

FuelTech



OWNER'S MANUAL

FTSPARK
750mJ / 1500mJ

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2. Presentation

FTSPARK is a high energy capacitive ignition module that meets the highest levels of spark energy demand, being able to generate a spark with **750mJ** (mJ = milli Joules guaranteed minimum energy, can reach up to 850mJ) or **1500mJ** (FTSPARK EXTREME - guaranteed minimum energy, can reach up to 1700mJ) and it is capable of discharging with currents up to 140Amps and 475V in the primary coil circuit. With these features, the FTSPARK generates a spark with approximately 5 times more energy and 10 times more current compared to a SparkPRO, ensuring a complete combustion in any condition, especially in extremely rich air fuel ratios.

FTSPARK Differentials:

- Compatible with rotary engines
- Programmable energy level over CAN bus or analog input for energy level configuration
- 475V in the primary coil circuit, helps avoiding electromagnetic noise in the system
- Up to 140Amps in the primary coil circuit using FuelTech CDI Racing Ignition Coil
- Up to 175Amps in the primary coil circuit using FuelTech CDI Racing Ignition Coil and FTSPARK 1500mJ (FTSPARK EXTREME)
- CAN communication with FuelTech Power FT product line, for diagnostics and data logging
- Anodized aluminum housing
- Automotive connector with gold-plated terminals
- Serial bus (1 wire) allows the use of only one ECU output to trigger all FTSPARK ignition outputs

3. Warranty terms

The use of this equipment implies in total accordance with the terms described in this manual and exempts the manufacturer from any responsibility regarding product misuse.

This product must be installed and tuned by specialized auto shops or professionals with experience on engine tuning.

The oversight of any of the warnings or precautions described in this manual can cause engine damage and lead to warranty void of this product warranty. Before starting any electrical installation, disconnect the battery.

This product is not certified for aeronautic purposes or any flying vehicles, as it has not been designed for such applications.

In some countries where an annual inspection of vehicles is enforced, no modification in the OEM ECU is permitted. Be informed about local laws and regulations prior to the product installation.



Important warning for proper installation of this product:

Always remove and insulate unused wires. NEVER roll up excess wiring as this may create an antenna that captures electromagnetic interference that may generate product malfunction.

Limited Warranty

This product warranty is limited to one year from the purchase date, only covering manufacturing defects and requiring purchase invoice presentation. Damages caused by misuse of the unit are not covered by the warranty. Warranty void analysis is done exclusively by FuelTech technical support team.



WARNING:

Warranty seal violation results in product warranty void.

Manual Version 2.2 – August/2020

4. Characteristics

- Dimensions: 4.92 x 6.0 x 1.9 in.;
- Weight: 32.8 oz;
- Body: Anodized aluminum and plastic;
- Voltage supply required for full power: 14-26V. Minimum voltage during cranking 8V;
- Maximum operating frequency: 670 Hz;

Specifications	**600mJ	750mJ	1500mJ
Minimum energy	600mJ	750mJ	1500mJ
Maximum Energy	680mJ	850mJ	1700mJ
Primary coil current	125A	140A	175A
Spark plug (non-resistive) current	1.70A	1.95A	2.50A
Spark duration	300uS	330uS	400uS

**** Previous Version**

Maximum Current Consumption

FTSPARK-4 (4 Coils)	20A @ 10000RPM
FTSPARK-6 (6 Coils)	30A @ 10000RPM
FTSPARK-8 (8 Coils)	40A @ 10000RPM
FTSPARK-4 EXTREME (4 Coils) 1500mJ	40A @ 10000RPM
FTSPARK-8 EXTREME (8 Coils) 1500mJ (using 2 FTSPARK ignition module)	FTSPARK(A) - 40A @ 10000RPM FTSPARK(B) - 40A @ 10000RPM

Wiring Harness

FTSPARK-4 (4 Coils):	23 Wires
FTSPARK-6 (6 Coils):	29 Wires
FTSPARK-8 (8 Coils):	35 Wires
FTSPARK-8 EXTREME (4 Coils):	21 Wires
FTSPARK-8 EXTREME (8 Coils):	42 Wires

Wire harness length: 59 in. at power outputs connected to coils and 118 in. at the other cables.

Maximum piston engine speed (with 16V battery)

Cylinders	Sequential	Wasted spark / 2 Stroke
4	22.500 RPM	11.250 RPM
4 (EXTREME)	11.250 RPM	NOT COMPATIBLE
5	15.000 RPM	NOT COMPATIBLE
6	15.000 RPM	NOT COMPATIBLE
8	11.250 RPM	NOT COMPATIBLE
8 (EXTREME)	11.250 RPM	NOT COMPATIBLE

Maximum rotary engine speed (with 16V battery)

Rotors	Rotary	Units
2	11.250 RPM	1 x FTSPARK-4
3	15.000 RPM	2 x FTSPARK-4
4	11.250 RPM	2 x FTSPARK-4



IMPORTANT

FTSPARK EXTREME is not compatible with rotary engines.

5. Installation

Capacitive ignition systems require special installation care for correct operation. The vehicle's electrical system suffers high current and voltage demand from the FTSPARK ignition system. It is essential to follow the installation instructions in this manual.



NOTE

If the LOG shows energy drop, it's necessary to check the harness and wires that go to the battery. And on situations where the FTSPARK is far from the battery, it's mandatory to increase wire gauge.

A good solution is to make a secondary power terminal from the battery, using 2 AWG cable.

5.1 Mounting

Mounting must be done using the rubber cushions. Always use the 4 spots available on the FTSPARK body.

The FTSPARK must be installed as far away from heating sources as possible (such as turbochargers and exhaust manifolds) because it generates a lot of heat by itself.

If installed on the engine bay, it must be mounted where air flows best.

5.2 Power supply

Never Invert the FTSPARK power connections.

The FTSPARK power supply, as well as all other electric loads of the car, must pass through the master switch for safety reasons and the master switch must NEVER interrupt the battery ground, always the hot terminal.



IMPORTANT

- Always connect the power supply harness directly to the battery with a 50A fuse for each FTSPARK BOX.
- Do not use the chassis or engine block to ground the FTSPARK. Use the negative battery terminal.

To turn the FTSPARK on and off use a 12V switch connected to the analog input on pin 12.

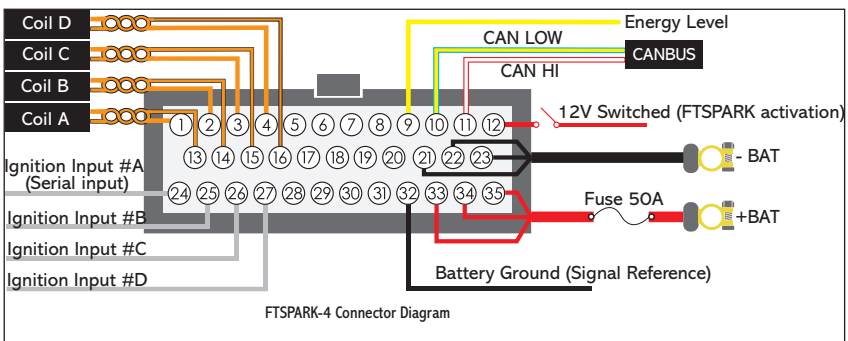
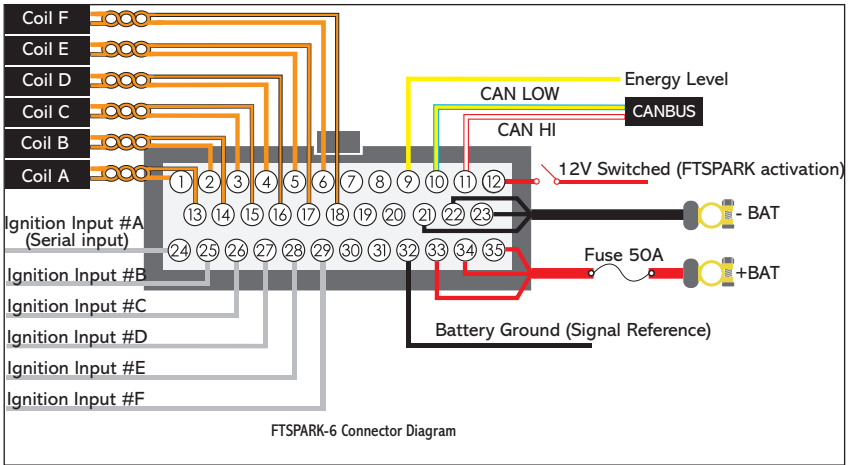
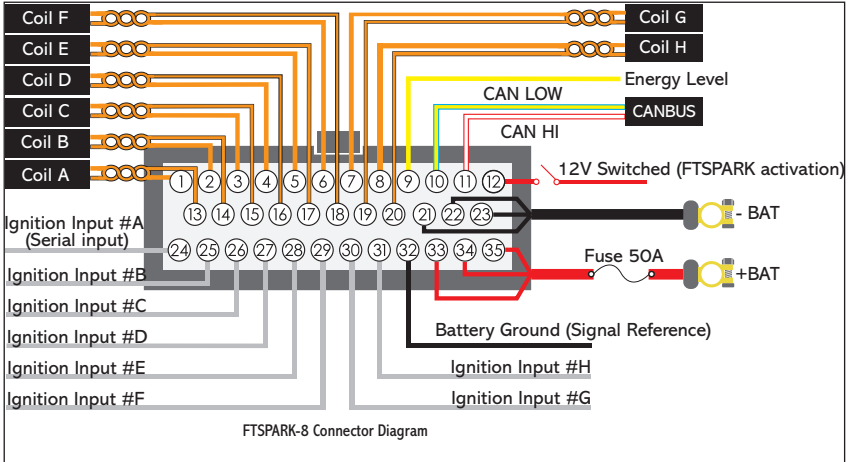
Do not connect the FTSPARK to a voltage booster, it demands current peaks of more than 100A and will cause the system to malfunction. Do not use the The FTSPARK on systems with over 20V power supply.

Do not use FTSPARK on systems with power supply voltage over 26V.

5.3 Harness connections table

750mJ connection table

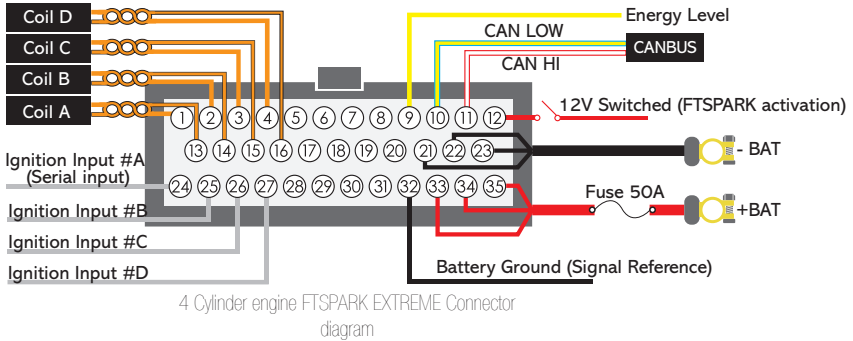
Pin	Wire	Label	Function
1	Orange	COIL A (+)	Coil primary output. High voltage (Positive side)
2	Orange	COIL B (+)	
3	Orange	COIL C (+)	
4	Orange	COIL D (+)	
5	Orange	COIL E (+)	
6	Orange	COIL F (+)	
7	Orange	COIL G (+)	
8	Orange	COIL H (+)	
9	Yellow	Energy level	Energy level selection; (ground trigger) NOTE: If the FTSPARK is connected via the CAN network, it is not necessary to use this wire.
10	Yellow/Blue	--	Wiring harness CANBUS CAN LOW
11	Yellow/White	--	Wiring harness CANBUS CAN HI
12	Red	Switched 12V	FTSPARK Switch ON/OFF
13	Orange/Black	COIL A (-)	Coil primary output. Wire 750V. Twisted. (Power ground side)
14	Orange/Black	COIL B (-)	
15	Orange/Black	COIL C (-)	
16	Orange/Black	COIL D (-)	
17	Orange/Black	COIL E (-)	
18	Orange/Black	COIL F (-)	
19	Orange/Black	COIL G (-)	
20	Orange/Black	COIL H (-)	
21	Black	-BAT	Power ground. Connect to battery
22	Black	-BAT	
23	Black	-BAT	
24	Gray	Ignition Input A	Ignition trigger input A or Serial bus (1 wire)
25	Gray	Ignition Input B	Ignition trigger input B
26	Gray	Ignition Input C	Ignition trigger input C
27	Gray	Ignition Input D	Ignition trigger input D
28	Gray	Ignition Input E	Ignition trigger input E
29	Gray	Ignition Input F	Ignition trigger input F
30	Gray	Ignition Input G	Ignition trigger input G
31	Gray	Ignition Input H	Ignition trigger input H
32	Black	GND	Battery ground. Trigger signal reference
33	Red	+BAT	Power supply for FTSPARK. Connect to battery positive or main switch when required.
34	Red	+BAT	
35	Red	+BAT	



1500mJ (FTSPARK EXTREME) connection table - 4 Cylinder

Pin	Wire	Label	Function
1	Orange	COIL A (+)	Coil primary output. High voltage (Positive side)
2	Orange	COIL B (+)	
3	Orange	COIL C (+)	
4	Orange	COIL D (+)	
5	Not Used	-	Not Used
6	Not Used		
7	Not Used		
8	Not Used		
9	Yellow	Energy level	Energy level selection; (ground trigger) NOTE: If the FTSPARK is connected via the CAN network, it is not necessary to use this wire.
10	Yellow/Blue	-	Wiring harness CANBUS CAN LOW
11	Yellow/White	-	Wiring harness CANBUS CAN HI
12	Red	Switched 12V	FTSPARK Switch ON/OFF
13	Orange/Black	COIL A (-)	Coil primary output. 750V wire. Twisted. (Power ground side)
14	Orange/Black	COIL B (-)	
15	Orange/Black	COIL C (-)	
16	Orange/Black	COIL D (-)	
17	Not Used	-	Not Used
18	Not Used		
19	Not Used		
20	Not Used		
21	Black	-BAT	Power ground. Connect to battery
22	Black	-BAT	
23	Black	-BAT	
24	Gray	Ignition Input A	Ignition trigger input A or Serial bus (1 wire)
25	Gray	Ignition Input B	Ignition trigger input B
26	Gray	Ignition Input C	Ignition trigger input C
27	Gray	Ignition Input D	Ignition trigger input D
28	Not Used	-	Not Used
29	Not Used		
30	Not Used		
31	Not Used		

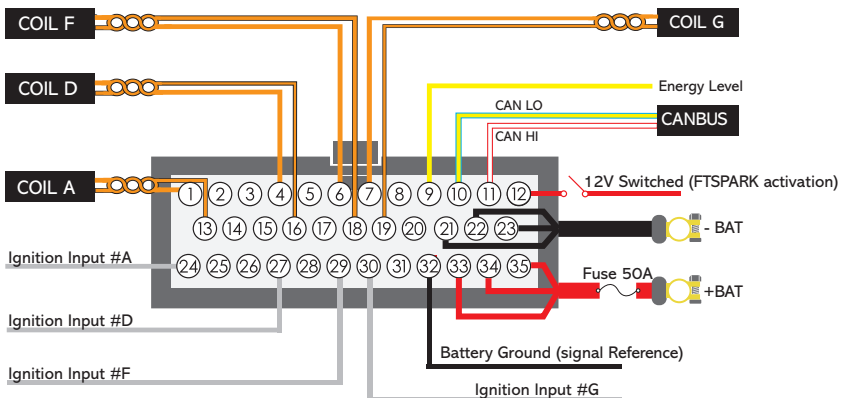
Pin	Wire	Label	Function
32	Black	GND	Battery ground. Trigger signal reference
33	Red	+BAT	Power supply for FTSPARK. Connect to battery positive or main switch when required..
34	Red	+BAT	
35	Red	+BAT	



1500mJ (FTSPARK EXTREME) connection table - 8 Cylinder (BOX A)

Pin	Wire	Label	Function
1	Orange	COIL A (+)	Coil primary output. High voltage (Positive side)
2	Not Used	-	
3	Not Used	-	
4	Orange	COIL D (+)	
5	Not Used	-	
6	Orange	COIL F (+)	
7	Orange	COIL G (+)	
8	Not Used	-	
9	Yellow	Energy level	Energy level selection; (ground trigger) NOTE: If the FTSPARK is connected via the CAN network, it is not necessary to use this wire.
10	Yellow/Blue	-	Wiring harness CANBUS CAN LOW
11	Yellow/White	-	Wiring harness CANBUS CAN HI
12	Red	Switched 12V	FTSPARK Switch ON/OFF

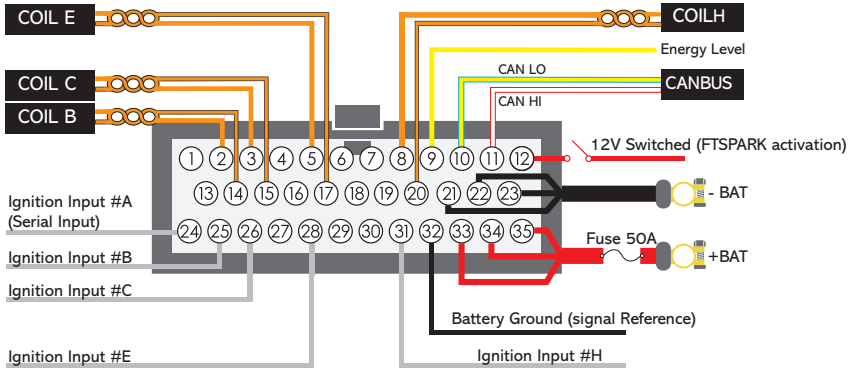
Pin	Wire	Label	Function
13	Orange/Black	COIL A (-)	Coil primary output. 750V wire. Twisted. (Power ground side)
14	Not Used	-	
15	Not Used	-	
16	Orange/Black	COIL D (-)	
17	Not Used	-	
18	Orange/Black	COIL F (-)	
19	Orange/Black	COIL G (-)	
20	Not Used	-	
21	Black	-BAT	Power ground. Connect to battery
22	Black	-BAT	
23	Black	-BAT	
24	Gray	Ignition Input A	Ignition trigger input A or Serial bus (1 wire)
25	Not Used	-	Not Used
26	Not Used	-	Not Used
27	Gray	Ignition Input D	Ignition trigger input D
28	Not Used	-	Not Used
29	Gray	Ignition Input F	Ignition trigger input F
30	Gray	Ignition Input G	Ignition trigger input G
31	Not Used	-	Not Used
32	Black	GND	Battery ground. Trigger signal reference
33	Red	+BAT	Power supply for FTSPARK. Connect to battery positive or main switch when required.
34	Red	+BAT	
35	Red	+BAT	



1500mJ (FTSPARK EXTREME) connection table - 8 Cylinder (BOX B)

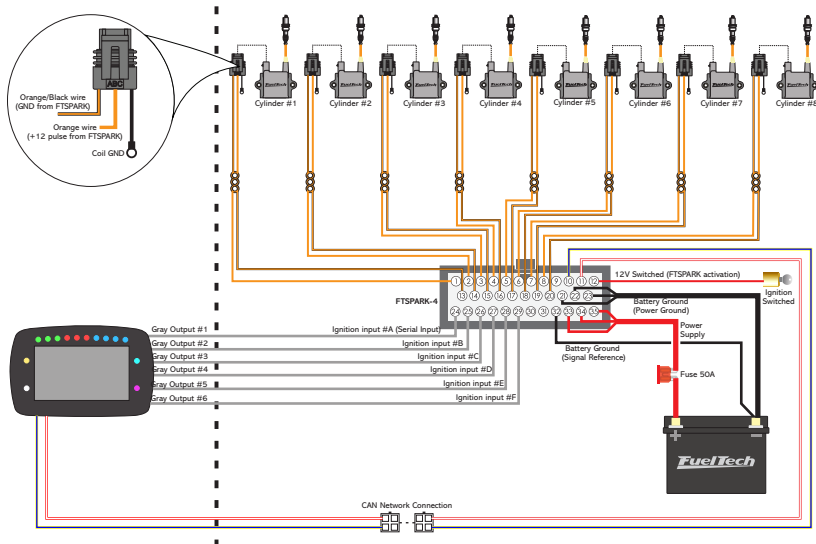
Pin	Wire	Label	Function
1	Not Used	-	Coil primary output. High voltage (Positive side)
2	Orange	COIL B (+)	
3	Orange	COIL C (+)	
4	Not Used	-	
5	Orange	COIL E (+)	
6	Not Used	-	
7	Not Used	-	
8	Orange	COIL H (+)	
9	Yellow	Energy level	Energy level selection; (ground trigger) NOTE: If the FTSPARK is connected via the CAN network, it is not necessary to use this wire.
10	Yellow/Blue	-	Wiring harness CANBUS CAN LOW
11	Yellow/White	-	Wiring harness CANBUS CAN HI
12	Red	Switched 12V	FTSPARK Switch ON/OFF
13			
14	Orange/Black	COIL B (-)	Coil primary output. 750V wire. Twisted. (Power ground side)
15	Orange/Black	COIL C (-)	
16	Not Used	-	
17	Orange/Black	COIL E (-)	
18	Not Used	-	
19	Not Used	-	
20	Orange/Black	COIL H (-)	
21	Black	-BAT	Power ground. Connect to battery
22	Black	-BAT	
23	Black	-BAT	
24	Gray	Ignition Input A	Ignition trigger input A or Serial bus (1 wire)
25	Gray	Ignition Input B	Ignition trigger input B
26	Gray	Ignition Input C	Ignition trigger input C
27	Not Used	-	
28	Gray	Ignition Input E	Ignition trigger input E
29	Not Used	-	
30	Not Used	-	

Pin	Wire	Label	Function
31	Gray	Ignition Input H	Ignition trigger input H
32	Black	GND	Battery ground. Trigger signal reference
33	Red	+BAT	Power supply for FTSPARK. Connect on battery positive or when main switch required.
34	Red	+BAT	
35	Red	+BAT	

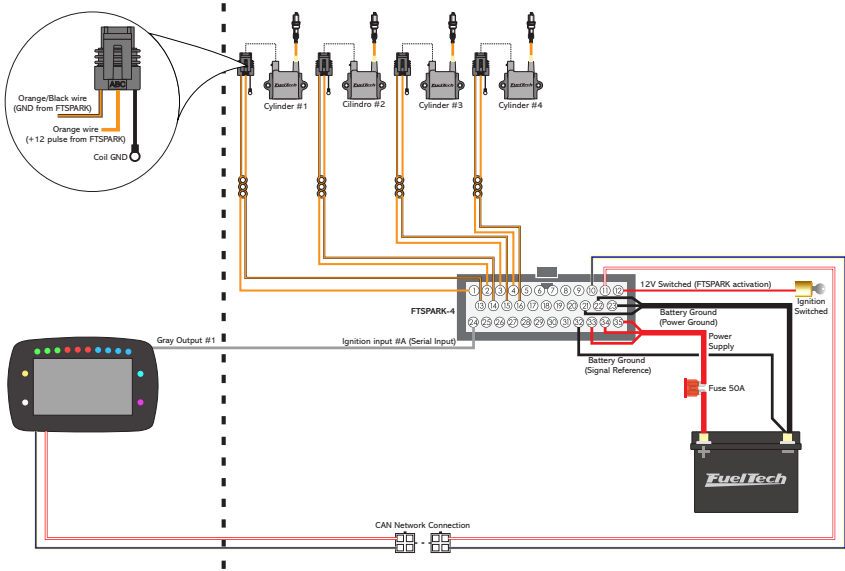


5.4 Connection diagrams

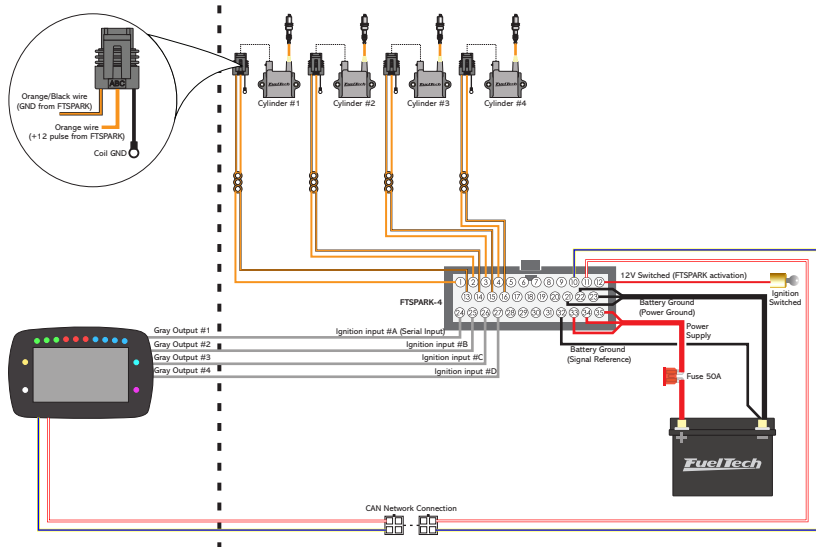
Individual FuelTech CDI Racing Ignition Coil



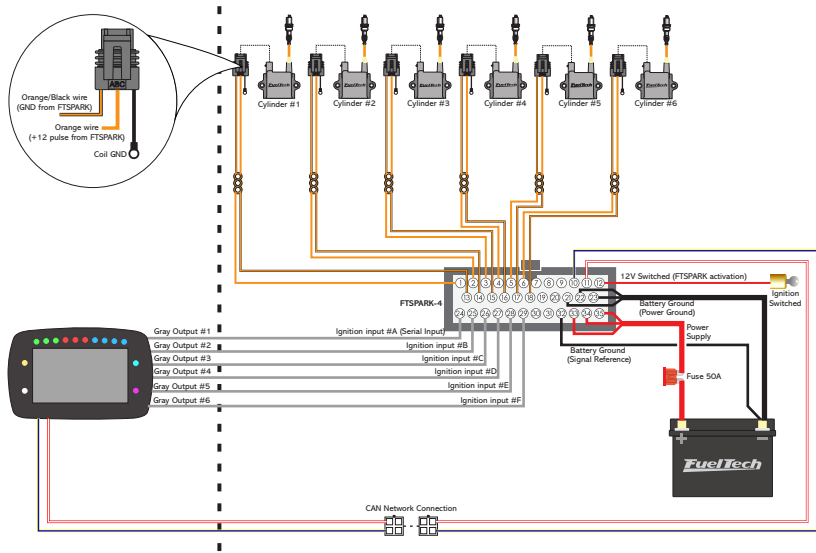
4 Cylinder with Serial bus (Single wire - PowerFT ECU's)



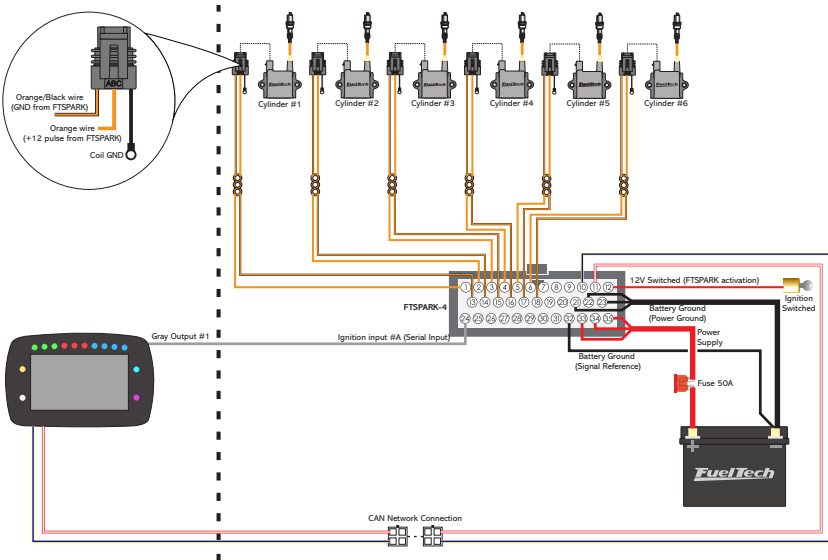
4 Cylinder with multiple wires



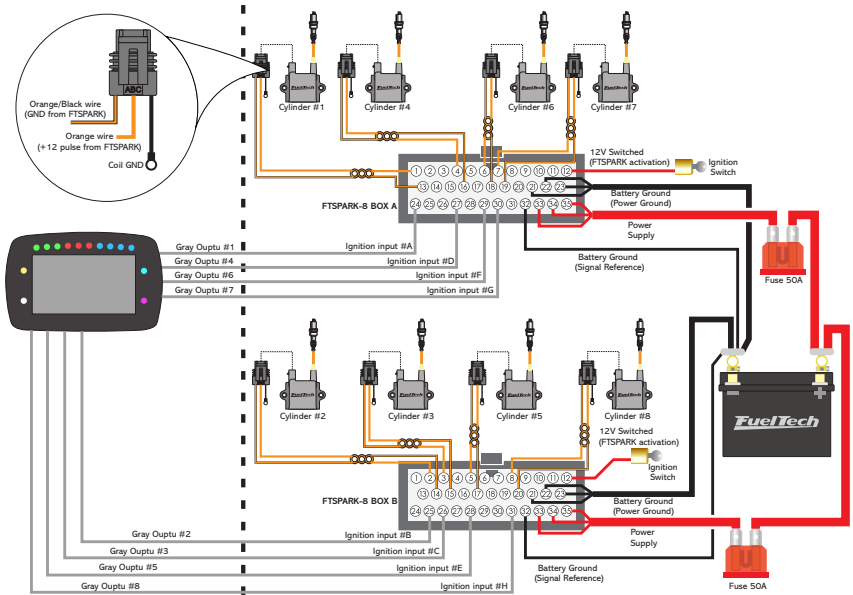
6 Cylinder with multiple wires



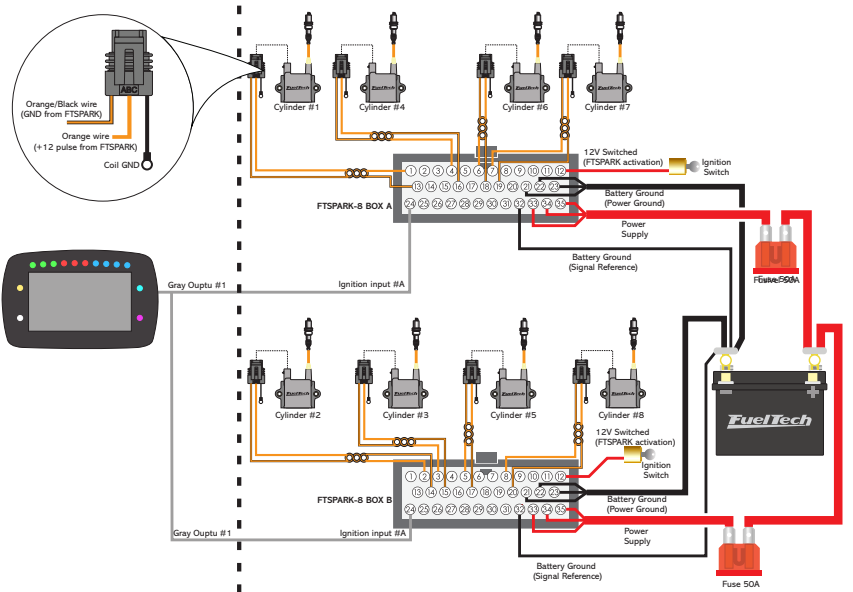
6 Cylinder with Serial bus (Single wire - PowerFT ECU's)



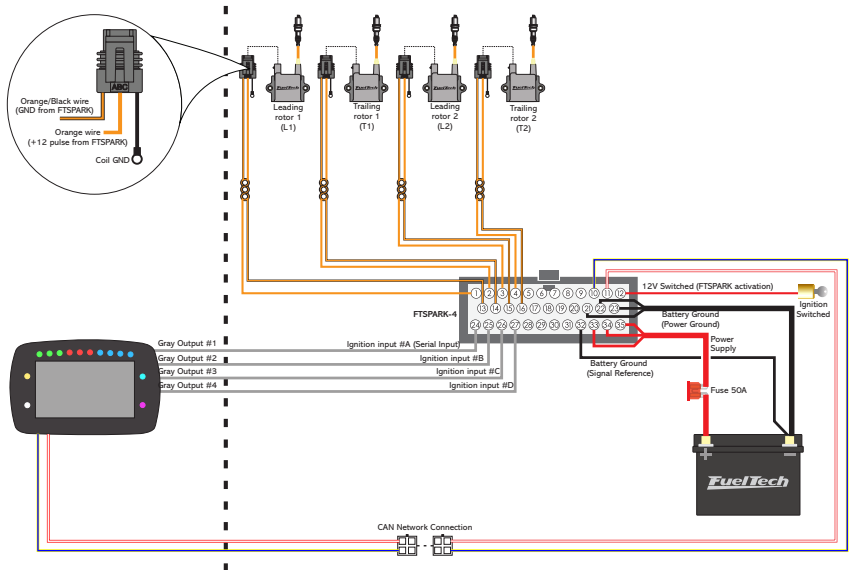
FTSPARK EXTREME 8 Cylinder with multiple wires



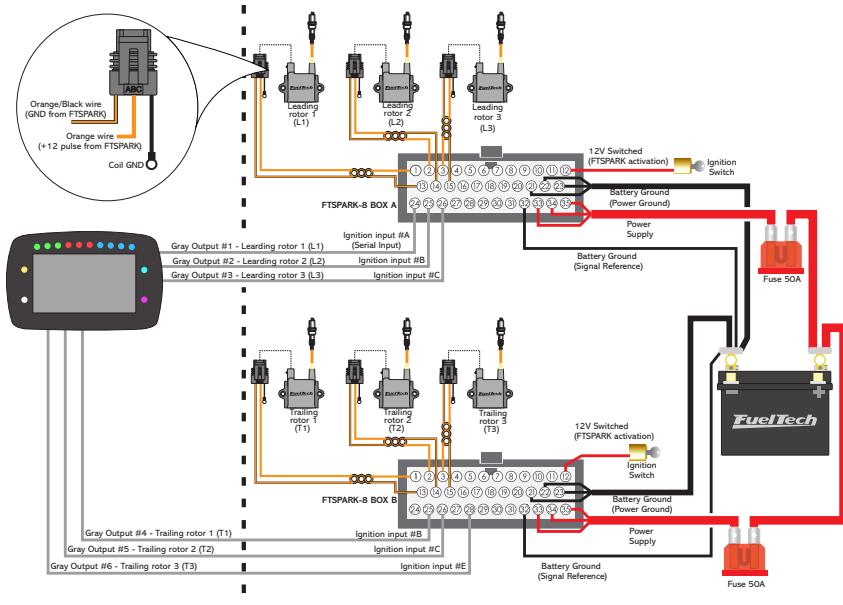
FTSPARK EXTREME 8 Cylinder with Serial bus (Single wire)



2 Rotors with individual coils



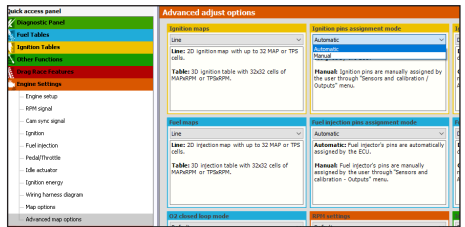
3 Rotors with individual coils - 2 FTSPARK-4 boxes



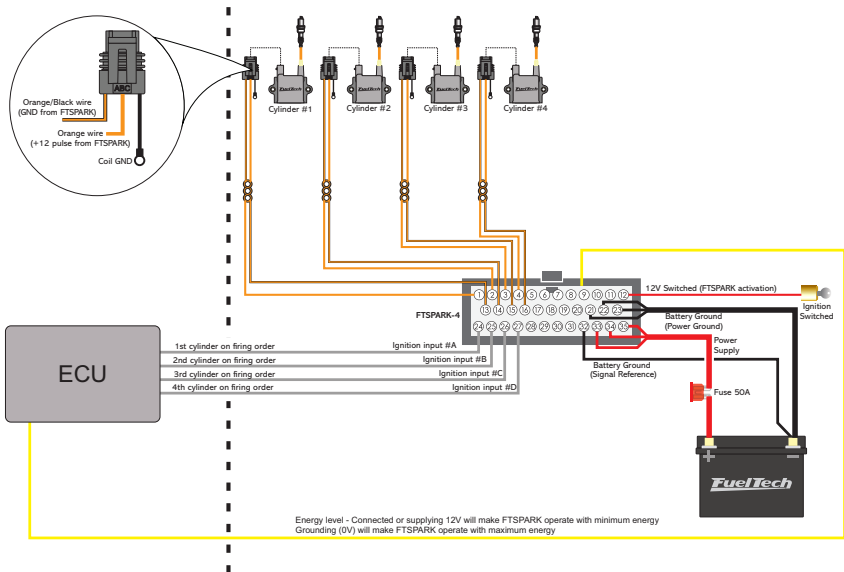
Ignition pins assignment

After FTSPARK installation, follow the steps below if changes on the ignition outputs are needed:

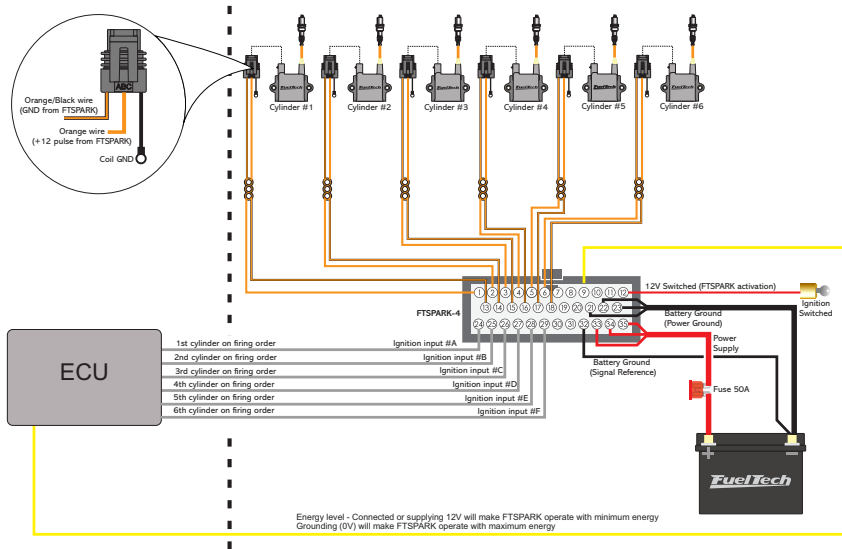
- 1 - Open the map on FTManager
- 2 - Click on "Sensors and calibration / Outputs"
- 3 - Check which gray outputs are set as ignition outputs. If you need to change output order, proceed to step 4
- 4 - Click on "Engine settings / Advanced map options"
- 5 - Click on "Ignition pins assignment mode and change it from "Automatic" to "Manual"
- 6 - Return to the "Sensors and calibration / outputs" menu and change the ignition outputs according to your installation



FTSPARK-4 managed by other aftermarket ECU's



FTSPARK-6 managed by other aftermarket ECU's



Electrical wire specifications

Function	Color / Wire Gauge
Ignition output (COILS)	Orange AWG 16 (1.5mm ²) isolation 750V
Ground ignition (COILS)	Orange/Black AWG 16 (1.5mm ²) isolation 750V
- BAT	Black AWG 16 (1.5mm ²) Isolation 300V until the splice and after AWG 10 (4.5mm ²)
+ BAT	Red AWG 16 (1.5mm ²) Isolation 300V until the splice and after AWG 10 (4.5mm ²)
Ignition input	Gray AWG 20 (0.5mm ²) Isolation 300V
Energy level	Yellow AWG 20 (0.5mm ²) Isolation 300V
12V	Red AWG 20 (0.5mm ²) Isolation 300V
ECU GND	Black AWG 20 (0.5mm ²) Isolation 300V

5.5 Wiring harness installation

The main connector terminals must be crimped with appropriate pliers. Never solder terminals. Additional metal will cause electrical insulation problems inside the connector.

Plan the installation to avoid wiring joints on the wiring harness. If this is unavoidable, the twisted wires should continue to be braided in the extended part. Power outputs connected to the primary coil must use wires with a minimum 750V insulation.

5.6 Wiring harness positioning

Never route the output cables that connect the coils (59 in. Twisted orange cables) together with the other FTSPARK wires or other electrical wiring in the vehicle. The output cables that connect to the coils may induce a high amount of current in surrounding wires, which can cause malfunction in other systems of the vehicle and even damage inputs and outputs of other modules.

It's recommended to keep a distance of at least 4" between the ignition coils wiring and all other wiring harness parts. If this can't be done, the wiring should be covered with braided steel wiring sleeve.

5.7 Coils

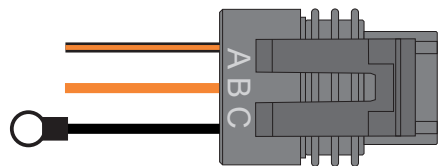
Use only coils that are approved and tested by FuelTech. The vast majority of coils designed for inductive operation greatly reduces the performance of the FTSPARK. A good inductive coil is not guaranteed of similar performance when used with the FTSPARK.

Some coils developed for use with OEM CDIs (nautical or motorcycle use) may damage the CDI because it can not absorb the peak power sent by FTSPARK. Below is the coil recommended by FuelTech.

Model	Manufacturer
CDI Racing Coil	FuelTech

Racing CDI FuelTech wiring diagram

- A - Orange/Black wire (GND from FTSPARK)
- B - Orange wire (+12 pulse from FTSPARK)
- C - Coil GND



IMPORTANT

The C pin ring terminal must be bolted on the cylinder head as close as possible to the spark plug that it's going to fire.

5.8 Spark plug wires

Do not use spark plug wires without suppression or cables with suppressor terminals only. Use of RFI (radio frequency interference) spark plugs wire is required to ensure the proper operation of all electronic equipment on the vehicle.

Low resistance spark plug wires with suppressive characteristics are recommended.

5.9 Spark plugs

Using non-resistive spark plugs greatly increases spark energy with capacitive ignitions, however not all installations will function properly depending on the level of interference generated. In these cases using resistive spark plugs is mandatory.

Keep the spark plugs clean and free of oil or grease to prevent electrical insulation problems.

Spark plugs that do not allow GAP adjustment or surface discharge are designed for use only in naturally aspirated engines. For turbocharged engines keep the spark plug GAP always less than 0.02 in.



WARNING

Faults in the ignition system due to excessive GAP damage the coils and also FTSPARK. When the energy released by the ignition cannot find a path to be dissipated, it returns to the coil or to the output of the FTSPARK output.

6. FTSPARK control

FTSPARK has two operation modes. Individual triggering (using two or more ignition outputs) or through Serial bus (1 wire).

6.1 Individual triggering

For the Power FT product line, it is necessary to enable the FTSPARK option and select multiple outputs in the ignition settings. For older modules, it's necessary to select SparkPRO/3 wires option with a dwell time of 3 ms. Longer or shorter times may cause abnormal operation. The recommended voltage on input signals is 0V to low level and 5-14V to high level. Use ECU NEGATIVE (pin 32) connected to the sensor ground output of FT600 or battery negative in other situations as a reference for these triggering signals.

6.2 Serial bus triggering

In this mode, FTSPARK operates using signals present in IGNITION INPUT A only. This mode allows more outputs to be used in other features and reduces the quantity of harness wires. This mode is only available when the FTSPARK is connected to an ECU of the Power FT product line.

FTSPARK EXTREME

For 8 Cylinder engines using 1500mJ (minimum energy, can reach up to 1700mJ) it's mandatory to have the Serial bus activation wire shared between Box A and Box B, connecting it to pin 24 in both boxes.



NOTES

- *This serial protocol is not compatible with any other ECU, it's a FuelTech exclusive compatibility.*
- *The serial bus triggering can **NOT** be used for rotary engines.*

6.3 Input signal trigger edge

All the FTSPARK units are designed to receive FALLING TRIGGER EDGE signal from the EFI, make sure you have your EFI settings for ignition output signal as falling edge to assure accurate ignition timing.

6.4 CAN network

The CAN network allows the ECU to select the energy level without the use of the energy level selection wire.

In addition, FTSPARK is capable of generating a series of CAN network diagnostics that are recorded by the ECU (FuelTech FT500 or higher).

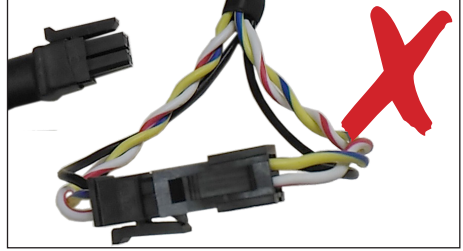
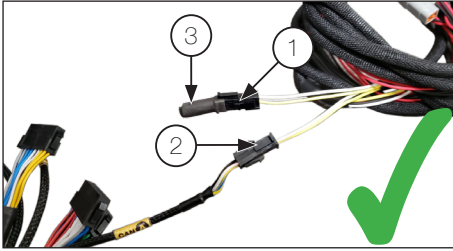
CAN Network connection

FTSPARK harness has 2 connectors for CAN network connection with FuelTech products.

- 1 - Female connector
- 2 - Male connector
- 3 - CAN terminator

Plug the male connector from the FTSPARK harness (2) to the female connector on the back of the ECU. In case you have other products that are already connected to the CAN network (WB-O2 Nano, for instance), then connect the male connector from FTSPARK to the female connector from the WB-O2 Nano. It may be necessary to remove the CAN terminator from the WB-O2 Nano harness.

The CAN terminator (3) must remain plugged to the female connector of the last equipment on the network. This helps to prevent noise on the CAN network. Male connector from the FTSPARK (1) **MUST NOT** be plugged to the female connector on the same harness. CAN communication will work properly with this connection.



WARNING

When the CAN network is disconnected, the user loses the option of selecting the energy level through the MAP and visualizing all the diagnostics and measures that the ignition module is capable of performing.

Through the diagnostic panel it's possible to identify if the FTSPARK is connected. If it's not connected, product will operate normally (with energy set by the energy setting wire).

6.5 Energy level selection

Energy level may be selected by two ways: ENERGY LEVEL input ground trigger (pin 9, yellow cable), or through CAN network (values are set in the ECU's ignition energy table).



IMPORTANT

In order to run on 750mJ of energy when not connected to a FuelTech ECU through CAN network, the Energy level selection wire (pin #9 - yellow wire) must be connected to the battery negative.

If this wire is not connected, the FTSPARK will run on 400mJ only.

Operation without CAN network

Select energy level through ENERGY LEVEL input:

- 400 mJ: Do not connect ENERGY LEVEL input.
- 750 mJ: ENERGY LEVEL input must be connected to a ground or auxiliary output.
- FTSPARK EXTREME: 800mJ minimum to 1500mJ maximum



NOTES

- 750mJ (guaranteed minimum energy, can reach up to 850mJ)
- 1500mJ (guaranteed minimum energy, can reach up to 1700mJ)

Operation with CAN network

When the CAN network is connected to a FuelTech ECU, the ENERGY LEVEL input is ignored and the energy level is set by the ECU via CAN.



WARNING

If the maximum internal operation temperature is exceeded, the FTSPARK thermal protection reduces power output to prevent hardware damage, regardless of user programming, which may cause abnormal ignition.

6.6 Wasted spark operation (750mJ Only)

The FTSPARK has 2 banks of capacitors that are alternately connected at the outputs. The first bank of capacitors fires the “odd” outputs, which are designated A, C, E and G, and the second bank fires the “even” outputs, designated B, D, F and H.

To obtain the maximum performance, the installation must always consider the sparks alternating the use of the capacitor banks, that is, 1 spark on one “odd” bank and the next on one “even” bank, and so on.

Doing so will allow the operation on rotary engines (which has the sparks timed very close to each other) and wasted spark on engines with up to 4 cylinders.



IMPORTANT

Only engines with 4 cylinders or less can use the wasted spark configuration. Engines with 5 to 8 cylinders must use sequential ignition.

6.7 Safety Features

The FTSPARK has many internal safety protections to avoid damage to the product in case of misuse or improper installation.

Every failure is automatically reset, that is, if the error is gone, the FTSPARK resumes operation normally.

Some protections require special attention.

The errors 41 and 43, which are related to a failure to charge the internal capacitors, prevent the FTSPARK from functioning if they occur 10 consecutive times. Normal operation is resumed when the error trigger signal is absent. Removing the power is not needed.

The error 22, related to operation while overheated, has 2 stages of protection. If the temperature is above 203 F, but less than 212 F, the energy is reduced to 400mJ, regardless of map table or external command. If the temperature goes beyond 212 F, the FTSPARK is turned off.

6.8 Ignition delay time

The FTSPARK has a pre defined "Ignition delay" between processing the input signal and firing the ignition of 30uS (0.000030 second) that should be added to the existing ignition delay time set on the ECU when switching from another ignition system that has close to zero delay.

Typical ignition delay time of a complete ECU, ignition system, coil and spark wires are 70uS.

To confirm this setting on your system, lock the ignition timing advance to a fixed timing and check with a timing light that you have no timing change over the RPM range from idling to high RPM, this means that your "ignition delay" was set correctly.

If you experience timing being retarded over RPM, you need to increase the "ignition delay".

As a reference number, on a sequential ignition setup with locked timing on ECU, if you are checking timing at 1,000 RPM and then at 9,000 RPM and timing is retarding 1 degrees over this range, you will need to add 20uS to the "ignition delay" on the ECU.

7. Recalibrating ignition and fuel map

The additional energy generated and precise ignition timing (related to short spark duration), generally require ignition map to be recalibrate when FTSPARK is installed to replace an inductive system.

The additional spark energy allows the engine to operate with richer mixtures before failure or loss of power. It's possible to take advantage of this and operate with a richer fuel map for the same power level, putting the engine in a safer range of operation avoiding all the problems that might occur when running with a lean mixture.

8. LED operation indicator

FTSPARK has a LED that allows to diagnose its basic operation. It's possible states are listed in the table below.

State	Diagnose
Off	No power input switched 12V
Lit Green	FTSPARK is on, no errors, waiting triggering pulses
Blinking Green	Triggering pulses on input, no errors, operating with standard energy (400mJ)
Blinking Orange	Triggering pulses input, no errors, operating with maximum energy (750mJ - guaranteed minimum energy, can reach up to 850mJ)
Fast/slow blinking Red	Failure detected. Displaying error code.

The FTSPARK can report a two-digit error code on the diagnostic LED. Slow blinks indicate the tens, dozens quick blinks indicate the unit. Example: 4 slow blinks followed 3 quick blinks. Error code 43.

Following is the list of errors currently reported by the FTSPARK.

Error Code	Diagnose	Solution
21	ECU is operating on wasted spark with wrong firing order.	When activating two outputs simultaneously, it's mandatory to trigger one even and one odd channel. Example: AB, CD, EF, GH. * A = 1 B = 2 C = 3 ... H = 8
22	FTSPARK has overheated	Increase the airflow around FTSPARK or turn it off so it can cool down to its normal operating temperature.
31	Off Power Supply	Check the power supply circuit the FTSPARK, relays and fuses.
41	Hardware error. Over voltage on internal capacitors.	Contact FuelTech.
42	Hardware error. Internal voltage below minimum. FTSPARK switches off during this fault condition.	It may be caused by a power failure on FTSPARK or discharged battery.
43	Hardware error. FTSPARK can not charge the capacitors.	Probable output failure. Contact FuelTech.
44	Hardware error. FTSPARK has internal protection fuse ruptured	This fuse is not accessible and can not be replaced by the user. Contact FuelTech.

9. FTSPARK settings and operation

9.1 FTSPARK settings

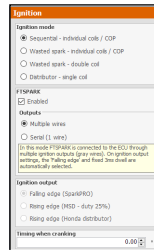
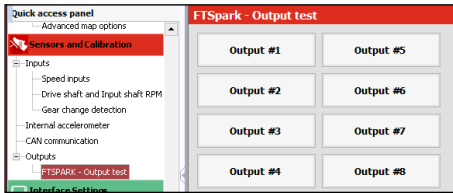
Through FTManager it's possible to configure the FTSPARK output, to do so go to 'Engine Settings' then 'Ignition'.

Set FTSPARK to 'Enabled' then select the output.

Multiple wires: This mode will activate individual coil outputs.

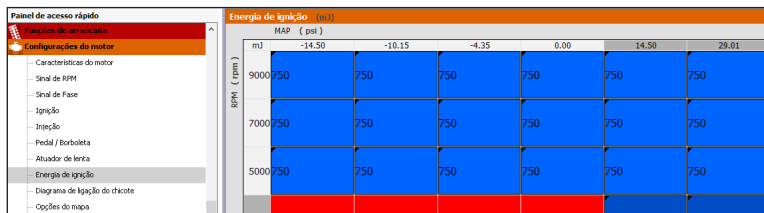
Serial bus (1 wire): In this mode the connection with the FTSPARK is made on the IGNITION INPUT A (gray wire #1). All of the ignition signals will be sent through this connection.

When the multiplexed output is selected, its possible to test the FTSPARK outputs using a "test function" on the FTManager. To do so, go to 'Sensors and Calibration' then 'Outputs' and select FTSPARK - Output test.



9.2 Ignition energy

On this MAPxRPM table it's possible to set the energy level of the FTSPARK. Adjust this table according to the FTSPARK maximum and minimum possibilities.



9.3 Using two FTSPARK units in the same installation:

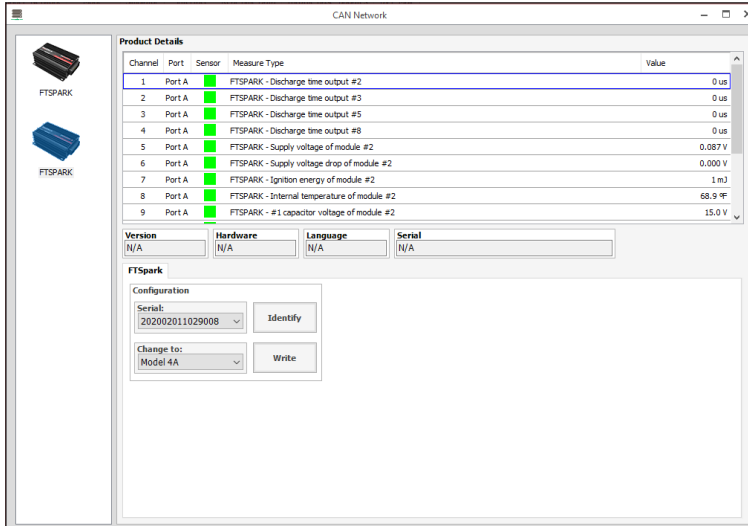
When the installation requires 2 FTSPARK units, it's necessary to identify which unit will be the Box B, using FuelTech FTManager software.

Procedure:

1. Connect both units in the CAN bus along with the FuelTech PowerFT ECU
2. Turn ignition ON to power FTSPARK boxes
3. Under the tab Tools, in the top of the software, select CAN Network
4. In the case that the units are all Box A, the product icon in the left column will show up as just one. Click on top of the product and select the module you want to identify according to its serial number to become the Box B and select "Identify" to blink the desired product LED, after that just click "Save". All new modules are configured as "Box A" as default.

For rotary engines with 3 or 4 rotors, is required 2 FTSPARK-4 units, the second one that will trigger "Trailing" spark plugs must be configured as Box B. Using FTSPARK EXTREME on 6 and 8 cylinder engines is necessary 2 units, select Box B to control cylinder 2, 3, 5 and 8.

This configuration is only possible with FTSPARK Generation 2 750mJ or FTSPARK EXTREME 1500mJ. FTSPARK Generation 1 600mJ does not allow this configuration.



NOTE
 On step 4, if having difficult to change unit assignment, unplug the Box A that will be used in the installation and let only the unit that will be renamed connected to CAN.

9.4 Setup on engines with sequential ignition

Sequential ignition setup on engines with individual coils.

4 cylinders - FTSPARK-4	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4

4 cylinders - FTSPARK-8 EXTREME	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4

5 cylinders - FTSPARK-6	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4
E	#5
F	Not used

6 cylinders - FTSPARK-6	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4
E	#5
F	#6

8 cylinders - FTSPARK-8	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4
E	#5
F	#6
G	#7
H	#8

8 cylinders - FTSPARK-8 EXTREME	
Output	Cylinder
A (BOX A)	#1
B (BOX B)	#2
C (BOX B)	#3
D (BOX A)	#4
E (BOX B)	#5
F (BOX A)	#6
G (BOX A)	#7
H (BOX B)	#8

Wasted setup spark on engines with 4 cylinders

VW (1-3-4-2) / motorcycles (1-2-4-3)	
Output	Cylinder
A	#1
B	#4
C	#3
D	#2

FT (1-2-3-4) / VW Air-cooled (1-4-3-2)	
Output	Cylinder
A	#1
B	#3
C	#2
D	#4

Subaru (1-3-2-4)	
Output	Cylinder
A	#1
B	#2
C	#3
D	#4

ROTARY setup engines.

The order must be altered so that the Leading and Trailing outputs of the same rotor are placed in sequence, as shown in the table below.



WARNING

The setup on the following table is mandatory on a ROTARY engine, because the "Trailing" and "Leading" coils will fire practically at the same time and they must be on different capacitor banks to ensure the maximum energy available.

2 rotors - FTSPARK-4	
Output	Rotor
A	Leading rotor 1 (L1)
B	Trailing rotor 1 (T1)
C	Leading rotor 2 (L2)
D	Trailing rotor 2 (T2)

3 rotors - 2 X FTSPARK-4	
Output	Rotor
A - FTSPARK (BOX A)	Leading rotor 1 (L1)
B - FTSPARK (BOX A)	Leading rotor 2 (L2)
C - FTSPARK (BOX A)	Leading rotor 3 (L3)
D - FTSPARK (BOX A)	-
A - FTSPARK (BOX B)	Trailing rotor 1 (T1)
B - FTSPARK (BOX B)	Trailing rotor 2 (T2)
C - FTSPARK (BOX B)	Trailing rotor 3 (T3)
D - FTSPARK (BOX B)	-

4 rotors - 2 X FTSPARK-4	
Output	Rotor
A - FTSPARK (BOX A)	Leading rotor 1 (L1)
B - FTSPARK (BOX A)	Leading rotor 2 (L2)
C - FTSPARK (BOX A)	Leading rotor 3 (L3)
D - FTSPARK (BOX A)	Leading rotor 4 (L4)
A - FTSPARK (BOX B)	Trailing rotor 1 (T1)
B - FTSPARK (BOX B)	Trailing rotor 2 (T2)
C - FTSPARK (BOX B)	Trailing rotor 3 (T3)
D - FTSPARK (BOX B)	Trailing rotor 4 (T4)

9.5 Datalogger channels

Discharge time: Each output has an individual monitoring channel for the discharging time on the coil, which allows to diagnose malfunctions on the coils, channels or harness. The discharge time of the capacitor is not related to spark time, a long discharge might indicate problems on the coil or harness and connector.

Supply voltage: shows the effective power received by the FTSPARK.

Supply voltage drop: shows the difference of the voltage supply between the FTSPARK and the ECU. In case this value is too high, there might be a problem on the power harness of the FTSPARK.

Capacitor voltage 1 and 2: FTSPARK has two banks of capacitors that are charged and discharged alternately on the outputs, allowing higher engine rotations and operation on ROTARY engines, the first bank of capacitors fires the outputs A-C-E-G and the second bank fires the outputs B-D-F-H.

Capacitor charge time 1 and 2: The monitoring of the charging time allows

the diagnostic of a possible internal problem on the FTSPARK, power deficiency or RPM limit settings where the required charging time cannot be respected.

<input checked="" type="checkbox"/> FTSPARK - Discharge time output #1	63 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #2	64 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #3	61 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #4	67 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #5	58 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #6	75 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #7	58 us
<input checked="" type="checkbox"/> FTSPARK - Discharge time output #8	72 us
<input checked="" type="checkbox"/> FTSPARK - Supply voltage	16.283 V
<input checked="" type="checkbox"/> FTSPARK - Supply voltage drop	0.000 V
<input checked="" type="checkbox"/> FTSPARK - Ignition energy	610 mJ
<input checked="" type="checkbox"/> FTSPARK - Internal temperature	20.0 °F
<input checked="" type="checkbox"/> FTSPARK - #1 capacitor voltage	423.0 V
<input checked="" type="checkbox"/> FTSPARK - #2 capacitor voltage	423.2 V
<input checked="" type="checkbox"/> FTSPARK - #1 capacitor charge time	1189 us
<input checked="" type="checkbox"/> FTSPARK - #2 capacitor charge time	1196 us

9.6 Status Events Information

Message	Possible causes	Solutions
Output # damaged	Output is damaged	Send to FuelTech's technical assistance
Output disabled	WARNING stating that an output has been disabled. Due to failure or high temperature.	This message is always displayed along with the reason that caused the shutdown.
Low voltage on the 12V switch	Voltage below 12V	Check the battery or a harness problem
Low voltage on the 15V power supply	Internal problem.	Send to FuelTech's technical assistance
Charging circuit can not load the capacitors	This message is always displayed along with the reason that caused the shutdown.	It may be a hardware problem or the positive power disconnected/off.
Overvoltage on high voltage bus	WARNING that the capacitor voltage exceeded 460V.	It cannot exceed 480V. If it exceeds the unit has to be sent to FuelTech's technical assistance.
Incorrect firing order	Wire connection is wrong when operating in wasted spark mode	Adjust the ignition order.

Blown internal fuse	Internal problem.	Send to FuelTech's technical assistance
Restarted unexpectedly during the operation	Generally, this message is caused by interference or an electrical problem in the installation	Check the installation, power grounds, ignition grounds, spark plugs and spark plugs cables.
Low voltage on the power supply	It may be an electrical problem (harness, connectors or kill switch) or a battery problem.	Check battery and harness
Power stage temperature exceeded 212 ° F	Severe use under not recommended conditions by FuelTech	Check the recommended conditions on this manual
Module restarted unexpectedly during spark	This problem is caused by ignition interference/noise.	Check spark plugs cables, spark plugs, coil harness route, etc.
Pulse not recognized	In serial mode, it received a signal out of specification.	It is usually a harness or harness route problem.
No load connected at output	There is nothing connected at the output	Check the harness, coil and connectors
Output with partial discharge	The coil is not consuming all energy sent by FTSPARK	Check the harness, coil and connectors

10. FTCAN 2.0 protocol

FTSPARK has an advanced diagnosis system for malfunctions, faults and problems. This helps a lot to diagnose and monitor the functions of your ignition system. When used in conjunction with a FuelTech PowerFT series ECU (FT450 or higher), this programming is already built in your ECU and no additional programming is required to receive and interpret all the information. When using FTSPARK together with other aftermarket ECU's or data acquisition systems that have a CAN communication port and can be programmed, it's still possible to have access to all of that data in order to use the benefits of the FTSPARK to its fullest.



NOTE

The CAN 2.0 protocol is available on our website under the manuals section



NOTE

Contact your ECU or data acquisition system manufacturer for instructions on how to make CAN programming according to this document.

10.1 Physical layer

CAN 2.0B extended mode

Rate: 1Mbps

10.2 Features

In this document we will approach the implementation of a custom protocol (FTCAN) running on top of a CAN 2.0B physical layer. One main feature of the FTCAN protocol is to provide a means to segment a large stream of data into many smaller CAN packets. We will consider a CAN FRAME as indicated below:

CAN FRAME	
<i>29 bits</i>	<i>0 to 8 bytes</i>
IDENTIFICATION	DATA FIELD

10.3 IDENTIFICATION

Each product that wants to send data to the CAN bus must have a unique identifier. Devices that will only receive data from the CAN bus don't need to have a unique ID.

IDENTIFICATION (29 bits)		
<i>Bits 28 to 14 (15 bits)</i>	<i>Bits 13 to 11 (3 bits)</i>	<i>Bits 10 to 0 (11 bits)</i>
ProductID	DataFieldID	MessageID

ProductID

Identifies the product that has sent the message. The lower the ProductID the higher is the priority in the CAN bus. In the network two devices that are the same type of product

(two O2 sensors for example) cannot have the same ProductID. In order to differentiate two products of the same type the ProductID bits are divided as show below.

ProductID (15 bits)	
<i>Bit 14 to 5 (10 bits)</i>	<i>Bits 4 to 0 (5 bits)</i>
ProductTypeID	Unique identifier

Each product that wants to send data to the CAN bus must have a unique identifier. Devices that will only receive data from the CAN bus doesn't need to have a unique ID.

The ProductIDs are divided in priority ranges:

- Critical priority: 0x0000 to 0x1FFF
- High priority: 0x2000 to 0x3FFF
- Medium priority: 0x4000 to 0x5FFF
- Low priority: 0x6000 to 0x7FFF

A list with all the possible ProductTypeID is presented later in this document.

DataFieldID

Identifies the type of data structure that is being sent in the CAN FRAME -> DATA FIELD. There are 4 possible data layouts:

- 0x00: Standard CAN data field
- 0x01: Standard CAN data field coming from/going to a bus converter.
- 0x02: FTCAN 2.0 data field
- 0x03: FTCAN 2.0 data field coming from/going to a bus converter.

MessageID

Identifies the data in the DATA FIELD. Example: commands, configuration data, real time readings, etc. The lower the MessageID the higher is the priority. The MessageID's most significant bit is reserved in order to identify a response from a command:

MessageID (11 bits)	
Bit 10	Bits 9 to 0 (10 bits)
Response (value 1)	Message code

The priorities ranges are:

- Critical priority: 0x000 a 0x0FF
- High priority: 0x100 a 0x1FF
- Medium priority: 0x200 a 0x2FF
- Low priority: 0x300 a 0x3FF

A list with all the possible MessageIDs is presented later in this document.

10.4 DATA FIELD

In this data layout all 8 bytes of the DATA FIELD are used as valid data (PAYLOAD). All data is transmitted in one shot since this mode doesn't implement data segmentation.

DataFieldID 0x00: Standard CAN

In this data layout all 8 bytes of the DATA FIELD are used as valid data (PAYLOAD). All data are transmitted in one shot since this mode doesn't implement data segmentation.

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
PAYLOAD							

DataFieldID 0x01: Standard CAN Bridge (bridge, gateway or converter)

In this data layout all 8 bytes of the DATA FIELD will be forwarded by the bus converter.

The DataFieldID (0x01) is also used to identify packets that are originated outside the CAN bus. Bridge examples are: Standalone USB-CAN converter, FT500's USB-CAN bridge, etc.

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
PAYLOAD							

DataFieldID 0x02: FTCAN 2.0

This is the DataFieldID that all FuelTech's devices will use to communicate with each other in the CAN bus. The data segmentation feature is implemented in this type of data layout. As can be seen in the diagrams below, the segmentation feature uses the first byte of the DATA FIELD to indicate which segment the following bytes are associated with.

- Single packet (all data is transmitted in one CAN packet)
- Segmented packet (data is transmitted in multiples CAN packets)

Single packet

The first byte of the DATA FIELD will have the value of 0xFF. The following 7 bytes will have the message data (PAYLOAD).

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
0xFF	PAYLOAD						

Segmented packet

In the first byte of the DATA FIELD there will be values ranging from 0x00 to 0xFE. The first segment will have the 0x00 value and the following packets will contain 0x01, 0x02 and so on. In the first segment the 2 bytes following the 0x00 value contain the segmentation data.

DATA FIELD (8 bytes)							
0	1	2	3	4	5	6	7
0x00	SEGMENTATION DATA		PAYLOAD				

First segment

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
0x00	PAYLOAD						

Second segment

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
0x01	PAYLOAD						

Third segment (if present)

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
0x02	PAYLOAD						

Last segment (if present)

DATA FIELD (1 to 8 bytes)							
0	1	2	3	4	5	6	7
0xFE	PAYLOAD						



NOTE
 The maximum PAYLOAD length will be: $5 + (0xFD * 7) = 1776$ bytes.

The segmentation data contains the following information:

SEGMENTATION DATA (2 bytes)																
Bytes	1							2								
Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	RFU	RFU	RFU	RFU	RFU	PAYLOAD total length (in bytes)										

RFU: Reserved for Future Use

DataFieldID 0x03: FTCAN 2.0 Bridge (bridge, gateway or converter)

This DataFieldID uses the same data layout from DataFieldID's 0x02 when the data is going to or coming from a BUS converter.

10.5 Attachments

ProductID's list

Since the 5 least significant bits of the ProductID are used for the unique value the FTCAN protocol can have up to 32 devices of the same product type at the same time. The unique value will range from 0x00 to 0x1F. The limit for different products types will be 1024.

Priority	ProductID			Product Type
	ProductTypeID	Range		
		Start	Finish	
Critical	----	0x0FFF	0x0FFF	Device searching a ProductID (unique value undefined)
Medium	0x0243	0x4860	0x4861	FTSPARK

MessageID's list

- 0x0FF, 0x1FF, 0x2FF and 0x3FF – Real time reading broadcast
- 0x0FF – Critical priority
 0x1FF – High priority
 0x2FF – Medium priority
 0x3FF – Low priority

Those are the MessageIDs that the FuelTech's device will use to transmit its real time readings. The rate for each broadcast will depend on the type of data, critical data will be broadcasted more often. Examples of critical data: Ignition Cut, Two Step signal, emergency signals, etc. Examples of high priority data: RPM, ignition timing, actual injection flow, MAP, TPS, etc. Values are always transmitted as signed 16 bits in big-endian byte order. Statuses are transmitted as big-endian unsigned 16 bits. Each real time data will be composed of 4 bytes:

REAL TIME DATA	
0-1	2-3
Data identifier (MeasureID)	Value or status (big endian)

If a device needs to broadcast more than one reading at the same time it can do so using a segmented packet:

Segmented packet PAYLOAD	
MEASURE 1	
0-1	2-3
MeasureID	Value/Stat

MEASURE 2	
4-5	6-7
MeasureID	Value/Stat

MEASURE 3	
8-9	10-11
MeasureID	Value/Stat



NOTE

The maximum number of measures that can be transmitted on segmented packages are: $1776/4 = 444$

Another possibility is to use a CAN standard data frame to transmit 2 measures at a time, all the devices in the CAN bus must be capable of receiving data using all the data layouts.

Segmented packet PAYLOAD			
MEASURE 1		MEASURE 2	
0-1	2-3	4-5	6-7
MeasureID	Value	MeasureID	Value

A list with the available MeasureIDs is presented further in this document.

- 0x600, 0x601, and 0x602 – Real time simple broadcast

Those are the MessageIDs that the FuelTech's device will use to transmit its real time readings using a fixed set of MeasureIDs. Each measure value is prefixed in a specific position in payload. The rate for each broadcast is 100Hz. Values are always transmitted as signed 16 bits in big-endian byte order.

The data is transmitted **always** using a CAN standard data frame (DataFieldID 0x00) to transmit 4 measures at a time as shown in the following image:

Segmented packet PAYLOAD			
MEASURE 1	MEASURE 2	MEASURE 3	MEASURE 4
0-1	2-3	4-5	6-7
Value	Value	Value	Value

MeasureIDs

The least significant bit of the MeasureID is used to indicate if the following value is the actual value or the reading status. Considering that the MeasureID have 16 bits in total we will use 15 bits to identify the data that is being transmitted.

MeasureID	
Bits 15 to 1	Bit 0
Data identifier (DataID)	0: Data value 1: Data status

MeasureID	DataID	Description	Unity	Multiplier	Broadcast source (rate)
0x00A4	0x0052	External Ignition output 1 discharge time	uS	1	FTSPARK 50Hz
0x00A6	0x0053	External Ignition output 2 discharge time			
0x00A8	0x0054	External Ignition output 3 discharge time			
0x00AA	0x0055	External Ignition output 4 discharge time			
0x00AC	0x0056	External Ignition output 5 discharge time			
0x00AE	0x0057	External Ignition output 6 discharge time			
0x00B0	0x0058	External Ignition output 7 discharge time			
0x00B2	0x0059	External Ignition output 8 discharge time			
0x00B4	0x005A	External Ignition output 9 discharge time			
0x00B6	0x005B	External Ignition output 10 discharge time			
0x00B8	0x005C	External Ignition output 11 discharge time			
0x00BA	0x005D	External Ignition output 12 discharge time			
0x00BC	0x005E	External Ignition output 13 discharge time			
0x00BE	0x005F	External Ignition output 14 discharge time			
0x00C0	0x0060	External Ignition output 15 discharge time			
0x00C2	0x0061	External Ignition output 16 discharge time			

MeasureID	DataID	Description	Unity	Multiplier	Broadcast source (rate)
0x00C4	0x0062	External Ignition Power Supply	V	.001	FTSPARK 50Hz
0x00C6	0x0063	External Ignition Power Supply Drop			
0x00C8	0x0064	External Ignition Power Level	mJ	1	
0x00CA	0x0065	External Ignition Temperature	°C	0.1	
0x00CC	0x0066	External Ignition Capacitor 1 charge	V	0.1	
0x00CE	0x0067	External Ignition Capacitor 2 charge			
0x00D0	0x0068	External Ignition Capacitor 3 charge			
0x00D2	0x0069	External Ignition Capacitor 4 charge			
0x00D4	0x006A	External Ignition Capacitor 1 charge time	uS	1	
0x00D6	0x006B	External Ignition Capacitor 2 charge time			
0x00D8	0x006C	External Ignition Capacitor 3 charge time			
0x00DA	0x006D	External Ignition Capacitor 4 charge time			
0x00DC	0x006E	External Ignition Error code	-	Note 1	FTSPARK 25Hz
0x00DE	0x006F	External Ignition no load outputs	-	Note 2	
0x00E0	0x0070	External Ignition partial discharge outputs	-		
0x00E2	0x0071	External Ignition damaged outputs	-		
0x00E4	0x0072	External Ignition disabled outputs	-	Note 3	
0x00E6	0x0073	External Ignition operation status	-		
0x022C	0x0116	External Ignition Switch voltage	V	0.001	
0x022E	0x0117	External Ignition CPU supply voltage			
0x0230	0x0118	External Ignition CPU temperature	°C	0.1	
0x0232	0x0119	External Ignition operation time	S	0.1	FTSPARK 10Hz
0x02A8	0x0154	External Ignition Power Supply – B	V	.001	FTSPARK 50Hz
0x02AA	0x0155	External Ignition Power Supply Drop - B			
0x02AC	0x0156	External Ignition Power Level – B	mJ	1	
0x02AE	0x0157	External Ignition Temperature - B	°C	0.1	
0x02B0	0x0158	External Ignition Capacitor 1 charge - B	V	0.1	
0x02B2	0x0159	External Ignition Capacitor 2 charge – B			
0x02B4	0x015A	External Ignition Capacitor 3 charge – B			
0x02B6	0x015B	External Ignition Capacitor 4 charge – B			
0x02B8	0x015C	External Ignition Capacitor 1 charge time – B	uS	1	

MeasureID	DataID	Description	Unity	Multiplier	Broadcast source (rate)
0x02BA	0x015D	External Ignition Capacitor 2 charge time – B	uS	1	FTSPARK 50Hz
0x02BC	0x015E	External Ignition Capacitor 3 charge time – B			
0x02BE	0x015F	External Ignition Capacitor 4 charge time - B			
0x02C0	0x0160	External Ignition Error code – B	-	Note 1	FTSPARK 25Hz
0x02C2	0x0161	External Ignition no load outputs – B	-	Note 2	
0x02C4	0x0162	External Ignition partial discharge outputs – B			
0x02C6	0x0163	External Ignition damaged outputs – B			
0x02C8	0x0164	External Ignition disabled outputs – B	-	Note 3	
0x02CA	0x0165	External Ignition operation status – B			
0x02CC	0x0166	External Ignition Switch voltage – B	V	0.001	
0x02CE	0x0167	External Ignition CPU supply voltage – B			
0x02D0	0x0168	External Ignition CPU temperature – B	°C	0.1	
0x02D2	0x0169	External Ignition operation time – B	S	0.1	FTSPARK 10Hz

Only one of the possible sources is allowed to broadcast a specific DataID on the network. If one or more sources are broadcasting the same DataID a network conflict state is raised.

Note 1

- **Bit 0:** Unknown pulse width received by the FT Ignition Bus.
- **Bit 1:** Incorrect ignition order in semi-sequential operation.
- **Bit 2:** Over voltage in the high voltage bus. (external ignition disabled until next power cycle).
- **Bit 3:** Under voltage in the output drivers power supply. (external ignition disabled while condition exists).
- **Bit 4:** Charge circuit unable to charge capacitors.
- **Bit 5:** Power supply under voltage.
- **Bit 6:** 12V switch under voltage.

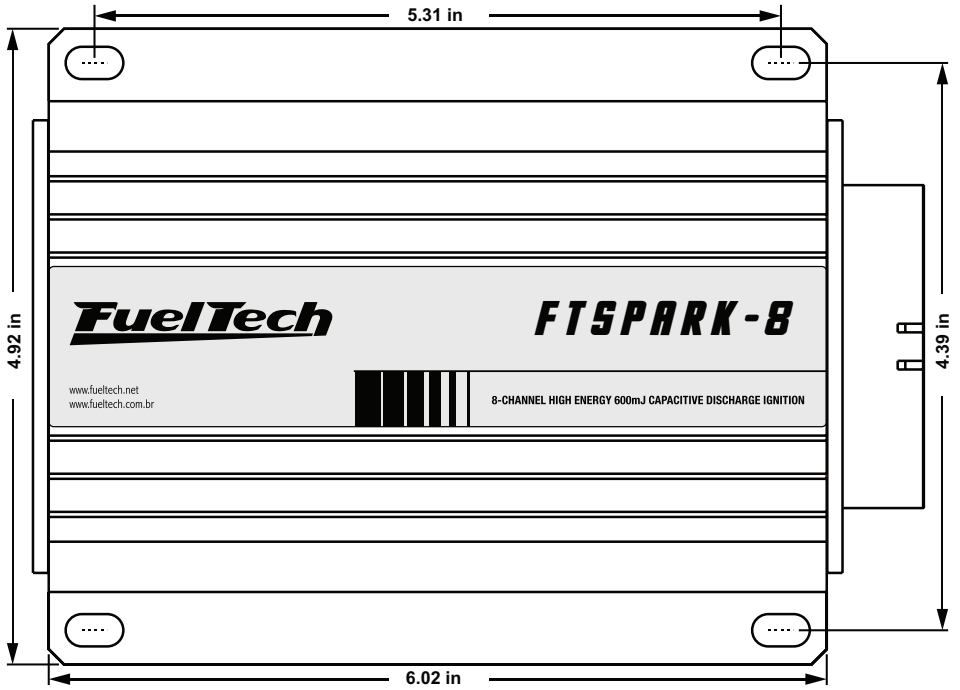
Note 2

- | | | | |
|--------|-----------|---------|------------|
| Bit 0: | Output #1 | Bit 8: | Output #9 |
| Bit 1: | Output #2 | Bit 9: | Output #10 |
| Bit 2: | Output #3 | Bit 10: | Output #11 |
| Bit 3: | Output #4 | Bit 11: | Output #12 |
| Bit 4: | Output #5 | Bit 12: | Output #13 |
| Bit 5: | Output #6 | Bit 13: | Output #14 |
| Bit 6: | Output #7 | Bit 14: | Output #15 |
| Bit 7: | Output #8 | Bit 15: | Output #16 |

Note 3

- Bit 0: Internal use
- Bit 1: Internal use
- Bit 2: High power mode enabled

11. Dimensions



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