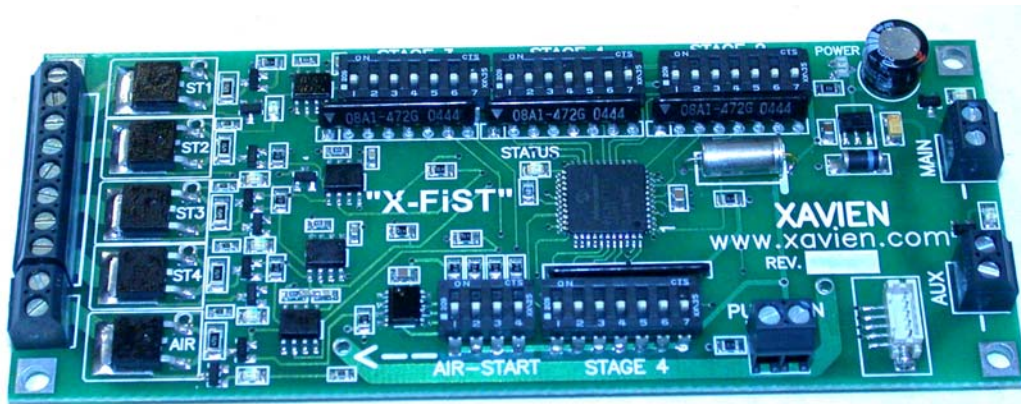




“X-FiST” – XAVIEN - Five Stage Timer
User Manual and Instructions



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System Overview

The “**X-FiST**” is a five (5) stage “**G-SWITCH**” / “**PULL-PIN**” activated sequential timing and control system. The “**X-FiST**” was designed to meet the needs of multi-staged rockets, some of these include air-starting of clusters and parallel boosters as well as advanced multi-staged rockets. Time and mode settings are set using multiple DIP switches that allow programming of each stage. It runs off of an external DC power supply ranging from +7V to +15V with the option of an “**AUX**” (*AUXILLARY*) input for connecting a secondary DC power source to increase output to pyrotechnics. Both the “**MAIN**” and “**AUX**” power inputs are reverse battery protected with LED indicator to show reverse connection. The “**X-FiST**” has a total of five (5) stages that can be configured in various ways. Stages 1, 2 and 3 can be “triggered” in four different ways; “**G-SWITCH**” **CLOSE**, “**G-SWITCH**” **OPEN**, “**PULL-PIN**” **OPEN** and finally “**G-SWITCH**” **CLOSE** and “**PULL-PIN**” **OPEN**. Stage 4 can be configured as either “**G-SWITCH**” **OPEN** or “**G-SWITCH**” **CLOSE**. The air-start stage is designed to activate on “**G-SWITCH**” **CLOSE**, this is NOT configurable. The “**AIR-START**” stage is designed to allow people to air-start a cluster of motors as part of their staging. Each stage has a red LED indicator to show continuity of pyrotechnic, the LED is *ON* when the “**X-FiST**” senses continuity.

Specifications

Battery “MAIN”	external 7-15 VDC
Battery “AUX”	external 7-15 VDC
PEAK Firing Current	25A @ 3sec.
PEAK Firing Current	50A @ 10m sec.
PEAK Firing Current	90A @ 1m sec.
Dimensions	1.95”W x 4.8”L
Weight (without battery)	≈40.0 grams
Delay Settings (ST1)	1 second to 31 seconds (in 1 sec. increments)
Delay Settings (ST2)	1 second to 31 seconds (in 1 sec. increments)
Delay Settings (ST3)	1 second to 31 seconds (in 1 sec. increments)
Delay Settings (ST4)	1 second to 63 seconds (in 1 sec. increments)
Delay Settings (AIR-ST)	0.5 seconds to 7.5 seconds (in 0.5 sec. increments)

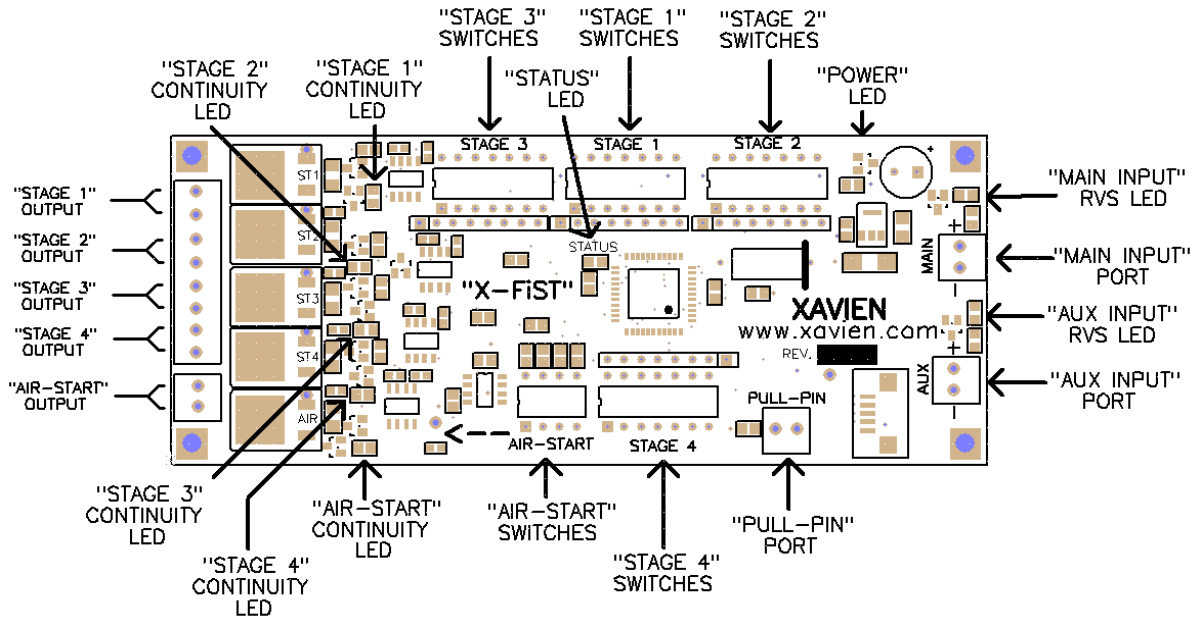
MIN Battery Load (All switches OFF – All outputs OFF): **40mA**

MAX Battery Load (All switches ON – All outputs OFF): **75mA**

Operational Overview

Figure 1 depicts the layout of the "X-FiST".

Figure 1. "X-FiST" Assembly.

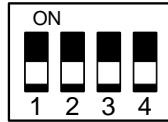


**** IMPORTANT **: Switches *MUST* be set prior to turning power on to "X-FiST". The microcontrollers *ONLY* read the switch settings on power up. If changes need to be made, turn unit OFF, set switches, and cycle power back ON. The "G-SWITCH" used by the "X-FiST" closes at 2.1G (+/- 10%); please keep this in mind for SLOW launches. If your rocket will have less than 2.1G's (+/- 10%) of acceleration please configure your system for "PULL-PIN" operation. Unit *MUST* be powered OFF when installing pyrotechnics to the "X-FiST". *ONLY* turn power on AFTER the "X-FiST" has been installed, the rocket is setup on the launch pad and you are ready to launch the rocket. NEVER transport your rocket with an "X-FiST" that is installed and powered up! Not following these precautions can cause damage and a potential injury, safety is critical!**

“AIR-START” Configuration and Operation:

The “AIR-START” stage begins countdown after the “G-SWITCH” has closed. **Figure 2** shows the DIP switch and the associated values of each switch. To “activate” a switch you move it to the upper position towards the “ON” silk screened on the DIP switch.

Figure 2. “AIR-START” stage DIP Switch with all switches in the OFF position.



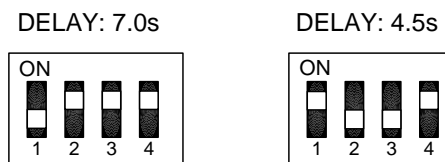
Switch	Value
1	0.5 seconds
2	1.0 second
3	2.0 seconds
4	4.0 seconds

Table 1 gives examples of a few of the DIP switch settings for the “AIR-START” stage. For example, to get a delay of 3.0 seconds you would turn ON switch 2 and switch 3 (1 second + 2 seconds = 3 seconds), the rest would be OFF. **Figure 3** gives you switch examples for a delay of 7.0 seconds and 4.5 seconds.

Table 1 (Examples of “AIR-START” delay settings)

AIR-START Switch Settings [1, 2, 3, 4]	AIR-START Time Delay
Off-Off-Off-Off	0.5 seconds (DEFAULT)
On-Off-Off-Off	0.5 seconds
Off-On-Off-Off	1.0 second
On-On-Off-Off	1.5 seconds
On-Off-On-Off	2.5 seconds
Off-On-On-Off	3.0 seconds
On-On-On-Off	3.5 seconds
Off-Off-Off-On	4.0 seconds
Off-On-Off-On	5.0 seconds
On-On-Off-On	5.5 seconds
On-Off-On-On	6.5 seconds
Off-On-On-On	7.0 seconds
On-On-On-On	7.5 seconds

Figure 3. Example switch settings.



“ST1”, “ST2” and “ST3” Configuration and Operation:

“ST1”, “ST2” and “ST3” can be programmed using the *M-A* and *M-B* switches to activate in four different modes; “G-SWITCH CLOSE”, G-SWITCH OPEN, “PULL-PIN OPEN” and “G-SWITCH CLOSE and “PULL-PIN OPEN”. Figure 4 shows the DIP switch and the associated values of each switch. To “activate” a switch you move it to the upper position towards the “ON” silk screened on the DIP switch.

Figure 4. ST1, ST2 and ST3 DIP Switches with all switches in the OFF position.



Switch	Value
1	M-A
2	M-B
3	1.0 second
4	2.0 seconds
5	4.0 seconds
6	8.0 seconds
7	16.0 seconds

Stages 1, 2 and 3 can be independently configured for four modes of triggering using the *M-A* and *M-B* switches. Figure 5 explains each switches meaning and gives 2 examples of configuration.

Figure 5. “TRIGGERING” MODES for ST1, ST2 and ST3.

“TRIGGER MODE”	SWITCH SETTINGS
G-SWITCH CLOSE (GS-C)	M-A = OFF, M-B = OFF
G-SWITCH OPEN (GS-O)	M-A = ON, M-B = OFF
PULL-PIN OPEN (PP-O)	M-A = OFF, M-B = ON
PULL-PIN OPEN & G-SWITCH CLOSE (PP-O / GS-C)	M-A = ON, M-B = ON

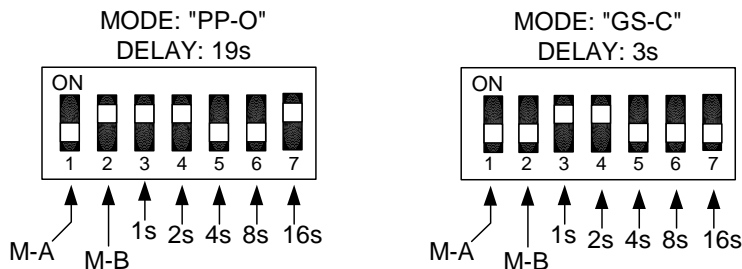


Table 2 gives examples of a few settings. For example, to get a delay of 10 seconds in “GS-C” you would turn ON switch 4 and switch 6 (2 seconds + 8 seconds = 10 seconds), the rest would be OFF.

Table 2 (Example of ST1, ST2 and ST3 delay settings)

ST1, ST2, ST3 Switch Settings [1, 2, 3, 4, 5, 6, 7]	ST1, ST2, ST3 Time Delays
Off-Off-Off-Off-Off-Off-Off	0.5 second : MODE = GS-C
Off-Off-On-Off-Off-Off-Off-Off	1.0 second : MODE = GS-C
Off-Off-Off-Off-On-Off-Off-Off	4.0 seconds : MODE = GS-C
Off-Off-On-Off-Off-On-Off-Off	9.0 seconds : MODE = GS-C
Off-Off-On-On-Off-Off-On	19.0 seconds : MODE = GS-C
On-Off-Off-On-On-Off-Off-Off	6.0 seconds : MODE = GS-O
On-Off-On-Off-On-On-Off-Off	13.0 seconds : MODE = GS-O
On-Off-Off-On-Off-Off-On	18.0 seconds : MODE = GS-O
On-Off-Off-On-On-Off-On	26.0 seconds : MODE = GS-O
On-Off-On-On-On-On-On	31.0 seconds : MODE = GS-O
Off-On-On-Off-On-Off-Off-Off	5.0 seconds : MODE = PP-O
Off-On-On-On-Off-On-Off-Off	11.0 seconds : MODE = PP-O
Off-On-On-On-On-On-On-Off	15.0 seconds : MODE = PP-O
Off-On-Off-On-Off-On-On	26.0 seconds : MODE = PP-O
Off-On-Off-On-On-On-On	30.0 seconds : MODE = PP-O
On-On-On-On-Off-Off-Off	3.0 seconds : MODE = PP-O & GS-C
On-On-Off-On-On-Off-Off	6.0 seconds : MODE = PP-O & GS-C
On-On-On-Off-On-On-Off	13.0 seconds : MODE = PP-O & GS-C
On-On-On-Off-On-Off-On	21.0 seconds : MODE = PP-O & GS-C
On-On-On-Off-On-On-On	29.0 seconds : MODE = PP-O & GS-C

“ST4” Configuration and Operation:

“ST4” can be programmed using the *M-A* switch to activate in two different modes; “**G-SWITCH CLOSE**” or **G-SWITCH OPEN**. **Figure 6** shows the DIP switch and the associated values of each switch. To “activate” a switch you move it to the upper position towards the “ON” silk screened on the DIP switch.

Figure 6. ST4 DIP Switch with all switches in the OFF position



Switch	Value
1	M-A
2	1.0 second
3	2.0 seconds
4	4.0 seconds
5	8.0 seconds
6	16.0 seconds
7	32.0 seconds

Stage 4 can be independently configured for two modes of triggering using the *M-A* switch. **Figure 7** explains each switches meaning and gives 2 examples of configuration.

Figure 7. “TRIGGERING” MODES for ST1, ST2 and ST3.

“TRIGGER MODE”	SWITCH SETTINGS
G-SWITCH CLOSE (GS-C)	M-A = OFF, M-B = OFF
G-SWITCH OPEN (GS-O)	M-A = ON, M-B = OFF

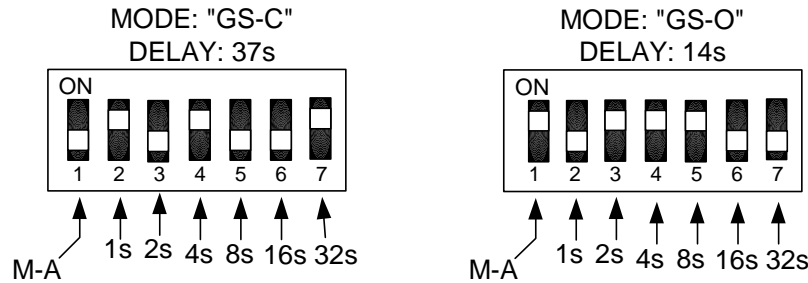


Table 3 gives examples of a few settings. For example, to get a delay of 18 seconds in “GS-O” mode you would turn ON switch 1, 3 and switch 6 (1 second + 16 seconds = 17 seconds), the rest would be OFF.

Table 3 (Example of ST4 delay settings)

ST4 Switch Settings [1, 2, 3, 4, 5, 6, 7]	ST4 Time Delays
Off-Off-Off-Off-Off-Off-Off	0.5 second : MODE = GS-C
Off-Off-On-Off-Off-Off-Off	2.0 seconds : MODE = GS-C
Off-On-Off-Off-On-Off-Off	9.0 seconds : MODE = GS-C
Off-Off-On-Off-Off-On-Off	18.0 seconds : MODE = GS-C
Off-Off-On-On-Off-Off-On	38.0 seconds : MODE = GS-C
On-Off-Off-On-On-Off-Off	12.0 seconds : MODE = GS-O
On-Off-On-Off-On-On-Off	26.0 seconds : MODE = GS-O
On-Off-Off-On-Off-Off-On	36.0 seconds : MODE = GS-O
On-Off-Off-On-Off-On-On	52.0 seconds : MODE = GS-O
On-On-On-On-On-On-On	63.0 seconds : MODE = GS-O

“X-FiST” Modes of Triggering:

The “X-FiST” operates in four different modes for triggering pyrotechnics:

- **“G-SWITCH CLOSE” (GS-C):** This mode begins timing once the G-SWITCH has closed for a minimum of 0.5s (The G-SWITCH closes at 2.1G’s (+/-10%) of acceleration).
- **“G-SWITCH OPEN” (GS-O):** This mode begins timing once the G-SWITCH has opened (slowed down) for a minimum of 0.5s (The G-SWITCH closes at 2.1G’s (+/-10%) of acceleration, opens at less than that).
- **“PULL-PIN OPEN” (PP-O):** This mode begins timing once the PULL-PIN port connection is open for a minimum of 0.5s (also called a “BREAK WIRE” system).
- **“PULL-PIN OPEN and G-SWITCH CLOSE” (PP-O & GS-C):** This mode begins timing once the PULL-PIN port connection is open for a minimum of 0.5s (also called a “BREAK WIRE” system) as well as the G-SWITCH has been closed for at least 0.5s.

Battery Connections:

The “X-FiST” was designed to operate using 9V batteries. We here at XAVIEN recommend using a switch to insure ease of use when powering the unit up and down. The “X-FiST” has an “AUX” (AUXILLARY) input that allows the user to connect a secondary power source. The “AUX” input is **ONLY** used when you want to have more current sourcing for your pyrotechnics; this port is **NOT** intended to be used to power the “X-FiST” by itself. If using the “AUX” port make sure you are also using the “DC INPUT” port as well. The voltage ratings at both the “AUX” and “DC INPUT” ports are minimum of +7V with a maximum of +15V DC. We have equipped the unit with a small green power indicator so the user can easily identify when the unit has power applied, this only applies for the “DC INPUT” port. It is recommended to always ground test your setup to verification purposes. This will help to insure that the “X-FiST” and your configuration will work to your expectations. **It is always a good idea to insure you have a fresh (new) battery before any launches occur.** Both the “AUX” and “DC INPUT” ports **ARE** reverse polarity (battery) protected with red LEDs to indicate reverse polarity.

Pyrotechnic Installation:

The “X-FiST” has been tested using various igniters and electric matches. To install a pyrotechnic device onto the “X-FiST” (power needs to be OFF), you simply unscrew the output terminals. The terminals are screw based terminal blocks for easy access and reliability. *User does not need to worry about which terminal goes to which leg of the igniter / electric match.* Make sure you **hand tighten ONLY (too much torque can damage the unit)** screw terminals after igniter / electric match has been installed.

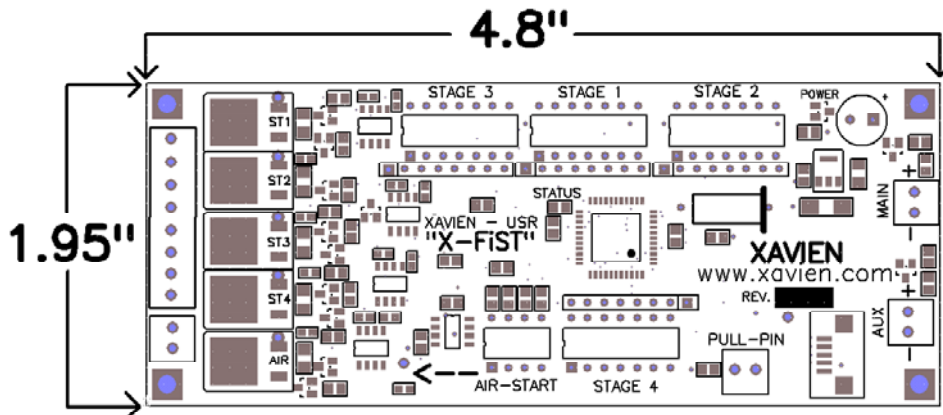
Setup Sequence:

This is the recommended sequence for setting up the “X-FiST”.

1. Connect power source to “DC INPUT” port, turn power on, verify green “POWER” LED is on. If red “RVS POLARITY” LED is on, turn power off and reverse power leads. Repeat step 1.
2. Turn “DC INPUT” port off.
3. Connect power source to “AUX” port (if being used), turn power on, if red “RVS POLARITY” LED is on, turn power off and reverse power leads. Repeat step 3.
4. Turn “AUX” port off.
5. Make sure unit is **NOT** powered up, if it is turn it OFF,
6. Set DIP switches to desired time delay.
7. Verify “PULL-PIN” is connected as desired (NOTE: if “PULL-PIN” is chosen and the unit senses it open at POWER-UP, the unit goes into a “PULL-PIN” lockout mode and blinks the blue “STATUS” LED. Turn off power, connect the “PULL-PIN” line and repeat step 7).
8. Install igniter / electric match, making sure screw terminals are not loose, hand tighten only.
9. Turn “POWER” on to the “X-FiST”; verify that the green (“POWER”) LED and the red (“CONTINUITY”) LED’s are ON. If the red continuity LEDs are OFF you have a continuity issue with your pyro, if the green LED is OFF, you have a power problem. If all 6 LED’s are on (green “POWER” and 5 red “CONTINUITY”), unit is ready for launch! (NOTE: you will **ONLY** see the continuity light on if a pyrotechnic is installed at that channel.)

Mounting / Installation

The “X-FiST” must be installed securely to prevent the unit from being damaged during use. Since this unit does depend on a “G-SWITCH”, orientation of the unit is very important; the “arrow” must be pointing in the direction of travel. The mounting holes are 0.125”; this allows various size screws to be used. Just verify the clearance of both the screw and the head to insure a proper fit without damaging the unit.



URGENT: The “X-FiST” MUST be protected from ejection charge and motor residue. These are corrosive and over time can damage the “X-FiST”. It is good practice to clean the unit using Isopropyl Alcohol (70% alcohol or better) after the unit has been used. “ARROW” on PCB MUST be pointed in direction of travel.

**** Handling Precautions ****

These units are sensitive to damage from ESD and should always be handled in a properly grounded environment; damage from ESD is not covered under the warranty. Never transport or handle a rocket with an “X-FiST” that is powered up and connected to live pyrotechnic charges. When installing electric matches to an “X-FiST”, make sure unit is powered off. Before launching, verify that the red “CONTINUITY” LED is on for each output stage that has a pyro installed.

!! Product Disclaimer and Limit of Liability !!

Since the use and application of this equipment are beyond our control, the purchaser or user agrees to hold “XAVIEN” and their agents from any and all legal claims, demands, actions, debts, liabilities, judgments, costs and attorney fees arising out of, claimed on account of, or in any manner predicted upon loss or damage to property of, or injuries to or death of, any and all persons arising out of the use of this equipment. Due to the nature of electronic devices, the application and environments for these devices, the possibility of failure can never be completely ruled out. It is the responsibility of the purchaser or user of this equipment to properly test and simulate the actual conditions under which the device is intended to be used to ensure the highest degree of reliability, safety and success.

!! Product Warranty !!

The “X-FiST” has a warranty of 1 year starting from date of purchase as long as all the guidelines have been followed that are outlined in this document. Any improper use or carelessness on the part of user will void the warranty. If your unit has problems send an email to:

RMA@XAVIEN.COM

Once this has been done, XAVIEN will send you a return material authorization (RMA) number that you need to include with your unit. **DO NOT send any units back to XAVIEN without this RMA number, if we receive product with no RMA it will NOT be accepted and mailed back unrepaired.**



Revision History

PCB REV: 1.00A
FW REV: 1.00A
DOC REV: 1.01A

DATE: 05/30/2006
DATE: 05/30/2006
DATE: 05/30/2006