Ford Fusion Shift-By-Wire

Shifting by-wire in the Ford Fusion

Features

- Computer control of shifting
- Measure gear positions
- Driver override by shifting manually
- CAN and USB interfaces
- No modifications to vehicle
- Signal passthrough on power off

Applications

- Driverless car research
- Advanced Driver Assist (ADAS) research

Description

The Dataspeed Inc. Shift-By-Wire interface enables computer control of gear shifting in a safe and effective manner. This plug-in ready kit requires no modification to the factory harnessing and can be installed in minutes. Industry standard CAN and USB networks enable control and monitoring of the shifting system.

Contents

DISCLAIMER:

This product is intended for research purposes only. Steps have been taken to ensure function on power or communication loss. However, in no event shall Dataspeed Inc. be liable for any direct, indirect, punitive, incidental, special consequential damages, to property or life, whatsoever arising out of or connected with the use or misuse of its products.

1   Connector Pin Description

1.1   CAN/DB9 Connector

The CAN/DB9 connector is used for power and CAN communication. Short pins 1 and 6 together to activate the digital input.

Table 1: CAN/DB9 connector pin description.

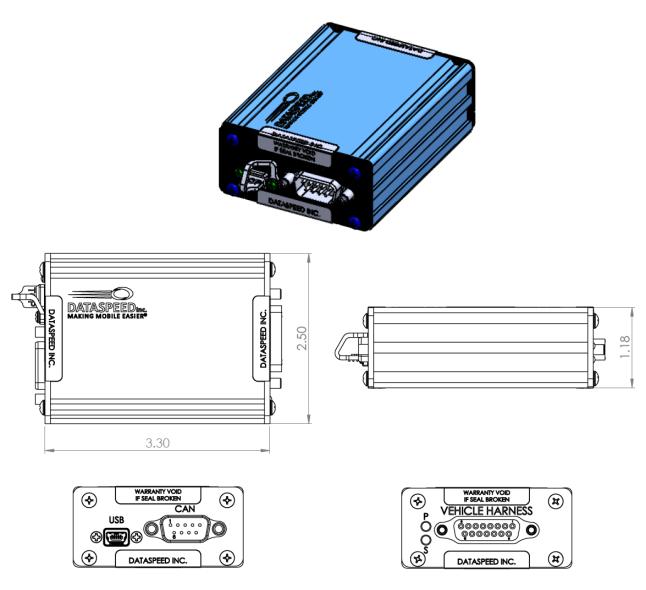| Pin	Symbol	Description
1	DIGIN	Digital Input
2	CANL	CAN Low
3	GND	Ground
4	IGNITION	Ignition (12V)
5	NC	No Connect
6	GND	Ground
7	CANH	CAN High
8	NC	No Connect
9	POWER	Power (12V)

1.2   USB Connector

The USB connector is used for introspection and firmware upgrade.

2   Electrical Characteristics

Table 2: Electrical Characteristics.

Characteristic	Min	Typ	Max	Units	Conditions
$V_{IGNITION}$ ON	9	12	16	V	
$V_{IGNITION}$ OFF	-0.3	0	2	V	
V_{POWER}	9	12	16	V	
I_{POWER}		125	300	mA	V_{POWER}=12V, $V_{IGNITION}$>9V
I_{POWER}			0.2	mA	V_{POWER}=12V, $V_{IGNITION}$<2V
Temperature	-40		+85	°C	

3   Mechanical Drawings

SHOWN WITHOUT USB PLUG

Figure 1: Mechanical Drawing

4 CAN Messages

Table 3: CAN bus configuration.

Parameter	Value	Units
Terminated	No	
BitRate	500	k
t_q	200	ns
SyncSeg	1	t_q
PropSeg	3	t_q
PhaseSeg1	3	t_q
PhaseSeg2	3	t_q
SyncJumpWidth	2	t_q

4.1 Shifting

4.1.1 Command

Message ID: 0x066
Receive Rate: On Event

Table 4: Gear Command CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CLEAR	—	—	—	—	GCMD		

bit 0-2   **GCMD:** Gear Command
               0 = None
               1 = Park
               2 = Reverse
               3 = Neutral
               4 = Drive
               5 = Low
bit 3-6   **Unimplemented:** Set to '0'
bit 7   **CLEAR:** Clear driver override flag
               1 = request clear of driver override
               0 = normal operation

Note: Gear commands will be rejected if OVERRIDE=1 for any of brake/throttle/steering. See the REJECT field on the next page for more information.

4.1.2 Report

Message ID: 0x067
Transmit Rate: 50ms

Table 5: Gear Report CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	FLTBUS	CMD			DRIVER	STATE		
1	15:8	READY	—	—	—	—	REJECT		

bit 0-2   **STATE:** Gear State
               0 = None
               1 = Park
               2 = Reverse
               3 = Neutral
               4 = Drive
               5 = Low
bit 3   **DRIVER:** Driver Override
               0 = Last shift requested by-wire
               1 = Last shift requested by driver
bit 4-6   **CMD:** Gear Command
               0 = None
               1 = Park
               2 = Reverse
               3 = Neutral
               4 = Drive
               5 = Low
bit 7   **FLTBUS:** CAN bus fault
               0 = No Fault
               1 = Fault
bit 8-10   **REJECT:** Gear rejected enumeration
               0 = Not rejected
               1 = Shift in progress
               2 = Override (on brake/throttle/steering)
               3 = Rotary shifter can't shift to Low
               4 = Rotary shifter can't shift out of Park
               5 = Rejected by vehicle (try pressing the brakes)
               6 = Unsupported
               7 = Fault
bit 10-14   **Unimplemented:** Set to '0'
bit 15   **READY:** Gear shift ready
               0 = Not ready for shift command
               1 = Ready for shift command

4.2 Version

Message ID: 0x07F
Transmit Rate: 1000ms

Table 6: Version CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	MODULE							
1	15:8	PLATFORM							
2	23:16	MAJOR<7:0>							
3	31:24	MAJOR<15:8>							
4	39:32	MINOR<7:0>							
5	47:40	MINOR<15:8>							
6	55:48	BUILD<7:0>							
7	63:56	BUILD<15:8>							

bit 0-7	**MODULE:** Module enumeration	
	0x04 = Shifter module	
	Other = Ignore, not this module	
bit 8-15	**PLATFORM:** Vehicle platform enumeration	
	0x00 = FORD_CD4	
	Other = Ignore, not this vehicle platform	
bit 16-31	**MAJOR:** Firmware version major increment	
bit 32-47	**MINOR:** Firmware version minor increment	
bit 48-63	**BUILD:** Firmware version build increment	

5 Function

- **Modifying the Shifting Signal:** The by-wire interface modifies the shifting signal when power is applied and the required CAN messages are received. The vehicle shifting system will function regardless of the CAN messaging and applied power to the by-wire interface.
- **Power-off State:** Without power applied, the hardware passes signals through unaltered.
- **Disabled State:** In the disabled state, signals are not modified. This corresponds to GCMD = 0.
- **Power-up State:** The by-wire interface powers up in the disabled state. GCMD = 0.
- **Driver Override:** If the driver requests a shift, this is reported in the CAN shifting report message with DRIVER = 1. This is automatically cleared on the next by-wire shift request, but can also be cleared by setting CLEAR to 1 in the CAN shifting command message.

6 Supported Vehicles

The Shift By-Wire interface has been tested on the Ford Fusion for model years 2017-2019.

APPENDIX A: REVISION HISTORY

Revision A-01 (June 2018)
Modifications:

1. Initial release of this document.

Revision A-02 (October 2018)
Modifications:

1. Added READY bit to gear report message.
2. Updated supported vehicle model year range to 2019.

Revision A-03 (November 2018)
Modifications:

1. Added mechanical drawing.
2. Updated product photo.