CH701 AIRCRAFT WIRING
PRIMARY POWER & IGNITION

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Ayden Mitchell had purchased an unfinished STOL CH 701 experimental aircraft kit and being a qualified Electrical Engineer I was asked to assist with the aircraft wiring.

The electrical system on the aircraft was considered as 3 sections:

1 Primary Power
2 Secondary Power
3 Data Bus Wiring

Each section has been documented separately. The Data bus wiring was the first to be addressed from October 2020 to February 2021. The aircraft and associated primary power components were retrieved on 12 March 2021. The primary power section is the subject of this document.

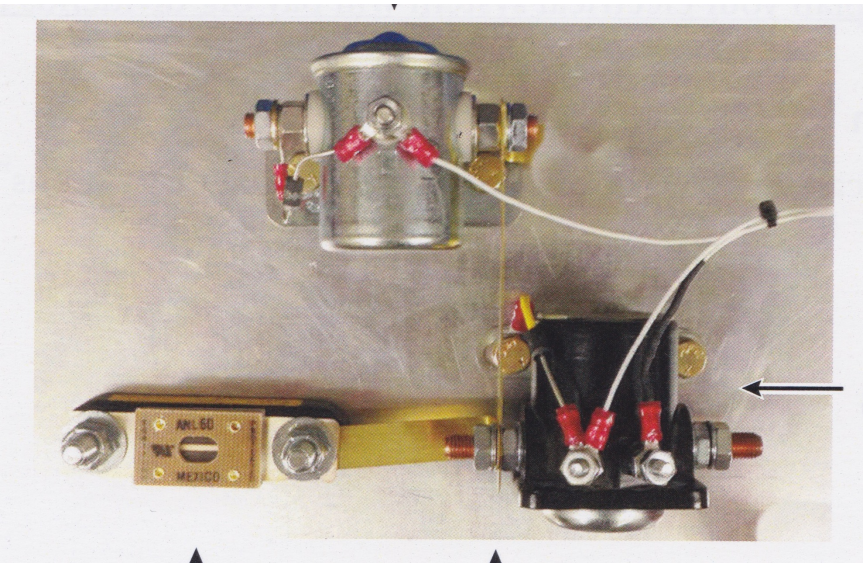
Two alternatives were considered for the Primary Power System (PPS), Vertical Power (Astronics) and the traditional contactor design. The following advantages/disadvantages were considered:

	Advantages	Disadvantages
Vertical Power PPS	Alleged high reliability Plug-and-play fast installation Saves space ? weight Reduces exposure to battery voltage Integrates with VP-X Low power draw 1ma won't drain battery if main switch accidentally left on	$1695 No serviceable internal components if faults develop
Traditional Contactor	50 years of experience/reliability Supplied with aircraft when purchased 'Learning' component of building experimental aircraft higher than buying a black box (red). Faulty components easily diagnosed and economically replaced.	Old way. Build from scratch, time consuming. Common errors in homemade circuits. Components not changed in half a century. Failure prone solenoids. Size.

Although cost was a consideration it is the experience of the author that 'power' faults on expensive circuit boards with combined power sections and signal sections can bring down the whole board. Serviceability is therefore a key issue. Traditional primary power circuits are not complex compared with say secondary power circuits eg VP-X. The contactor components were included in the purchase price of the aircraft. Should it turn out that the advantages of the VP PPS system, in practice, outweigh those of the traditional contactor, it has the advantage of also being a plug-and-play replacement. Should this be the case the learning component of assembling the contactor circuit will not be lost. LAA inspectors will recognise both options as equally valid and the path to certification should not be affected. For these reasons the traditional contactor approach was chosen in combination with a VP-X Pro.

The decision by Ayden Mitchell to have a single bus, single battery (front mounted with a small

backup battery) and single alternator was chosen after clarifying his mission (VFR, simplicate & add more lightness). The Rotax 912 series engine purchased with the aircraft had an in-built alternator and external regulator. An internal magneto-generator supplied twin module (A & B) electronic ignition modules.



The components used in the PPS were as follows:

Makbat 20AH battery
Battery Contactor
Master Switch
Rotax internal alternator and external regulator
Alternator fuse (ANL)
Starter Contactor
Keyed ignition switch (ACS A-510-2)
Rotax Ignition magneto-generator
Rotax Electronic Ignition Modules A & B
Contactor diodes (1N5400)
VP-X Pro (over-voltage protection alternator, annunciator, auxiliary battery)

The following table gives **PPS issues** and how they are addressed

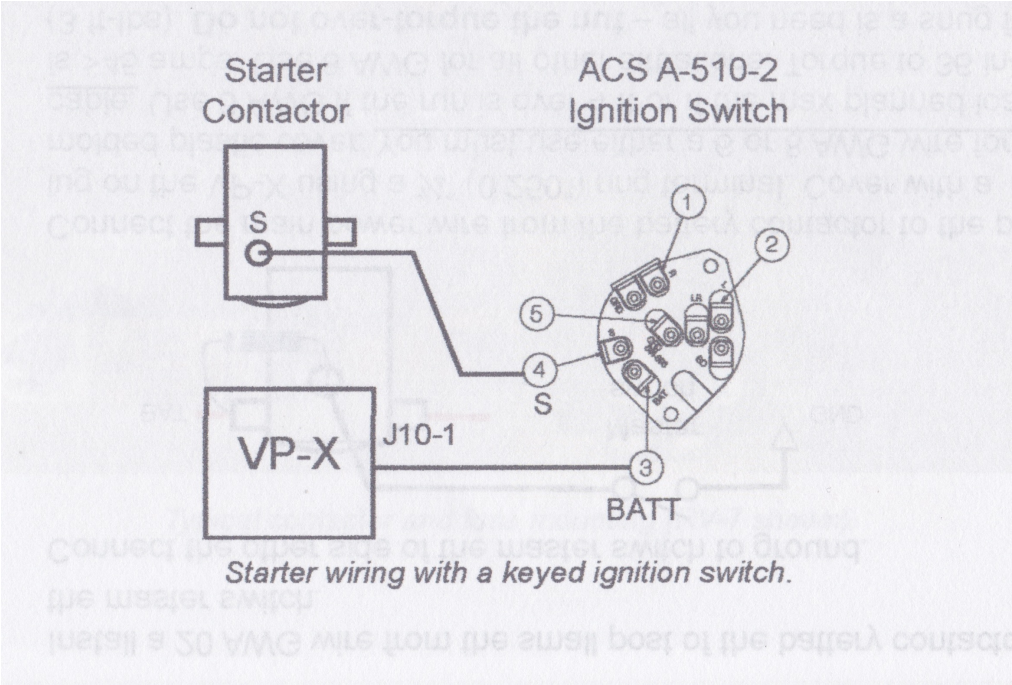
Issue	
Location of battery contactor	Near to main battery
Location of starter contactor	On firewall in engine compartment
Bus bar current (shunt B)	VP-X measures bus bar currents and shunt not required
Alternator output (shunt A)	Not required as alternator working determined by output voltage
Failure detection	VP-X calls out an over-voltage condition (traditional breakers trip without explanation)
Rotax alternator	Built in alternator always on and wired separately from VP-X

Contactor Wiring (See Attachment 1 - Vertical Power Contactor Wiring Rev G)

20 AWG from small post of battery contactor to master switch
Cable from battery to contactor 8AWG or 6 AWG if run over 4 feet or max planned load >45A
0.250" ring terminal to VP-X torqued to 3 ft-lb
18 AWG wire from J10-1 to starter switch (ACS A-510-2)
18 AWG from starter switch (ACS A-510-2) to 'S' terminal of starter contactor
Install diode on each contactor

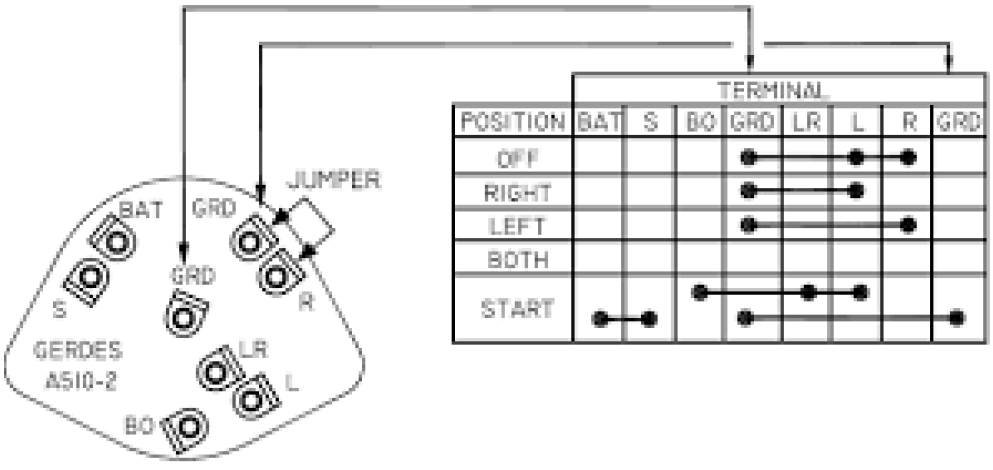
Keyed Ignition Switch

The connections to the ignition/starter switch are shown below:



Starter wiring with a keyed ignition switch.

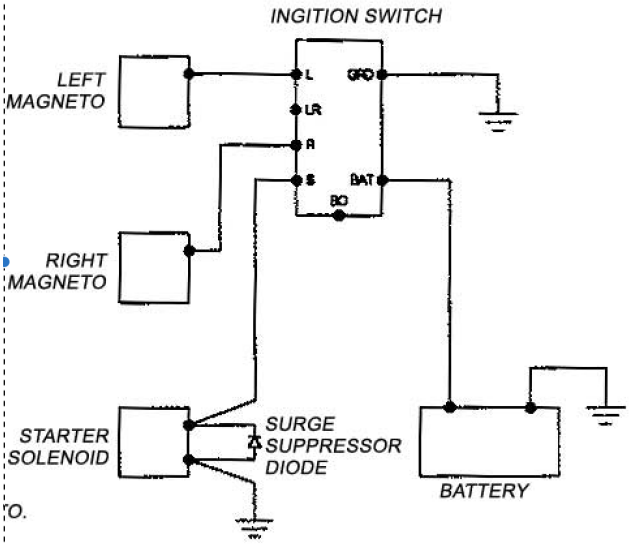
The switch connection diagram is shown below Note that the 'old white' terminal board assembly is shown whereas the battery (BAT) and S terminals are transposed in the 'new green' board.



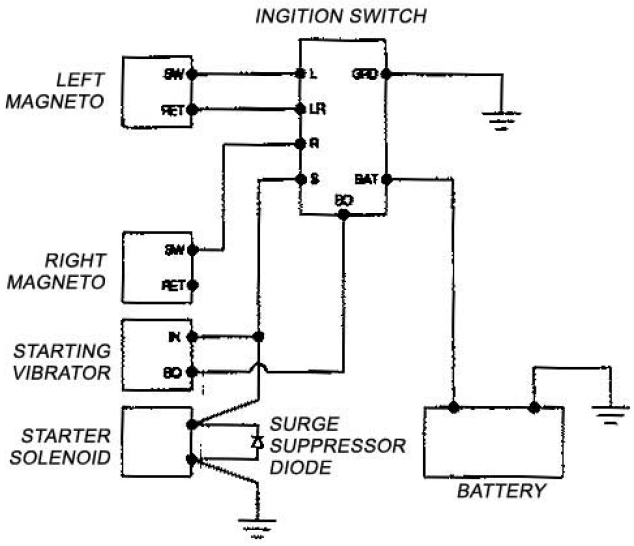
ACS issued Service Bulletin SB92-01 in 2008 (Attachment 2) providing instructions for inspection and lubrication of ignition switches manufactured by ACS Products Co. and for installation of a diode across the starter solenoid coil.

The ACS A-510-2 was originally designed for a number non-electronic magneto ignition systems shown below for reference:

TALLATION OF ACS A-510-2 IGNITION SWITCH



WIRING DIAGRAM FOR IGNITION SWITCH WITH STRAT DIAGRAM



WIRING DIAGRAM FOR IGNITION SWITCH WITH STRAT POSITION & 2-TERMINAL STARTING VIBRATOR.

This explains the need for separate connections to the right and left magnetos. The switch has been adopted to work with the electronic ignition in the Rotax 912 series engines. The BPR-Powertrain installation manual for Ignition switches (MAG switch) is provided as Attachment 3. The switching voltage is a minimum of 250V with a minimum current of 0.5A. The ACS A-510-A contact ratings are provided by CPS (California Power Systems) – "Momentary 'on' function on 'start' (spring return to 'both'). Current through 'BAT' & 'S' terminals is 2 amps inductive at 12 volts. Current through 'L' and 'R' magneto grounding circuits is less than 0.5 amps. Open circuit voltage is 300 volts". It is important to note the high switching voltage required with the electronic ignition.

The diagram below is from Attachment 4 – Service Instruction Standardization of the Ignition Unit for Rotax Engine Type 912 Series. ACS A-510-2 switch replaces the two shorting switches labelled 7.

Fig. 6

05808

wiring diagram 912 Series

T = top = oben
B = bottom = unten

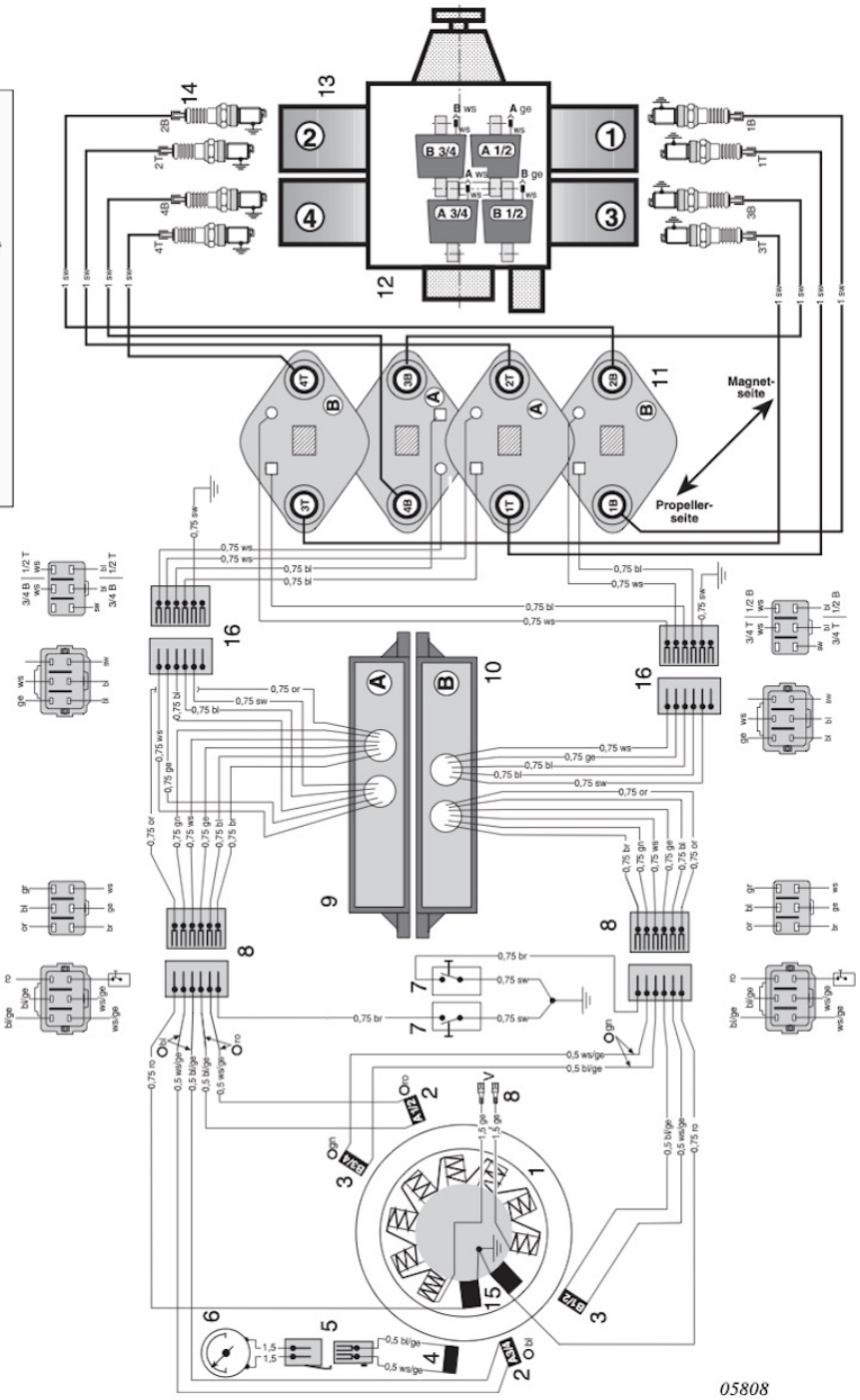
1. ignition magneto-generator
2. pick-up for ignition circuit A"
3. pick-up for ignition circuit B"
4. pick-up for rev-counter
5. plug receptacle 2-pole
6. electronic tachometer
7. shorting switch for ignition circuit "A" and "B"
8. plug receptacle 6-pole
9. electronic module for circuit "A"
10. electronic module for circuit "B"
11. double ignition coil
12. engine
13. cylinder 1-4
14. spark plugs
15. charging coils
16. plug receptacle 6-pole

V consumer connection
o colour code

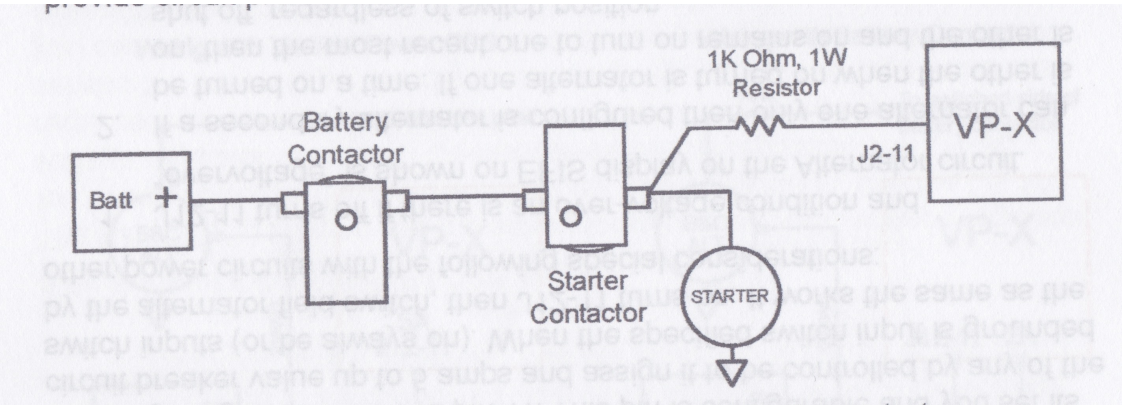
ignition circuit A: 1 u. 2 TOP
3 u. 4 BOT
ignition circuit B: 1 u. 2 BOT
3 u. 4 TOP

bl	blue
br	brown
ge	yellow
gn	green
ro	red
rs	pink
sw	black
ws	white
or	orange

912 Serie

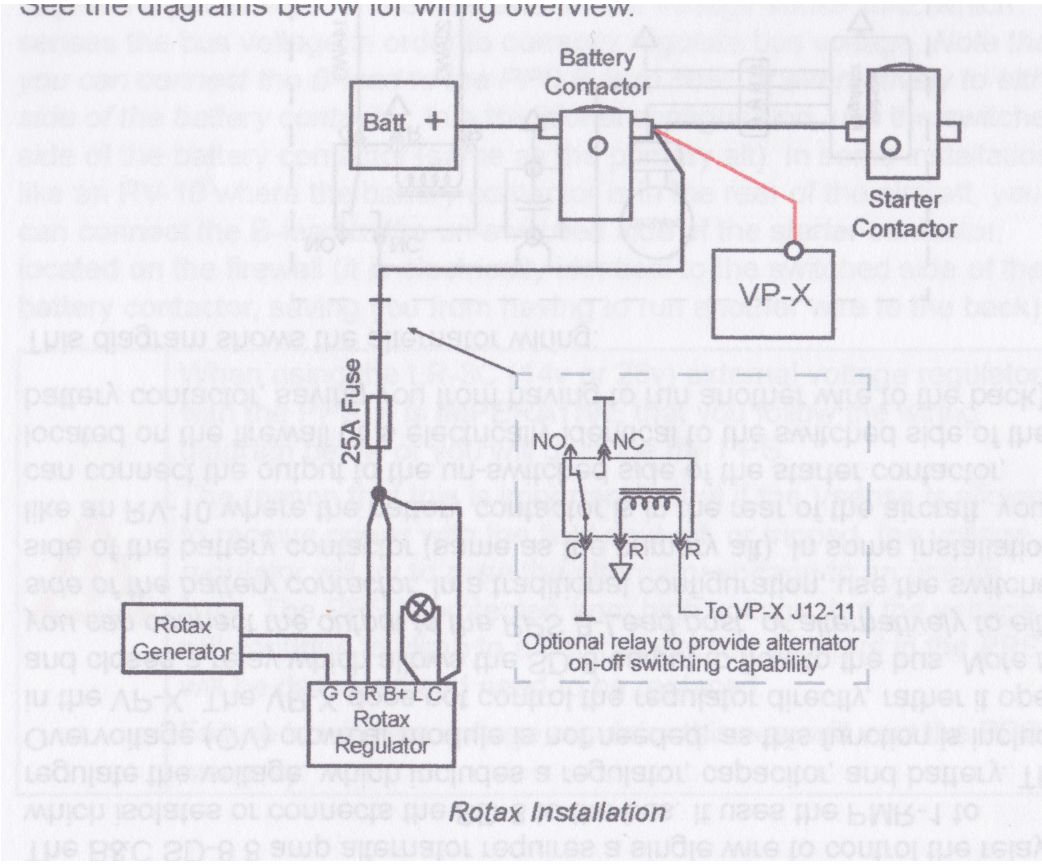


Starter Annunciator



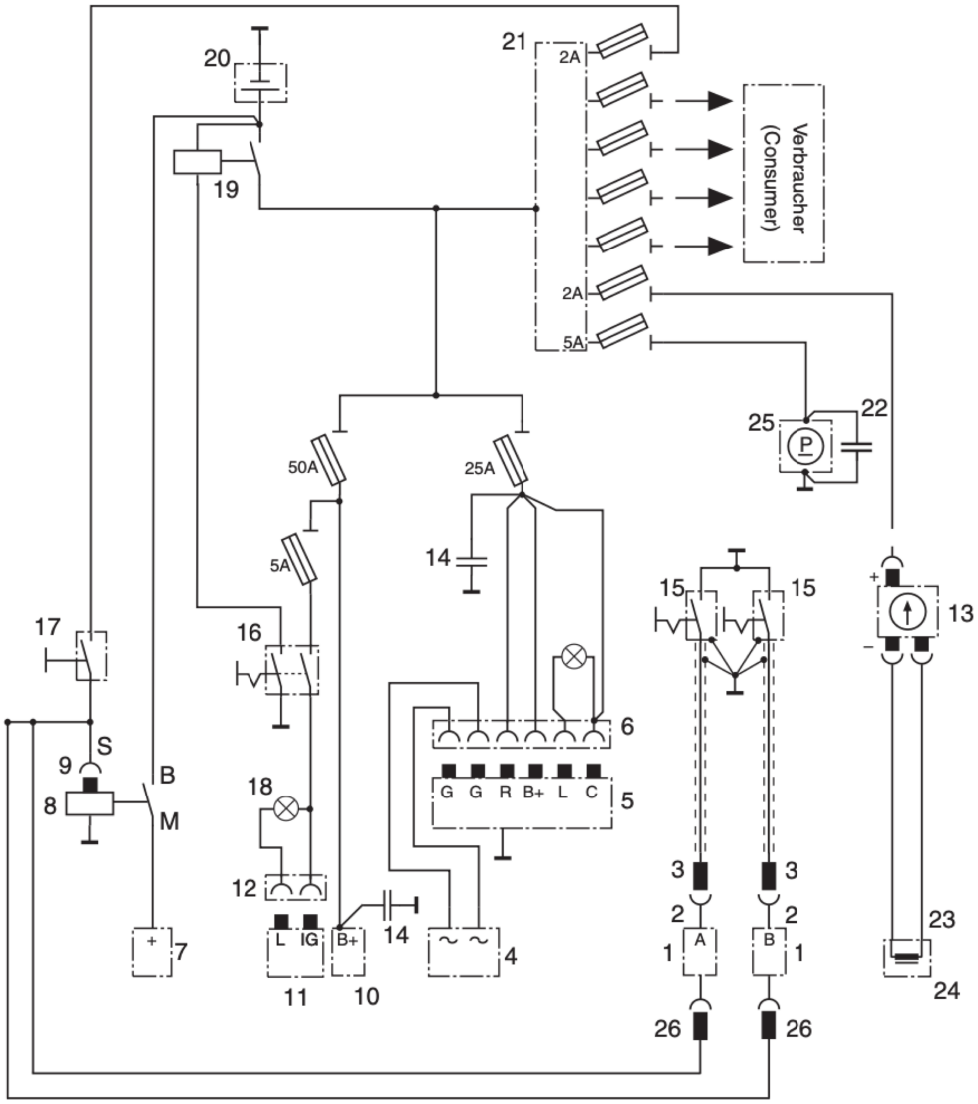
A 1K Ohm 1W resistor is placed near the contactor to provide circuit protection for the wire. A 20AWG wire then goes to pin J2-11 of the VP-X.

Alternator



Rotax engines have a built-in alternator with their own external regulator mounted on the engine side of the firewall. They do not provide a standard method to turn on and off the alternator from the cockpit. It is planned to include the optional relay as shown above to provide alternator on-off switching capability. Connection to VP-X J12-11 will be made to access to the VP-X alternator control circuit. The wire from the battery contactor to the VP-X is either 6 or 8AWG.

The Rotax wiring diagram from Attachment 3 is reproduced below for reference:



Part	Function	Part	Function
1	2 Electronic modules (A and B)	17	Starter switch
2, 3	Plug connection for ignition switch	18	Control lamp
4	Integrated generator	19	Battery relay
5, 6	External regulator - rectifier with plug connections	20	Battery
7	Electric starter	21	Bus Bar
8, 9	Starter relay with plug connection	22	Capacitor 1 µF
10, 11, 12	External alternator with connection	23	Plug connection for trigger coil assy.
13	Electric rev counter	24	Trigger coil assy. (tachometer)
14	2 capacitor 1 µF	25	Electrical fuel pump
15	2 ignition switches	26	Starting equipment at the electronic modules
16	Masterswitch		