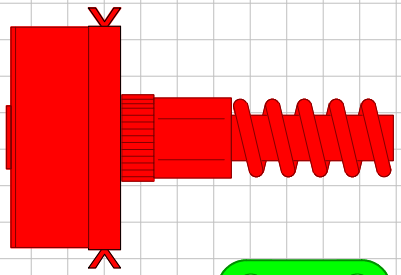
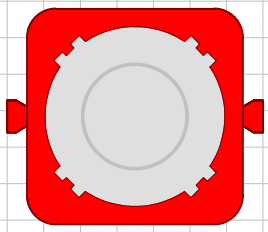
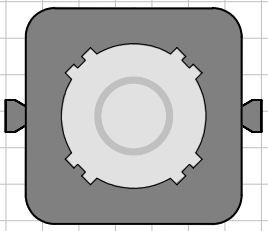
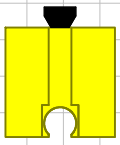
STEM education CLASS

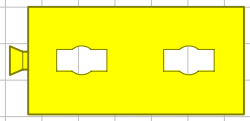
SUPPLEMENT PARTS LISTS AND WIRING DIAGRAMS FOR FISCHERTECHNIK EDUCATION CLASS KITS

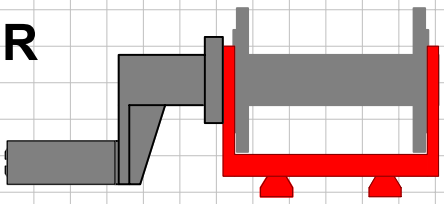


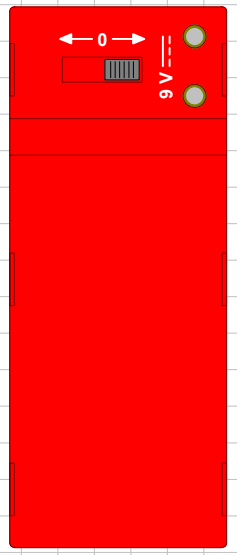


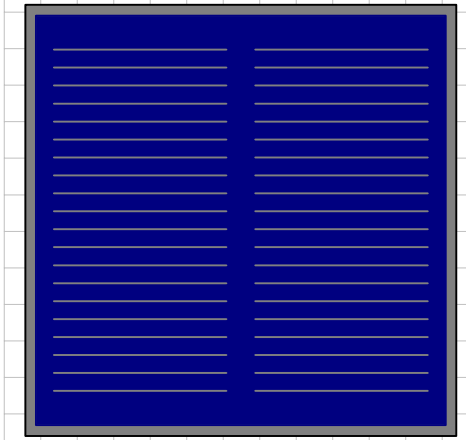




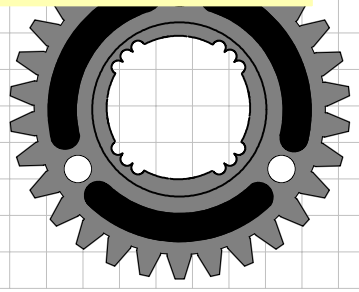


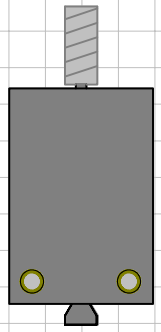


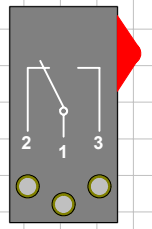




ELECTRICAL CONTROL
SOLAR ENERGY
GEARS, OPTICS, STATICS
SIMPLE MACHINES







CLASS-FT	A4	udo@elgers.com	ue-ERT20250306-01	06-MAR-2025
001	A	FT STEM CLASS EDUCATION SETS - SUPPLEMENT		

www.retro-circuits.com

FOR FULLY COMPONENT SPECS. SEE MANUFACTURER INFORMATION.

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Bad Bentheim, 18th. Mar. 2025

Udo Elger

NOTE: ...all included QR codes are links to the original OEM assembly instructions on: www.fischertechnikclub.nl

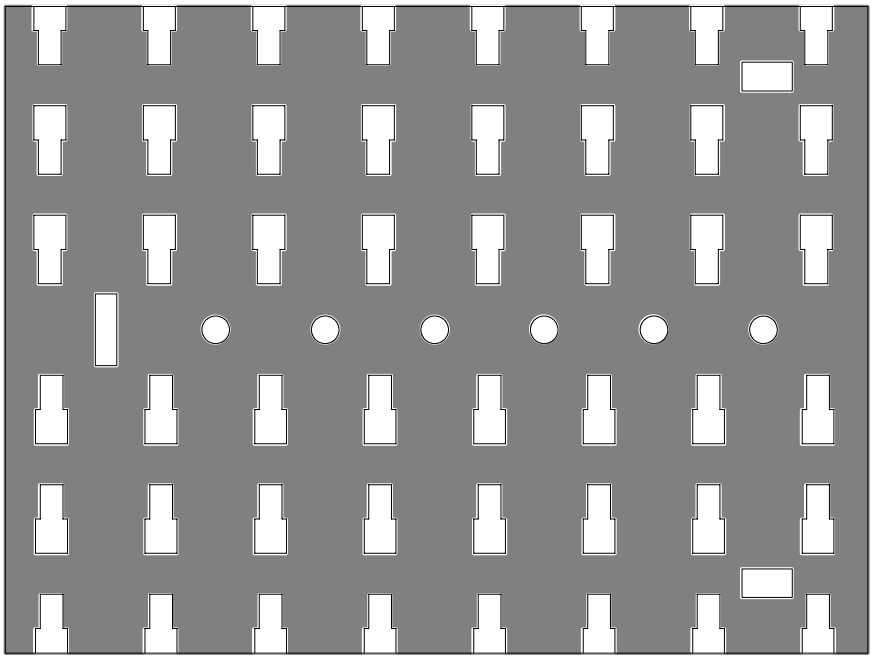
Udo Elger
48455 Bad Bentheim / Kuhlenkamp 22
Germany
Email: info@retro-circuits.com

FT STEM - SUPPLEMENT BROCHURE FOR FISCHERTECHNIK EDUCATION CLASS SETS

FT STEM - FISCHERTECHNIK education Class Set Electrical Control

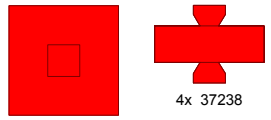
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-EC	A4	udo@elgers.com	ue-ERT20250318-02	18-MAR-2025
004	A	FT STEM CLASS SET ELECTRICAL CONTROL		

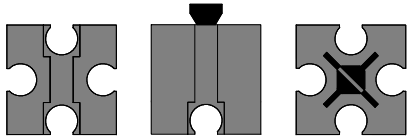


1x 182622

2x 35049

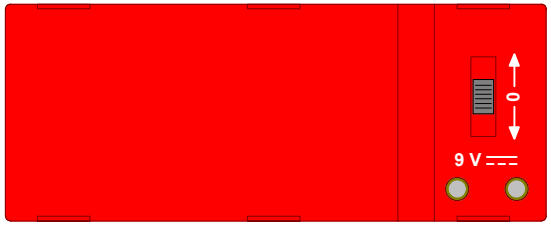


4x 37238

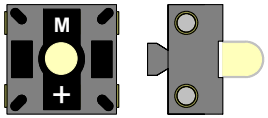


1x 32881

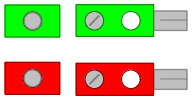
1x 31330



1x 135719

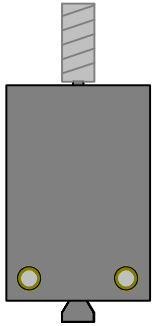


1x 162134

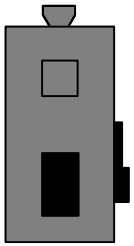


4x 31336 (181583)

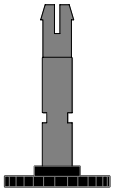
8x 31337 (181584)



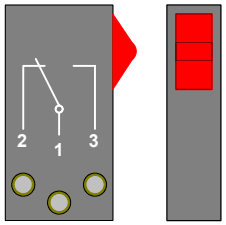
1x 137096



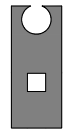
1x 31078



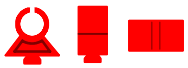
1x 31082



2x 37783



1x 36227



2x 35969

31078	MOTOR REDUCING GEAR BOX
31082	CLIP AXLE WITH GEAR WHEEL T=28 M=0.5
31330	LINK 45
31336	FLAT PLUG, GREEN
31337	FLAT PLUG, RED
32881	BUILDING BLOCK 15, BLACK
35049	BUILDING BLOCK 15x30x5 WITH GROVE
35969	REED CONTACT AND CABLE CLAMP
36227	CLIP ADAPTER
37238	BUILDING BLOCK 5 WITH 2 PINS
37783	MINI SWITCH
135719	BATTERY HOLDER 9V
137096	MOTOR XS 9V
162134	LED ASSEMBLED 9V 0.01A
182622	BASE PLATE 90x120, BLACK

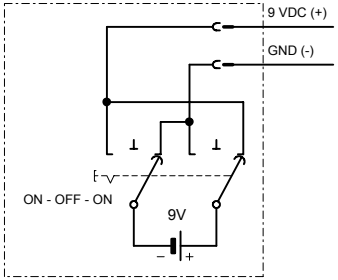
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BILL OF MATERIAL (BOM)

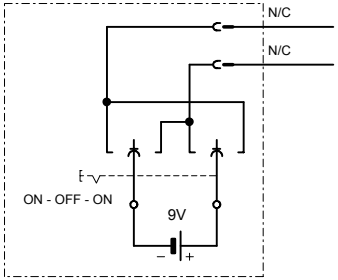
CLASS-EC	A4	udo@elgers.com	ue-ERT20250312-01	12-MAR-2025
005	A	FT STEM CLASS SET ELECTRICAL CONTROL - BOM		

RETRO CIRCUITS

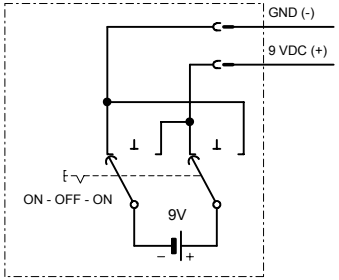
FT - BATTERY BOX - PN: 135719 (PRINCIPAL SCHEMATICS)



FORWARD (FWD)
CLOCKWISE (CW)
LED (ON)

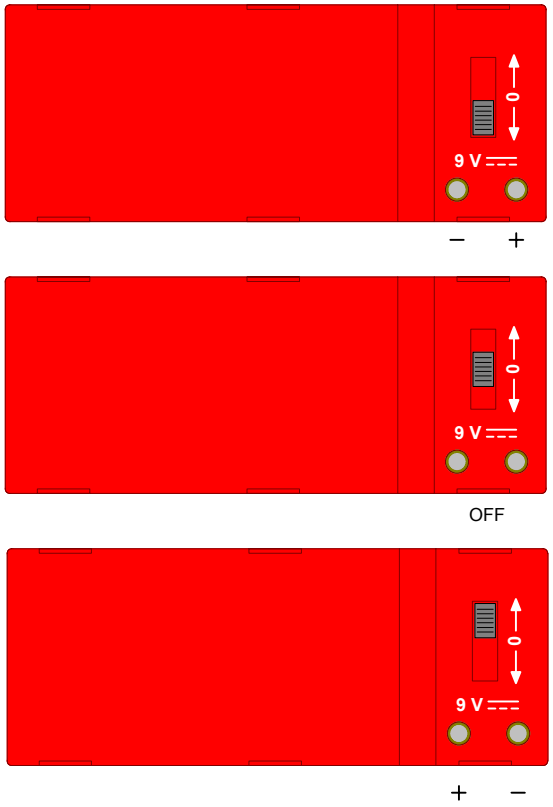


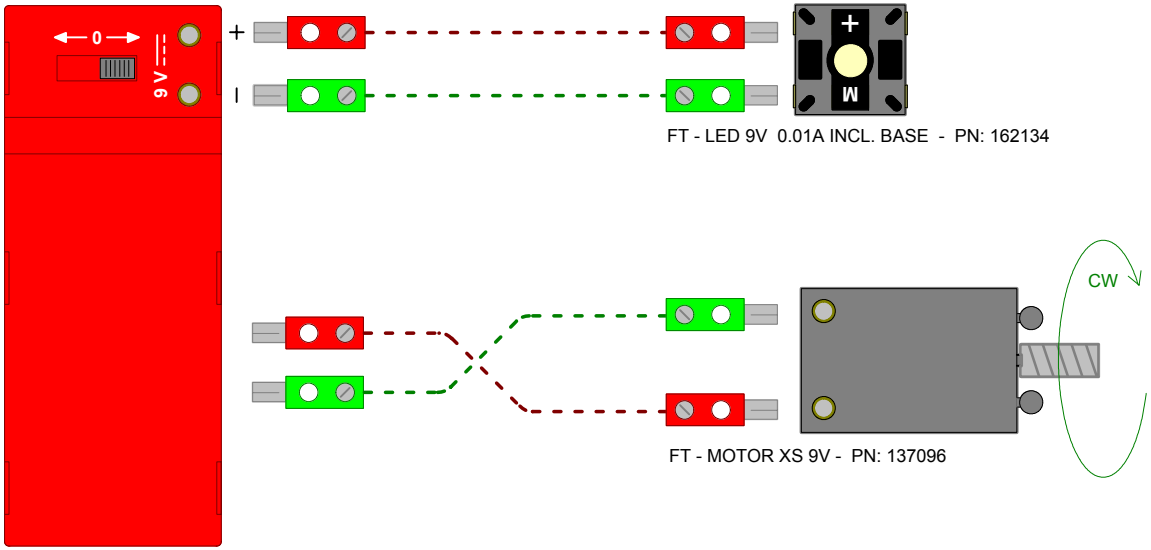
LED (OFF)



BACKWARD OR REVERSE (REV)
COUNTER-CLOCKWISE (CCW)
LED (OFF)

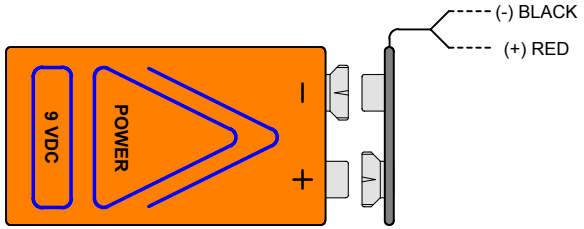
FT - BATTERY BOX - PN: 135719





FT - LED 9V 0.01A INCL. BASE - PN: 162134

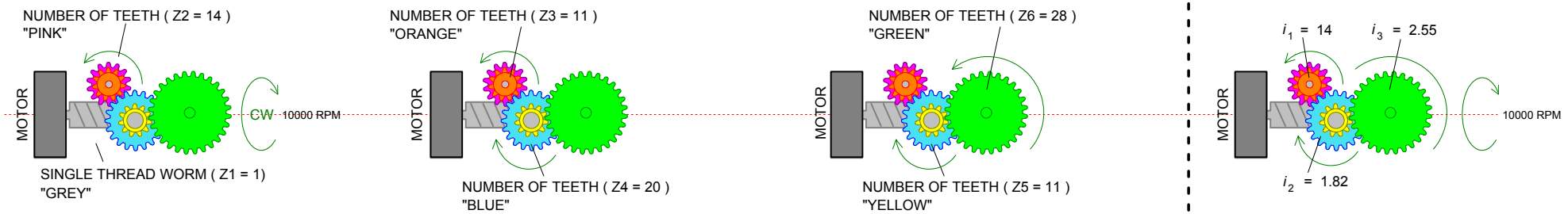
FT - MOTOR XS 9V - PN: 137096



FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

POWER SUPPLY (PS) / 9 V BATTERYBOX WITH POLARITY CHANGE-OVER SWITCH

CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-01	13-MAR-2025
006	A	FT - STEM CLASS SET ELECTRICAL CONTROL - PWRS		



$$i_1 = \frac{Z2}{Z1} \quad \frac{14}{1} = 14 \quad i_1 = 14:1$$

$$i_2 = \frac{Z4}{Z3} \quad \frac{20}{11} = 1.82 \quad i_2 = 1{,}82:1$$

$$i_3 = \frac{Z6}{Z5} \quad \frac{28}{11} = 2.55 \quad i_3 = 2.55:1$$

$$i_{tot} = i_1 \times i_2 \times i_3$$

$$14 \times 1.82 \times 2.55 = 65$$

$$\frac{10000}{14} = 715 \text{ RPM}$$

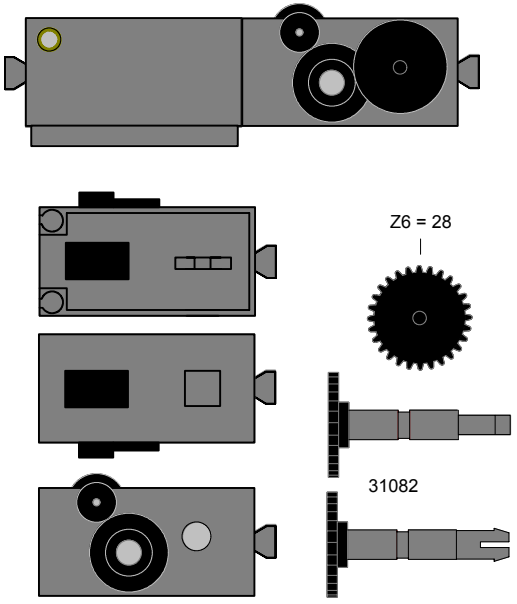
$$\frac{715}{1.82} = 393 \text{ RPM}$$

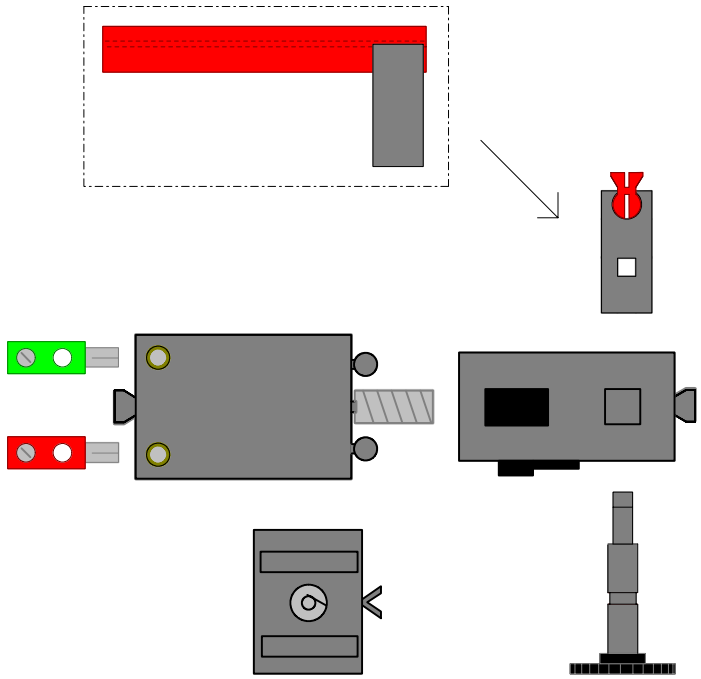
$$\frac{393}{2.55} = 154 \text{ RPM}$$

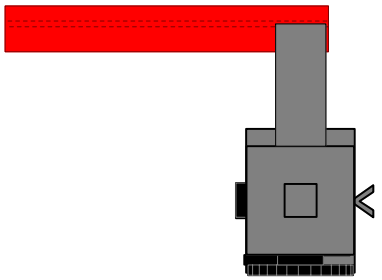
$$\frac{10000}{65} = 154 \text{ RPM}$$

137096 - XS MINI MOTOR 9 VDC
W x H x L = 30 x 15 x 20
11000 RPM (MEASURED AT 9 V)

31078 - MINI U-GEAR
i = 65



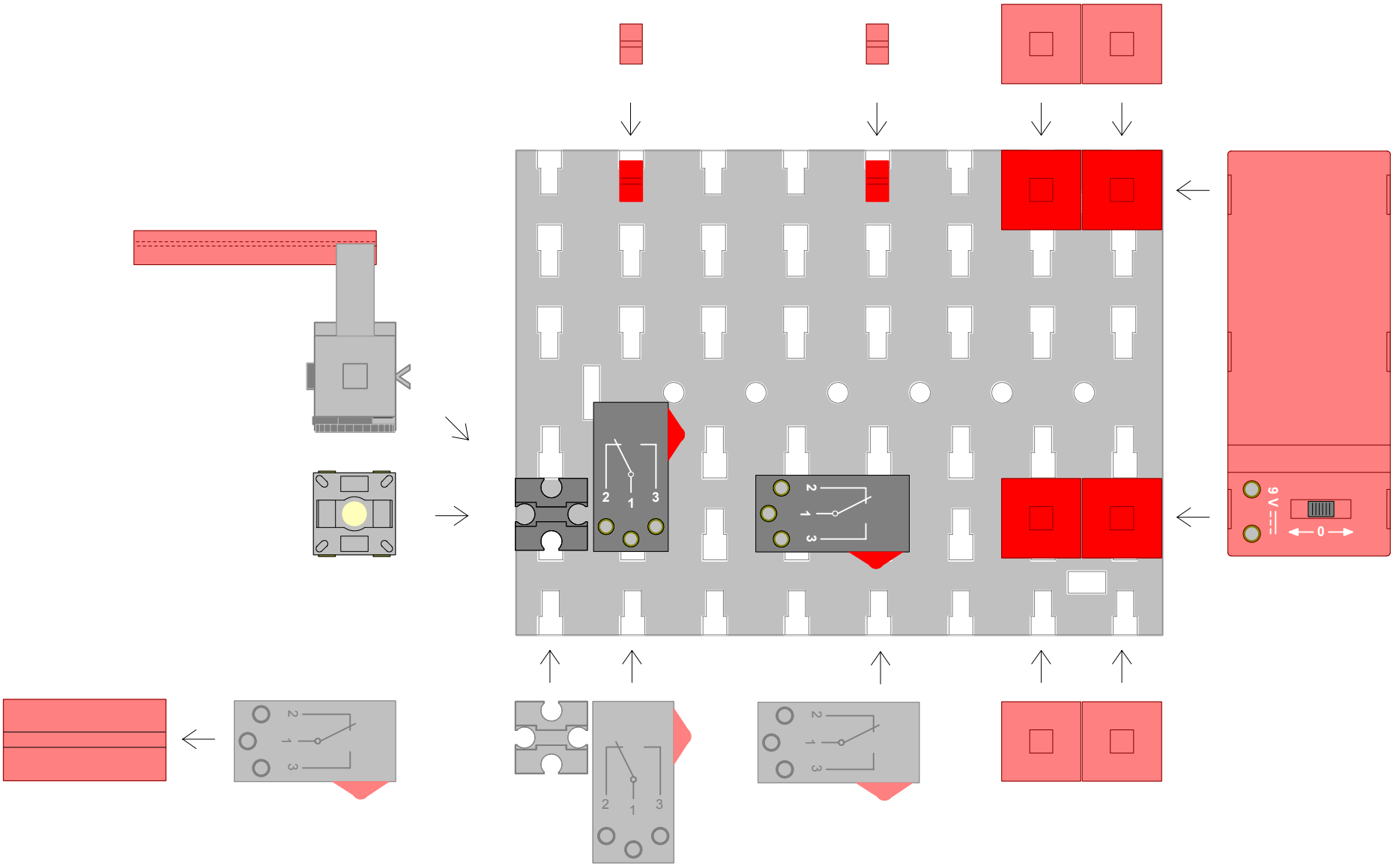




FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
MOTOR RPM & AND MOTOR CURRENT ARE STRONGLY DEPENDING ON THE AGE OF THE MOTOR. POLARITY OF MOTOR CONNECTOR VARIES.
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

MOTOR XS 9V & REDUCTION GEAR

CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-02	13-MAR-2025
007	A	FT STEM CLASS SET ELECTRICAL CONTROL - GEAR		



FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
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BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT STEM CLASS SET ELECTRICAL CONTROL - ASSEMBLING

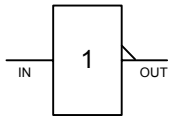
CLASS-EC	A4	udo@elgers.com	ue-ERT20250312-02	12-MAR-2025
008	A	FT STEM CLASS SET ELECTRICAL CONTROL - ASSY		

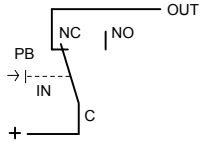
NOT FUNCTION (not gate) "inverter"

If the input is OFF (L),
the NOT function gives an ON (H) output.

If the input is ON (H),
the NOT function gives an OFF (L) output.

INPUT PB	OUTPUT LED
L	H
H	L





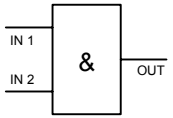
EXPERIMENT 03a
(ADDITIONAL OPTION)

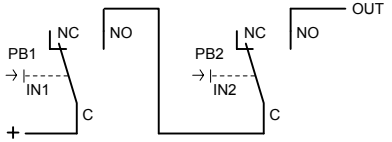
AND FUNCTION (and gate)

If both inputs are ON (H),
the AND function gives an ON (H) output.

If one or both inputs are OFF (L),
the AND function gives an OFF (L) output.

INPUT PB 1	INPUT PB 2	OUTPUT LED
L	L	L
H	L	L
L	H	L
H	H	H





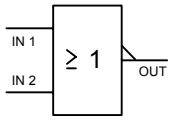
EXPERIMENT 04

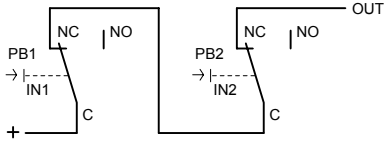
NOR FUNCTION (nor gate)

If both inputs are OFF (L),
the NOR function gives an ON (H) output.

If one or both inputs are ON (H),
the NOR function gives an OFF (L) output.

INPUT PB 1	INPUT PB 2	OUTPUT LED
L	L	H
H	L	L
L	H	L
H	H	L





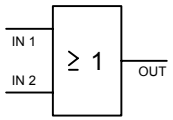
EXPERIMENT 04a
(ADDITIONAL OPTION)

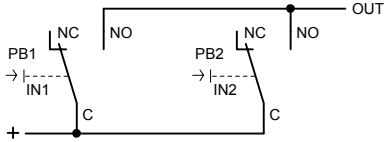
OR FUNCTION (or gate)

If both inputs are OFF (L),
the OR function gives an OFF (L) output.

If one or both inputs are ON (H),
the OR function gives an ON (H) output.

INPUT PB 1	INPUT PB 2	OUTPUT LED
L	L	L
H	L	H
L	H	H
H	H	H





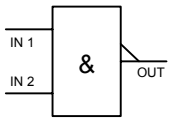
EXPERIMENT 05

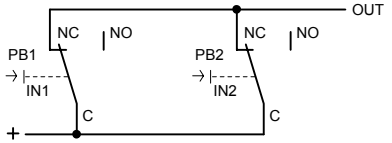
NAND FUNCTION (nand gate)

If both inputs are ON (H),
the NAND function gives an OFF (L) output.

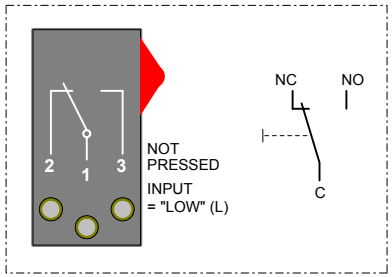
If one or both inputs are OFF (L),
the NAND function gives an ON (H) output.

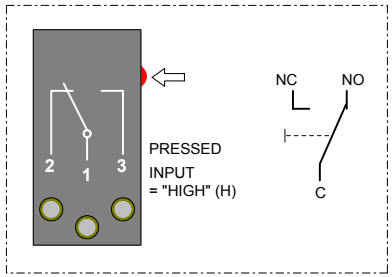
INPUT PB 1	INPUT PB 2	OUTPUT LED
L	L	H
H	L	H
L	H	H
H	H	L

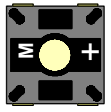




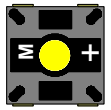
EXPERIMENT 05a
(ADDITIONAL OPTION)







LED NOT LIGHT UP
OUTPUT = LOW (L)



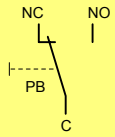
LED LIGHT UP
OUTPUT = HIGH (H)

An SPDT NO NC push button is a Single Pole Double Throw switch with Normally Open (NO) and Normally Closed (NC) contacts.

Function:
NO (Normally Open): Circuit is open when the button is not pressed; closes when pressed.

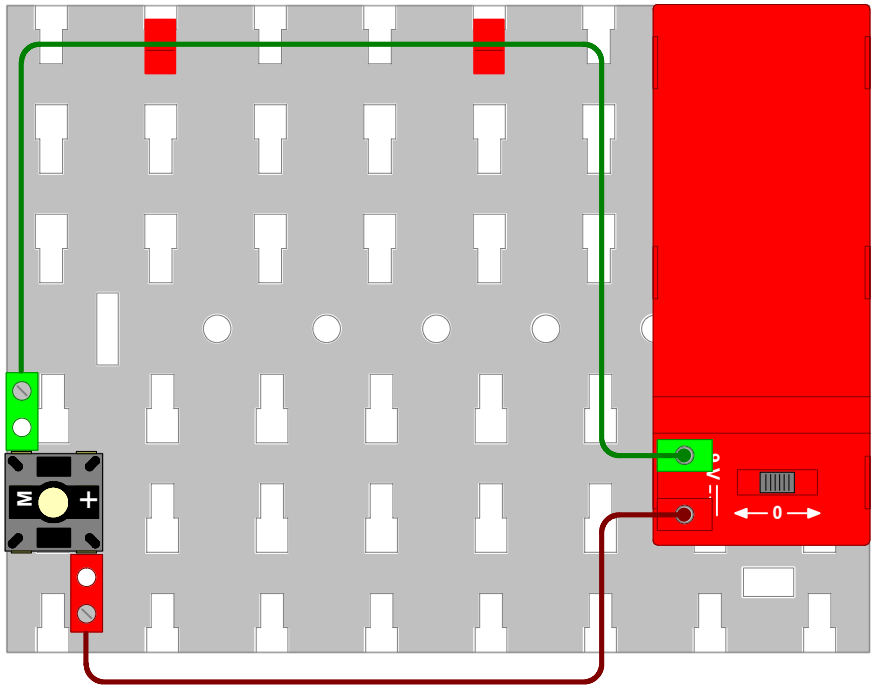
NC (Normally Closed): Circuit is closed when the button is not pressed; opens when pressed.

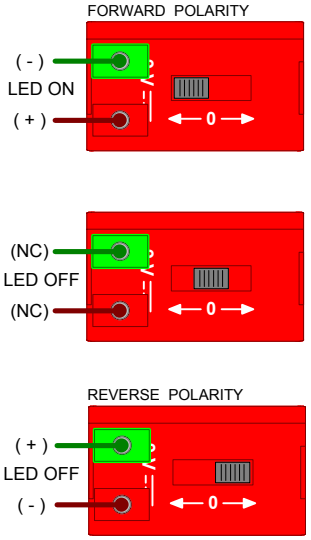
Common (C): The moving contact that switches between NO and NC.



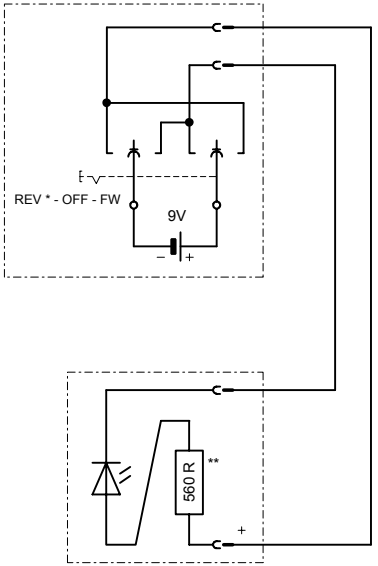
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-EC	A4	udo@elgers.com	ue-ERT20250316-03	16-MAR-2025
009	A	FT STEM CLASS SET ELECTRICAL CONTROL - LOGIC		

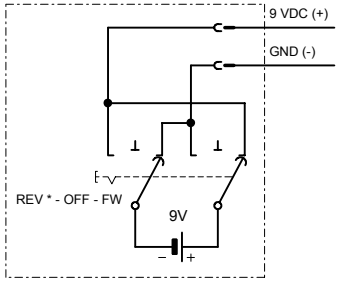




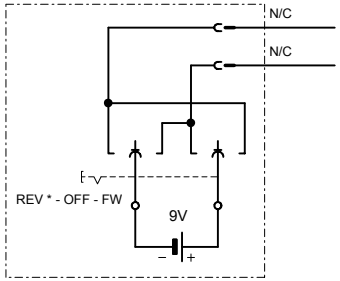
FT - BATTERY BOX WITH POLARITY CHANGING SWITCH
PN: 135719 (PRINCIPAL SCHEMATICS)



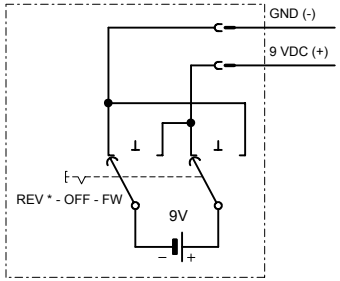
FT - LED ASSEMBLED 9 V 0.01 A
PN: 162134 (PRINCIPAL SCHEMATICS)



POLARITY FORWARD LED (ON)

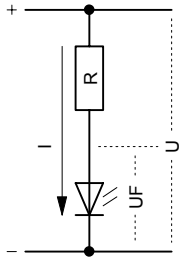


LED (OFF)



POLARITY REVERSAL LED (OFF)

** LED CURRENT LIMITING SERIES RESISTOR



$$R = \frac{U - UF}{I}$$

$$R = \frac{9 - 3.6}{0.01}$$

R = 540 (560 R)

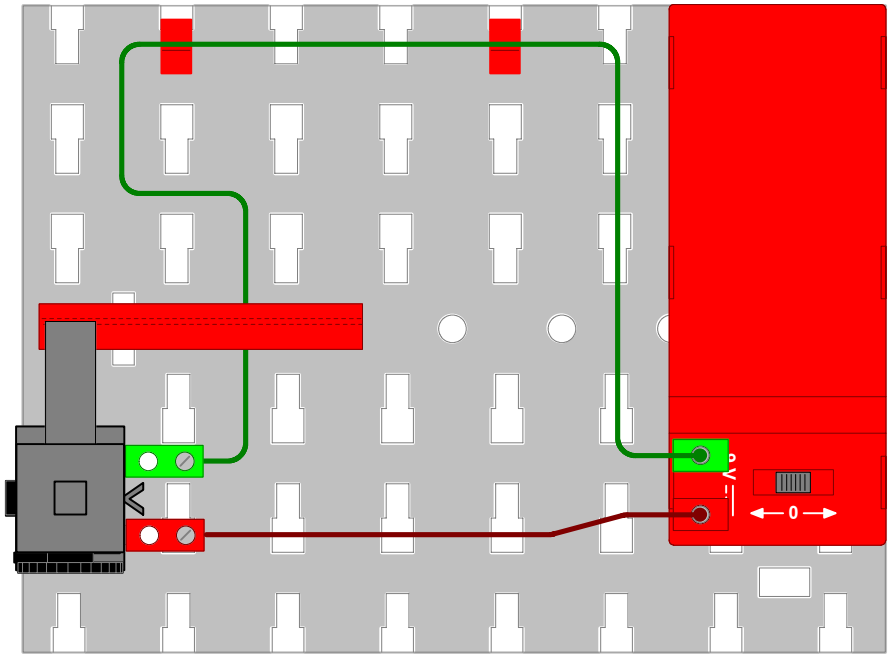
* Polarity Reversal:
The LED blocks current and does not light up when connected in reverse.

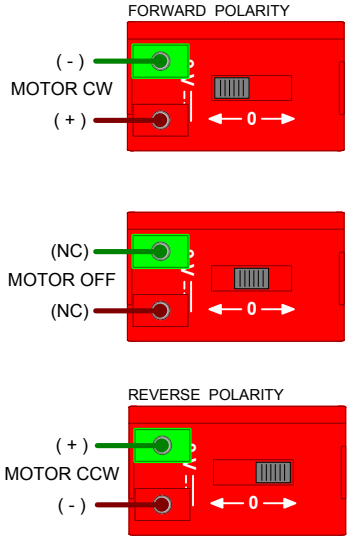
** Series Resistor:

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

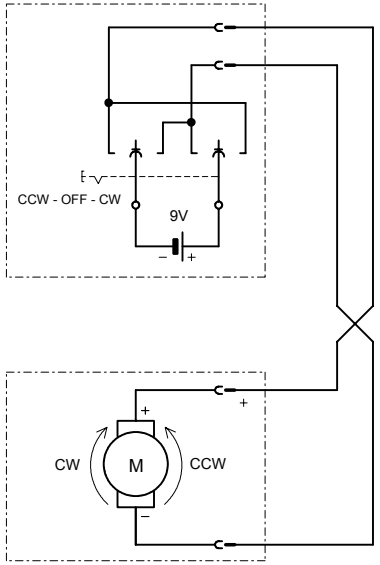
FT OEM MANUAL PAGE 04 + 05
SIMPLE CIRCUIT WITH POLARITY-CHANGING SWITCH WITH LED

CLASS-EC	A4	udo@elgers.com	ue-ERT20250312-03	12-MAR-2025
010	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 01		

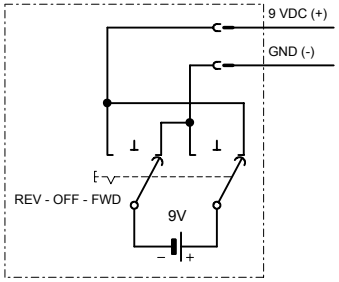




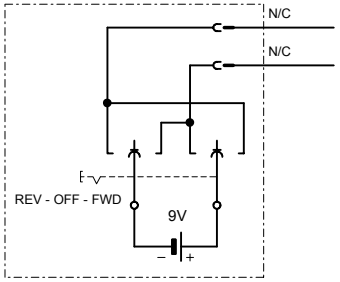
FT - BATTERY BOX WITH POLARITY CHANGING SWITCH
PN: 135719 (PRINCIPAL SCHEMATICS)

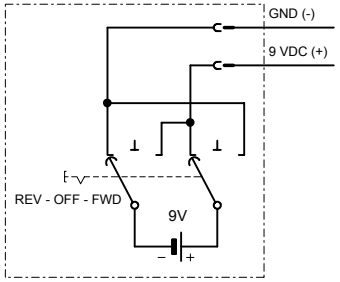


FT - MOTOR XS 9V - PN: 135719 (PRINCIPAL SCHEMATICS)



FORWARD (FWD)
CLOCKWISE (CW)





BACKWARD OR REVERSE (REV)
COUNTER-CLOCKWISE (CCW)

A polarity changing switch for a DC motor allows the motor to run in both forward and reverse directions by reversing the voltage polarity.

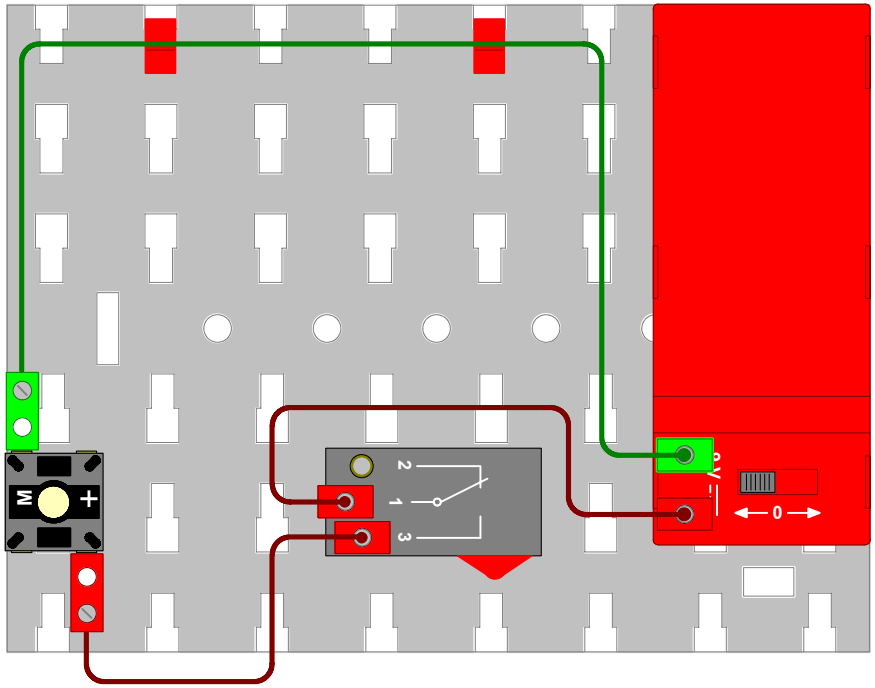
Basic Function:
The switch swaps the connections of the motor to the power supply.
When flipped one way, the motor spins forward (+ to +, - to -).
When flipped the other way, the polarity reverses (- to +, + to -), making the motor spin backward.

Common Implementation:
DPDT (Double Pole Double Throw) switch is often used, wired in an H-bridge configuration for polarity reversal.

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
MOTOR RPM & AND MOTOR CURRENT ARE STRONGLY DEPENDING ON THE AGE OF THE MOTOR. POLARITY OF MOTOR CONNECTOR VARIES.
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

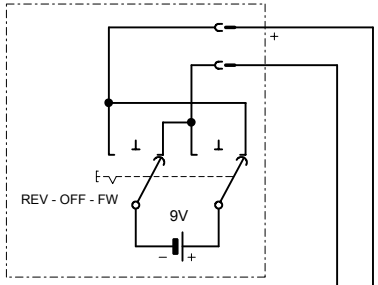
FT OEM MANUAL PAGE 06 - 08
SIMPLE CIRCUIT WITH POLARITY-CHANGING SWITCH WITH DC-MOTOR CHANGE OF ROTATION DIRECTION EXPERIMENT

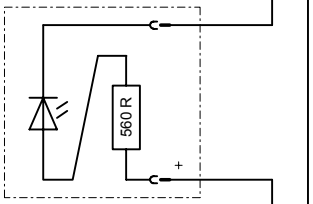
CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-03	13-MAR-2025
011	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 02		



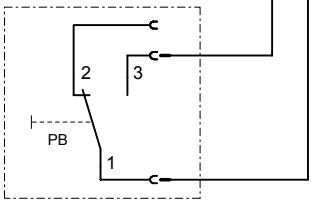
NO CONTACT
"LED NOT LIGHT UP WHEN PB IS NOT PRESSED"
"LED LIGHT UP WHEN PB IS PRESSED"

FT - BATTERY BOX WITH POLARITY CHANGING SWITCH
PN: 135719 (PRINCIPAL SCHEMATICS)





FT - LED ASSEMBLED 9 V 0.01 A
PN: 162134 (PRINCIPAL SCHEMATICS)



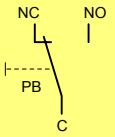
FT - SPDT MINI MOMENTARY PUSH BUTTON
PN: 37783 (PRINCIPAL SCHEMATICS)

An SPDT NO NC push button is a Single Pole Double Throw switch with Normally Open (NO) and Normally Closed (NC) contacts.

Function:
NO (Normally Open): Circuit is open when the button is not pressed; closes when pressed.

NC (Normally Closed): Circuit is closed when the button is not pressed; opens when pressed.

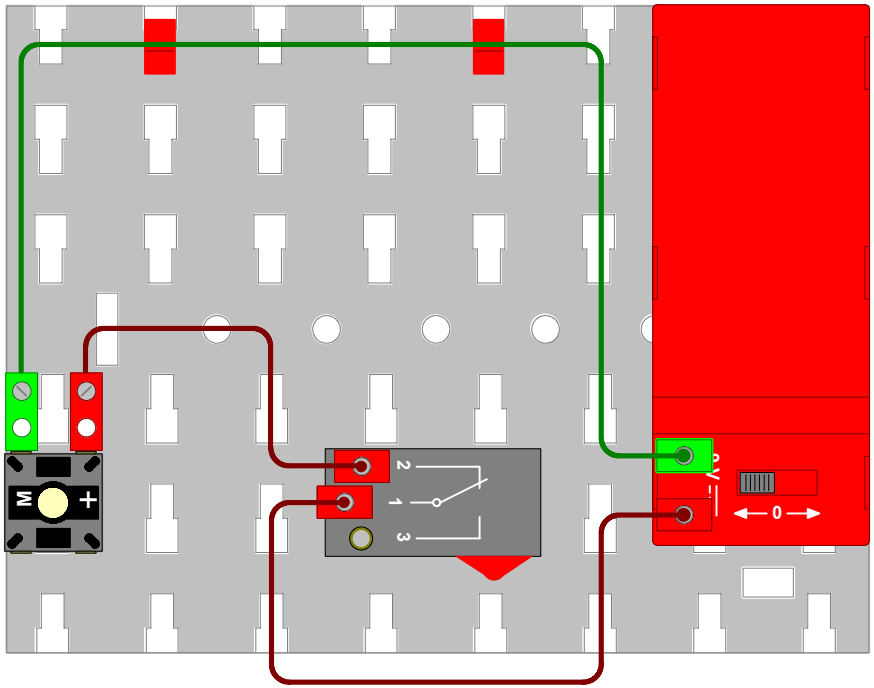
Common (C): The moving contact that switches between NO and NC.



FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

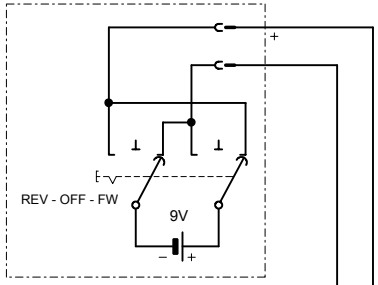
FT OEM MANUAL PAGE 09 - 11
SWITCHING ON & OFF BUTTON - NORMALY OPEN (NO) CONTACT "LED LIGHT UP WHEN PB IS PRESSED"

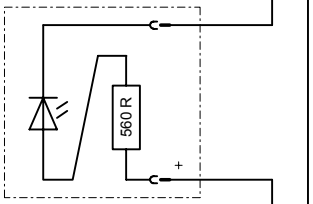
CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-03	13-MAR-2025
012	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 03		



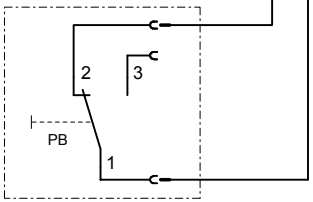
NC CONTACT - LOGICAL NOT FUNCTION
"LED LIGHT UP WHEN PB IS NOT PRESSED"
"LED NOT LIGHT UP WHEN PB IS PRESSED"

FT - BATTERY BOX WITH POLARITY CHANGING SWITCH
PN: 135719 (PRINCIPAL SCHEMATICS)





FT - LED ASSEMBLED 9 V 0.01 A
PN: 162134 (PRINCIPAL SCHEMATICS)



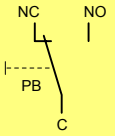
FT - SPDT MINI MOMENTARY PUSH BUTTON
PN: 37783 (PRINCIPAL SCHEMATICS)

An SPDT NO NC push button is a Single Pole Double Throw switch with Normally Open (NO) and Normally Closed (NC) contacts.

Function:
NO (Normally Open): Circuit is open when the button is not pressed; closes when pressed.

NC (Normally Closed): Circuit is closed when the button is not pressed; opens when pressed.

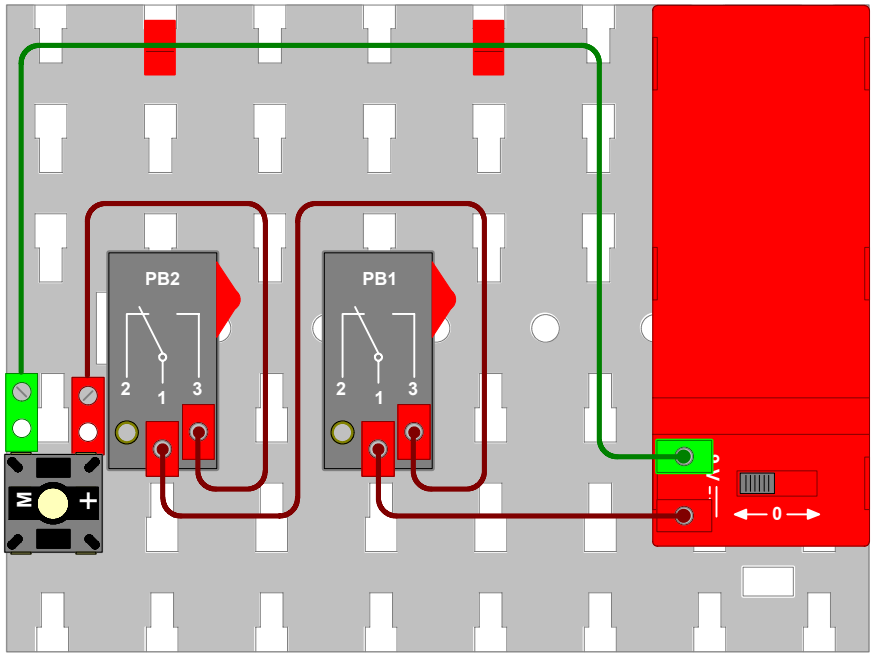
Common (C): The moving contact that switches between NO and NC.



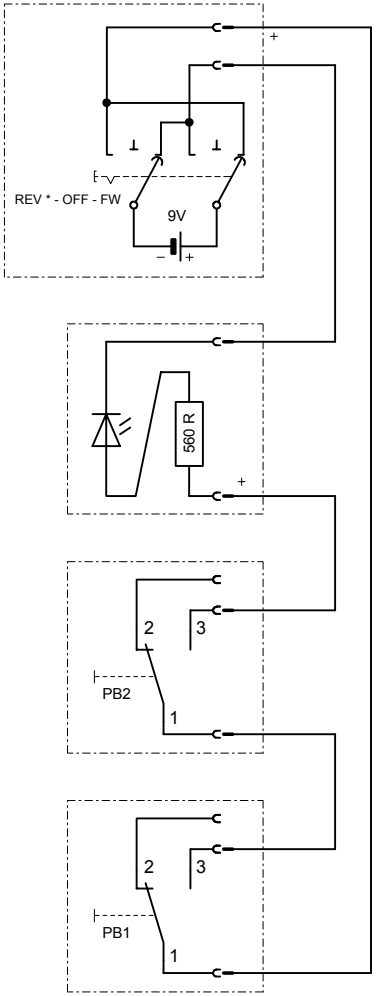
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

ADDITIONAL OPTIONAL EXPERIMENT BASED ON OEM MANUAL PAGE 09 - 11 SETUP
SWITCHING ON & OFF BUTTON - NORMALY CLOSED (NC) CONTACT "LED NOT LIGHT UP WHEN PB IS PRESSED" (LOGICAL NOT FUNCTION)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250315-01	15-MAR-2025
013	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 03a		



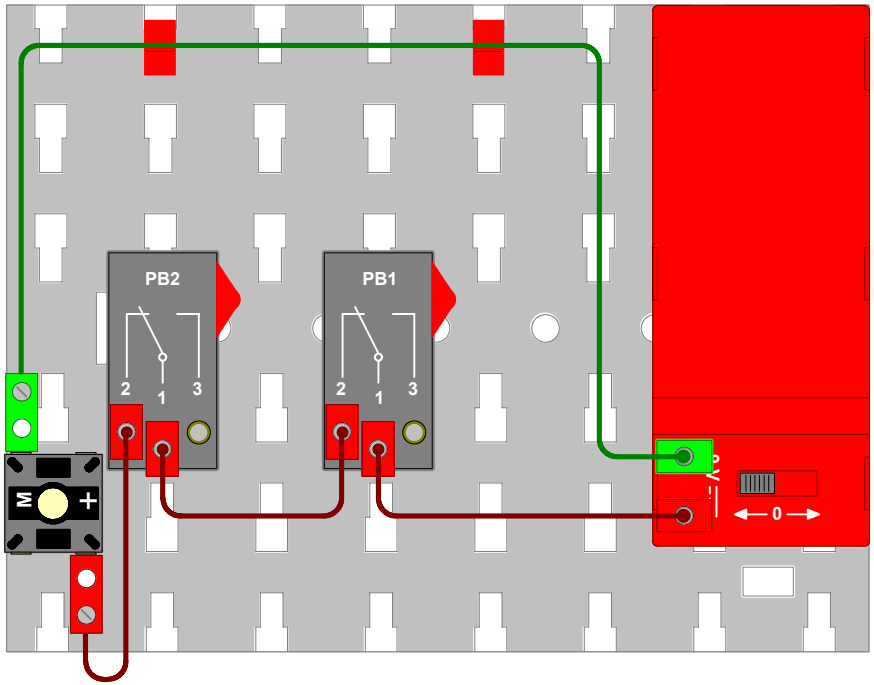
TWO NO CONTACTS IN SERIES - (LOGICAL AND FUNCTION)
"LED NOT LIGHT UP IF ONE OR BOTH PB ARE NOT PRESSED"
"LED ONLY LIGHT UP WHEN BOTH PB ARE PRESSED"



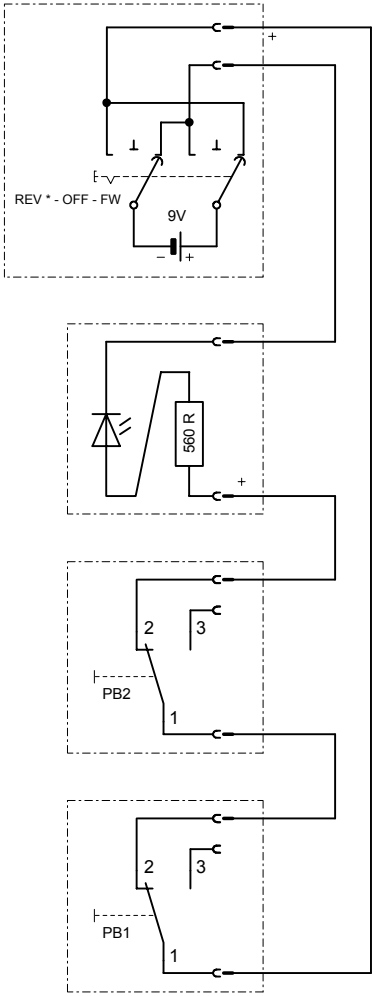
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT OEM MANUAL PAGE 12 - 14
SERIES CONNECTION OF PUSH BUTTON - (LOGICAL AND FUNCTION)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-04	13-MAR-2025
014	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 04		



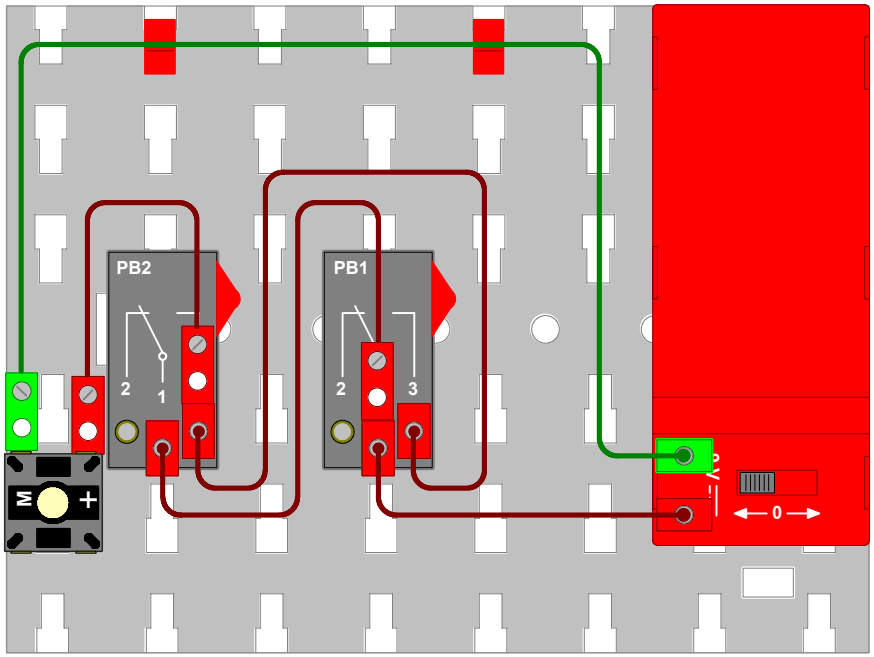
TWO NC CONTACTS IN SERIES - (LOGICAL NOR FUNCTION)
"LED NOT LIGHT UP IF ONE OR BOTH PB ARE PRESSED"
"LED ONLY LIGHT UP WHEN BOTH PB ARE NOT PRESSED"



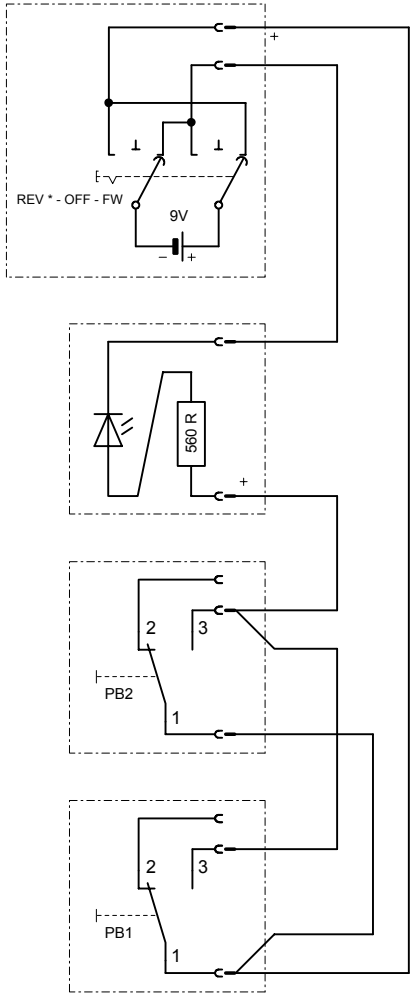
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

ADDITIONAL OPTIONAL EXPERIMENT BASED ON FT OEM MANUAL PAGE 12 - 14 SETUP
SERIES CONNECTION OF PUSH BUTTON - TWO NC CONTACTS IN SERIES, LED ONLY LIGHT UP WHEN BOTH PB ARE NOT PRESSED (LOGICAL NOR FUNCTION)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250315-02	15-MAR-2025
015	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 04a		



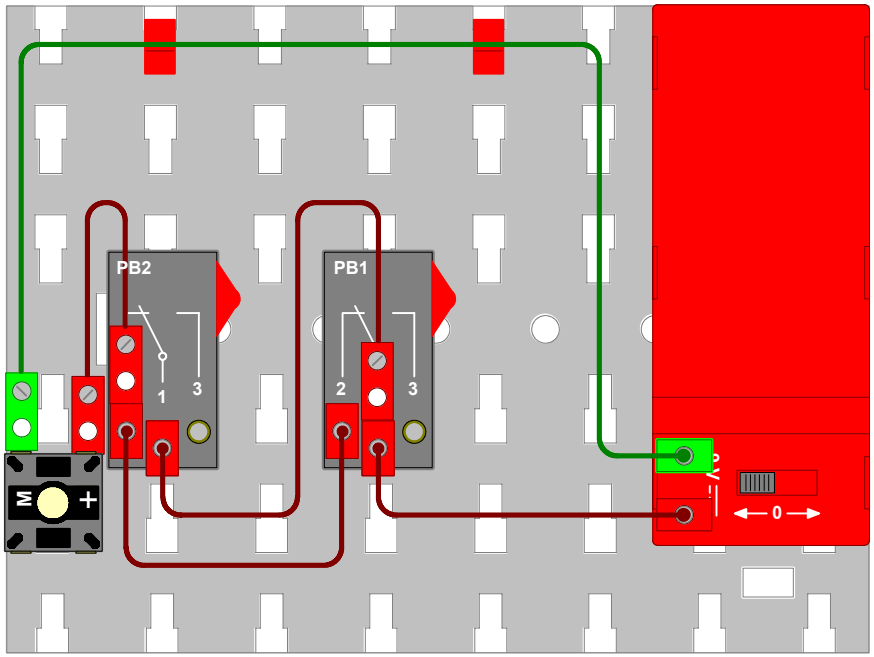
TWO NO CONTACTS IN PARALLEL - (LOGICAL OR FUNCTION)
"LED LIGHT UP IF ONE OR BOTH PB ARE PRESSED"
"LED NOT LIGHT UP WHEN BOTH PB ARE NOT PRESSED"



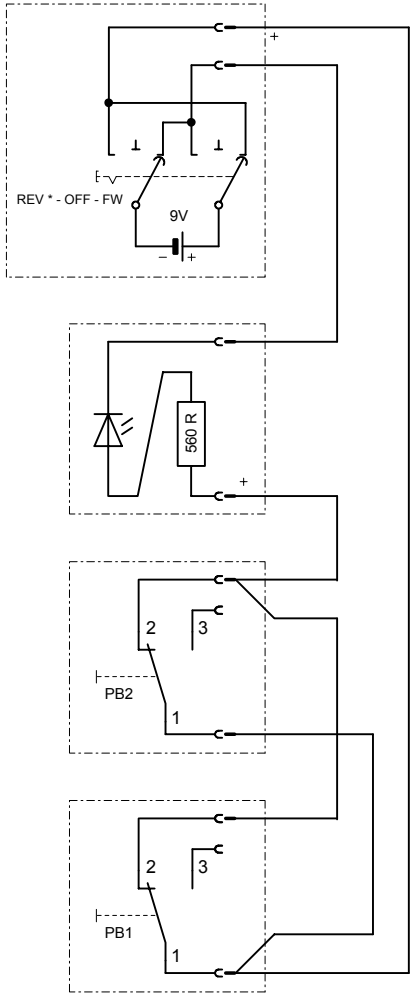
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT OEM MANUAL PAGE 15 - 17
PARALLEL CONNECTION OF PUSH BUTTONS - (LOGICAL OR FUNCTION)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-05	13-MAR-2025
016	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 05		



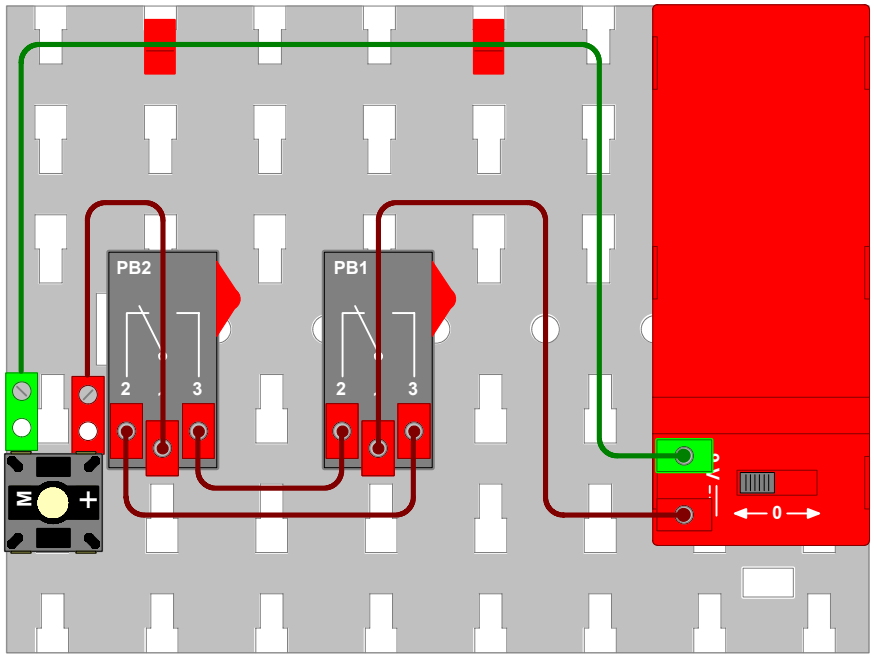
TWO NC CONTACTS IN PARALLEL - (LOGICAL NAND FUNCTION)
"LED LIGHT UP IF ONE OR BOTH PB ARE NOT PRESSED"
"LED ONLY NOT LIGHT UP WHEN BOTH PB ARE PRESSED"

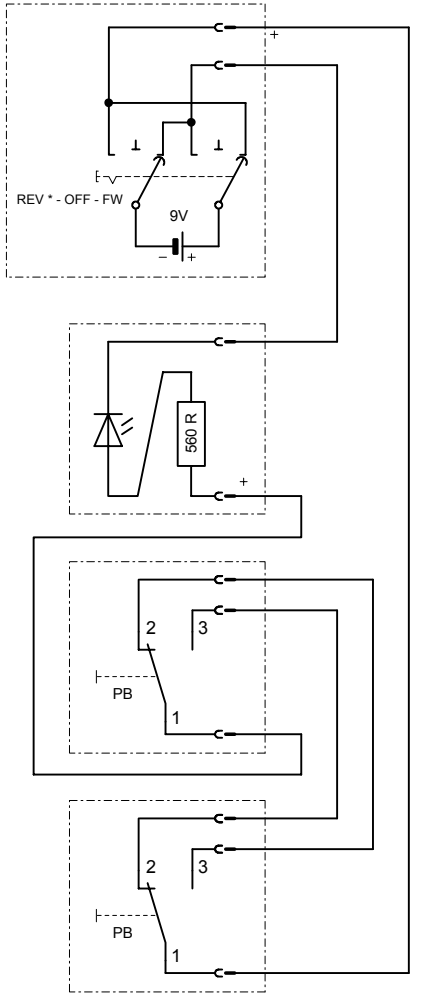


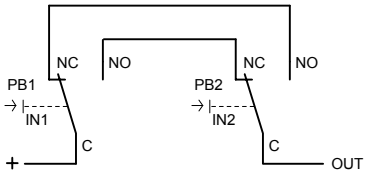
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

ADDITIONAL OPTIONAL EXPERIMENT BASED ON FT OEM MANUAL PAGE 15 - 17 SETUP
PARALLEL CONNECTION OF PUSH BUTTONS - NORMALLY CLOSED PB IN PARALLEL (LOGICAL NAND FUNCTION)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250316-01	16-MAR-2025
017	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 05a		







A TWO-WAY SWITCH SYSTEM CIRCUIT USED TO CONTROL A SINGLE LIGHT OR ELECTRICAL DEVICE FROM TWO DIFFERENT SWITCHES.

THE TWO SWITCHES ARE CONNECTED BY TWO TRAVELER WIRES BETWEEN NO AND NC. THE POWER SUPPLY IS CONNECTED TO THE COMMON TERMINAL OF THE FIRST SWITCH, WHILE THE LIGHT IS CONNECTED TO THE COMMON TERMINAL OF THE SECOND SWITCH.

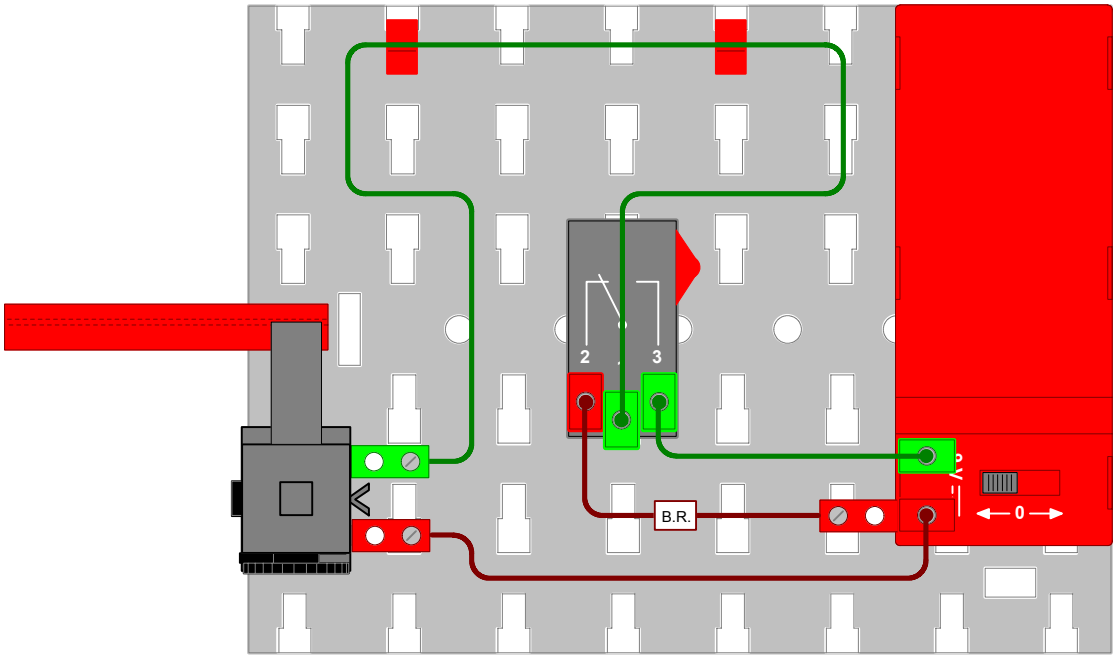
FLIPPING EITHER SWITCH CHANGES THE STATE OF THE LIGHT.

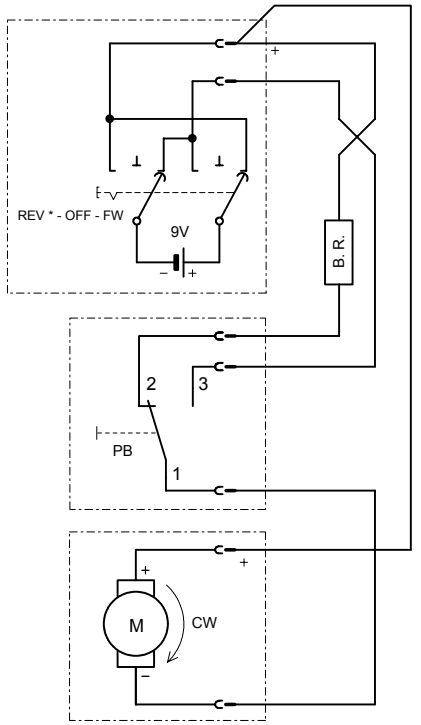
USED IN HALLWAYS, STAIRCASES, AND LARGE ROOMS WHERE LIGHTS NEED TO BE CONTROLLED FROM TWO DIFFERENT LOCATIONS.

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT OEM MANUAL PAGE 18 - 20
TWO-WAY SWITCH SYSTEM

CLASS-EC	A4	udo@elgers.com	ue-ERT20250313-06	13-MAR-2025
018	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 06		



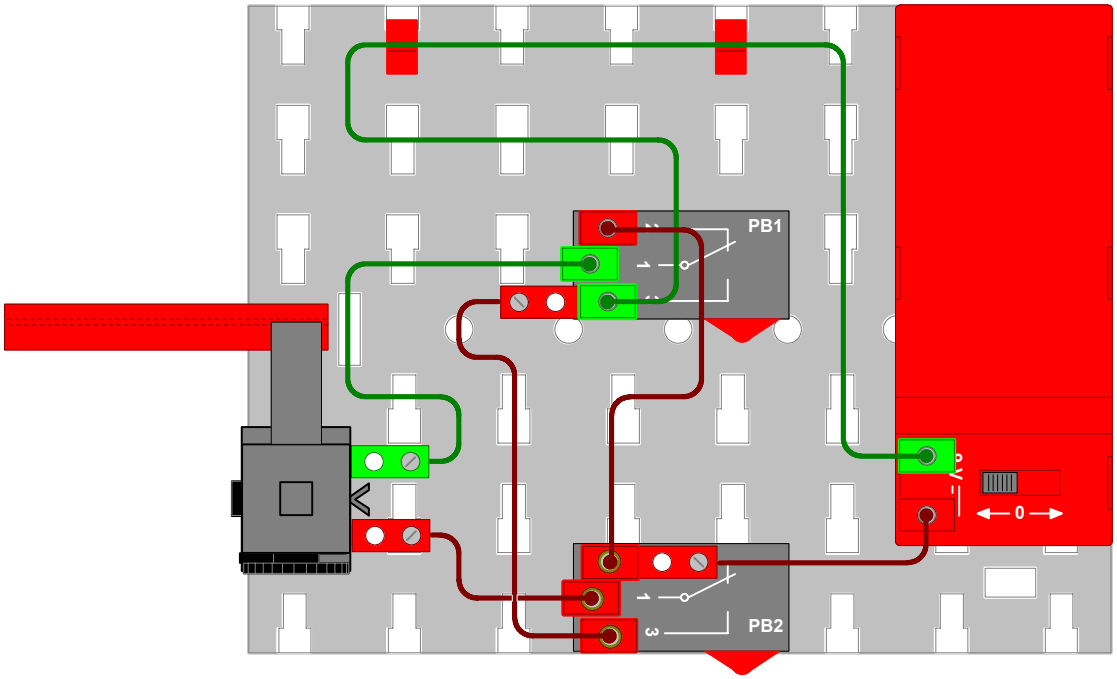


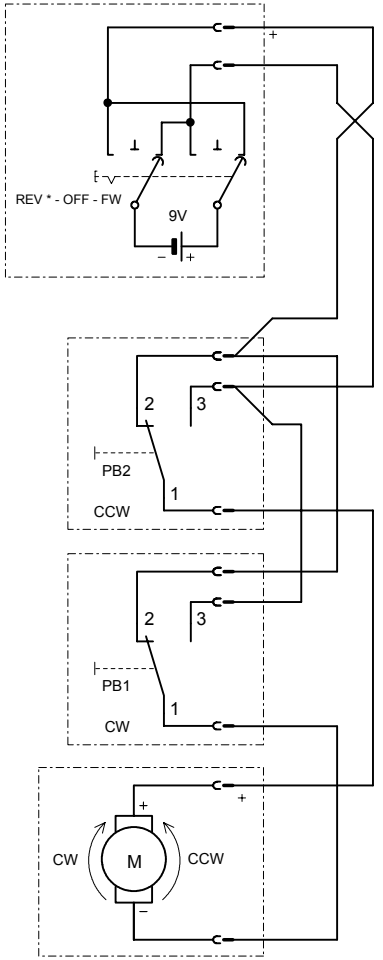
DYNAMIC BRAKING IS A METHOD OF SLOWING DOWN A MOTOR, OFTEN USED IN TRAINS AND SOME ELECTRIC VEHICLES. IN SIMPLE TERMS, WHEN A VEHICLE USES DYNAMIC BRAKING, IT TAKES ADVANTAGE OF THE ELECTRIC MOTORS ABILITY TO WORK AS A GENERATOR. INSTEAD OF RELYING SOLELY ON BRAKE PADS TO CREATE FRICTION AND SLOW DOWN, THE ELECTRIC MOTOR SWITCHES ROLES AND BECOMES A GENERATOR. THE ELECTRICAL ENERGY PRODUCED BY THE GENERATOR IS THEN DISSIPATED AS HEAT THROUGH RESISTORS (B. R.), HERE IT IS JUST A JUMPER WIRE INSTEAD.

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
MOTOR RPM & AND MOTOR CURRENT ARE STRONGLY DEPENDING ON THE AGE OF THE MOTOR. POLARITY OF MOTOR CONNECTOR VARIES.
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT OEM MANUAL PAGE 21 - 23
SHORT-CIRCUIT BRAKE - (DYNAMIC BRAKING)

CLASS-EC	A4	udo@elgers.com	ue-ERT20250316-04	16-MAR-2025
019	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 07		





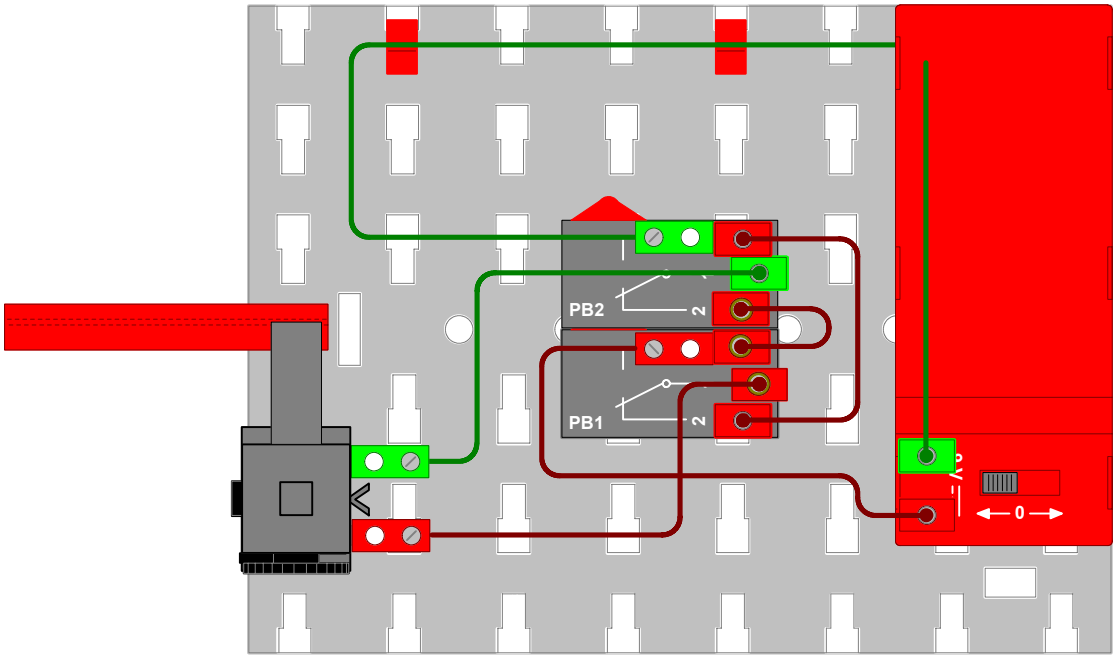
WHEN PRESSED PB1 THE MOTOR SPINS FORWARD "CW" (+ to +, - to -).
WHEN PRESSED PB2 THE MOTOR SPINS BACKWARD "CCW" (- to +, + to -).

WHEN PB1 & PB2 NOT PRESSED THE MOTOR DOES NOT SPIN (+ to +, + to -).
WHEN PB1 & PB2 PRESSED THE MOTOR DOES NOT SPIN (- to +, - to -).

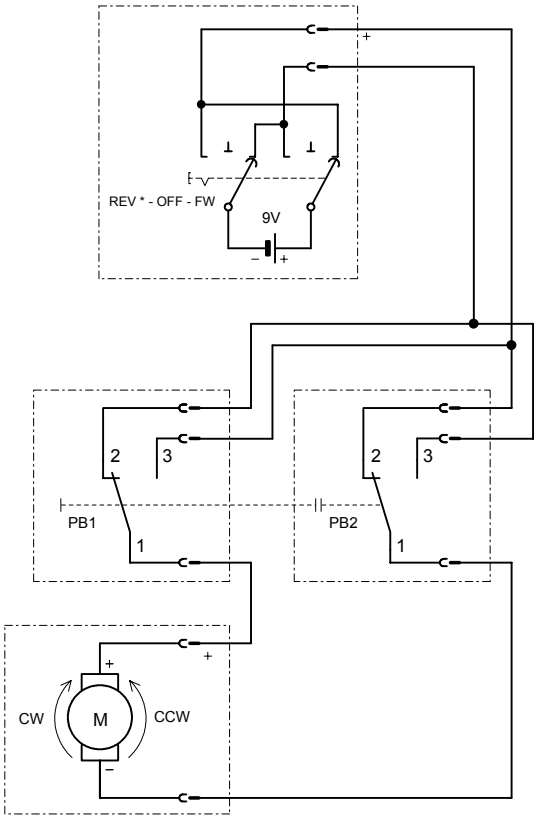
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
MOTOR RPM & AND MOTOR CURRENT ARE STRONGLY DEPENDING ON THE AGE OF THE MOTOR. POLARITY OF MOTOR CONNECTOR VARIES.
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

FT OEM MANUAL PAGE 24 - 26
LEFT-RIGHT-OFF WITH TWO BUTTONS

CLASS-EC	A4	udo@elgers.com	ue-ERT20250317-01	17-MAR-2025
020	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 08		



WHEN PB NOT PRESSED THE MOTOR SPINS BACKWARD "CCW" (+ to -, - to +).
WHEN PB PRESSED THE MOTOR SPINS FOREWARD "CW" (+ to +, - to -).



FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
MOTOR RPM & AND MOTOR CURRENT ARE STRONGLY DEPENDING ON THE AGE OF THE MOTOR. POLARITY OF MOTOR CONNECTOR VARIES.
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FT OEM MANUAL PAGE 27 - 29
POLE CHANGING SWITCH WITH TWO LINKED SPDT PUSH BUTTONS

CLASS-EC	A4	udo@elgers.com	ue-ERT20250317-02	17-MAR-2025
021	A	FT STEM CLASS SET ELECTRICAL CONTROL - EXP 09		

RETRO CIRCUITS

NOTES:

CLASS-EC	A4	udo@elgers.com	ue-ERT20250318-03	18-MAR-2025
022	A	FT STEM CLASS SET ELECTRICAL CONTROL - NOTES		

FT STEM - FISCHERTECHNIK education Class Set Solar Energy

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
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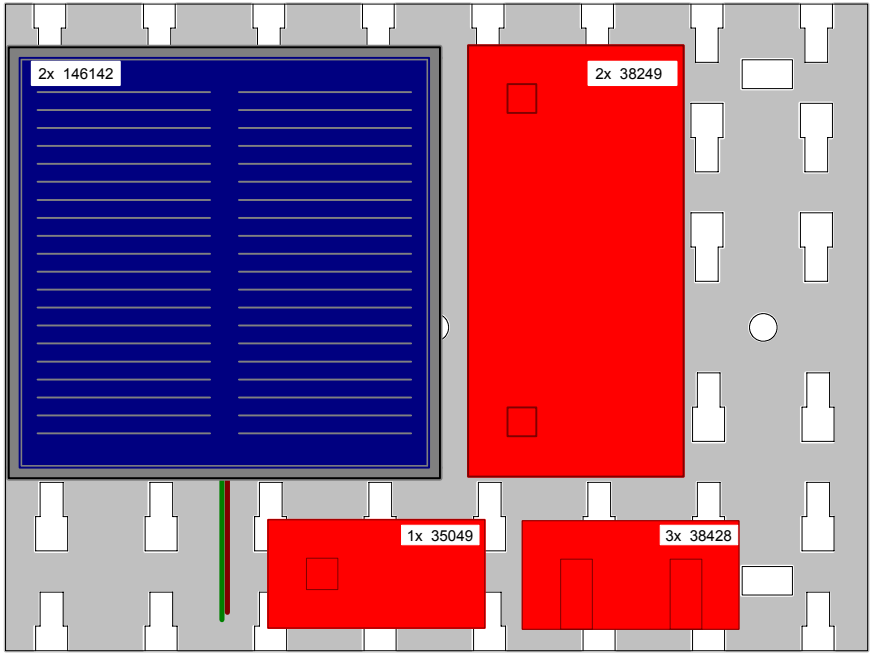
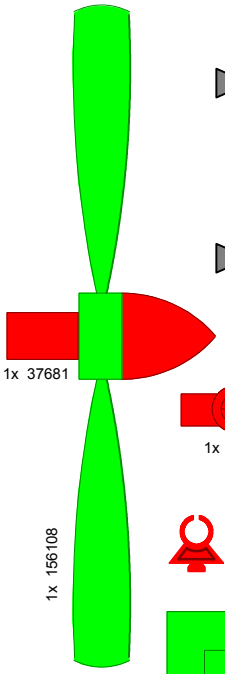
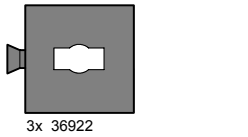
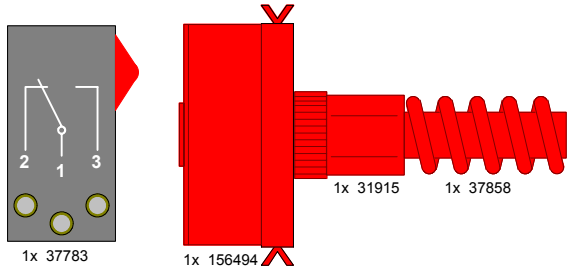
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

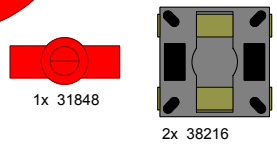
CLASS-SE	A4	udo@elgers.com	ue-ERT20250320-04	20-MAR-2025
023	A	FT STEM CLASS SET SOLAR ENERGY - CONTENT		

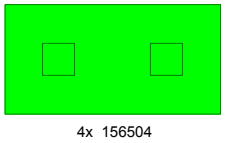


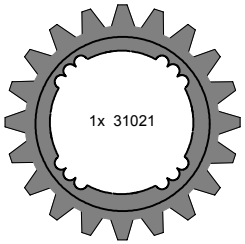


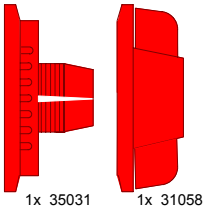


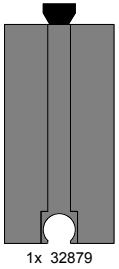


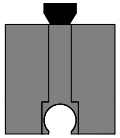


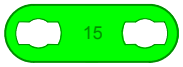


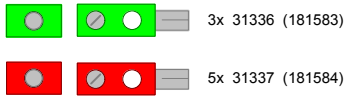


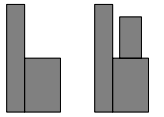


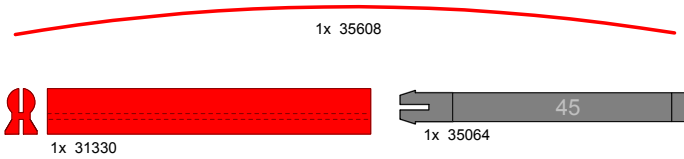


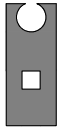










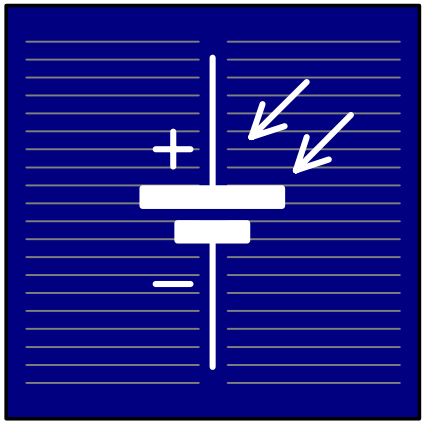


31010	ANGULAR BLOCK 60°, RED
31011	ANGULAR BLOCK 30°, RED
31021	GEAR WHEEL T20, BLACK
31058	HUB NUT, RED
31330	LINK 45, RED
31848	STRUT ADAPTER, RED
31915	HUB NUT, RED
31981	ANGULAR BLOCK 15°, RED
32064	BUILDING BLOCK 15 WITH BORE, RED
32879	BUILDING BLOCK 30, BLACK
32881	BUILDING BLOCK 15, BLACK
35031	FLAT HUB COLLET, RED
35049	BUILDING BLOCK 15x30x5 WITH GROOVE AND PIN, RED
35064	CLIP AXLE 45, BLACK
35608	LEAD 300, RED
35969	REED CONTACT AND CABLE CLAMP, RED
36227	CLIP ADAPTER, BLACK
36920	ANGLE GIRDER 30, BLACK
36922	ANGLE GIRDER 15, BLACK
37237	BUILDING BLOCK 5, RED
37238	BUILDING BLOCK 5 WITH 2 PINS, RED
37468	BUILDING BLOCK 7.5, RED
37679	CLIP 5, RED
37681	POINTED ADAPTER FOR PROPELLERS, RED
37783	MINI SWITCH, BLACK
37858	LOCKING WORM M=1.5, RED
38216	PLUG IN LIGHT HOLDER, BLACK
38240	BUILDING BLOCK V15 CORNER, RED
38249	MOUNTING PLATE 30x60, RED
38423	ANGULAR BLOCK 10x15x15, RED
38428	BUILDING PLATE 15x30x5 WITH 3 GROOVES
146142	SOLAR PANEL 1V 440mA
146529	I-STRUT WITH BORE 15, GREEN
156108	PROPELLER 100, GREEN
156494	SOLAR MICROMOTOR 0.5 - 2V WITH HOUSING
156504	MOUNTING PLATE 15x30, GREEN
172804	SWIVEL JOINT PIN, BLACK
172805	SWIVEL BEARING, BLACK
181583	FLAT PLUG, GREEN (31336)
181584	FLAT PLUG, RED (31337)
182622	BASE PLATE 120x90, BLACK

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BILL OF MATERIAL (BOM)

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-01	18-MAR-2025
024	A	FT STEM CLASS SET SOLAR ENERGY - BOM		



Solar panels are devices that convert sunlight into electricity. They work using a process called the photovoltaic effect. Here's how it works in simple terms:

Sunlight:
When sunlight hits the solar panels, it contains tiny particles of energy called photons.

Absorption:
The solar panels are made up of special materials called semiconductors, usually silicon. These materials have properties that allow them to absorb photons from sunlight.

Electron Release:
When the photons are absorbed by the semiconductors, their energy is transferred to the atoms in the material. This causes some of the electrons in the atoms to become excited

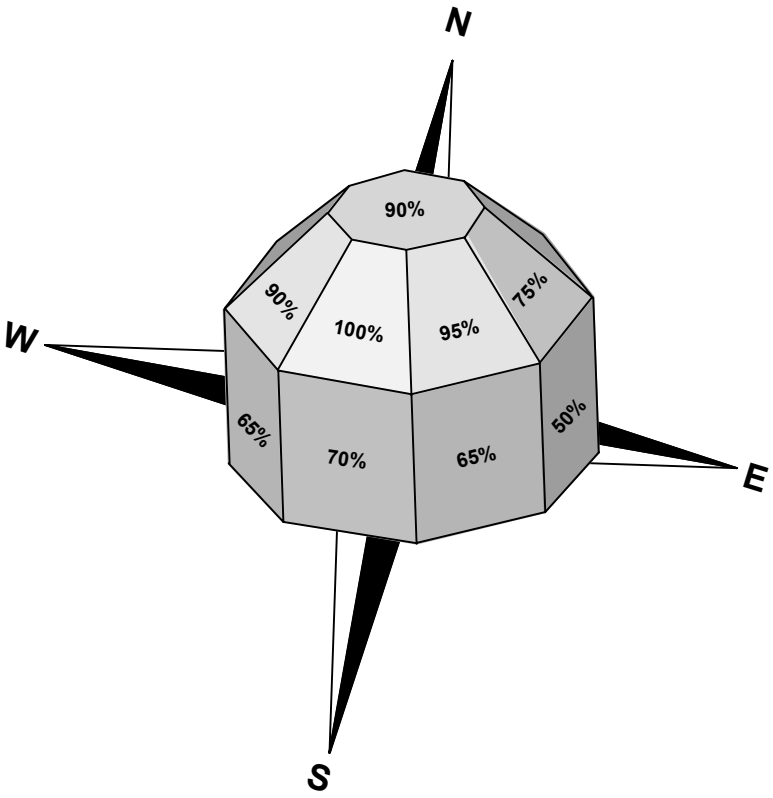
Electric Field:
The solar panels have an electric field created by the arrangement of different layers of semiconductors. This electric field helps to separate the free electrons from the atoms and create a flow of electricity.

Electrical Current:
The separated electrons are directed by the electric field to flow in a specific direction, creating an electric current. This current is then captured by metal contacts on the solar panel and can be used to power electrical devices or stored in batteries for later use.

In simple terms, solar panels work by capturing the energy from sunlight and using it to generate electricity through the movement of electrons. They provide a clean and renewable source of energy that can be harnessed for various applications.

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-05	18-MAR-2025
025	A	FT STEM CLASS SET SOLAR ENERGY - PANEL		



Solar panels have a few dependencies to function properly. Here's a simple explanation of their dependencies:

Sunlight:
Solar panels need sunlight to generate electricity. They rely on the photons (tiny particles of energy) present in sunlight to produce an electric current. Therefore, a sufficient amount of sunlight is essential for solar panels to work effectively.

Position and Orientation:
Solar panels should be placed in a location where they receive maximum sunlight throughout the day. This typically means installing them on rooftops, open fields, or any area with good exposure to the sun. The orientation and tilt angle of the panels also play a role in optimizing sunlight absorption.

Weather Conditions:
While solar panels can still generate electricity on cloudy or overcast days, their efficiency is reduced when there is less sunlight. Rain or snow can also affect their performance temporarily, but they are designed to be weather-resistant and continue functioning.

Maintenance:
Solar panels require minimal maintenance, but some routine care is necessary. This includes cleaning the panels to remove dirt, dust, or any obstructions that can reduce their efficiency. Regular inspections and occasional repairs are also important to ensure their longevity and performance.

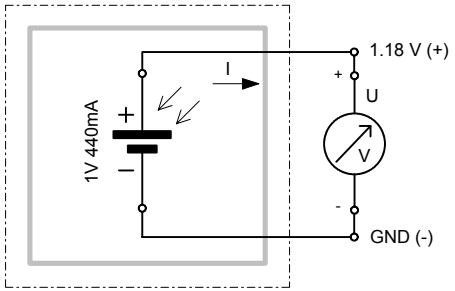
Temperature:
Solar panel temperature dependencies occur when higher temperatures affect efficiency and power output. Increased electron movement and resistance lead to reduced efficiency. Panels typically have a negative temperature coefficient, causing decreased power output with rising temperatures. Cooling methods like ventilation or liquid circulation can help mitigate these effects. Environmental factors such as shading and sunlight intensity also impact panel temperature. Understanding and addressing these dependencies is essential for optimizing the performance of solar panels and maximizing energy production.

Overall, solar panels depend on sunlight availability, proper positioning, favorable weather conditions, and regular maintenance to generate electricity efficiently. By understanding and addressing these dependencies, solar panel owners can maximize the benefits of this renewable energy source.

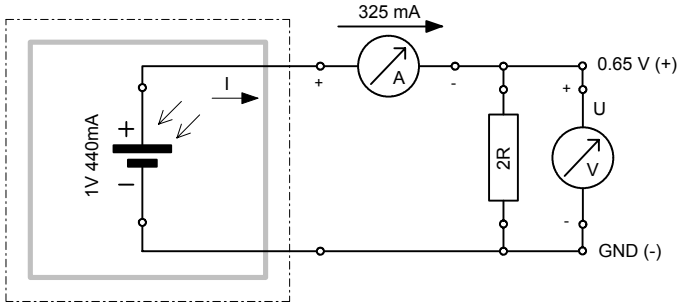
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-07	18-MAR-2025
026	A	FT STEM CLASS SET SOLAR ENERGY - DEPENDENCIES		

FT SOLAR MODULE 1V - 440 mA - PN: 146142
EXPOSED TO BRIGHT SUNLIGHT (about 70000 LUX)
OPEN CIRCUIT VOLTAGE



FT SOLAR MODULE 1V - 440 mA - PN: 146142
EXPOSED TO BRIGHT SUNLIGHT (about 70000 LUX)
CLOSED CIRCUIT VOLTAGE



$$I = \frac{0.65}{2} = 0.325\ A = 325\ mA$$

$$P = 0.65 \times 0.325 = 0.211\ W = 211\ mW$$

$$I = \frac{U}{R}$$

$$P = U \times I$$

U = Voltage (V)
I = Current (A)
R = Resistance (Ω)
P = Power (W)

The open-circuit voltage refers to the voltage output of a solar panel when no external load is connected to it. In other words, it is the maximum voltage that the solar panel can produce under ideal conditions.

When a solar panel is exposed to sunlight, it generates a certain amount of voltage based on the intensity of the light and the characteristics of the panel itself. This voltage is typically higher than the voltage required by most electrical devices. In the absence of a load, the generated voltage builds up to its maximum value, resulting in the open-circuit voltage.

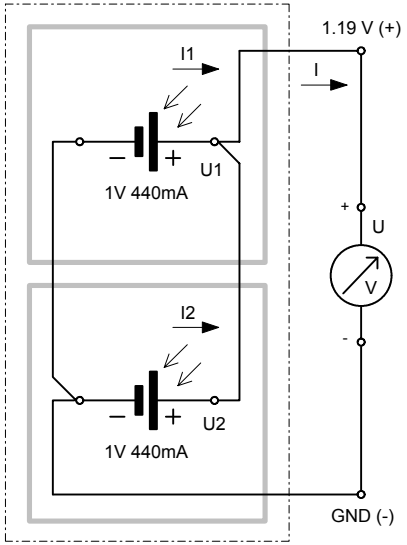
The open-circuit voltage is an important parameter because it helps determine the potential power output of a solar panel. It represents the maximum voltage that can be obtained from the panel and is typically measured under standard test conditions to provide a reference value for comparison between different panels.

However, it's important to note that the open-circuit voltage alone does not provide information about the panel's actual power output. To obtain usable electrical power from a solar panel, it needs to be connected to a load or a complete electrical circuit. In such a closed circuit, the voltage and current interact to deliver power to the connected devices or charge batteries.

In summary, the open-circuit voltage of a solar panel refers to the maximum voltage it can produce when no load is connected. It serves as an important parameter for understanding the panel's characteristics and its potential power output, but it needs to be considered in conjunction with other factors like current and load requirements to determine the panel's overall performance.

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-08	18-MAR-2025
027	A	FT STEM CLASS SET SOLAR ENERGY - LOAD		



PARALLEL CONNECTION (1st. KIRCHHOFF'S LAW)

Kirchhoff's Current Law (KCL): This law states that the sum of currents flowing into any junction or node in a circuit is equal to the sum of currents flowing out of that junction. In simple terms, it means that the total amount of current entering a junction is equal to the total amount of current leaving that junction.

I = I1 + I2 | I = I1 + I2 + I3 + I... | I = Current (A)

EXAMPLE WITH RATED MAX. CURRENT VALUES:

I = 0.44 A + 0.44 A = 0.88 A = 880 mA

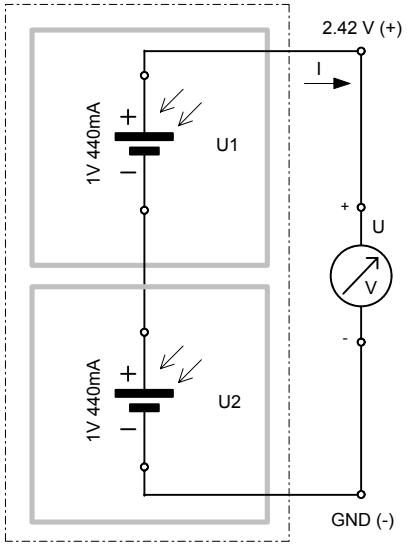
When solar panels are connected in parallel or in series, it refers to how their positive and negative terminals are connected together to form an electrical circuit. These connections affect the overall voltage and current characteristics of the solar panel system.

Parallel Connection:
When solar panels are connected in parallel, the positive terminals of all the panels are connected together, and the negative terminals are also connected together. This results in a configuration where the voltage across each panel remains the same, but the total current increases.

Voltage:
The voltage across each panel remains the same as the individual panel's voltage.

Current:
The current adds up, meaning that the total current output of the parallel-connected panels is the sum of the current produced by each panel.

Power Output:
The power output of the parallel-connected panels is higher than that of a single panel since power is the product of voltage and current. The increased current allows for a greater power output. Parallel connections are often used when there is a need for higher current output, such as in situations with larger energy demands or when connecting multiple solar panels to charge a battery bank.



SERIES CONNECTION (2nd. KIRCHHOFF'S LAW)

Kirchhoff's Voltage Law (KVL): This law states that the sum of all the voltage drops (or rises) around any closed loop in a circuit is equal to the sum of all the voltage sources in that loop. In other words, the total voltage around a closed loop is zero.

U = U1 + U2 | U = U1 + U2 + U3 + U... | U = Voltage (V)

EXAMPLE WITH RATED MAX. VOLTAGE VALUES:

U = 1 V + 1 V = 2 V

Series Connection:
When solar panels are connected in series, the positive terminal of one panel is connected to the negative terminal of the next panel, forming a chain-like configuration. This results in a configuration where the total voltage increases, while the current remains the same.

Voltage:
The voltages of each panel add up, resulting in a higher total voltage across the series-connected panels.

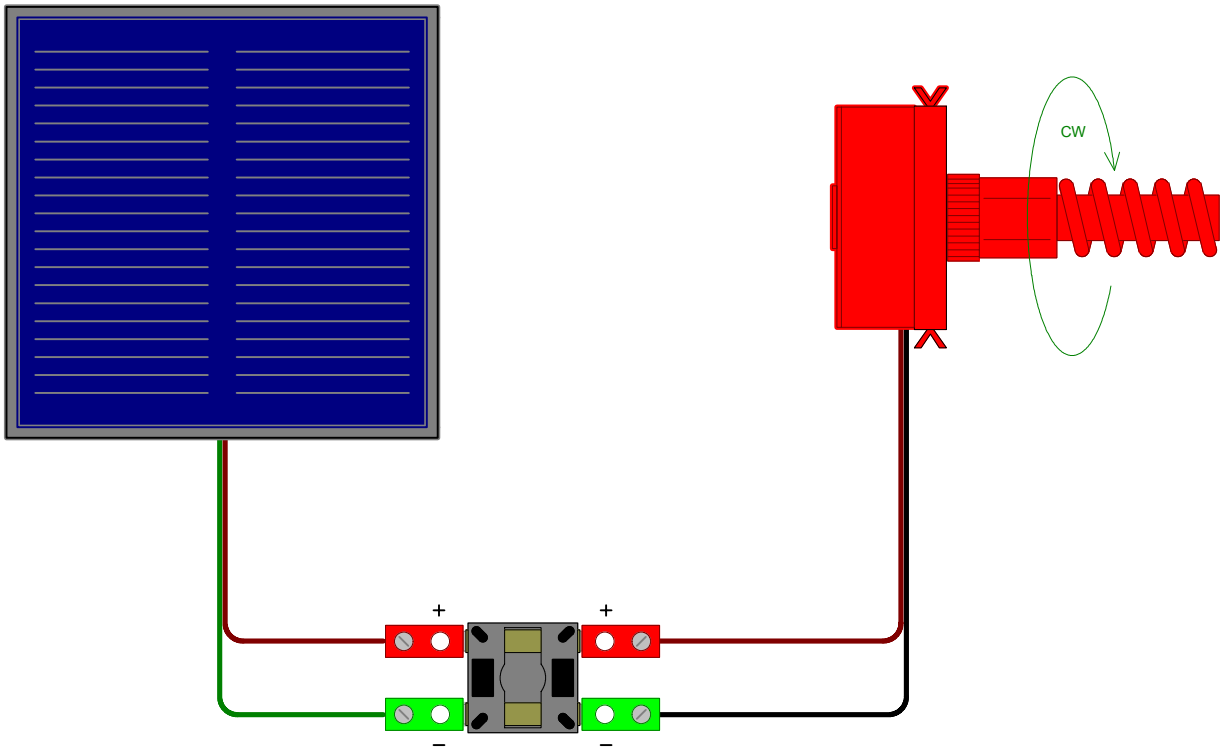
Current:
The current remains the same throughout the series-connected panels, as the current through a series circuit is constant.

Power Output:
The power output of the series-connected panels is determined by the voltage and current of the lowest performing panel in the series. If one panel in the series is shaded or underperforming, it can limit the power output of the entire series-connected system.
Series connections are often used when there is a need for higher voltage output, such as in grid-tied systems or applications where the voltage requirement is higher.

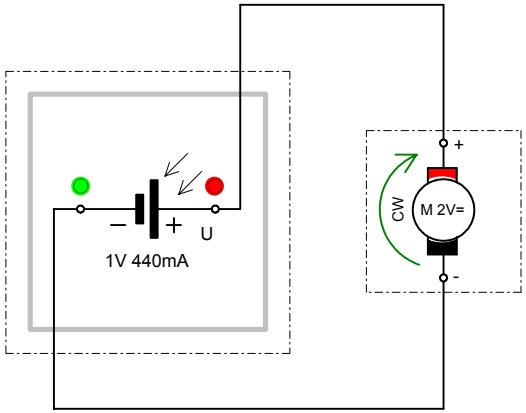
It's important to note that the choice between parallel and series connections depends on the specific requirements of the solar panel system, such as the voltage and current needed for the load or the system's compatibility with inverters, batteries, or grid connections. Proper sizing and configuration considerations are essential to ensure optimal performance and safety of the solar panel system.

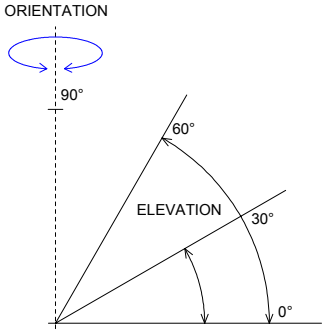
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-09	18-MAR-2025
028	A	FT STEM CLASS SET SOLAR ENERGY - CIRCUITS		



WHEN WHEN SOLAR PANEL PRODUCES ENERGY, MOTOR SPINS FOREWARD "CW" (+ to +, - to -).

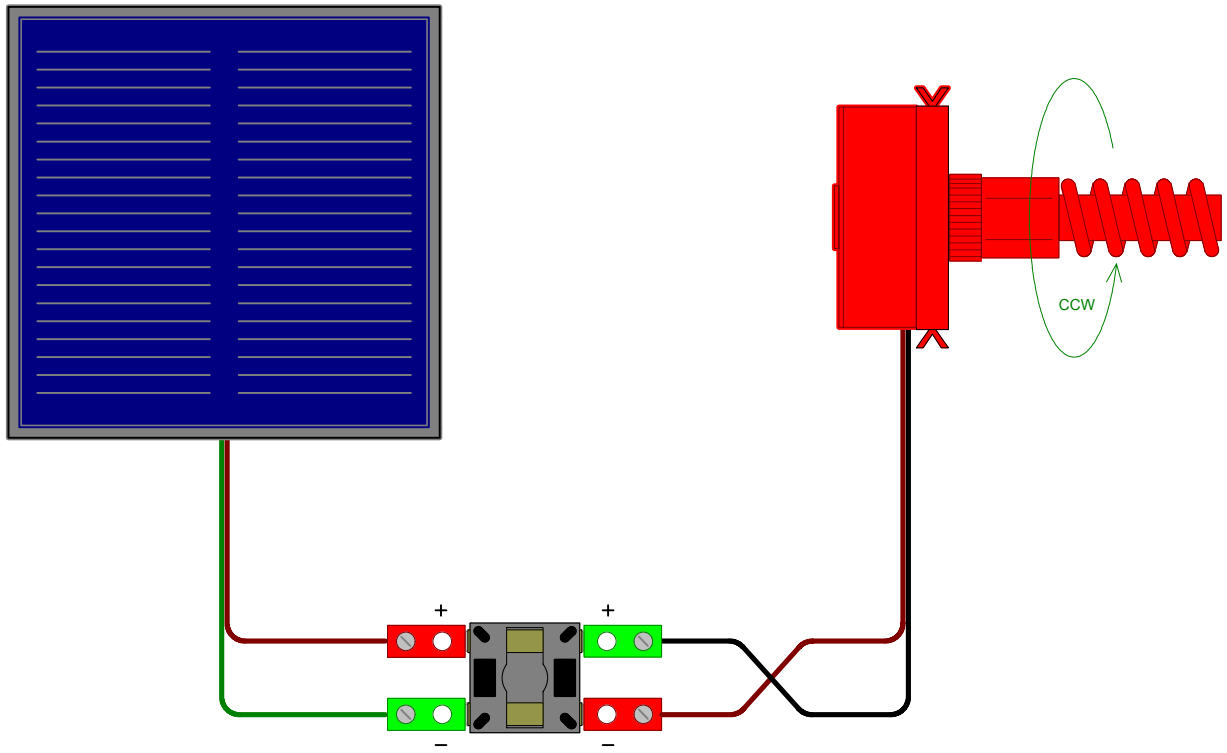




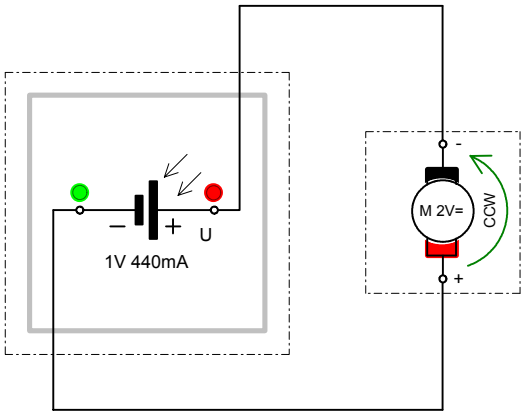
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

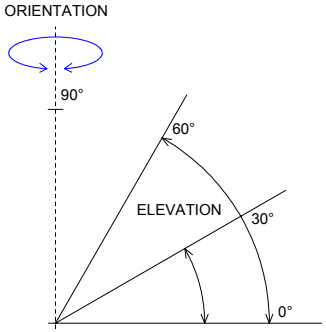
BASED ON FT OEM MANUAL PAGE 5 - 8
FT OEM MODEL NO.: 01 - ORIENTATION & ELEVATION EXPERIMENT WITH ONE SOLAR PANEL 1V / 440mA AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-10	18-MAR-2025
029	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 01		



WHEN WHEN SOLAR PANEL PRODUCES ENERGY, MOTOR SPINS BACKWARD "CCW" (+ to -, - to +).

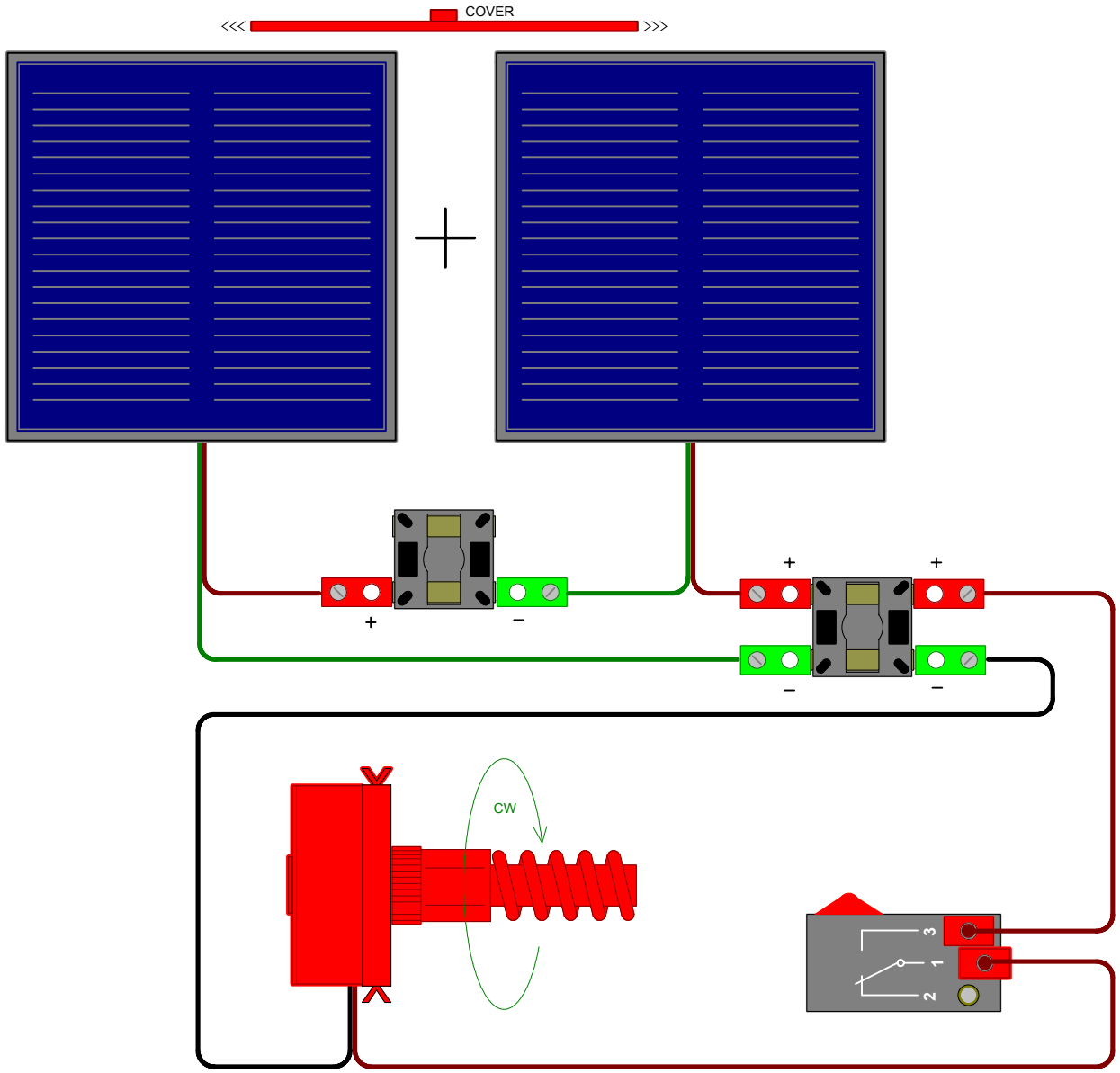


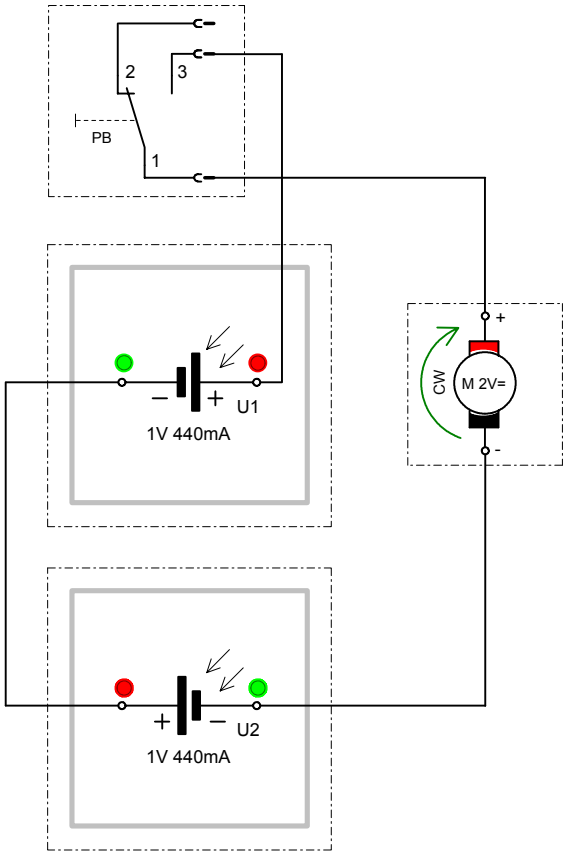


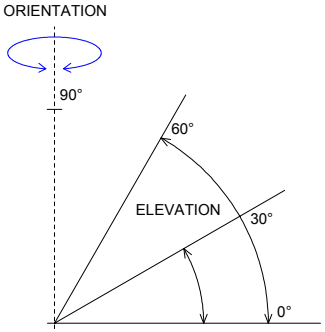
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 5 - 8
FT OEM MODEL NO.: 01a - ORIENTATION & ELEVATION EXPERIMENT WITH ONE SOLAR PANEL 1V / 440mA AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-10	18-MAR-2025
030	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 01a		





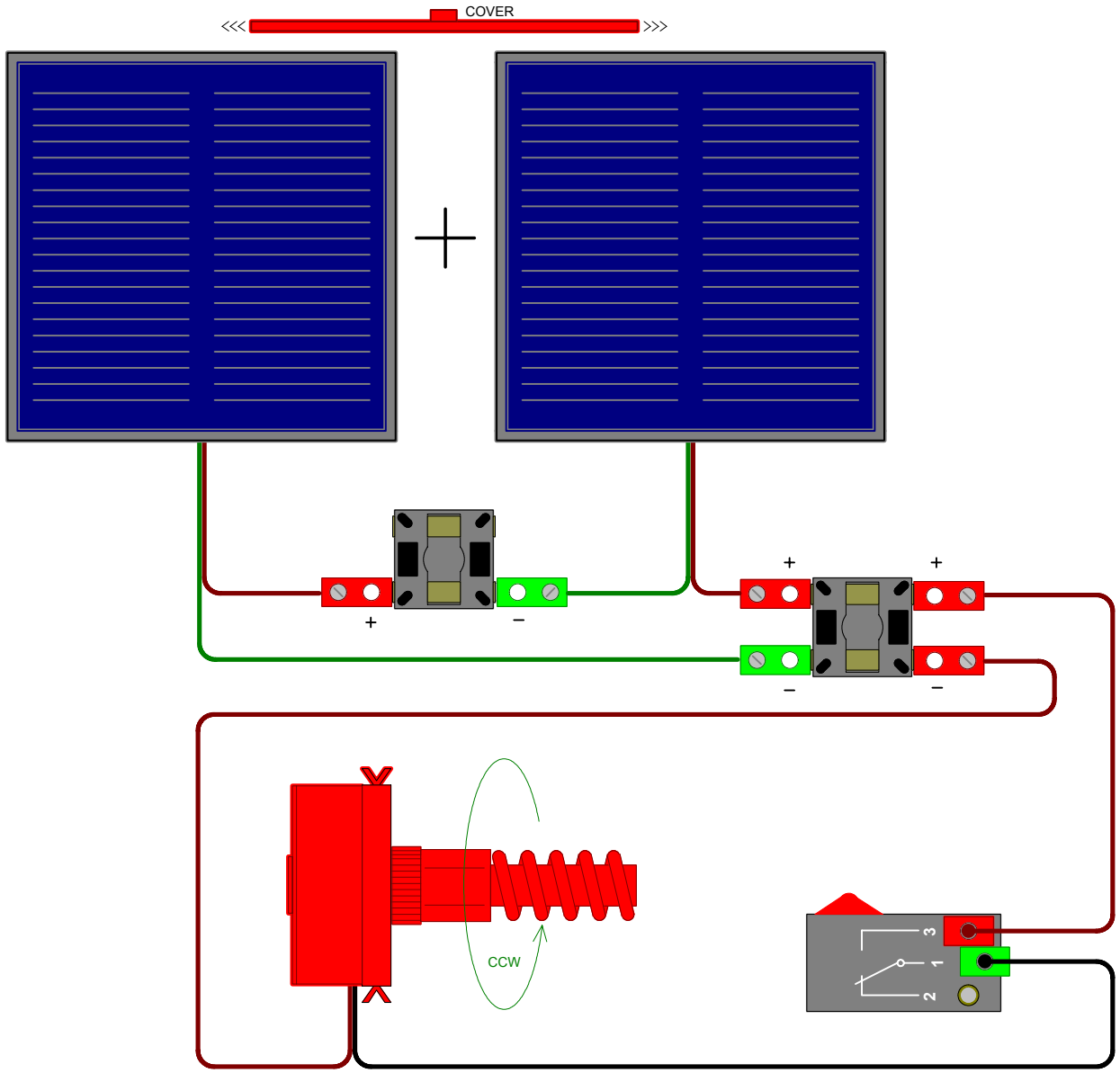


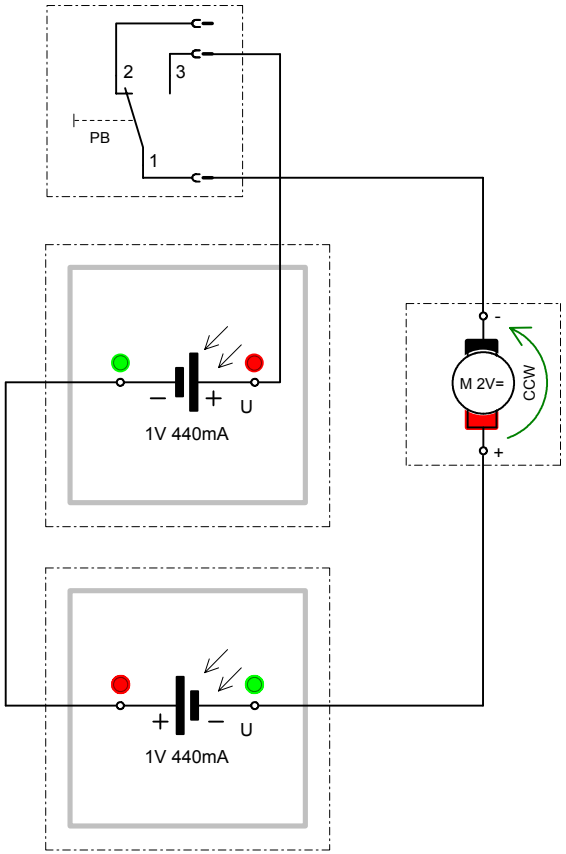
WHEN SOLAR PANELS PRODUCES ENERGY (U = U1 + U2) AND PB IS PRESSED, MOTOR SPINS FOREWARD "CW" (+ to +, - to -).

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

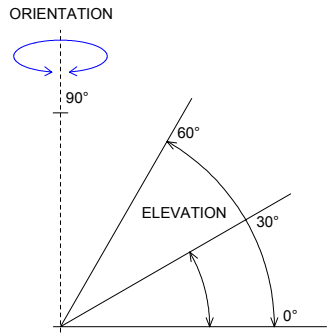
BASED ON FT OEM MANUAL PAGE 9 - 13 - TASK 1 / SERIES / CW
FT OEM MODEL NO.: 02 - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN SERIES AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-11	18-MAR-2025
031	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 02		





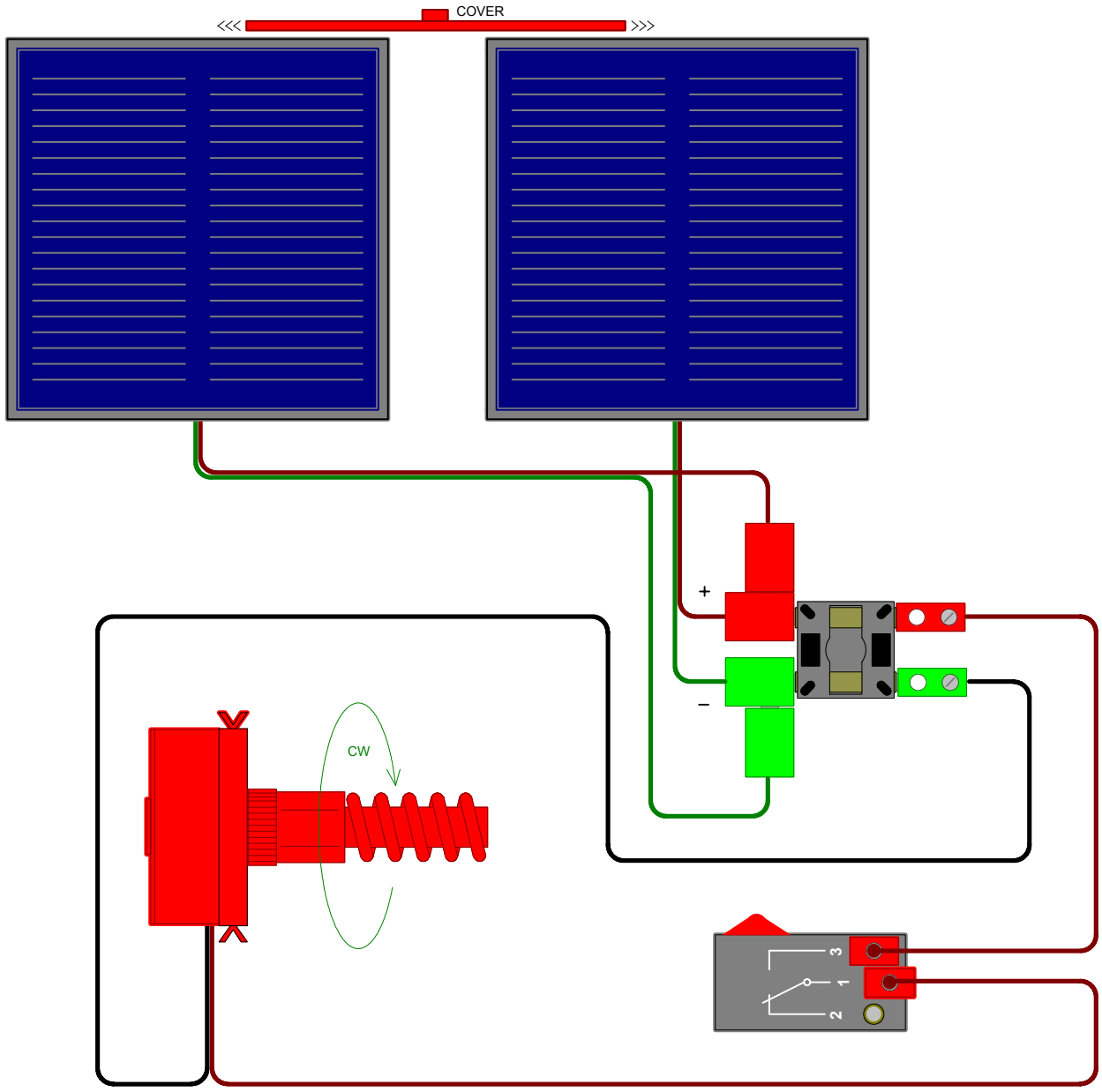
WHEN SOLAR PANELS PRODUCES ENERGY (U = U1 + U2) AND PB IS PRESSED, MOTOR SPINS BACKWARD "CCW" (+ to -, - to +).

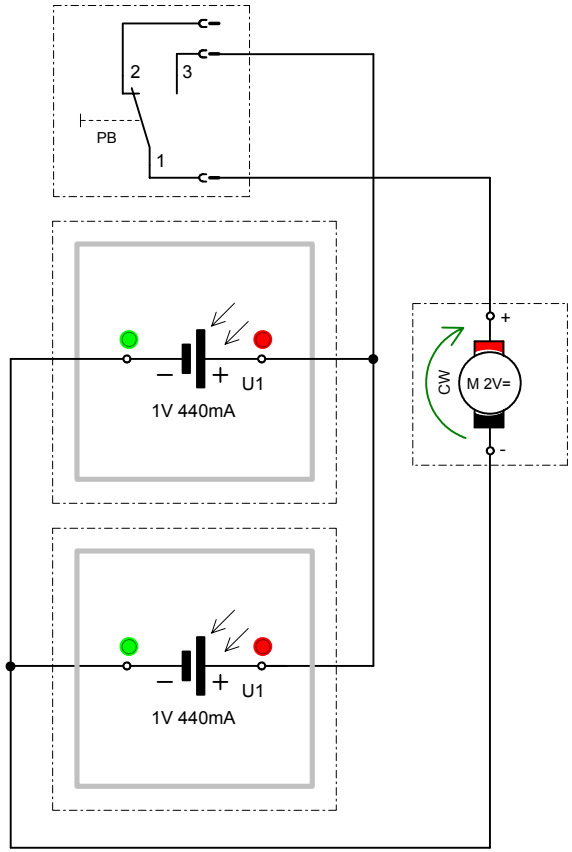


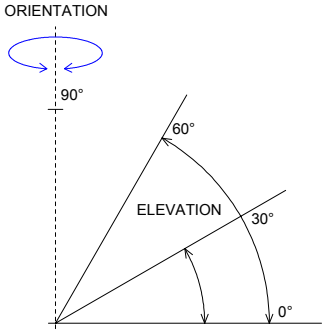
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 9 - 13 - TASK 1 / SERIES / CCW
FT OEM MODEL NO.: 02a - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN SERIES AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250318-11	18-MAR-2025
032	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 02a		





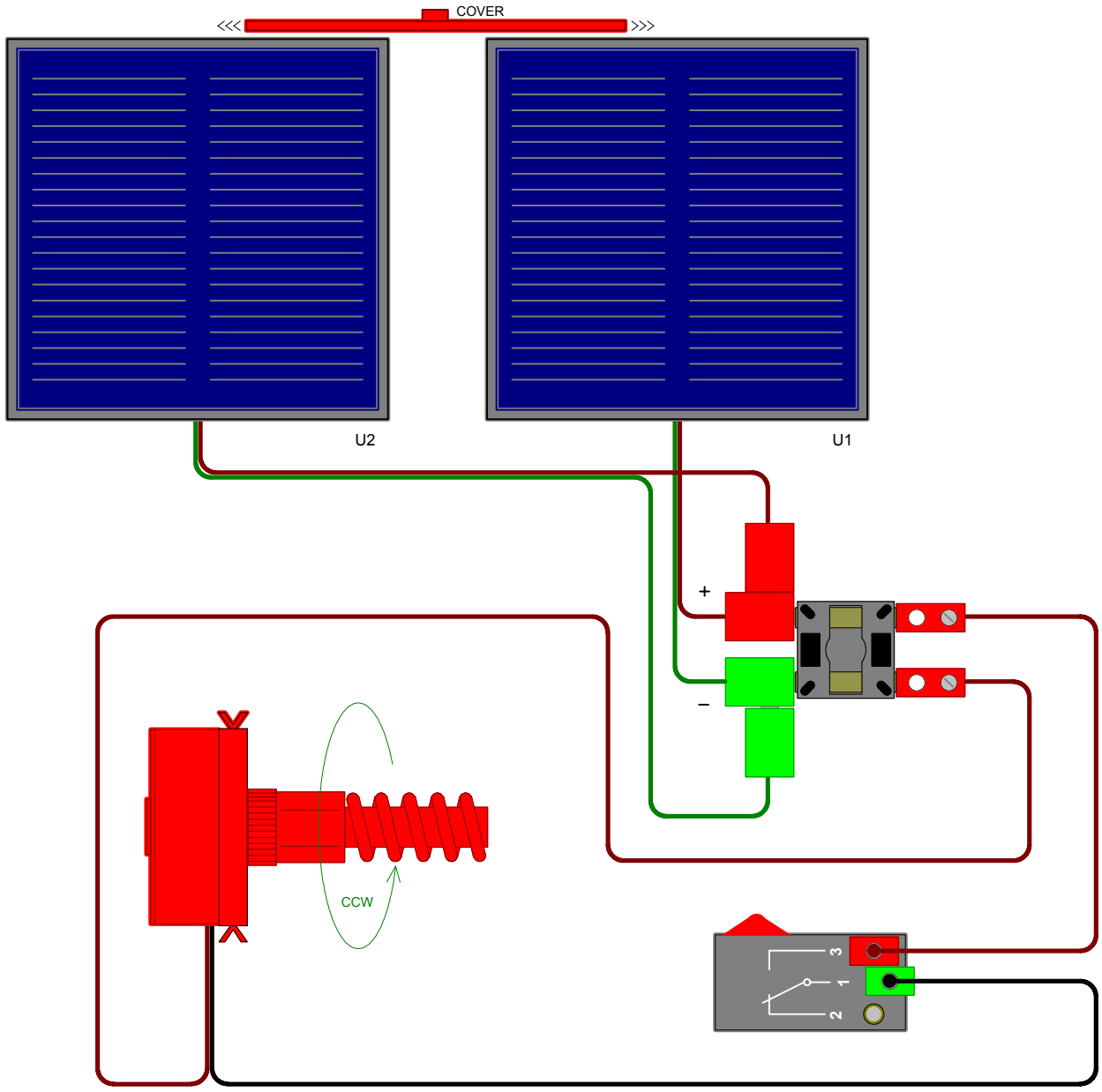


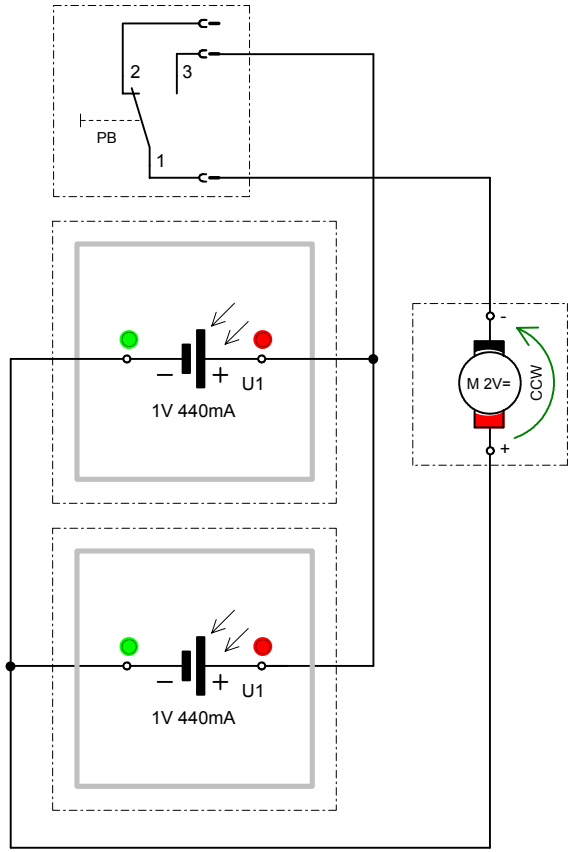
WHEN SOLAR PANELS PRODUCES ENERGY AND PB IS PRESSED, MOTOR SPINS FOREWARD "CW" (+ to +, - to -).

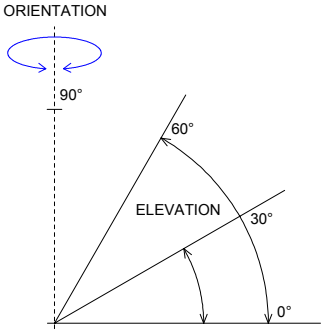
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 9 - 13 - TASK 2 / PARALLEL / CW
FT OEM MODEL NO.: 02b - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN PARALLEL AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250319-01	19-MAR-2025
033	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 02b		





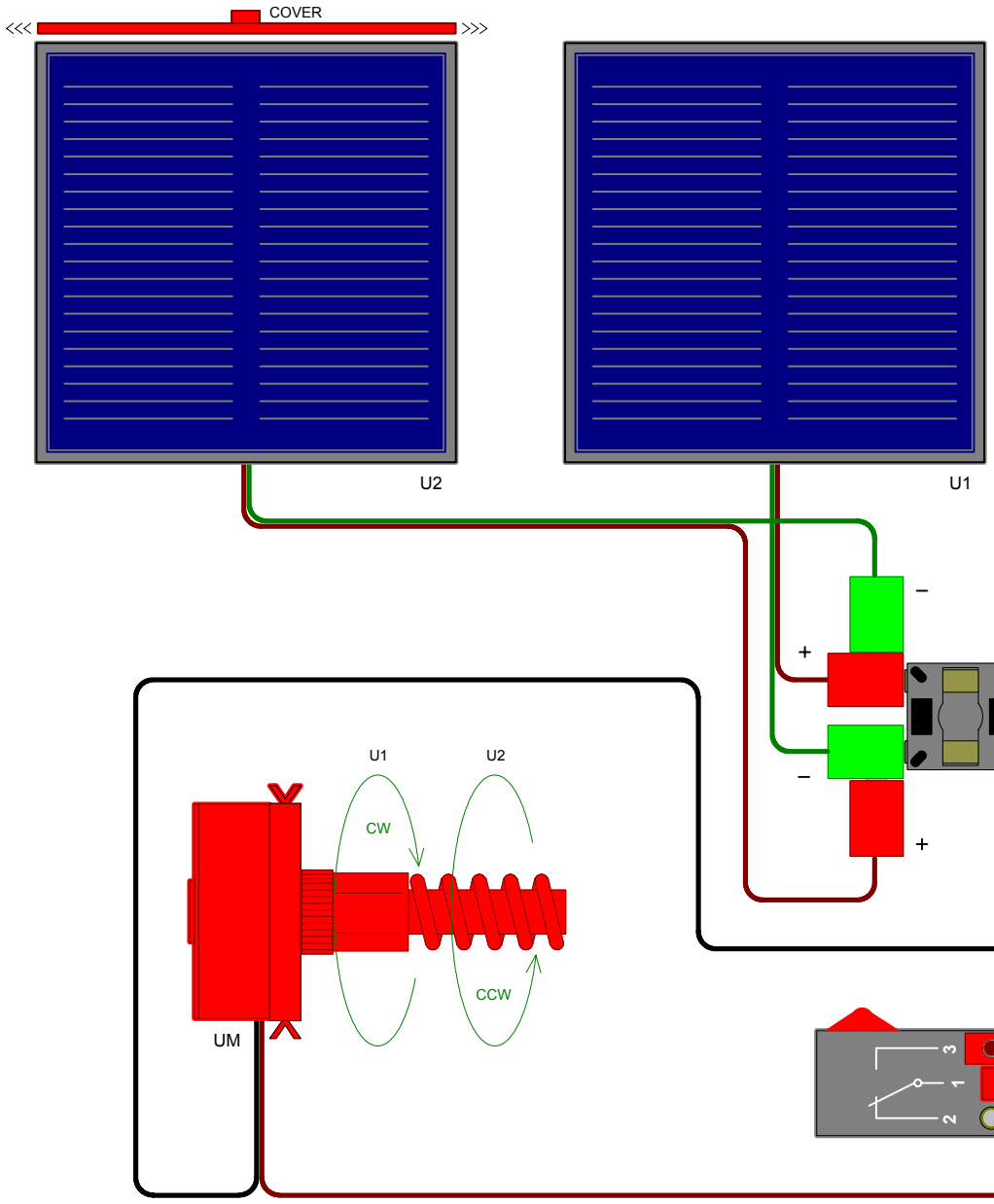


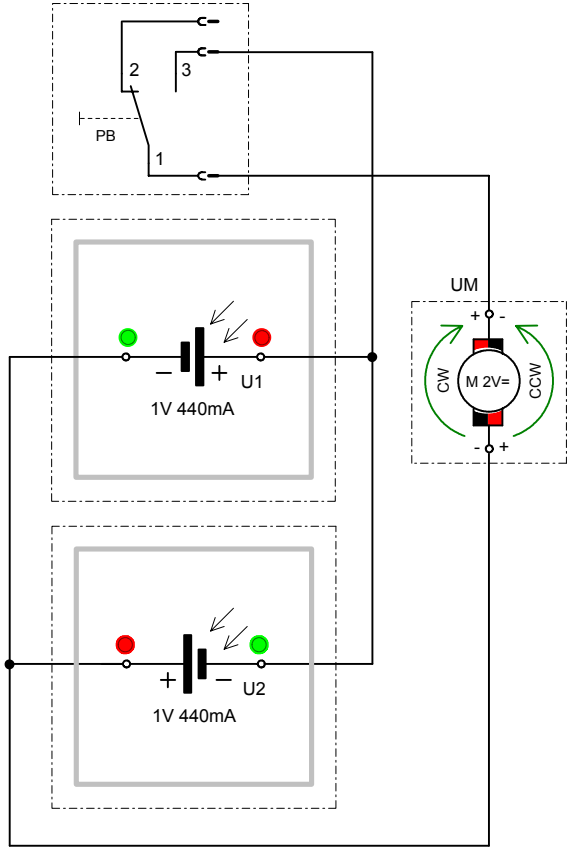
WHEN SOLAR PANELS PRODUCES ENERGY AND PB IS PRESSED, MOTOR SPINS FOREWARD "CCW" (+ to -, - to +).

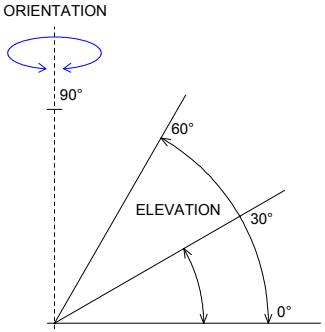
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 9 - 13 - TASK 2 / PARALLEL / CCW
FT OEM MODEL NO.: 02c - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN PARALLEL AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250319-02	19-MAR-2025
034	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 02c		





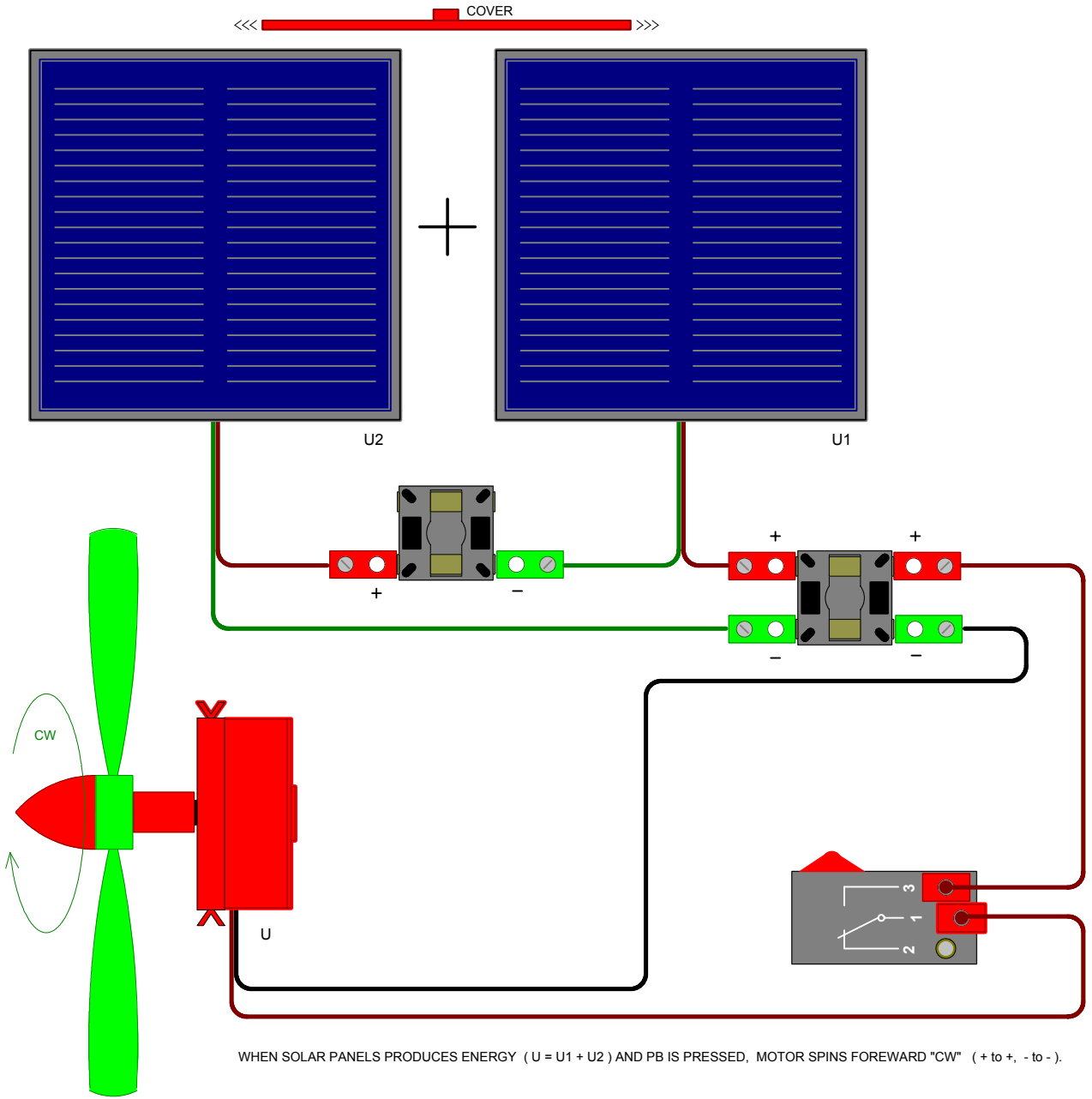


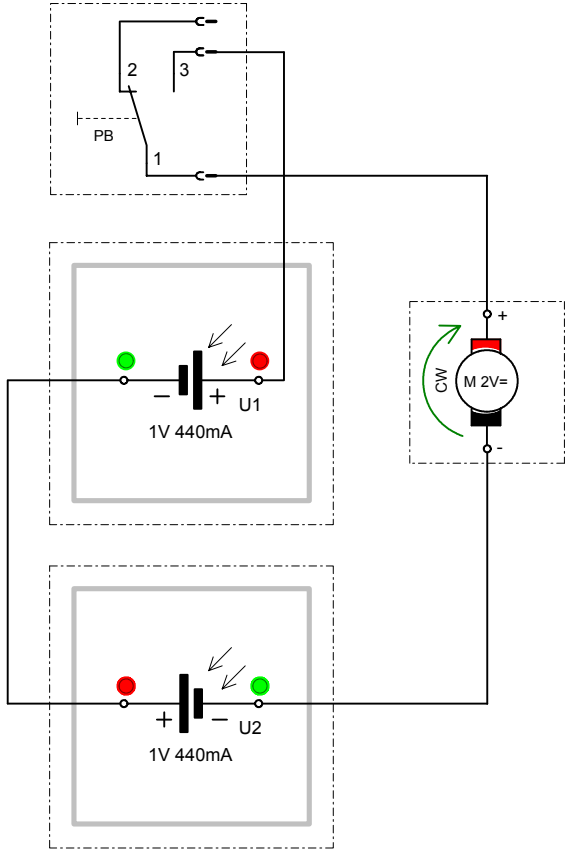
WHEN SOLAR PANEL 1 PRODUCES ENERGY (PANEL 2 COVERED), MOTOR SPINS FOREWARD "CW" (U1+ to M+, U1- to M-, U2 = 0).
WHEN SOLAR PANEL 2 PRODUCES ENERGY (PANEL 1 COVERED), MOTOR SPINS BACKWARD "CCW" (U2+ to M-, U2- to M+, U1 = 0).
WHEN BOTH SOLAR PANEL PRODUCING ENERGY (BOTH PANELS NOT COVERED), MOTOR DOES NOT SPIN (U2 ELEMINATES U1, UM = U1 - U2)

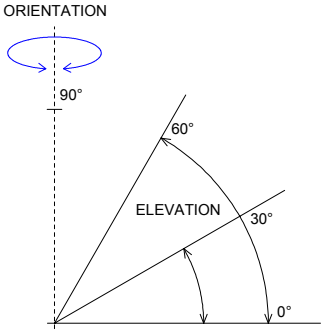
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 9 - 13 - EXTRA TASK / ANTIPARALLEL / CW OR CCW DEPENDING WHICH PANEL IS EXPOSED TO LIGHT OR COVERED
FT OEM MODEL NO.: 02d - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN ANTIPARALLEL AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250320-01	20-MAR-2025
035	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 02d		







WHEN SOLAR PANELS PRODUCES ENERGY (U = U1 + U2) AND PB IS PRESSED, MOTOR SPINS FOREWARD "CW" (+ to +, - to -).

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

BASED ON FT OEM MANUAL PAGE 14 - 17
FT OEM MODEL NO.: 03 - ORIENTATION & ELEVATION EXPERIMENT WITH TWO SOLAR PANEL 1V / 440mA IN SERIES AND SOLAR MOTOR 0.5 - 2.0 V

CLASS-SE	A4	udo@elgers.com	ue-ERT20250320-02	20-MAR-2025
036	A	FT - STEM CLASS SET SOLAR ENERGY - EXP.: 03		

RETRO CIRCUITS

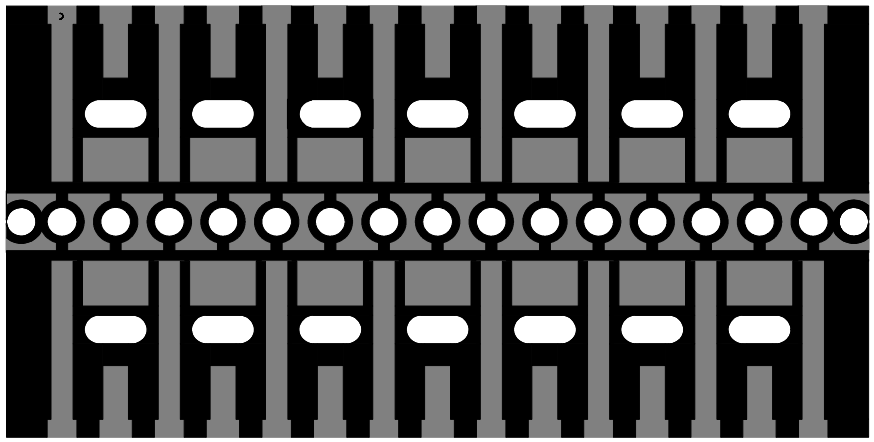
NOTES:

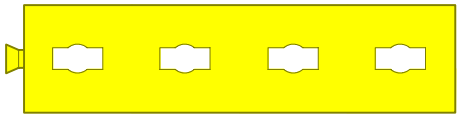
CLASS-SE	A4	udo@elgers.com	ue-ERT20250320-03	20-MAR-2025
037	A	FT STEM CLASS SET SOLAR ENERGY - NOTES		

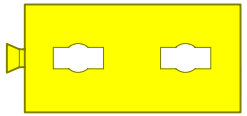
RETRO CIRCUITS

FT STEM - FISCHERTECHNIK education Class Set Optic

CLASS- O	A4	udo@elgers.com	ue-ERT20250322-04	22-MAR-2025
038	A	FT STEM CLASS SET ELECTRICAL OPTIC		


1x 35129


1x 36297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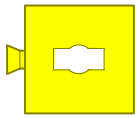
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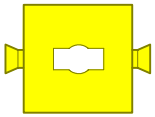
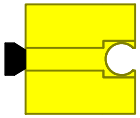
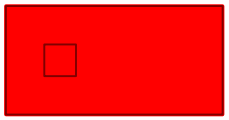

2x 36298


6x 136528


1x 136529

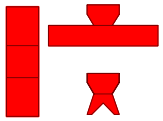

2x 35049


4x 31061


3x 37237


4x 37468


3x 31010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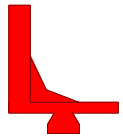
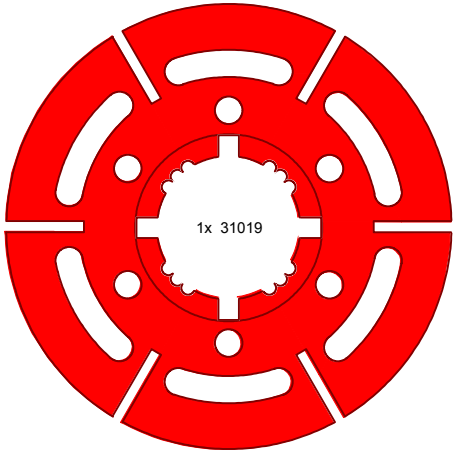
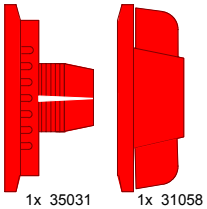
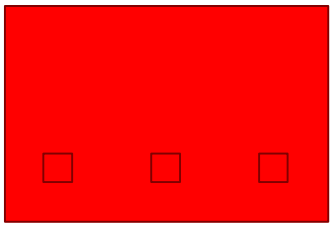

5x 38423

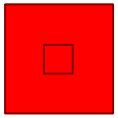

2x 38240

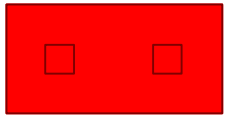

1x 31019

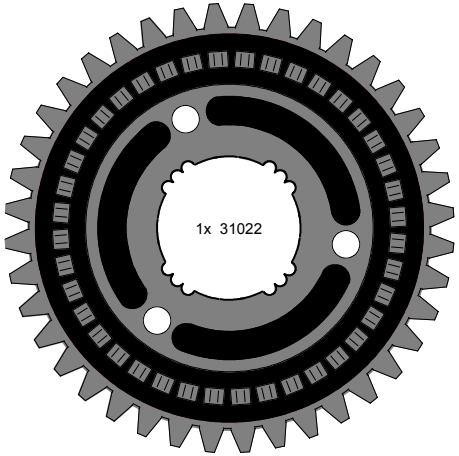

1x 35031 1x 31058


3x 38248


1x 37679


2x 38246


2x 38241


1x 31022


1x 38413


1x 32870


1x 35066

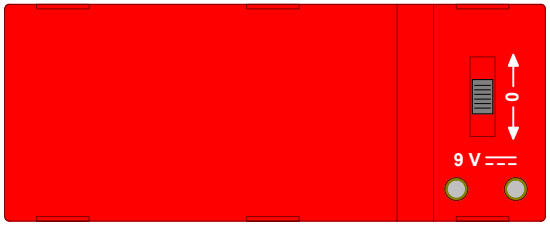

1x 35087


2x 35073

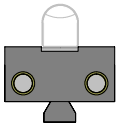
31010	ANGULAR BLOCK 60°, RED
31019	LARGE PULLEY 60, RED
31022	GEAR WHEEL T40/32, BLACK
31058	HUB NUT, RED
31061	LINK 30, RED
31982	SPRING CAM, RED
32870	AXLE WITH CLIP, BLACK
35031	FLAT HUB COLLET, RED
35049	BUILDING BLOCK 15x30x5 WITH GROOVE & PIN, RED
35053	ANGLE GIRDER 15, YELLOW
35066	CLIP AXLE 90, BLACK
35073	AXLE COUPLING, BLACK
35087	CLIP AXLE 75, BLACK
35129	BASE PLATE 120x60, BLACK
36297	ANGLE GIRDER 60, YELLOW
36298	ANGLE GIRDER 15 WITH TWO PINS, YELLOW
36299	ANGLE GIRDER 30, YELLOW
37237	BUILDING BLOCK 5, RED
37468	BUILDING BLOCK 7.5, RED
37679	CLIP 5, RED
38240	BUILDING BLOCK V15 CORNER, RED
38241	MOUNTING PLATE 15x30, RED
38246	MOUNTING PLATE 15x15, RED
38248	MOUNTING PLATE 30x45, RED
38413	PLASTIC AXLE 30, BLACK
38423	ANGULAR BLOCK 10x15x15, RED
136528	BUILDING BLOCK 30, YELLOW
136529	BUILDING BLOCK 15, YELLOW

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-O	A4	udo@elgers.com	ue-ERT20250321-02	21-MAR-2025
039	A	FT STEM CLASS SET OPTIC - BILL OF MATERIAL 1		

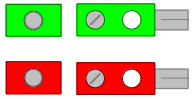


1x 135719



2x 162135

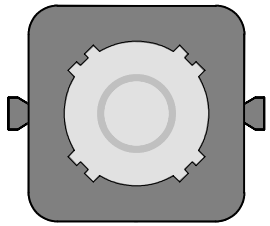
1x 35086



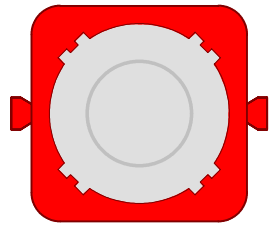
4x 31336 (181583)

4x 31337 (181584)

1x 36210



1x 145862 & 1x 145860



1x 145864 & 1x 145863

1x 146373

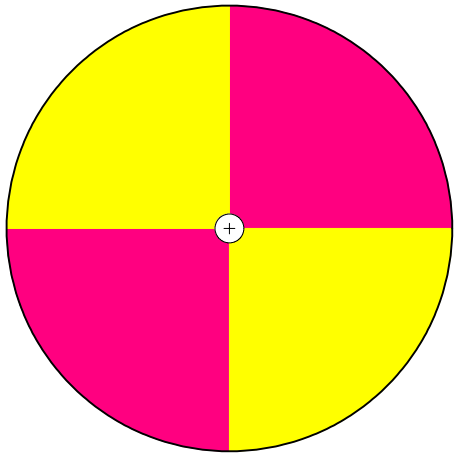
1x 37034

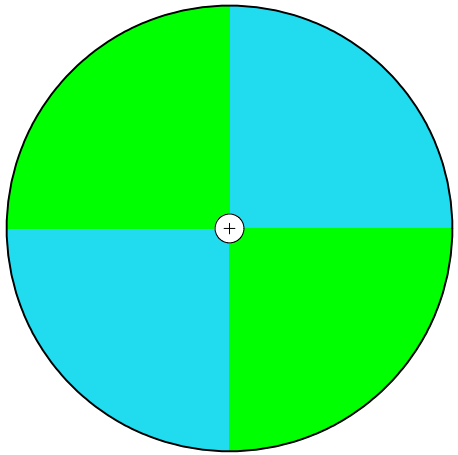
35086	LIGHT CAP, TRANSPARENT
36210	LEAD 250, RED / GREEN
37034	DOUBLE ADHESIVE STRIP 14x60
135719	BATTERY HOLDER 9V, RED
145860	LENS BICONVEX D=22.4; f=25, TRANSPARENT
145862	LENS HOLDER BICONVEX, BLACK
145863	LENS PLANO-CONVEX D=27; f=80, TRANSPARENT
145864	LENS HOLDER PLANO-CONVEX, RED
146373	REFLECTING PLATE 45x30x3
162135	LIGHT BARRIERS LED 9V 0.01A ASSEMBLED
181583	FLAT PLUG, GREEN (31336)
181584	FLAT PLUG, RED (31337)

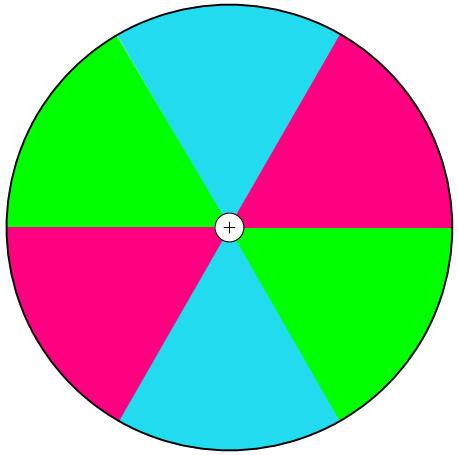
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

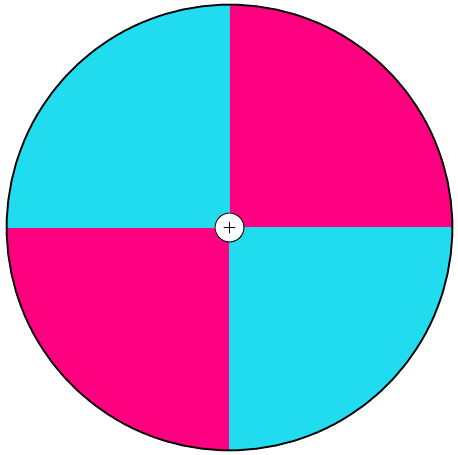
CLASS-O	A4	udo@elgers.com	ue-ERT20250322-01	22-MAR-2025
040	A	FT STEM CLASS SET OPTIC - BILL OF MATERIAL 2		

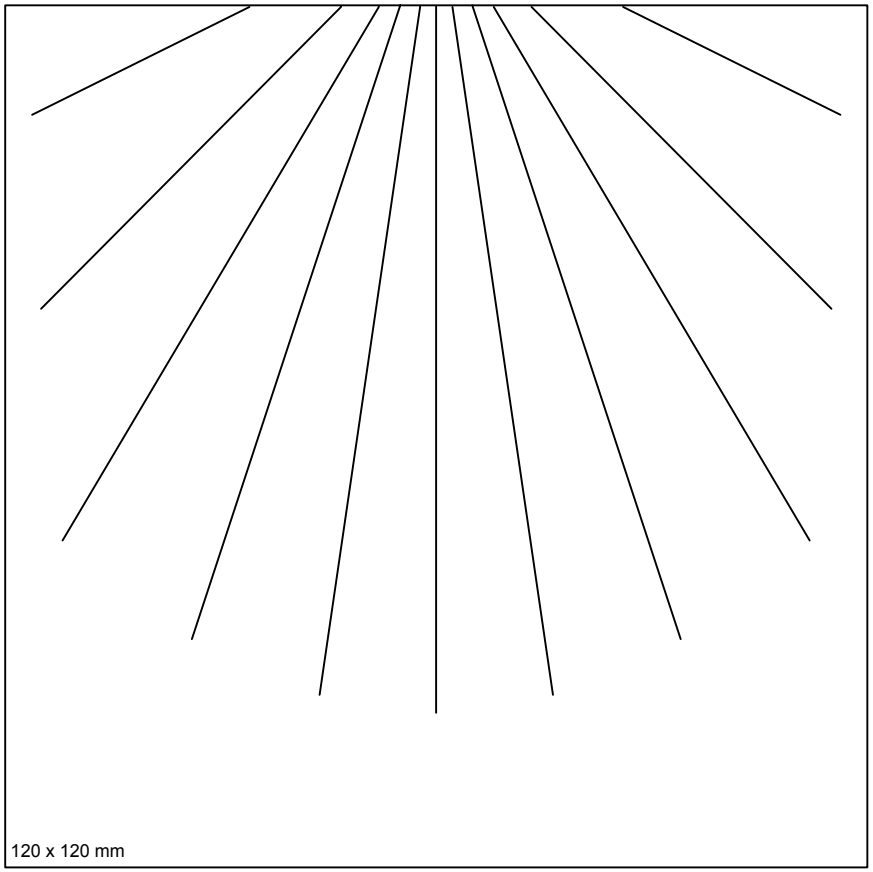
RETRO CIRCUITS

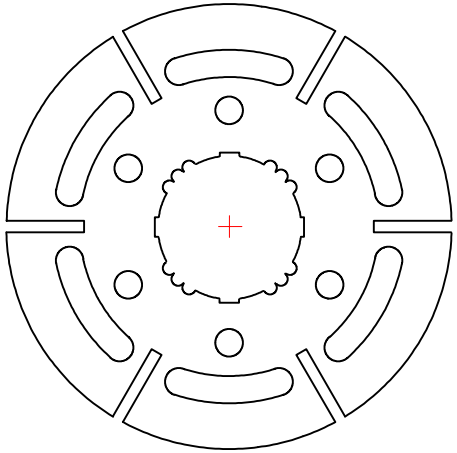


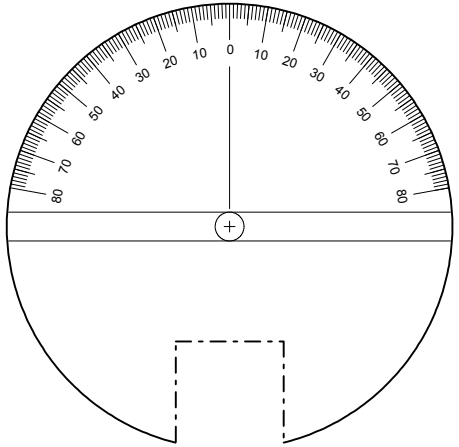


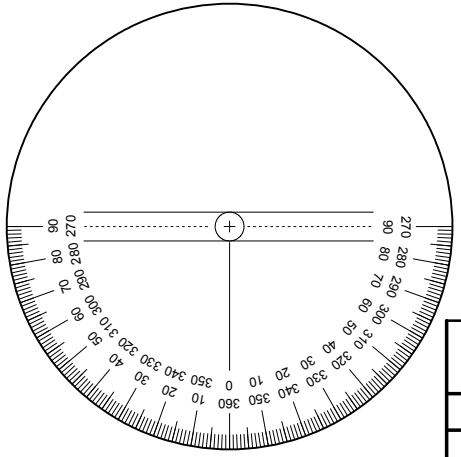






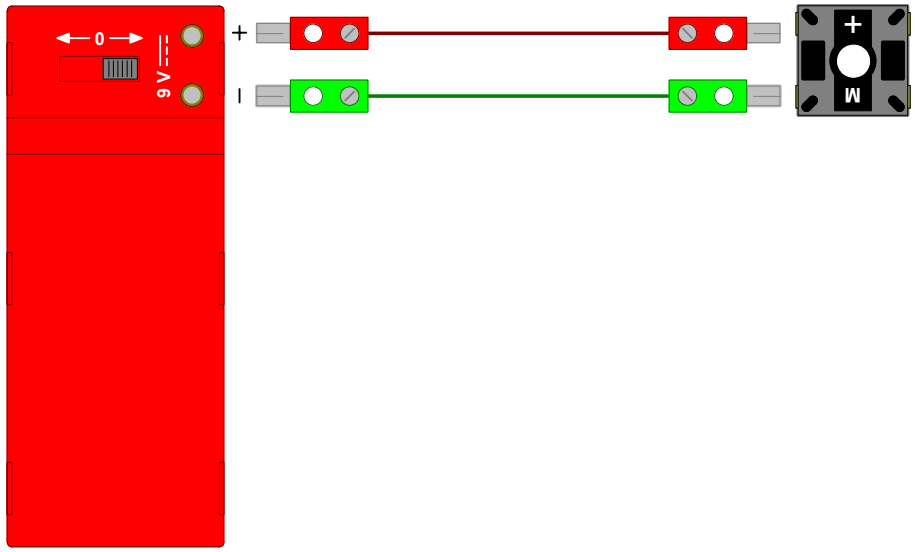




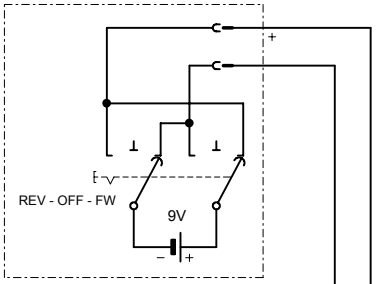


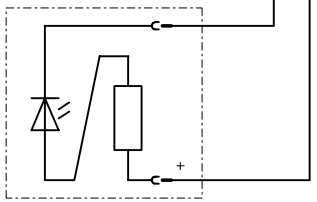
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-O	A4	udo@elgers.com	ue-ERT20250321-01	21-MAR-2025
041	A	FT STEM CLASS SET OPTICS - MODELING SHEET		



FT - BATTERY BOX WITH POLARITY CHANGING SWITCH
PN: 135719 (PRINCIPAL SCHEMATICS)



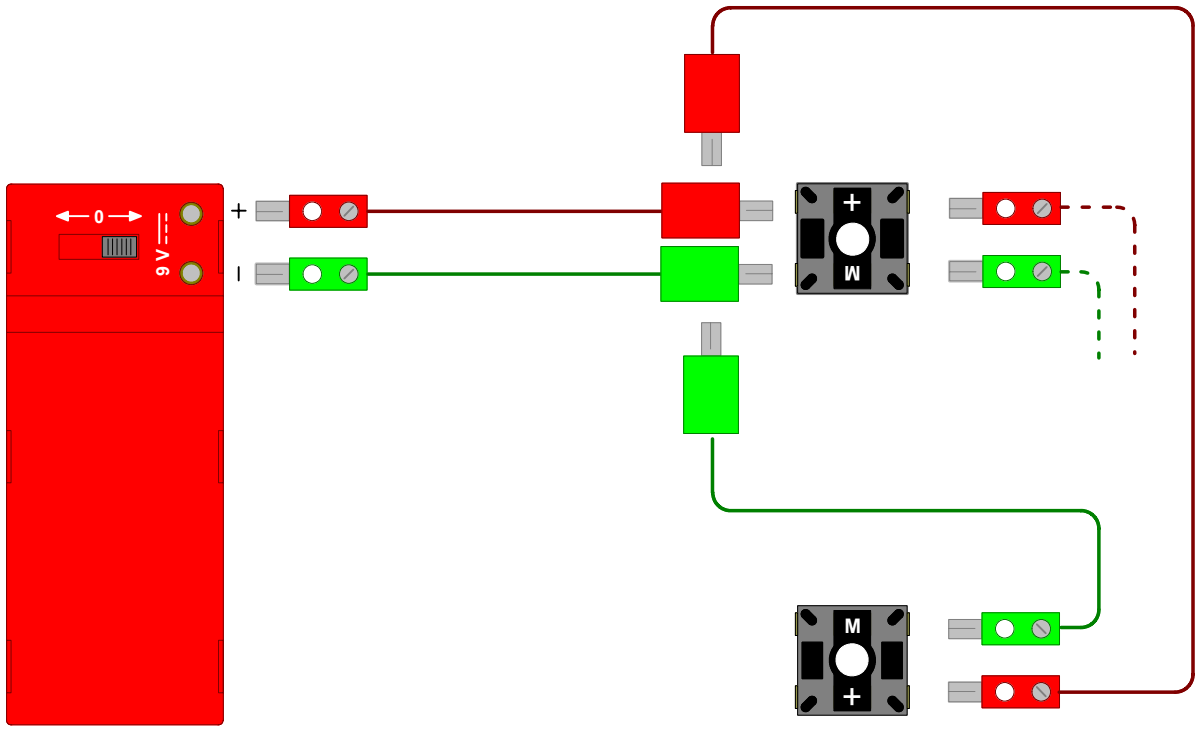


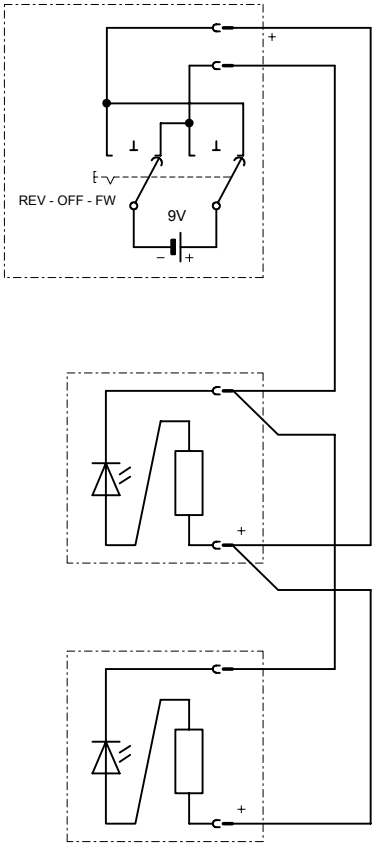
FT - LIGHT BARRIER LED ASSEMBLED 9 V
PN: 162135 (PRINCIPAL SCHEMATICS)

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

9 V BATTERYBOX WITH ONE LED ASSY

CLASS-O	A4	udo@elgers.com	ue-ERT20250322-02	22-MAR-2025
042	A	FT - STEM CLASS SET OPTIC - SINGLE LED		





FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

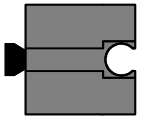
9 V BATTERYBOX WITH TWO LED ASSY

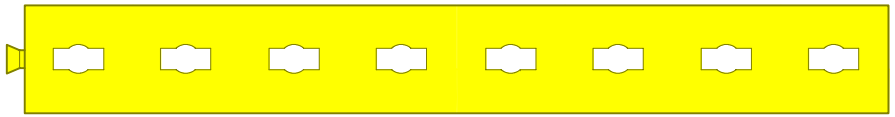
CLASS-O	A4	udo@elgers.com	ue-ERT20250322-03	22-MAR-2025
043	A	FT - STEM CLASS SET OPTIC - DUAL LED ASSY		

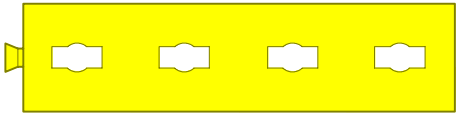
RETRO CIRCUITS

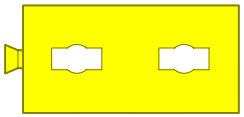
NOTES:

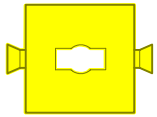
CLASS-O	A4	udo@elgers.com	ue-ERT20250322-03	22-MAR-2025
044	A	FT STEM CLASS SET OPTIC - NOTES		


4x 32881


6x 36294


8x 36297


4x 36299


4x 36298

20x 31764

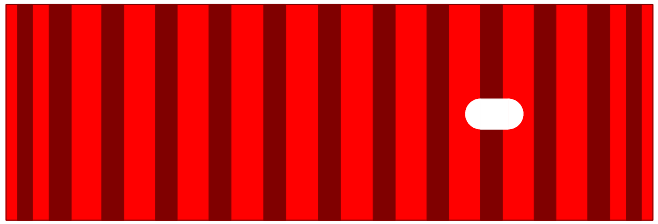

2x 32064


7x 31010


2x 38240

20x 38542

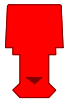

2x 31061


2x 32859

2x 36326

4x 32200


4x 36324


80x 36323


4x 36334

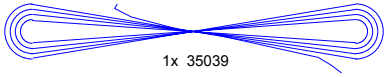

1x 38225

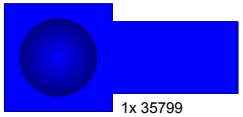
4x 35059

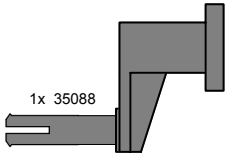
4x 36335

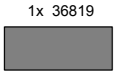

2x 31436

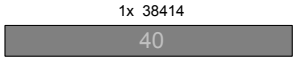

2x 31426


1x 35039


1x 35799

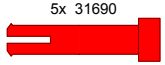

1x 35088


1x 36819



1x 38414


2x 163203


5x 31690

1x 35063


1x 38258

31010	ANGULAR BLOCK 60°, RED
31061	LINK 30, RED
31426	HINGE BLOCK TAP, RED
31436	HINGE BLOCK CLAW, RED
31690	CLIP AXLE 20, RED
31764	I-STRUT 30, YELLOW
32064	BUILDING BLOCK 15 WITH BORE, RED
32200	I-STRUT 75, YELLOW
32859	BOTTOM PLATE 30x90, RED
32881	BUILDING BLOCK 15, BLACK
35039	NYLON THREAD (ROPE) 600, BLUE
35059	X-STRUT 106, YELLOW
35063	CLIP AXLE 30, BLACK
35069	CABLE WINCH FRAME 30, RED
35070	CABLE WINCH DRUM, BLACK
35088	CRANK SHAFT, BLACK
35799	RIVET HOLDER, BLUE
36294	ANGLE GIRDER 120, YELLOW
36297	ANGLE GIRDER 60, YELLOW
36298	ANGLE GIRDER 15 WITH 2 PINS, YELLOW
36299	ANGLE GIRDER 30, YELLOW
36323	SINGLE RIVET 4, RED
36324	SINGLE RIVET 6, RED
36326	X-STRUT 63.6, YELLOW
36334	LOCKING WASHER, RED
36335	I-STRUT 120, YELLOW
36819	AXLE SLEEVE, BLACK
38225	HOOK, RED
38240	BUILDING BLOCK V15 CORNER, RED
38258	ROPE PULLEY D=12, BLACK
38414	PLASTIC AXLE 40, BLACK
38542	X-AXLE 42.4, YELLOW
163203	HOSE CONNECTION D4 ANGLED, BLACK

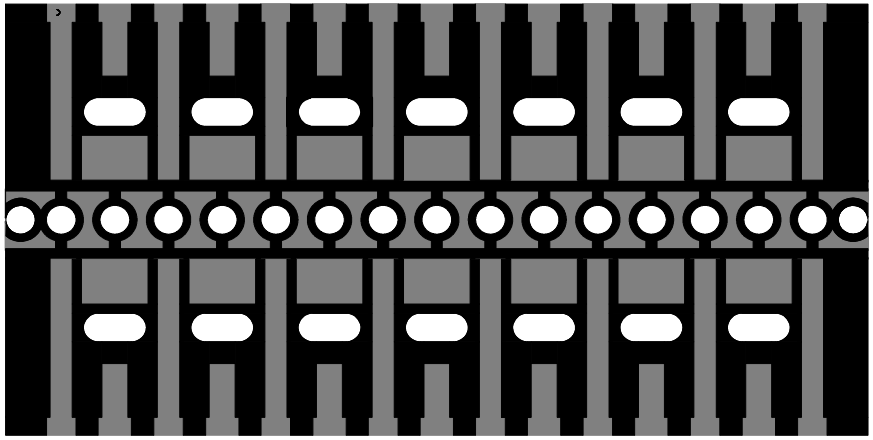
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-ST	A4	udo@elgers.com	ue-ERT20250322-05	22-MAR-2025
045	A	FT STEM CLASS SET STATICS - BILL OF MATERIAL		

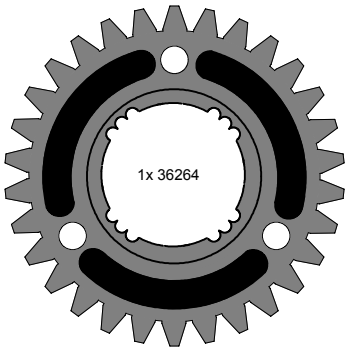
RETRO CIRCUITS

NOTES:

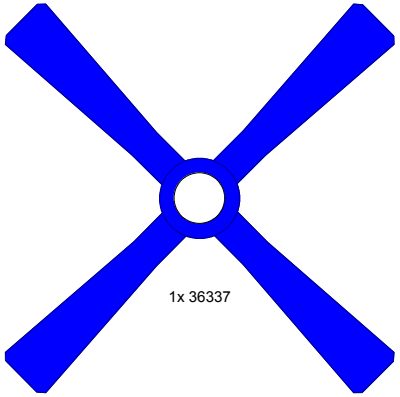
CLASS-ST	A4	udo@elgers.com	ue-ERT20250323-03	23-MAR-2025
046	A	FT STEM CLASS SET STATICS - NOTES		



1x 35129

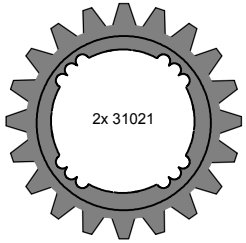


1x 36264

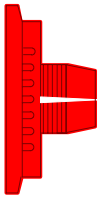


1x 36337

40x 36248

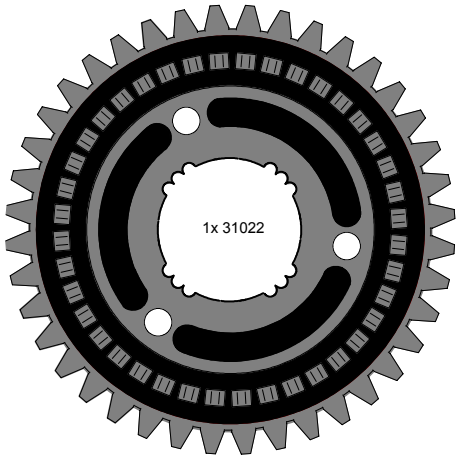


2x 31021

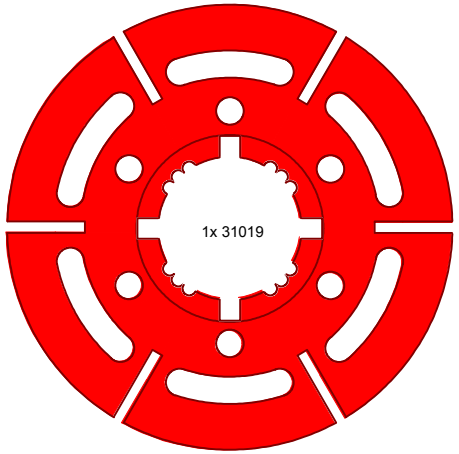


3x 35031

3x 31058



1x 31022

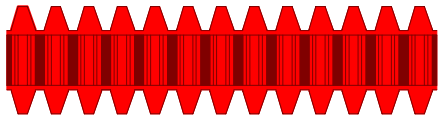


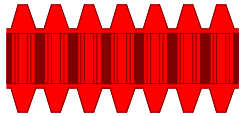
1x 31019

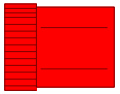
31019	LARGE PULLEY 60, RED
31021	GEAR WHEEL T20, BLACK
31022	GEAR WHEEL T40 / 32, BLACK
31058	HUB NUT, RED
35031	FLAT HUB COLLET, RED
35129	BASE PLATE 120x60, BLACK
36248	CHAIN LINK 11.5, RED
36264	GEAR WHEEL T30, BLACK
36337	4-BLADE PROPELLER, BLUE

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-GR	A4	udo@elgers.com	ue-ERT20250323-01	23-MAR-2025
047	A	FT STEM CLASS SET GEARS - BILL OF MATERIAL 1		


2x 31053


1x 31054


1x 31915


1x 37858

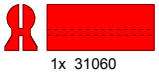

1x 37679

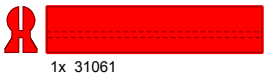

1x 31597


2x 31982


1x 31848


1x 36334

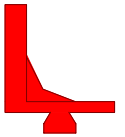

1x 31060


1x 31061

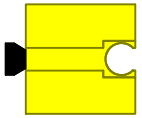

1x 37237


1x 37468


1x 31981


4x 38423

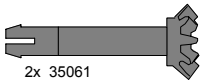

6x 136528


2x 136529

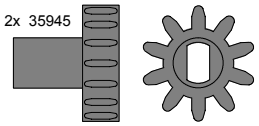

3x 32064

2x 35063

3x 35064

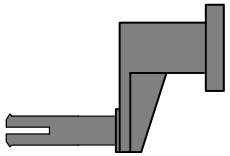

2x 35061

1x 35087


2x 35945


1x 35073

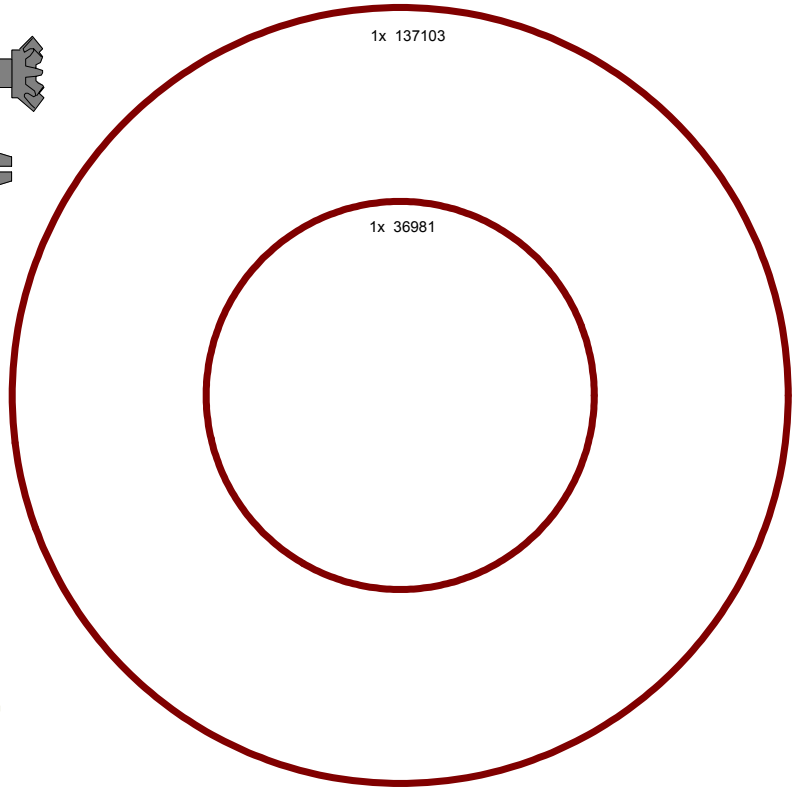

1x 36227


2x 35088


1x 31983


2x 36819

1x 36326



31053	RACK 60 M1.5, RED
31054	RACK 30 M1.5, RED
31060	LINK 15, RED
31061	LINK 30, RED
31597	SPACER RING, RED
31848	STRUT ADAPTER, RED
31915	HUB NUT, RED
31981	ANGULAR BLOCK 15°, RED
31982	SPRING CAM, RED
31983	SLEEVE 15, RED
32064	BUILDING BLOCK 15 WITH BORE, RED
35061	WHEEL AXLE WITH BEVEL GEAR, BLACK
35063	CLIP AXLE 30, BLACK
35064	CLIP AXLE 45, BLACK
35073	AXLE COUPLING, BLACK
35087	CLIP AXLE 75, BLACK
35088	CRANK SHAFT, BLACK
35945	COG WHEEL T10 M=1.5, BLACK
36227	CLIP ADAPTER, BLACK
36326	X-STRUT 63.6, YELLOW
36334	LOCKING WASHER, RED
36819	AXLE SLEEVE, BLACK
36981	O-RING 54
37237	BUILDING BLOCK 5, RED
37468	BUILDING BLOCK 7.5, RED
37679	CLIP 5, RED
37858	LOCKING WORM M=1.5, RED
38423	ANGULAR BLOCK 10x15x15, RED
136528	BUILDING BLOCK 30, YELLOW
136529	BUILDING BLOCK 15, YELLOW
137103	O-RING 108

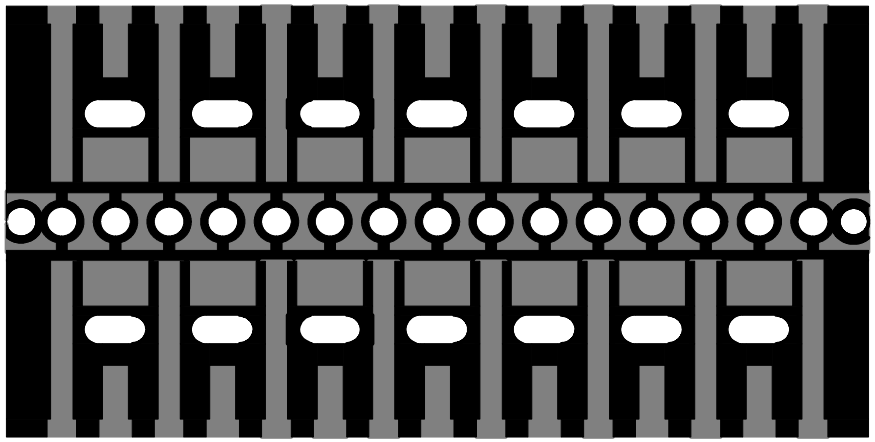
FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-GR	A4	udo@elgers.com	ue-ERT20250323-02	23-MAR-2025
048	A	FT STEM CLASS SET GEARS - BILL OF MATERIAL 2		

RETRO CIRCUITS

NOTES:

CLASS-GR	A4	udo@elgers.com	ue-ERT20250323-04	23-MAR-2025
049	A	FT STEM CLASS SET GEAR - NOTES		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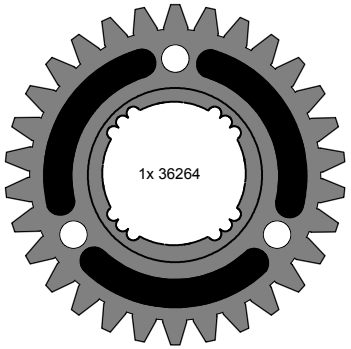
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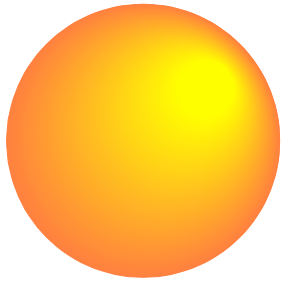
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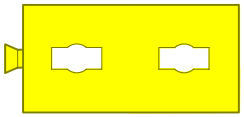
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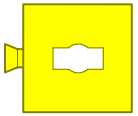
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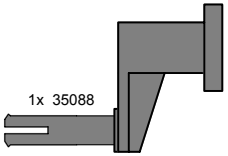
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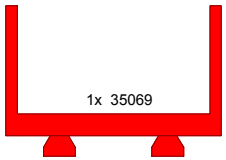
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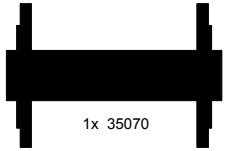
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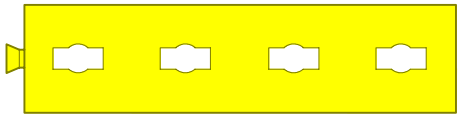
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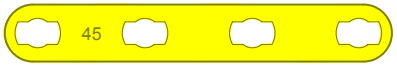

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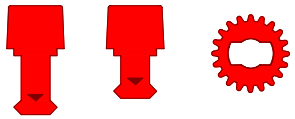
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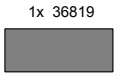
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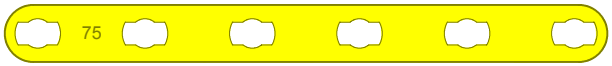
1x 38225



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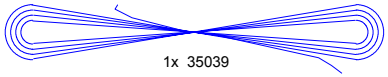
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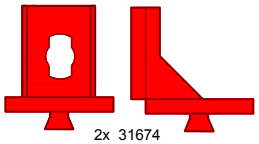
3x 38531

2x 35060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31674	ADAPTER GIRTH, RED
32869	NYLON ROPE 1200, BLUE
35053	ANGLE GIRDER 15, YELLOW
35060	I-STRUT 120 WITH BORE, YELLOW
35069	CABLE WINCH FRAME 30, RED
35070	CABLE WINCH DRUM, BLACK
35088	CRANK SHAFT, BLACK
35129	BASE PLATE 120x60, BLACK
36264	GEAR WHEEL T=30 M1.5, BLACK
36297	ANGLE GIRDER 60, YELLOW
36299	ANGLE GIRDER 30, YELLOW
35323	SINGLE RIVET 4, RED
36324	SINGLE RIVET 6, RED
36334	LOCKING WASHER, RED
36819	AXLE SLEEVE, BLACK
38225	HOOK, RED
38531	I-STRUT 90 WITH BORE, YELLOW
38541	I-STRUT 45 WITH BORE, YELLOW
38545	I-STRUT 75 WITH BORE, YELLOW
154485	TABLE TENNIS BALL D=38, ORANGE

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
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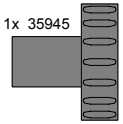
CLASS-GR	A4	udo@elgers.com	ue-ERT20250325-04	25-MAR-2025
050	A	FT STEM CLASS SET SIMPLE MACHINES - BOM 1		

1x 35063


1x 36227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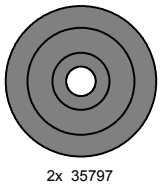
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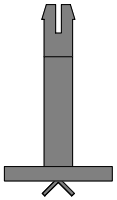
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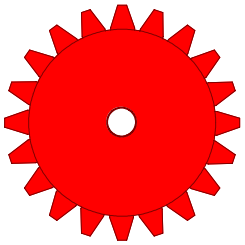
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1x 35064

1x 35087


3x 38413

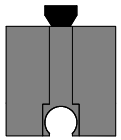

2x 31690


2x 38415


7x 37679


2x 31597


3x 31060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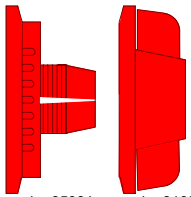
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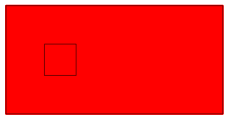
1x 31058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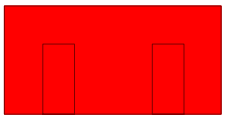
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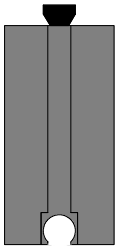
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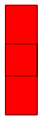
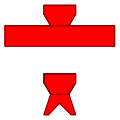
3x 32064

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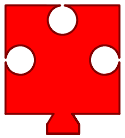
2x 37636


2x 38240


3x 37237


8x 37468


9x 32071


6x 31981


3x 31010


2x 31011

31010	ANGULAR BLOCK 60°, RED
31011	ANGULAR BLOCK 30°, RED
31058	HUB NUT, RED
31060	LINK 15, RED
31597	SPACER RING, RED
31690	WHEEL AXLE, RED
31981	ANGULAR BLOCK 15°, RED
31982	SPRING CAM, RED
32064	BUILDING BLOCK 15 WITH BORE, RED
32071	ANGULAR BLOCK 7.5°, RED
32879	BUILDING BLOCK 30, BLACK
32881	BUILDING BLOCK 15, BLACK
35031	FLAT HUB CHUCK, RED
35049	BUILDING BLOCK 15x30x5 WITH GROOVE & PIN, RED
35063	WHEEL AXLE 30, BLACK
35064	WHEEL AXLE 45, BLACK
35087	WHEEL AXLE 75, BLACK
35797	ROPE PULLEY 21, BLACK
35945	COG WHEEL T=10 M1.5, BLACK
36227	CLIP ADAPTER, BLACK
37237	BUILDING BLOCK 5, RED
37468	BUILDING BLOCK 7.5, RED
37636	ROLLER PEDESTAL, RED
37679	CLIP 5, RED
38240	BUILDING BLOCK V15 CORNER, RED
38413	PLASTIC AXLE 30, BLACK
38415	PLASTIC AXLE 50, BLACK
38428	BUILDING PLATE 14x30x5 WITH 3 GROOVES, RED
130593	CLIP AXLE WITH BASE
137677	CHAIN LINK WHEEL, RED

FIGURES ARE APROXMEDIATELY, DUE TO COMPONENT TOLERANCES!
FOR FULLY COMPONENT SPECS. SEE MANUFACTURER DATASHEETS.
BRANDS AND NAMES ARE MENTIONED PURELY FOR INFORMATION PURPOSES.

CLASS-SM	A4	udo@elgers.com	ue-ERT20250325-05	25-MAR-2025
051	A	FT STEM CLASS SET SIMPLE MACHINES - BOM 2		

RETRO CIRCUITS

NOTES:

CLASS-SM	A4	udo@elgers.com	ue-ERT20250325-06	25-MAR-2025
052	A	FT STEM CLASS SET SIMPLE MACHINES - NOTES		