XT912 Microlight Trike Hand Control Equipment

The following information details the hand control equipment and other minor adaptations that have been undertaken to allow me to independently and safely control an Airborne XT912 Microlight Trike aircraft in the air and on the ground. The new equipment items are not structural components and all new equipment either utilises the existing bolting positions or uses appropriate clamps for fastening into position without damage to the members.

The main elements of the new hand control equipment include power steering of the front nose wheel, a base bar adaptation (control bar) allowing the user to fasten their hands/wrists for control of the wing, throttle control via electric push button system and the disc brakes which were converted to hand lever operation.

The electrical supply to power the adaptive equipment is taken directly from the battery and is totally separate from the aircrafts electrical system.

Steering of the front nose wheel

The original ground steering setup of the trike is achieved by pushing on the foot pegs that are attached to the front forks. Without the use of my legs this arrangement was not feasible, the foot pegs have been removed and a power steering system is installed to rotate the forks for the steering.

The steering is achieved by puffing or sucking on a tube, which activates one of two pneumatic switches. If I puff on the tube with a constant breath, it will activate an electronic controller which in turn activates an electric actuator which will steer the trike into a right hand turn. If I suck on the tube the trike will steer left. When I stop puffing or sucking the front wheel will automatically self centre. The rate of the turn can be controlled by quick puffs or sucks as required. This system is very easy to use and reliable.

The tube is attached to the microphone boom which is easily accessible when I need it.

Figure 1 & 2 – Puff/suck tube for steering control

Figure 3 – Original configuration of the front forks

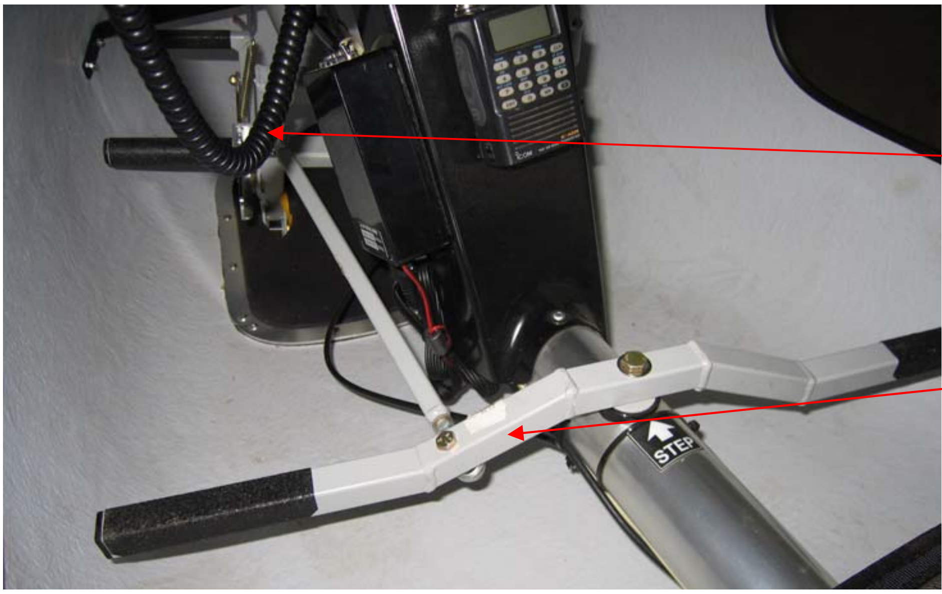


Figure 4 – Original rear steering configuration which has been removed

An electric linear actuator is utilised to rotate the front forks. The actuator is located under the pilot's seat and clamped to the keel member that runs down the centre of the aircraft. A stainless steel tube is connected to the end of the actuator and runs to the existing bolting point on the forks that were used for the original rear steering rod connection.

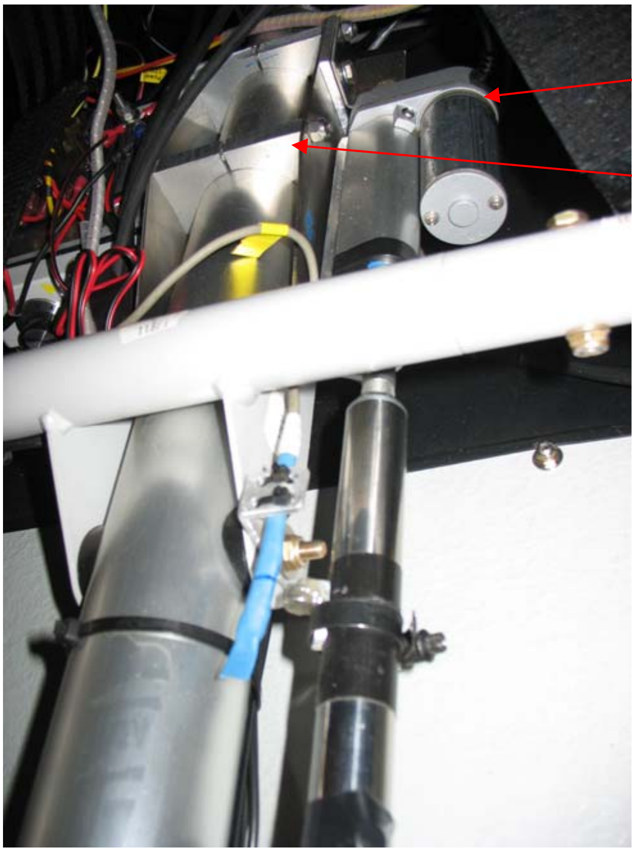


Figure 5 – Linear actuator and clamp arrangement

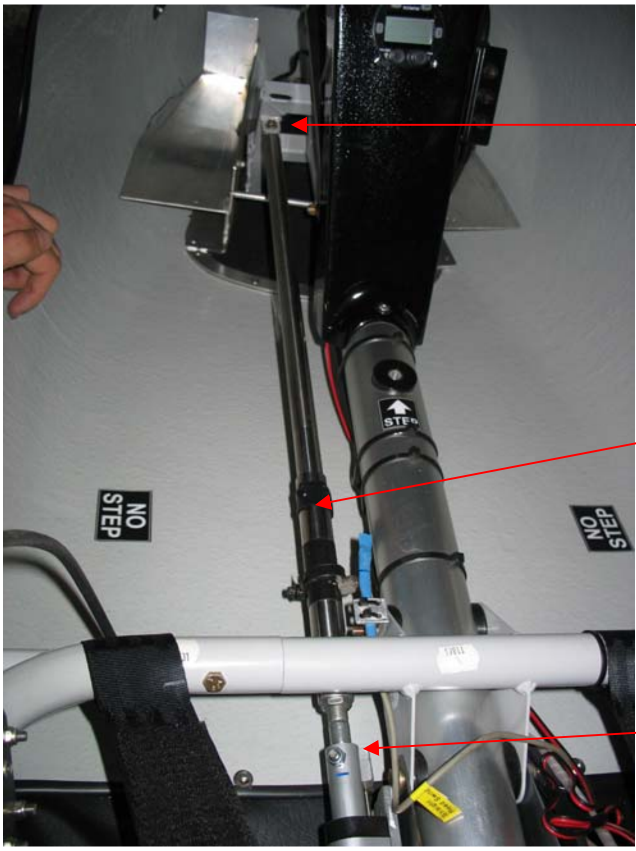
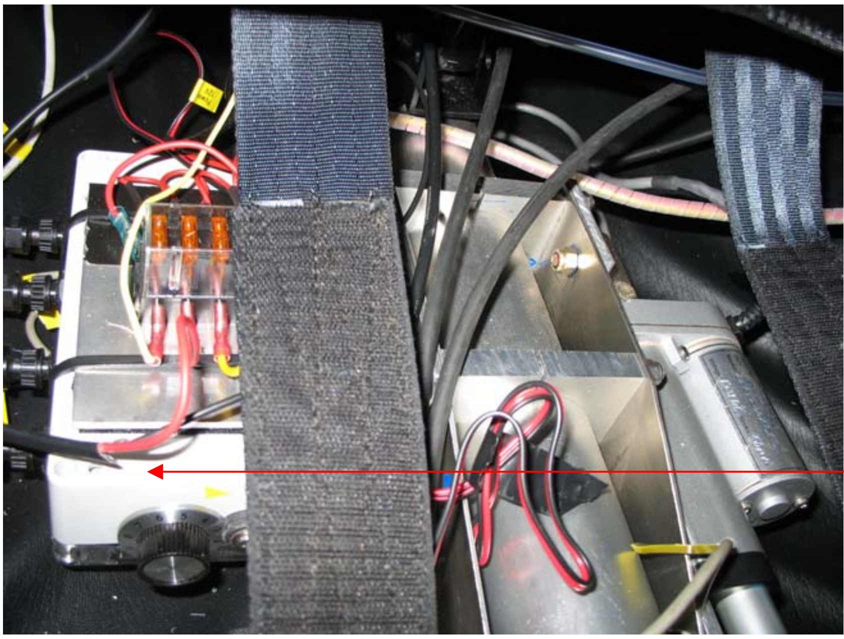


Figure 6 – Steering connection rod from actuator to forks

The steering rod is in two parts, an inner and outer sleave. This will allow the inner tube to slide in and out, allowing the front wheel to rotate freely when the locking pin is removed. The locking pin is attached to a lanyard to allow me to pull it out if necessary. The main reason this has been designed into the steering, is in the unlikely event that the forks were rotated and the power failed or a fault occurred in the electric controller where the forks were stuck in position off centre, the pin could be removed and the front wheel will caster straight upon landing.

The actuator is controlled by an electric controller which reads a signal from a linear potentiometer located on the actuator. This allows the position of the front wheel to be detected and the controller will automatically self centre the front wheel.



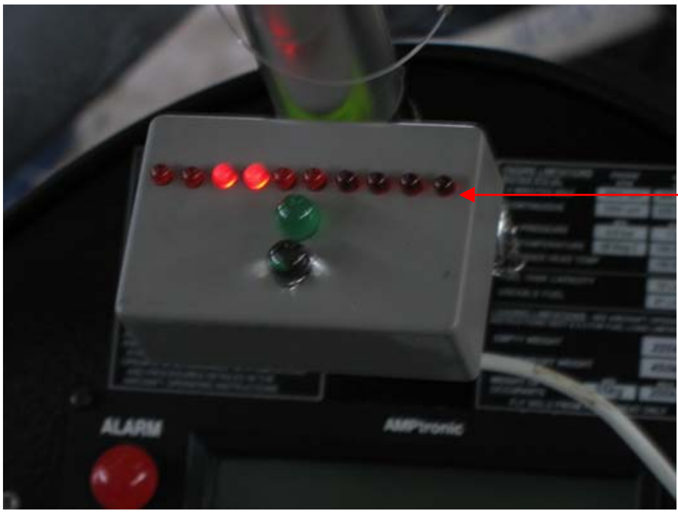
Electric controller which controls the actuator position. It is mounted on the opposite side if the actuator under the pilots seat

Figure 7 – Steering controller

To provide a visual aid to determine the position the front wheel is in, an indicator with LED lights is installed on the bar above the dash. This has a row of red LED's that light up if the forks are rotated left or right. When the forks are in the straight position, the two green lights illuminate. The top green light registers a signal from the position of the actuator via the controller and the bottom green light is a secondary back-up which is an independent system this is activated by a reed switch positioned on the steering rod. When a magnet located on the rod moves off centre the light goes off, and when it moves back into the straight position the magnet activates the switch and the light turns on. I can still see the position of the fork if I look down, however this indicator makes it easier and quicker to determine the position.

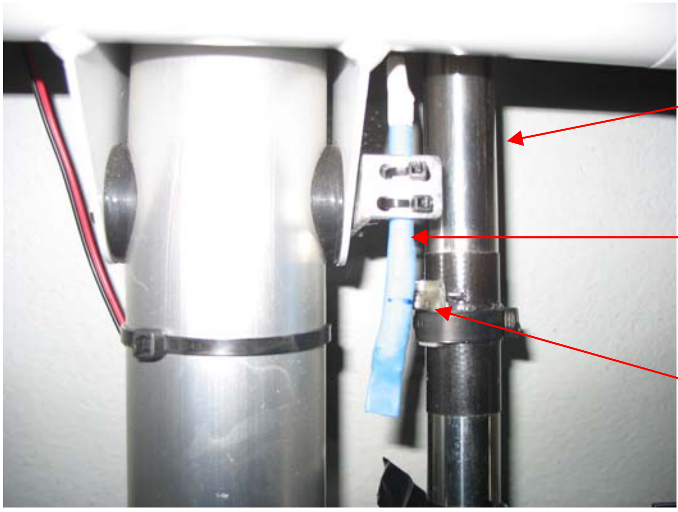
Position indicator showing the steering in the straight position

Mater switch for adaptations indicating that the system has power/on



Position indicator showing the steering turning left at about half lock

Figure 8 & 9 – LED position indicator



Steering rod

Reed switch in front of pilots seat

Magnet on steering rod

Figure 10 – Reed switch arrangement

Control Bar Adaptation

Having limited hand function, the main issue is not being able to grip the base bar with my hands. An adaptation to allow my hands/wrists be locked in place while being able to remove them easily and quickly was necessary for control of the wing in flight, this being the Control Bar.

Control Bar with hand in position

Figure 11 – Control Bar on Trike Base Bar (This is a photo from my old trike, but the set-up is the same for the XT912)

The hand supports consist of three upright posts. The wrist is supported between the two end posts with the hand and fingers wrapping around the long centre post. The wrist is then held in an extended position, which securely locks the hand in place. The hands can be removed easily and quickly by sliding them out in an upward direction.

Figure 12 – Control Bar on XT912

The Control Bar is constructed from aluminium, being 25x25mm square hollow section, 25mm diameter circular hollow section, 3mm plate and aluminium bar for the mounting clamps. All members have been fully welded.

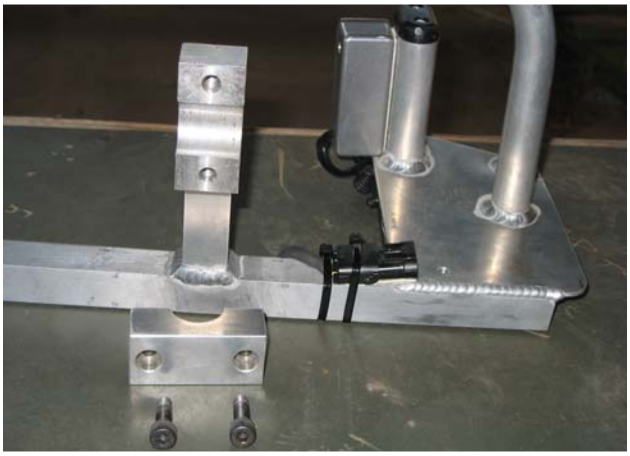


Figure 13 – Control Bar Clamp Arrangement

The Control Bar is clamped directly onto the base bar via the two clamps. Each clamp has been machined to precisely fit the diameter of the base bar tubing. Each clamp has two bolts, one top and bottom to secure it to the base bar.

Throttle Control

The throttle control was an extremely important aspect of the modifications to ensure that the throttling could be achieved with ease, reliably and most importantly safely.

A motorised system has been developed with push buttons for the throttle control, that are extremely easy to use allowing quick adjustments of the throttle from small increments to large, and also allowing operation of the throttle while retaining both hands on the control bar.

In addition to the motorised arrangement the existing cruise throttle is retained as a backup, which I can use if necessary.

Operation

The operation of the new throttle utilises the same principal as the original arrangement, which is achieved by pulling and retracting the existing foot throttle cable. The motorised system only replaces the foot pedal arrangement.

An electric linear actuator has been mounted under the dash and clamped to the keel.

The linear actuator has a stroke of 50mm, with a travel speed of 8mm/s. The travel of the throttle cable is 36mm, therefore a lever arrangement was used for the stroke reduction.

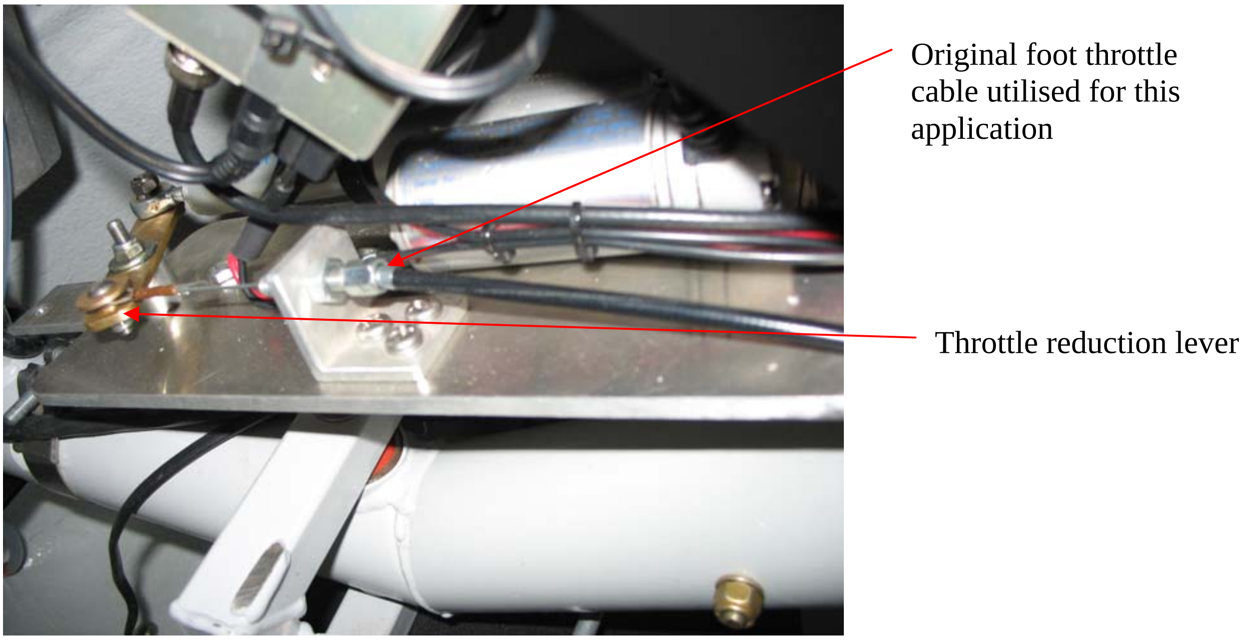


Figure 14 – Throttle (left side)

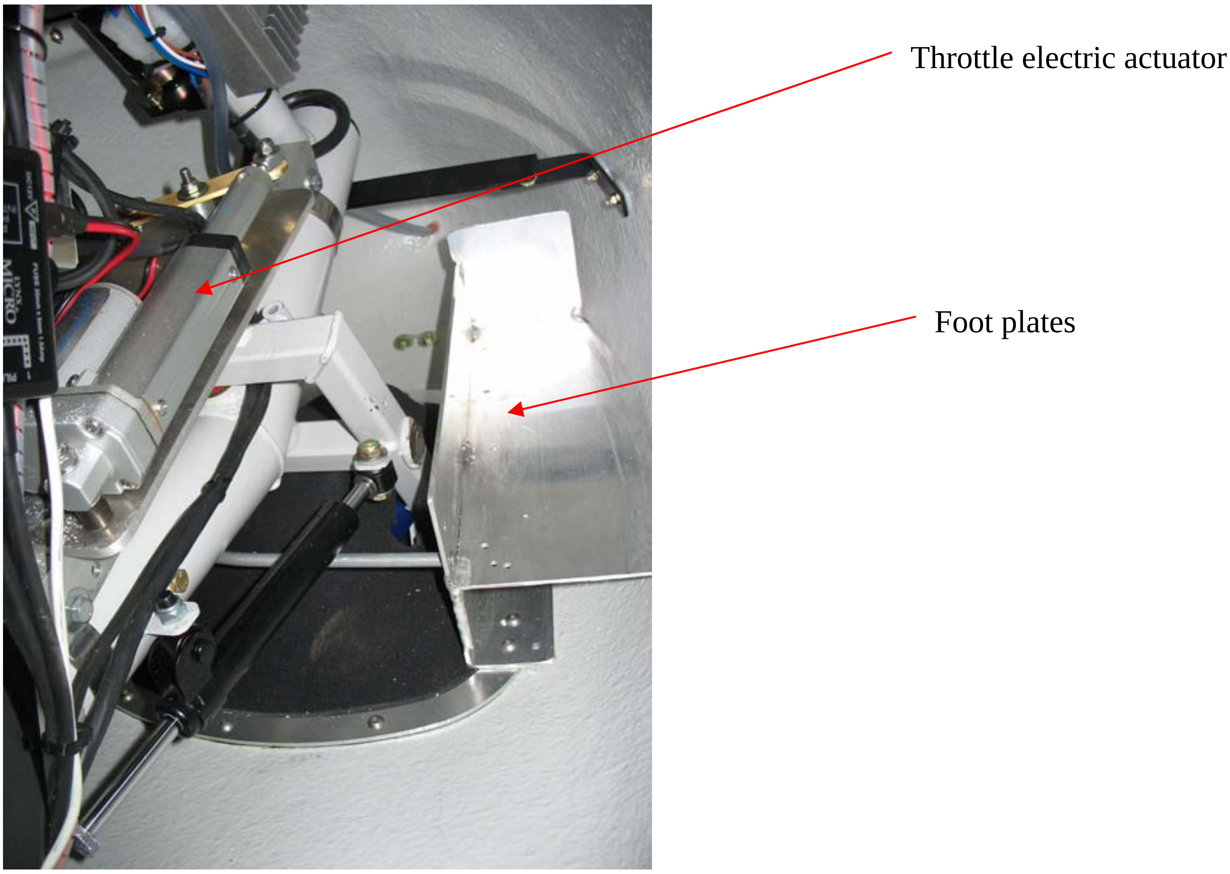


Figure 15 – Throttle (right side)

The control of the throttle/actuator is achieved by the uses of two push buttons positioned on the control bar centre posts. The Red one on the left side throttles down and the Green one on the right throttles up the engine. The positioning of these push buttons allows me to keep my wrists and hands in position, while pressing the switches (throttling up and down), maintaining full control of the wing at all times. The switches are IP65 Rated therefore wet conditions are not an issue and they are suitable for extreme temperatures.

Small adjustments of the throttling can be achieved by quick clicks of the pushbuttons or depress it for longer greater throttle adjustment.

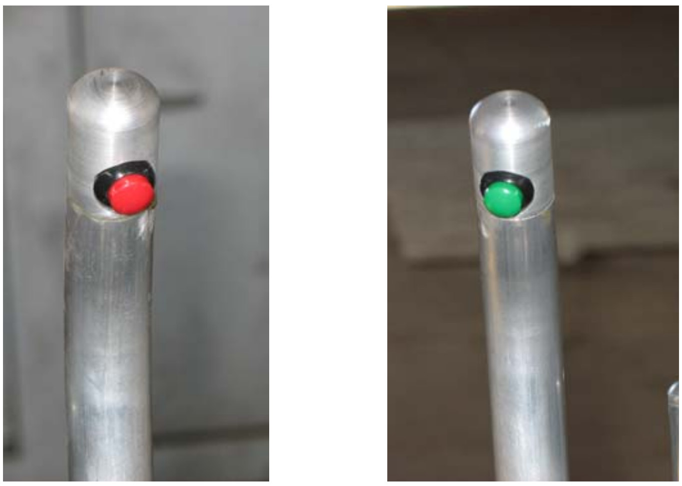


Figure 16 – Throttle control push buttons

As a safety measure a secondary throttle control has been included in case one of the push buttons fails. The control is a joystick located on the left hand side of the Control Bar.

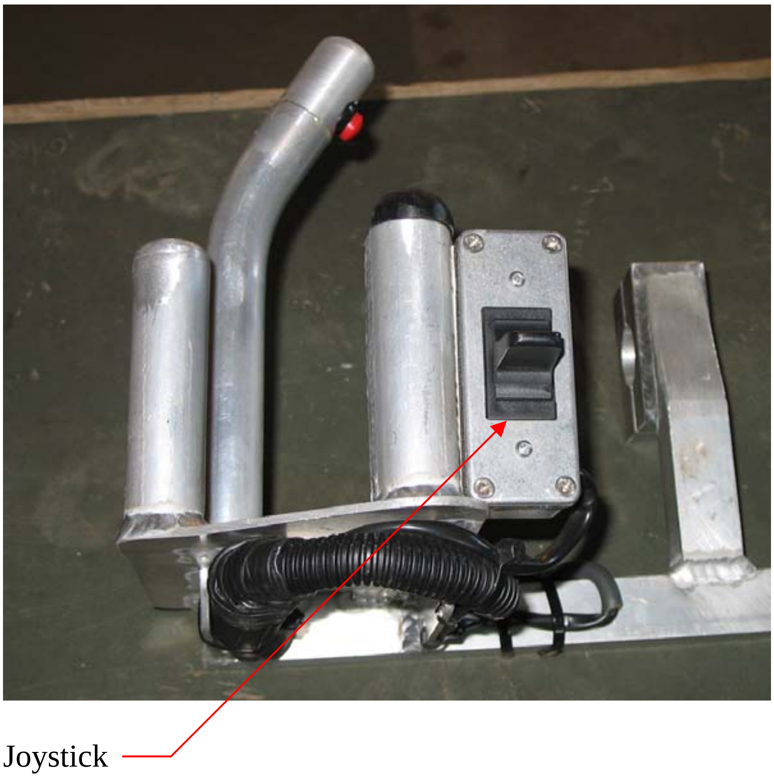


Figure 17 – Secondary/Backup throttle Control

Operational Safety

As part of the pre-start-up checks the correct operation of the actuator is verified by testing the primary and secondary control.

Prior to starting the engine, confirmation that the actuator is in the throttled down position, as with the cruise throttle, is undertaken.

Similarly, as with the original foot throttle arrangement, if the actuator stopped working and was in a throttled up position (same as if the foot throttle jammed in the throttled up position) the same emergency shutdown procedures would be undertaken.

In addition, if the actuator stopped working (in the throttled down position), the existing cruise throttle can be used as a backup in flight.

Brake

The existing foot brake has been converted to a hand lever operated brake. The brakes are hydraulic disc brakes. The hydraulic actuator was originally on the forks and operated via a foot pedal. The hydraulic actuator has been located on the seat frame and attached by a clamping arrangement. The hand lever folds back out of the way when not required.

Figure 18 & 19 – Hydraulic disc brake lever

On/Off Switches

The existing On/Off magneto switches were extremely difficult to use without finger function due to the switches being recessed inside a “U” bracket. The bracket was replaced with a mounting plate that was open on the side allowing clear access to operate the switches. The direction of the switches was reversed to allow easier operation for turning them off. To ensure the switches could not be accidentally operated switch covers are installed.

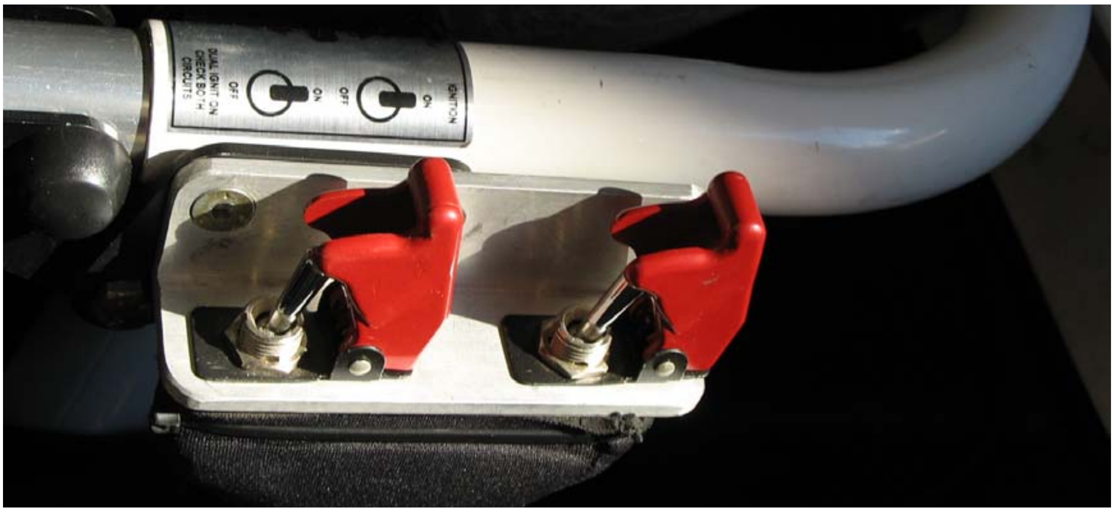


Figure 20 – On/Off Switches (shown in OFF position)