	XCan Protocol
12V HC	A19	12v Supply - High Current	
5v Out	A20	5v Output Supply	
AN1	A21	0-5v Analog Input	
AN2	A22	0-5v Analog Input	
AN3	A23	0-5v Analog Input	
AN4	A24	0-5v Analog Input	
PWRGND	A25	Ground	
PWRGND	A26	Ground	

Mating Connector – TE 2-1437285-3

Power Connection

The X4 has **four** power connection points, **three** of these are high current and can be connected to a fused battery power or switched power source. **One** of them is Logic Switch / Ignition Switch power and used to switch the power gate so that current is able to flow from the 3x High current 12v pins into the Device.

The three high current pins are **linked internally**, as are the power ground pins. If driving motors or solenoids which pull a lot of current then ensure the correct amount of pins are connected. Each pin on the X4 is able to sink around 14 amps of current continuously, so if driving multiple solenoids that pull 20+ amps total, ensure at **least** two high current 12v pins and two power ground pins are used.

Example Schematic
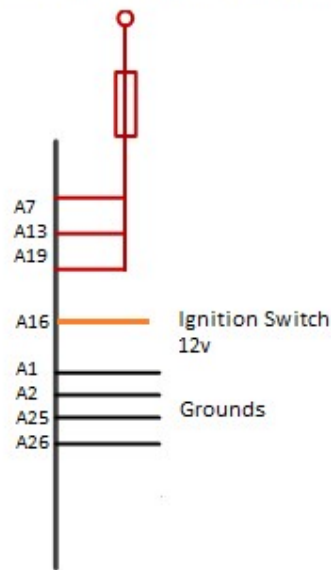
Figure 0-1 – Power and Ground Feeds

Pin Number	Function	Notes
A7	VBAT	Use a fused Switched feed.
A13	VBAT	Use a fused Switched feed.
A19	VBAT	Use a fused Switched feed.
A16	IGBAT	Ignition Switched 12v
A1	Power Ground	Ground for Power and Sensor Signal
A2	Power Ground	Ground for Power and Sensor Signal
A25	Power Ground	Ground for Power and Sensor Signal
A26	Power Ground	Ground for Power and Sensor Signal

CanBus Connections – Syvecs ECU Slave Link 1.33mb

S7

S7-I & S7Plus connect X4 Can0L (Pin15) to S7 Can2L (PinB2)

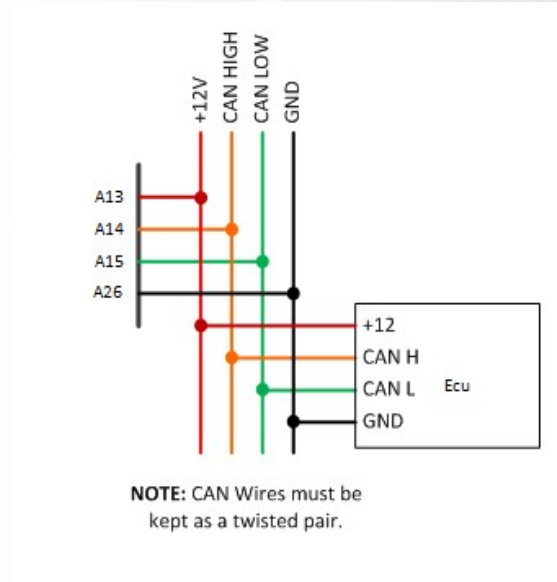S7-I & S7Plus connect X4 Can0H (Pin14) to S7 Can2H (PinB3)

S8/GDi4

S8 connect X4 Can0L (Pin15) to S8 Can2L (Pin79)

S8 connect X4 Can0H (Pin14) to S8 Can2H (Pin80)

S8/GDi4

S8 connect X4 Can0L (Pin15) to S8 Can2L (Pin18)

S8 connect X4 Can0H (Pin14) to S8 Can2H (Pin76)

NOTE: CAN Wires must be kept as a twisted pair.

ECU Pin Assignments – Syvecs ECU

The Syvecs range of ecus from S7 onwards can use the spare canbus available for communicating with the X4 expander over a slave protocol which runs at 1.33mb

To bring the Slave connection online you only need to assign a pin to the Slave of choice, do not need to setup anything in the DataStream section. If this is a S7 which has a slave1 already in use then use Slave2 Inputs and Output assignments. With the S8 and S12 you can use Slave 1.

After assigning and doing a Device – Program , The message system at the bottom right hand corner of Scal should state Master : Slave2 Online : SNXXX... If not check the canbus connections and ensure the canbus is terminated correctly.

Outputs

H Bridge outputs 1 -4 are assigned under Slave*Out 1-4. If wanting to control a Motor in Full bridge then it must be wired in equal pairs 1-2 / 3-4 / 5-6 etc then assign the first number of the pair. Example Motor connected to Hbridge 1 and 2, assign the strategy function to Slave* Out1 as below. Each H-Bridge output can handle **15amps peak** and **8amp continuous**.

Low side and High side drive can just be assigned to the corresponding pin as required in pin assignments

Calibrators need to set the Output type in the strategy they are planning to use. Example: user has assigned Slave out1 to Basic PWM strategy and requires the pin to be run in Full bridge for Motor control where 50% is zero drive and 0% or 100% is maximum drive.

The Output type can be set in the strategy they are planning to use:

Low-Side = Output drives to Ground
Half Bridge = Output Drives to 12v
Full bridge = Motor Drive

Example: Using basic PWM1 for Fully bridge Motor Control.. Output Functions – Basic PWM 1 – Output Type

Set Output Type as Full Bridge

The Minimum Frequency a H-Bridge output can be driven is 20hz

Current Sense Monitoring

H Bridge outputs 1 -4 have a current sensor fitted on each device. These can be monitored under Slave*AN 9-12 assignments in Scal. 2.5v is the rest voltage for 0mA

HBridge1 = Slave* AN9
HBridge2 = Slave* AN10
HBridge3 = Slave* AN11
HBridge4 = Slave* AN12

Scale is -18.3333A at 0V and 18.3333A at 5V

ADC Inputs

Four Analog Inputs are available on the X4. These are just 0-5v Analog inputs and cannot support frequency waveforms.
They are designed for sensors like pressure transducers or position sensors.

AN Inputs 1 -4 are assigned under Slave*AN 1-4.

A) Inputs : Cal Up Switch	NOT CONNECTED
A) Inputs : Calibration Override Switch A	NOT CONNECTED
A) Inputs : Calibration Override Switch B	NOT CONNECTED
A) Inputs : Calibration Switch	NOT CONNECTED
A) Inputs : Cam (Exhaust 1 Variable Valve Timing)	NOT CONNECTED
A) Inputs : Cam (Exhaust 2 Variable Valve Timing)	NOT CONNECTED
A) Inputs : Cam (Inlet 1 Variable Valve Timing)	NOT CONNECTED
A) Inputs : Cam (Inlet 2 Variable Valve Timing)	NOT CONNECTED
A) Inputs : Cam (Phase) A	AN 05 (AU) : C14
A) Inputs : Cam (Phase) B	NOT CONNECTED
A) Inputs : Clutch Depressed Switch	NOT CONNECTED
A) Inputs : Clutch Paddle Position A	NOT CONNECTED
A) Inputs : Clutch Paddle Position B	NOT CONNECTED
A) Inputs : Clutch Position	NOT CONNECTED
A) Inputs : Clutch Pressure	NOT CONNECTED
A) Inputs : Crank Case Pressure 1	SLAVE2 AN #01 :
A) Inputs : Crank Case Pressure 2	NOT CONNECTED
A) Inputs : Crank Case Pressure 3	NOT CONNECTED
A) Inputs : Crank Case Pressure 4	NOT CONNECTED
A) Inputs : Crank Position A	AN 01 (AB) : C10
A) Inputs : Crank Position B	NOT CONNECTED
A) Inputs : Cruise Control Nudge Down Switch	NOT CONNECTED
A) Inputs : Cruise Control Nudge Up Switch	NOT CONNECTED
A) Inputs : Cruise Control Switch	NOT CONNECTED
A) Inputs : Damper Position (Front Left Wheel)	NOT CONNECTED

The Input Type for the sensor it is assigned to, must be set to 5v otherwise the message system in the bottom right of Scal will bring up a Slave error and the engine won't be allowed to start

MagnetoResistive Inputs

The X4 expander supports four magneto-resistive wheels speed sensors which most new factory cars use. These can be connected directly to the Syvecs AWD controller via Pins 9 to 12.

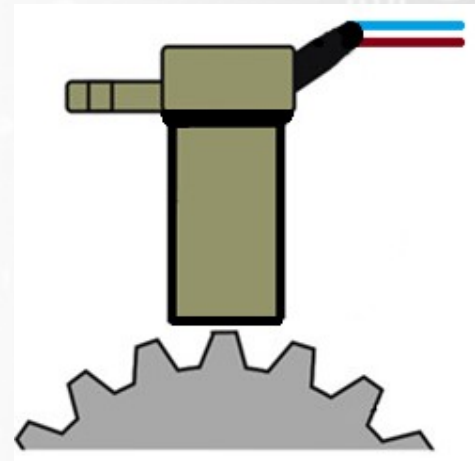This means users can remove the OEM ABS Computer from the car if wanted and read the sensors direct .

MagnetoResitive Inputs 1 -4 are assigned under Slave*AN 5-8.

MagnetoRes1 = Slave* AN5
MagnetoRes2 = Slave* AN6
MagnetoRes3 = Slave* AN7
MagnetoRes4 = Slave* AN8

Under Sensors – Vehicle Speed …Calibrators will then need to set the Measurement area up as below

Input Configuration – 5v
Input Filters – Off
Low Threshold Voltage – 1.25
High Threshold Voltage – 3.75
Tooth Timeout – 0.25
Number of teeth – Number of teeth on the ABS ring

XCan – Custom Projects / Other Engine Management Systems

The XCan protocol which is available on Can1 of the X4 is designed for other engine management systems or older Syvecs ecus which don't have a spare canbus.

The DBC for this Can Protocol can be found at the below link to help speed up development

www.syvecs.com/downloads/XCan_DBC.dbc

The X-CAN Protocol runs default at 500kb, Custom builds can be done to change this speed.

XCan Protocol - Outputs

H-Bridge Output Setup

Frame 0x770 is used to configure the output setup (Output Type & Output Frequency)

Output Setup frames can be sent to expander just once at boot up or continuously but the protocol only grabs the setup once when it recieves a frame. If can messages disappear (0x770 and 0x778) for longer than 1000ms then a reset is applied to the Output setup. This can be used for programming different types and frequencies.

Each Output channel is configured by 2 bytes in MSB data format

The top 2 bits set the Output type - 1100:0000 | 0000:0000
The 14 other bits set the Output Frequency as a raw decimal in HZ - 0011:1111 | 1111:1111

Output Type is set as below -
OFF(Output Off)   - 0x00 = 0000:0000 | 0000:0000
LS (Low Side Drive) - 0x40 = 0100:0000 | 0000:0000
HB (High Side Drive) - 0x80 = 1000:0000 | 0000:0000
FB (Motor Control)   - 0xC0 = 1100:0000 | 0000:0000

Example - 0x85DC = 1000:0101 | 1101:1100 = High Side Output at 1500hz

When controlling in FB Mode the opposite output channel needs to be set to OFF and 0 Frequency

Example - Byte0 | 0xC5DC and B1 | 0x0000 = Full Bridge Control on HBR1 and 2 at 1500hz

Ganged Mode Control - Allows 2 outputs to be driven off same duty. Useful for when needing to control very high current devices as a single pin on the superseal connector can only handle 15 amps.

If Out1 = FB, Out2 = OFF == BOTH Out1 and Out2 will be control in Full bridge motor and driven from the Duty on Out 1 frame
If Out1 = FB, Out2 = LS == BOTH Out1 and Out2 will be LS Ganged and driven from the Duty on Out 1 frame
If Out1 = FB, Out2 = HS == BOTH Out1 and Out2 will be HS Ganged and driven from the Duty on Out 1 frame
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H Bridge Outputs (HBR1-4) - Support OFF, LS, HS and FB, During FB Mode HBR1 and HBR2 would be linked to drive a Motor forward and back

Frame 0x770 - HBR1-4

Byte   B0   B1   B2   B3   B4   B5   B6   B7

0x770 - HBR1 : HBR1 : HBR2 : HBR2 : HBR3 : HBR3 : HBR4 : HBR4 :

Output Duty Setup

Frame 0x778 is used to configure the output duty cycle set on each output, these needs to be transmitted at 50ms per frame rate or faster

This again is done via 2 Bytes and the duty is calculated as a multiple of 81.92

If you wanted to drive the output at 22% Duty then would take 81.92 * 22 = 1802 (Decimal) convert to Hex 0x070A. Byte 0 = 0x07 Byte 1 = 0x0A

0x0000 = 0% Duty
0x2000 = 100% Duty

H Bridge Outputs(HBR1-4) - Duty Setup

Frame 0x778 - HBR1-4

Byte   B0   B1   B2   B3   B4   B5   B6   B7

0x778 - HBR1 : HBR1 : HBR2 : HBR2 : HBR3 : HBR3 : HBR4 : HBR4 :

XCan Protocol - Inputs

Frame 0x760 is used to configure the input setup (Input Type & Thresholds)

Input Setup frames can be sent to Expander just once at boot or continuously but the code only grabs the setup once when it recieves a frame. If can messages disappear for longer than 1000ms then a reset is applied
to the Input setup. This can be used for programming different input setups and thresholds for frequency inputs.

The MagnetoResistive Inputs and Current Measurement Inputs don't need to be setup, they will be transmitted when the X4 has received a 0x760 Frame.

The X4 expander has 4 x AV Inputs (AN01-4) , 4 x Freq (MagnetoResistive) Inputs and 4 x Current measurement values

- AV Input which mean they can only read a ADC Voltage 0-5v – DO NOT SUPPORT FREQ or Pull-Up

Each Input channel is configured by 2 bytes in MSB data format

Bit15 - (0x8000) - 1000:0000 | 0000:0000 = Sets the Input Pull-Up Option to be enabled . This enables a 5v 3k pull up on the input

Bit14 - (0x4000) - 0100:0000 | 0000:0000 = Sets the Input Type - If this bit is set then the input is setup for Frequency detection, if its NOT set then the input is setup for ADC monitoring

Bit13 - (0x2000) - 0010:0000 | 0000:0000 = Sets the bipolar flag but only if the Input is not in Frequency Mode.. If in Frequency Mode Bit5 is part of the High Thresold setup

Bit13 to Bit7 - (0x3F80) - 0011:1111 | 1000:0000 = These 7 bits set the High threshold for the Inputs when in Frequency mode | Engineering Value 0.078125 to V
Bit6 to Bit0 - (0x007F) - 0000:0000 | 0111:1111 = These 7 bits set the Low threshold for the Inputs when in Frequency mode | Engineering Value 0.078125 to V

Example - (0x578F) - 0101:0111 | 1000:1111 = Frequency Mode Enabled with Low Threshold at 1.2v and High Threshold at 3.7v

Frame 0x760 - AN1-4

```
Byte     B0      B1      B2      B3      B4      B5      B6      B7
```

0x760 - AN1 : AN1 : AN2 : AN2 : AN3 : AN3 : AN4 : AN4 :

AN1-4 Input Values

0x780 Frame transmits the readings on the Analog inputs.

Each Input reading is represented by 2 bytes in MSB data format. The 2 bytes represent the ADC Reading on the Input.

The Engineering value is 0.000076 to V. Example Hex 0x4E80 = 1.527v

Frame 0x780 - AN1-4
```
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Byte     B0      B1      B2      B3      B4      B5      B6      B7
```

0x780 - AS1 : AS1 : AS2 : AS2 : AS3 : AS3 : AS4 : AS4 :

HBR1-4 Current Values

0x200 Frame transmits the current readings on HBR1 -4

Each Input reading is represented by 2 bytes in MSB data format. The 2 bytes represent the ADC Reading on the Input.

The Engineering value is 0.001 to A.

Frame 0x200 – HBR1-4 Current
```
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Byte     B0      B1       B2        B3        B4        B5        B6        B7
```

0x780 - HBR1 : HBR1 : HBR2 : HBR2 : HBR3 : HBR3 : HBR4 : HBR4 :