# FX51-D Hall Sensor Datasheet

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Overview

The FX51-D is a hall sensor controller capable of detecting rotation and 3D positioning of magnets. Features include onboard switch / button configuration, diagnostic LEDs, and output protection.

Diagnostic LEDS

The SENSE LED illuminates when the solid-state X-Y output switch is closed.

The STAT LED is used to display error codes as well as to acknowledge the successful receipt of a command. A table of all possible flash codes is in the section **Flash Codes**.
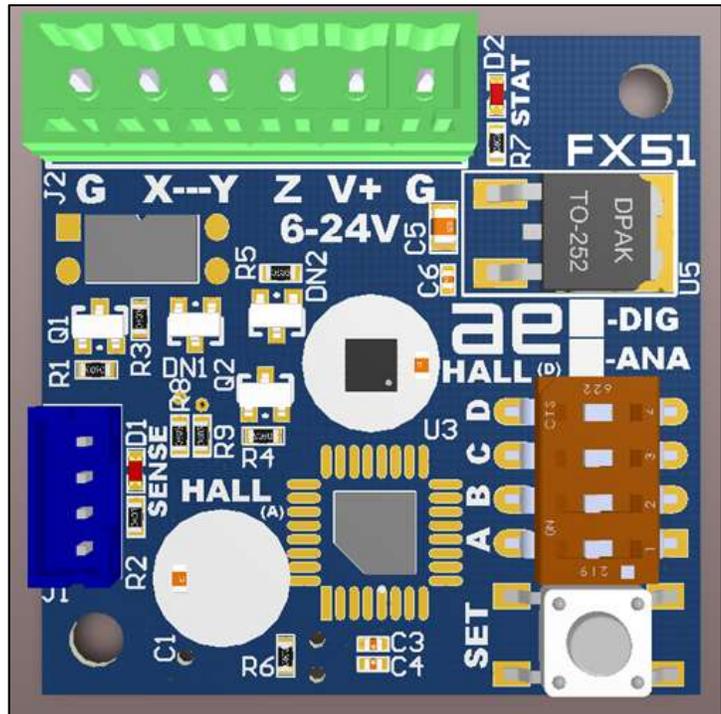
Magnet Considerations

Ring style magnets are not recommended for gated modes as they can produce inconsistent field strengths!

Magnets should be selected to provide a stable reading. Having too strong of a magnet or placing magnets too close (< ¾ " depending) to the sensor can cause saturation (> +/- 1000 gauss), causing erratic performance. For gated mode it is important that the magnet fields do not have overlapping strengths. For more information see sections **Magnetic Specifications** and **Example Offsets for Gated Mode**.

Installation

It is recommended to use double backed tape to test fit the sensor. Once the final mounting position has been determined, use small, #4 screws through the mounting holes.

Programming

There are a set of switches (A B C D) and a button (SET) in the lower right side of the circuit board. Set the DIP switches to the desired configuration specified in the table below and press SET. The STAT light will flicker once to acknowledge the change has been committed. Note that when setting unipolar mode, the STAT light will flicker once for North pole sensing and twice for South pole sensing. Press SET repeatedly to toggle the selected pole.

1
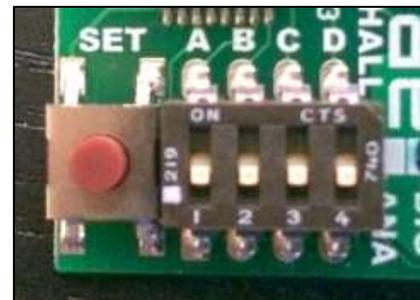
Switch Configuration Table

Mode	Config		Section
Switch A	Switch B & Switch C	Switch D	
1 – Output	1 1 – Lights	1 – Light Toggle	Toggle LEDs
		0 – Future Use	
	1 0 – Set / Clear	1 – Set	Set
		0 – Clear	Clear
	0 1 – Pulse	1 – Positive Pulse	Pulse High
		0 – Negative Pulse	Pulse Low
	0 0 – Active	1 – Active High	Active High
		0 – Active Low	Active Low
0 – Sense	1 1 – Rotate (Local / Networked)	1 – Custom (2°-178° radius)	Rotate Mode, Rotational Learning (Custom Radius)
		0 – Low Thresh (15° radius)	Rotate Mode, Rotational Learning (Default Radius)
	1 0 – Gate (Local / Networked)	1 – High Thresh (30%)	Gated Mode, Gated Learning
		0 – Low Thresh (20%)	Gated Mode, Gated Learning
	0 1 – Unipolar* (Local)	1 – High Thresh (30%)	Unipolar Mode
		0 – Low Thresh (20%)	Unipolar Mode
	0 0 – Bipolar*, ** (Local)	1 – High Thresh (30%)	Bipolar Mode
		0 – Low Thresh (20%)	Bipolar Mode
Press SET to Program			Programming

* These modes calibrate the hall sensor when SET.

** Bipolar mode also resets the output mode to Active High.

Calibration

If you are using FX51-SEN boards they should be connected for this step. Due to background magnetic fields, the sensor(s) must first be calibrated. This allows the sensor(s) to determine a true baseline and give more accurate readings when detecting a prop piece. To calibrate the sensor(s), remove any nearby magnets, set the FX51-D switches to and press SET. The STAT LED will blink once to acknowledge a successful calibration.

Sensing Modes

When the 'A' switch is in the 0 or 'Off' position, the rest of the switches are used to set the sensing mode. Refer to the **Switch Configuration Table**. There are 4 sensing modes for the FX51-D. Set the DIP switch to the desired mode and press SET to program.

Bipolar Mode
(Standalone)

Bipolar mode refers to the sensor triggering on both North **and** South poles. When this mode is set, there **should not** be a magnet near the sensor as the hall sensor will be calibrated. See the **Calibration**

section. This mode has a high and low threshold configuration.
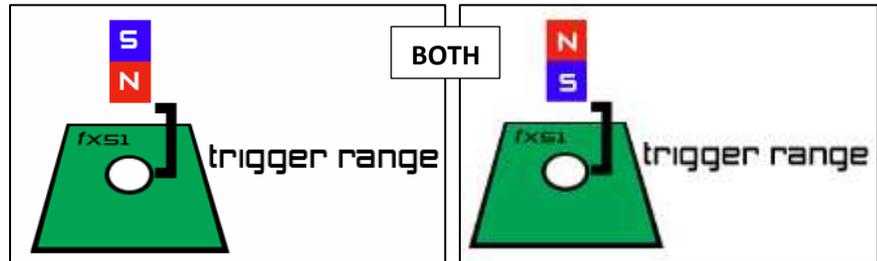
Low Threshold

 Using magnet A, the low threshold configuration triggers at about 1.25"

High Threshold

 Using magnet A, the high threshold configuration triggers at about 2.75".

Unipolar Mode
(Standalone)

Unipolar mode refers to the sensor triggering on either North **or** South poles, not both. When this mode is set, there **should not** be a magnet near the sensor as the hall sensor will be

calibrated. See the **Calibration** section. When configuring unipolar mode, pressing the SET button will alternate between triggering of the North pole (one off-flash) and the South pole (two off-flashes). This mode has a high and low threshold configuration.

Low Threshold

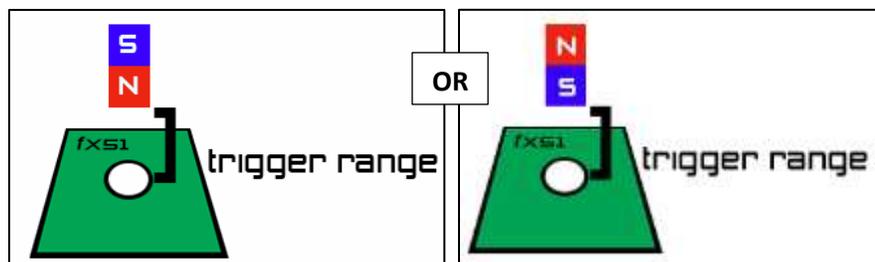 Using magnet A, the low threshold configuration triggers at about 1.25"
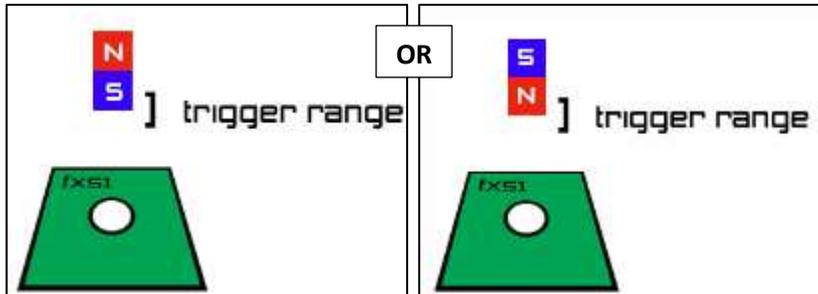
High Threshold

 Using magnet A, the high threshold configuration triggers at about 2.75".

Gated Mode
(Networked or Standalone)

Gated mode is used to train the device to trigger in only a very narrow range and only on one pole. This can be used to discriminate between different prop pieces. When this mode is selected, a magnet **should** be present at the desired trigger point. The module will automatically detect the distance and pole of the present magnet. Before using this mode, be sure to calibrate the hall sensor at least once by setting either unipolar or bipolar mode.

For gated mode, low threshold uses a narrow range (±20%) of magnetic strength to trigger, and high threshold uses a wider range (±30%) of magnetic strength to trigger. While this setting can be engineered for your solution, the most practical method is to experiment with your props to ensure each puzzle piece only triggers the correct sensor (no overlap in field strengths). For precalculated offsets see section **Example Offsets for Gated Mode**.

Low Threshold

The low threshold configuration triggers at about ±20% of the detected magnetic field strength.

See **Gated Learning**

High Threshold

The high threshold configuration triggers at about ±30% of the detected magnetic field strength.

See **Gated Learning**

Rotate Mode
(Networked or Standalone)

Rotation mode detects the absolute rotation of a magnet and can be used for sensing knob or wheel positions. When this mode is SET, a magnet should be present at the desired trigger angle. The sensitivity setting for the rotation mode is measured in degrees. In low angle mode, the trigger range will be +/- 15° around the learned position. In high angle mode, the trigger range is user defined by adjusting the angle of the magnet to a new position.

Low Threshold

The low threshold configuration triggers at a ±15° radius from the center point.

See **Rotational Learning (Default Radius)**

High Threshold

The high threshold configuration triggers at a user defined radius between ±2-178°from the center point.

See **Rotational Learning (Custom Radius)**

Output Modes

The FX51 is capable of 6 output modes and has a primary solid-state relay output which can drive maglocks and other loads (up to 2A, 24V) directly.

Set the FX51-D's configuration switch to the desired output mode below and press SET.

Active High (default)

The primary output is closed when triggered, otherwise open.

Active Low

The primary output is open when triggered, otherwise closed.

Pulse High

The primary output closes for ½ second when triggered, then opens.

Pulse Low

The primary output opens for ½ second when triggered, then closes.

Set

Primary output starts open. When triggered the output will close until reset.

Clear

Primary output starts closed. When triggered the output will open until reset.

Toggle LEDs

Toggles LED output in case the LEDs are visible through the prop. Keep the switch set to this configuration to prevent accidental mode changes if SET is inadvertently pressed.

RFU

Reserved For Future Use.-

FX51-SEN Networking

Wiring

The FX51-D can support up to 16 additional sensors via a connection at J1. It is designed to connect to the FX51-SEN sensor board module. They have in and out connections which facilitate easy chaining. It should be noted that the total wire lengths of the boards and extension wires should not exceed 3 ft. Consult Escape Room Techs for specifics and the availability of other length connection wires and network repeaters.

To connect FX51-SEN boards to your FX51-D, use the provided jumpers to connect all the boards together in a chain, starting with J1 on the FX51-D, then to the first FX51-SEN. The FX51-SEN has two identical connectors (J1 and J2) for chaining. It does not matter which is the in or which is the out.

FX51-SEN Addressing and Mode Selection

The switches on the FX51-SEN are the address selection switches. The A switch also serves an additional purpose. It is used to determine if the sensor is in the gated mode (switch on) or in rotational mode (switch off). Every FX51-SEN must have a unique address. This means that there is a maximum of 8 rotational + 8 gated FX51-SEN sensor boards in a system, plus the FX51-D sensor for a total of 17 sensors.

Rotational Addressing

Component	ABCD Switch	I²C Address
FX51-SEN (1)	(Rotate)	0x64
FX51-SEN (2)	(Rotate)	0x6C
FX51-SEN (3)	(Rotate)	0x60
FX51-SEN (4)	(Rotate)	0x68
FX51-SEN (5)	(Rotate)	0x66
FX51-SEN (6)	(Rotate)	0x6E
FX51-SEN (7)	(Rotate)	0x62
FX51-SEN (8)	(Rotate)	0x6A

Gated Addressing

| Component	ABCD Switch	I²C Address
FX51-SEN (1)	(Gated)	0x65
FX51-SEN (2)	(Gated)	0x6D
FX51-SEN (3)	(Gated)	0x61
FX51-SEN (4)	(Gated)	0x69
FX51-SEN (5)	(Gated)	0x67
FX51-SEN (6)	(Gated)	0x6F
FX51-SEN (7)	(Gated)	0x63
FX51-SEN (8)	(Gated)	0x6B

Learning

Note that it is possible to mix gated and sensing modes!

Gated Learning

Before learning gated mode, the sensors should be calibrated as outlined in the **Calibration** step. Wire the sensors as described in **FX51-SEN Networking**, and make sure to set the FX51-SEN addresses to available addresses outlined in the **Gated Addressing** table.

Next set the FX51-D to ![ABCD dip switch] for low threshold gated sensing or ![ABCD dip switch] for high threshold gated sensing. Place the prop pieces with embedded magnets in their desired locations, and press SET. The settings will save, and the FX51-D's switch will close (output on). Removing or swapping any of the pieces should unsolve the puzzle and the output will turn off. At this point you may set one of the other **Output Modes**.
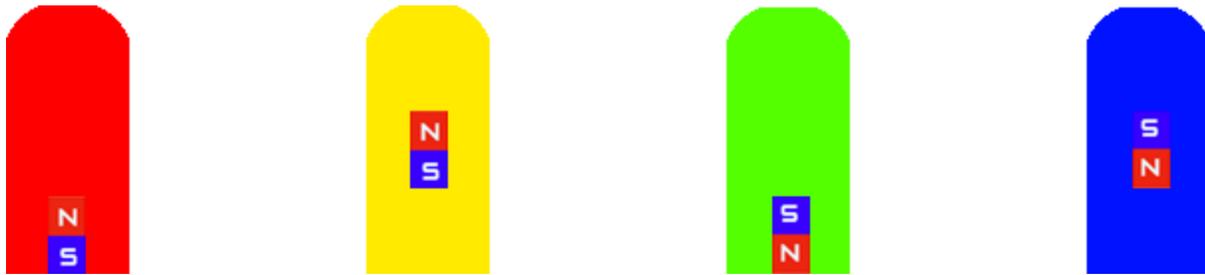
Rotational Learning (Default Radius)

The default radius is 15° which is useful for 12 position puzzles. Wire the sensors as described in **FX51-SEN Networking**, and make sure to set their addresses as described in the **Rotational Addressing** table.

Place your prop pieces with embedded magnets in their desired orientation.

Set the FX51-D to ![ABCD dip switch] and press SET. The settings will save, and the FX51-D's switch will close (output on). Removing or rotating any of the pieces beyond 15° will unsolve the puzzle and the output will turn off. At this point you may set one of the other **Output Modes**.

Rotational Learning (Custom Radius)

If a custom threshold is desired, follow the steps in **Rotational Learning (Default Radius)**. This will initially set a center point with a 15° radius.

Next adjust the prop pieces to their desired outer limit. Set the FX51-D to and press SET. If adjustments are necessary, this step may be repeated. The new thresholds will be saved. Thresholds are unique to each sensor, which means different sensors can have wider or narrower ranges.
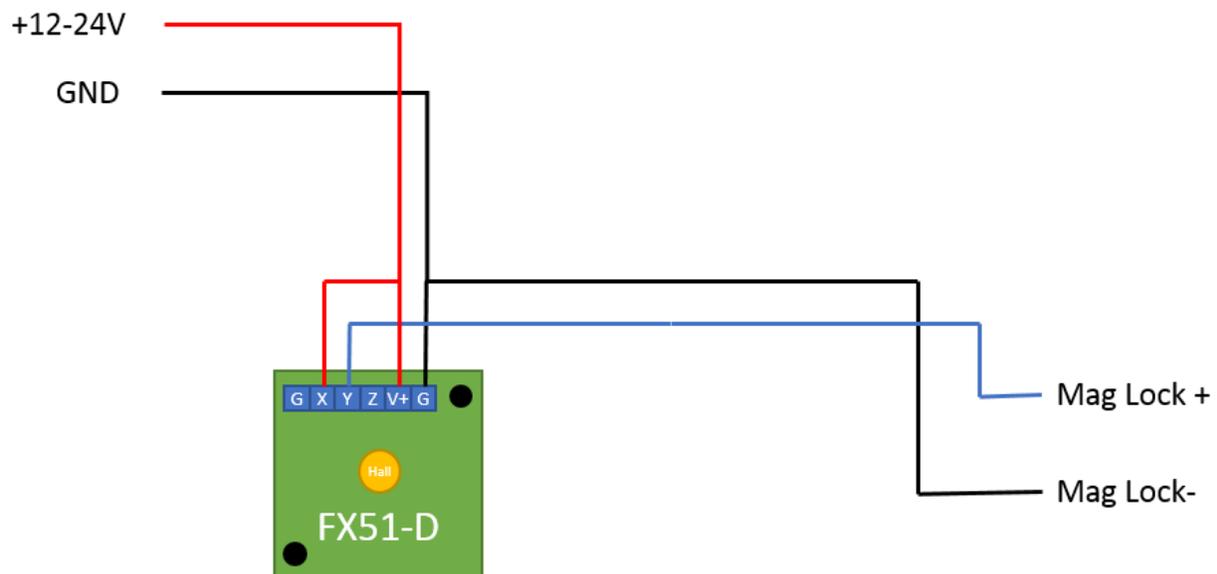
Examples

Simple Mag Lock Controller

This example shows how to use a single FX51-D as a simple maglock controller. Calibrate the sensor as described in the **Calibration** section. Then set one of the **Sensing Modes**. Next you want to set the output mode. Here you want power to the maglock to start then either cut it off for a pulse (to let a spring door open) or forever (for something you want to stay unlocked). If a pulse mode is desired, use output mode **Pulse Low**. If a permanent off mode is desired, use output mode **Clear**. Set the switches to the desired output mode and press the SET button.

When using a 12V or 24V maglock drawing less than 2A, the FX51's solid-state relay can drive it directly.

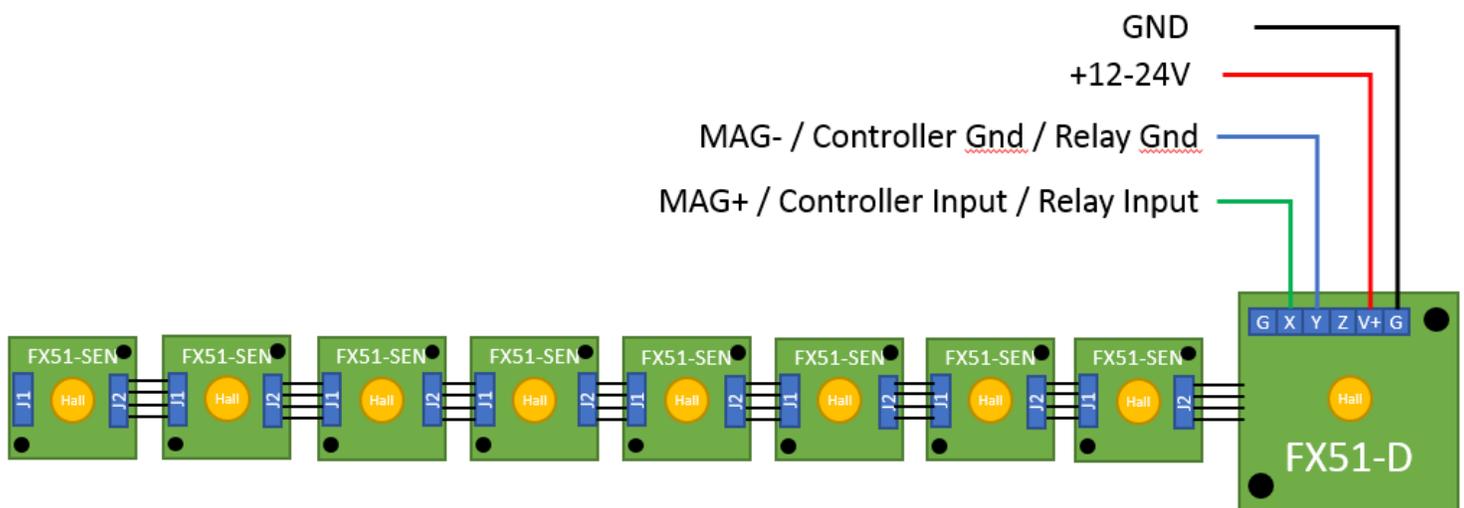Recommended maglock: http://www.seco-larm.com/E-941SA-80Q

Nine Sensor Puzzle (Rotational / Positional)

This example shows how to pair an FX51-D with eight FX51-SEN boards. Wire the setup according to the diagram below and apply power. Calibrate the sensor as described in the **Calibration** section. Then configure the FX51-SEN boards as outlined in the **FX51-SEN Addressing and Mode Selection** section. Next, position the prop pieces in the desired solved state. Finally, set the FX51-D to either **Gated Mode,** or **Rotate Mode**. The FX51-D will store the desired solution. For more information see the **Learning** section.
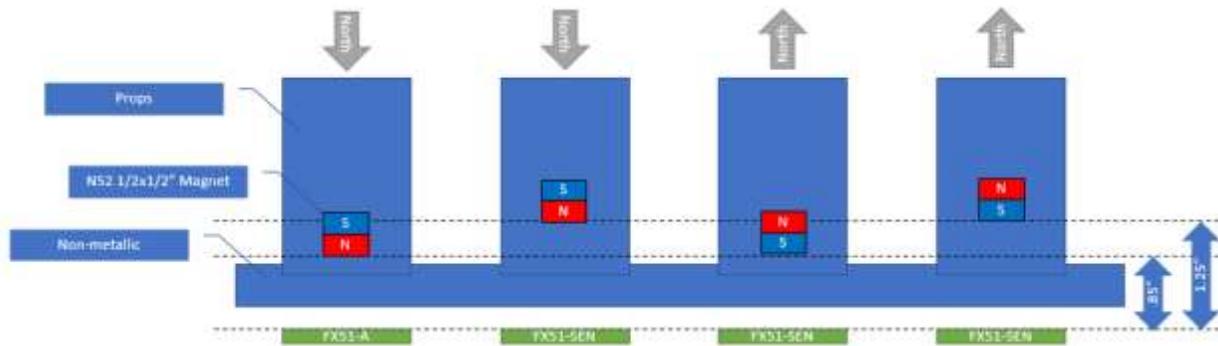
When using a 12V or 24V maglock drawing less than 2A, the FX51's solid-state relay can drive it directly.

Recommended maglock: http://www.seco-larm.com/E-941SA-80Q

Example Offsets for Gated Mode

N52 ½" x ½" Magnets

Props
N52 1/2x1/2" Magnet
Non-metalic

FX51-A   FX51-SEN   FX51-SEN   FX51-SEN

Magnet Size	Diameter		0.5	Magnet Type		14500
	Axial		0.5			
			A	B	Tol	
			173	75	20.00%	
Distance	D from Center	D from surface A	Gauss A	Gauss B		
	0.55	0.80	200	200		
	0.6	0.85	173	173		
	0.65	0.90	152	152		
	0.7	0.95	133	133		
	0.75	1.00	118	118		
	0.8	1.05	105	105		
	0.85	1.10	93	93		
	0.9	1.15	84	84		
	0.95	1.20	75	75		
	1	1.25	68	68		
	1.05	1.30	62	62		
	1.1	1.35	56	56		
	1.15	1.40	51	51		
	1.2	1.45	47	47		
	1.25	1.50	43	43		
	1.3	1.55	39	39		
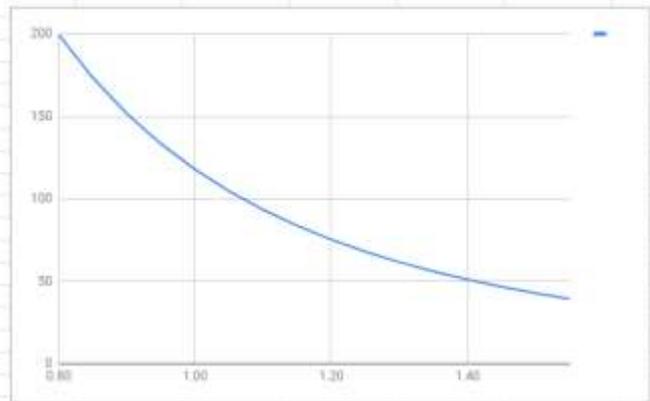
N52 ¼" x ¼" Magnets
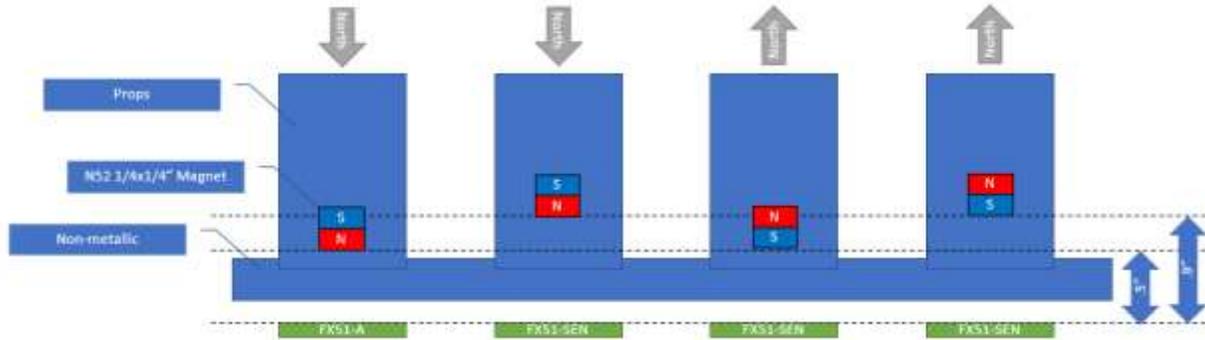
Magnet Size	Diameter		0.25	Magnet Type	14500	
	Axial		0.25			
			A	B		Tol
			105	29		30.00%
Distance	D from Center	D from surface	A Gauss A	Gauss B		
	0.35	0.48	133	133		
	0.4	0.53	105	105		
	0.45	0.58	84	84		
	0.5	0.63	68	68		
	0.55	0.68	56	56		
	0.6	0.73	47	47		
	0.65	0.78	39	39		
	0.7	0.83	33	33		
	0.75	0.88	29	29		
	0.8	0.93	25	25		
	0.85	0.98	21	21		
	0.9	1.03	19	19		
	0.95	1.08	16	16		
	1	1.13	15	15		
	1.05	1.18	13	13		
	1.1	1.23	12	12		
	1.15	1.28	10	10		
	1.2	1.33	9	9		
	1.25	1.38	8	8		
	1.3	1.43	8	8		

Flash Codes

Flash Codes	Type	Description
Constant Blinking	Error	No sensors detected, I²C bus is locked. Cycle power.
(4) Fast 100ms Blinks	Error	Sensor(s) missing. The FX51-D will assume the missing sensors are "solved" so that the puzzle may continue to work.
(4) Slow 250ms Blinks	Error	New sensors found since last configuration. All data is reset, and new sensors are saved.
One Blink	Acknowledge	Indicates successful receipt of a command. Unipolar mode: Indicates North pole sensing.
Two Blinks	Acknowledge	Unipolar mode: Indicates South pole sensing.

Specifications

Electrical Specifications

Input voltage	6 – 26V
Outputs	Primary: 1 Solid State Relay, 24V (max), 2A, TVS protected Secondary: 1 Transistor Output
Processor	NXP / Freescale ARM Cortex M0+
Gauss	+-1000G (gauss values above or below this will saturate the sensor)

Terminal Block J2

Pin ID	Use	Notes
G	Ground	
X	Solid State Relay Switch	These two pins are the contact for the solid-state switch. **NOTE: Do not attempt to switch AC line (110V/220V AC) with this contact. Use a relay or other appropriate level switch.** **NOTE: Some electronics (such as motors and maglocks) can induce voltage spikes, use with caution.** Recommended maglock: http://www.seco-larm.com/E-941SA-80Q
Y	Solid State Relay Switch	
Z	Transistor Output: 200mA, 50V	RFU
V+	Input Power: 6 – 26VDC+	<23mA
G	Ground	

Magnetic Specifications

Name	Product ID	Specs
Magnet A	MAGNETL12N52CYL	**N52 ½" x ½" Linear / Rotary Magnet**
Magnet B	MAGNETR424N52	**N52 ¼" x ¼" Rotary Magnet**
Magnet D	MAGNETR834N52	**N52 ½" x ¼" Rotary Magnet**

Contact

Web: www.escaperoomtechs.com
Email: support@escaperoomtechs.com
Phone: 561-708-0007

References

Solid State Relay: Omron G3VM-41DY1(TR05)

https://www.digikey.com/product-detail/en/omron-electronics-inc-emc-div/G3VM-41DY1(TR05)/Z5418TR-ND/5799757

Terminal Blocks: Onshore Tech

Header - OSTOQ063250 https://www.digikey.com/products/en?keywords=OSTOQ063250

Terminals - OSTTS06315B https://www.digikey.com/products/en?keywords=OSTTS06315B

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