

# **Installing and Operating the CSC-1/P Constant Speed Controller**

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Unless indicated otherwise, the contents of this document applies to any revision of the product's software.

The CSC-1 software revision number format has changed from X.Y to X. The last old-style revision was 1.163 and the first new-style revision is 455. The revision numbers always increase in value but are not necessarily consecutive.

#### Document Revision History

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# Chapter 1

## Introduction

This document describes how to install and use the Smart Avionics CSC-1/P constant speed controller. The CSC-1/P is designed to control an Arplast PV50 or PV55 variable pitch propeller fitted to a Rotax 912, 912S or 914 engine. Other engine types may be used as long as a suitable tachometer signal is available.

The CSC-1/P completely replaces the original control box and pitch display supplied with the PV50. The PV50's pitch sensor is retained to supply pitch information to the CSC-1/P. Optionally, the original pitch control switch may be retained and used with the CSC-1/P.

As the CSC-1/P continuously displays engine RPM, it may either replace, or work alongside, an existing tachometer.

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### **Important**

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The CSC-1/P is intended to be installed only in home-built or experimental category aircraft. Use in any other category aircraft is not approved by Smart Avionics.

For safe and reliable operation and to ensure that you get the maximum benefit from the CSC-1/P, it is important that you understand and comply with the installation and operating instructions contained in this document.

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## 1.1 Controller Capabilities

The controller provides the following capabilities:

### Multi-mode constant speed controller

Operates as an intelligent propeller pitch control system that maximises aircraft performance and reduces pilot workload.

### Tachometer

Displays engine revolutions to the nearest 10 RPM.

### Propeller pitch display (PV50 only)

Displays propeller pitch as a percentage (0–99%).

### Propeller pitch limit indication (PV55 only)

Indicates when the propeller has reached the fine or coarse pitch limits.

### Manifold pressure display

When combined with an external manifold pressure sensor<sup>1</sup>, the CSC-1/P displays manifold pressure as either inches of mercury (”Hg) or as an approximate percentage engine power.<sup>2</sup>

### Engine hours meter

When the engine is not running, the controller displays total tachometer time.

### Highly configurable

Many of the controller’s operational parameters can be adjusted from a simple to use ‘setup mode’.

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<sup>1</sup>Such as the Smart Avionics MPS-1. Unless indicated otherwise, the remainder of this document assumes that a manifold pressure sensor is fitted.

<sup>2</sup>Currently, the approximate percentage engine power display is only available when using a Rotax 4-stroke, Jabiru or fuel injected engine.

## 1.2 Overview of Operation

Electric variable pitch propellers have been around for a long time but it is only fairly recently that they have become popular with homebuilt aircraft constructors. As the engines fitted to most homebuilt aircraft are relatively small, using a variable pitch propeller can radically improve the aircraft's takeoff performance. The best results are obtained when the variable pitch propeller is used in conjunction with a constant speed controller.

A constant speed controller ensures that, for a given throttle setting, the engine RPM is constant irrespective of the aircraft's airspeed. This is achieved by altering the pitch of the propeller. If the RPM is less than the desired value (the target RPM), the propeller pitch is reduced and this will cause the RPM to increase. Conversely, if the RPM is greater than the target RPM, the propeller pitch will be increased and this will cause the RPM to reduce. In practice, the controller allows the RPM to vary slightly from the target RPM before making an adjustment to avoid continuously making very small propeller pitch changes. This variation is specified as a 'dead band' around the target RPM. So, if the target RPM is, say, 5300 and the dead band is 100 RPM, the pitch will be reduced if the measured RPM falls below 5200 and the pitch will be increased if the RPM is 5400 or greater.

The main benefit of using a constant speed controller is obtained at takeoff. At takeoff, the propeller pitch will be controlled such that the engine will deliver maximum power without exceeding the maximum allowed engine RPM. By contrast, if the aircraft is fitted with a variable pitch propeller alone, the pilot has to adjust the propeller pitch manually during takeoff to avoid reaching the 'red line'. As the pilot is also flying the aircraft and keeping an exemplary lookout, the actual propeller pitch used (and, therefore, performance) only approximates the ideal profile. Generally, the pilot will set the propeller pitch somewhat coarser than optimal to ensure that the engine does not exceed the maximum allowed RPM.

Using a constant speed controller, therefore, provides a dual benefit – it not only maximises the takeoff power by ensur-

ing that the RPM is maintained just below the red line but it also reduces pilot workload during one of the most important phases of flight.

### 1.3 Controller Display and Switches

The CSC-1/P has been designed to be very simple to use; in flight, the pilot only has to operate one push button and one toggle switch. Figure 1.1 shows the Pilot's view of the CSC-1/P when used with a PV50.

Figure 1.1: Pilot's View of the Controller



The pilot's view of the controller consists of:

#### **LCD display**

This continuously displays (clockwise from top left):

#### **Actual engine RPM**

The RPM value is rounded to the nearest 10.

**Operating mode**

The current operating mode is displayed (OFF, MAN, CRS or CLM).

**Percentage propeller pitch (PV50 only)**

The pitch of the propeller is displayed as a percentage. The displayed value is rounded to the nearest 5%. 0% indicates that the propeller is fully fine and 99% indicates fully coarse.<sup>3</sup>

**Propeller pitch limit indicator (PV55 only)**

When the propeller pitch becomes fully fine, -- is displayed below the last two characters of the operating mode. When the pitch becomes fully coarse, ++ is displayed. At other times, the pitch limit indicator is blank.

**Propeller pitch change indicator**

While the propeller pitch is being increased by the controller, + is displayed below the first character of the operating mode. While the pitch is being decreased, - is displayed. If in cruise mode and the throttle has been closed, T is displayed. For the PV50, if a fine pitch limit has been reached, L is displayed.

**Manifold pressure / engine power level**

The Manifold Absolute Pressure (MAP) may be displayed either as a pressure (in inches of mercury) or as an approximate percentage power (suffixed with a % character)<sup>4</sup>.

When climb or cruise modes are selected, or whenever the target RPM is being adjusted, the target RPM is displayed for a short time in place of the manifold pressure.

**RPM! indicator**

This is a warning indicator to alert the pilot to consider the RPM. The indicator may light up either red or yellow as follows:

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<sup>3</sup>As the pitch display uses just 2 digits, full scale is 99% rather than 100%.

<sup>4</sup>For some installations, an estimated fuel flow can be displayed here instead of percentage power.

**Continuous red**

This indicates that the RPM has reached the ‘red line’ (maximum allowed RPM).

**Continuous yellow**

This indicates that the RPM has reached the ‘yellow line’ (maximum continuous RPM).

**Continuous yellow with red flashes**

If the RPM is maintained above the maximum continuous RPM for more than 4 minutes<sup>5</sup>, the indicator flashes red to alert the pilot to the need to reduce the RPM.

**Flashing red**

This indicates that the RPM has fallen below 4000<sup>6</sup> and that cruise mode is still selected. The idea here is to alert the pilot to the need to select either manual or climb mode as it is likely that the throttle has been closed for descent.

**OK/DISABLE switch**

Enables/disables the automatic control functionality. In the DISABLE position, the computer is completely disconnected and the +/– switch can be used to change the propeller pitch manually. In normal operation, the OK/DISABLE switch can always be left in the OK position.

**+/– switch**

Depending on the mode of the controller, this switch either directly controls the propeller pitch or adjusts the target RPM. Pushing the switch up reduces the propeller pitch (increases RPM) and pushing the switch down increases the propeller pitch (decreases RPM).

**MODE button**

Pressing the MODE button changes the controller’s mode of operation (assuming the OK/DISABLE switch is in the OK position).

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<sup>5</sup>Time period configurable.

<sup>6</sup>RPM configurable.

**Pitch motor active indicator (optional)**

An optional panel mounted indicator can be installed that illuminates when the propeller pitch motor is active and has not reached a limit stop.

**External switches (optional)**

If required, external switches can be connected to duplicate the MODE button and +/– switch.

When power is applied to the controller, it flashes the RPM! indicator and briefly displays a banner and the software revision number. The total engine hours run is then displayed until either the MODE button or the +/– switch is pressed or the engine is started.

## 1.4 Controller Modes

The following modes of operation are provided:

### 1.4.1 Disabled mode

The controller is in disabled mode when the OK/DISABLE switch is in the DISABLE position. Propeller pitch control is via the +/– switch. All automatic control is disabled and the mode display will show OFF. The current RPM, propeller pitch and manifold pressure will continue to be updated on the display.

### 1.4.2 Manual mode

Propeller pitch control is manually adjusted using the +/– switch. Automatic RPM limiting is enabled. This means that if the RPM reaches the preset limit RPM, the pitch will be automatically coarsened to avoid exceeding the engine's maximum allowed RPM. The mode display will show MAN when the controller is in manual mode.

When power is applied to the controller, it always starts in manual mode (assuming the OK/DISABLE switch is in the OK position). It is not possible to change to another mode until the engine is started. Once the engine is running, if the MODE button is pressed briefly, the mode changes to cruise. If the MODE button is pressed for at least 3/4 of a second, the mode changes to climb.

### 1.4.3 Cruise mode

The controller endeavours to keep the RPM within a 'dead band' around the target RPM by adjusting the propeller pitch. The default value of the cruise mode target RPM is 5000. The target RPM may be adjusted in steps of 50 RPM using the +/–

switch<sup>7</sup>. On leaving cruise mode, the current target RPM is remembered and when, subsequently, cruise mode is entered again, that RPM value is reinstated. The mode display will show CRS when the controller is in cruise mode.

Pressing the MODE button briefly, reverts the mode to manual. Pressing the MODE button for at least 3/4 of a second selects climb mode.

If the RPM is less than half of the target RPM, the constant speed function is inhibited.

#### 1.4.4 Climb mode

Similar to cruise mode, except that on entering climb mode, the target RPM is set to the preset 'Climb RPM' and the mode display will show CLM. The target RPM may be adjusted in steps of 50 RPM using the +/– switch<sup>8</sup> but, unlike cruise mode, the current target RPM value is not remembered when climb mode is exited. This means that the next time climb mode is entered, the target RPM will again be set to the preset climb mode target RPM value (which can be altered using setup mode). The preset target RPM value is always used when climb mode is entered to reduce pilot workload by removing the need for the pilot to check (and possibly adjust) the target RPM.

Pushing the MODE button for a minimum of 3/4 of a second always selects climb mode (assuming the controller is not disabled using the OK/DISABLE switch). Pushing the MODE button briefly while in climb mode, reverts the controller to cruise mode.

If the RPM is less than half of the target RPM, the constant speed function is inhibited.

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<sup>7</sup>Software versions 1.155 onwards constrain the cruise mode target RPM to be no less than the value of the **Low RPM** parameter and no more than the value of the **Limit RPM** parameter.

<sup>8</sup>Software versions 1.155 onwards constrain the climb mode target RPM to be no less than the cruise mode target RPM and no more than the value of the **Limit RPM** parameter.

Table 1.1: Mode Change Procedure Summary

	To Manual	To Cruise	To Climb
From Manual		Press MODE button briefly once	Press MODE button for 3/4 second
From Cruise	Press MODE button briefly once		Press MODE button for 3/4 second
From Climb	Press MODE button briefly twice	Press MODE button briefly once	

## 1.5 Engine Power Display

For some engine types, the CSC-1/P can display the engine power level as a percentage of the maximum achievable power. Alternatively, if the engine is fuel injected or a MPS-1D differential MAP sensor is being used, the power level can be displayed as an estimated fuel flow.

### 1.5.1 Rotax 4-stroke engine power display

The displayed values are calculated from the current manifold pressure and RPM. The relationship between RPM, manifold pressure and engine power level is complex and so the controller derives the power level from the measured values using a set of profiles that approximate the real relationship. To account for the different characteristics of the Rotax 912, 912S and 914 engines, a different set of power level profiles is required for each engine and the correct engine type must be selected for the results to be valid (default is 912).

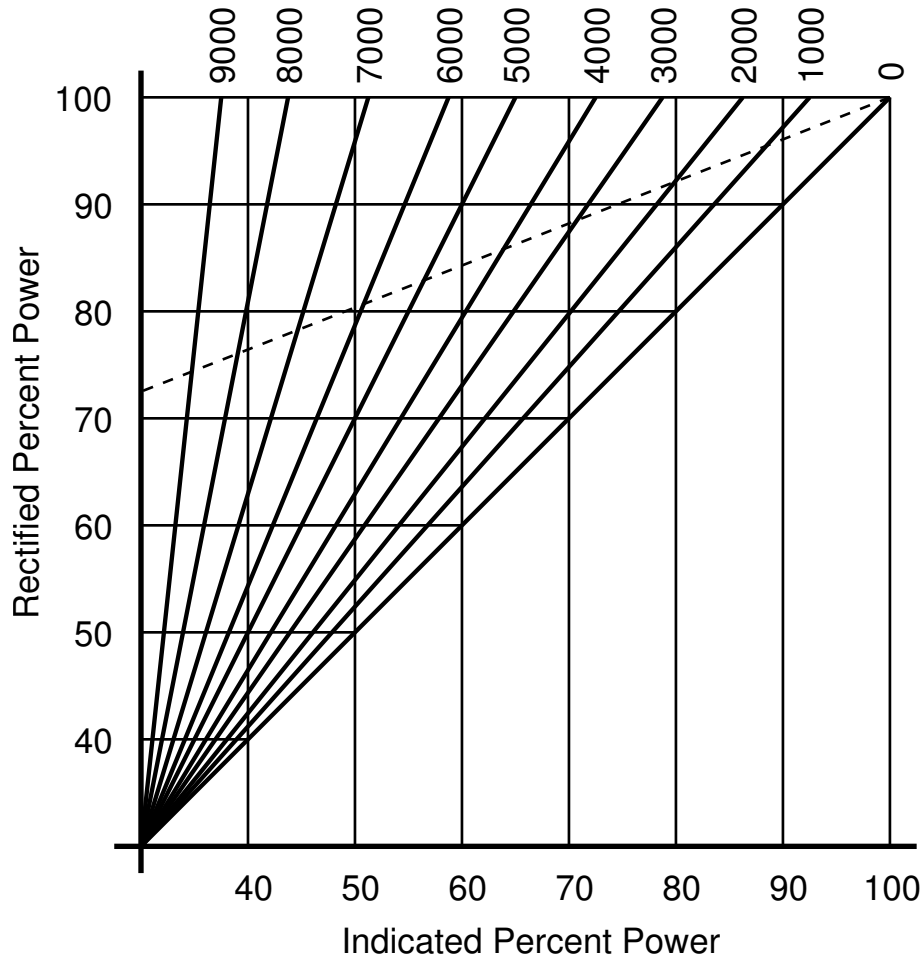
Although the percentage power values displayed are consistent inasmuch that the same value is always shown for a given combination of RPM and manifold pressure, it should be remembered that the displayed values are only an approximation to the actual engine power level.

In particular, for non-turbo engines (912 and 912S), as altitude is gained, the power display progressively underreads when using a manifold pressure sensor that measures absolute pressure. The amount the display underreads is dependent on both the altitude (relative to the 1013mB level) and the throttle setting. For low power settings (around 40%) the display underreads by approximately 1 per 1000 feet of altitude. At high power settings (around 80%) the display underreads by approximately 5 per 1000 feet. For power settings between 40% and 80% the deficit scales linearly between 1 and 5. For example, when flying with a high power setting at FL30 (3000' above the 1013mB level), the power display will be underreading by  $3 \times 5 = 15$ .

Figure 1.2 on the next page can be used to quickly determine the 'rectified percent power' from an 'indicated percent power'

and altitude (relative to 1013mB). Simply follow the indicated power up to the appropriate altitude line and read the rectified percent power on the left. The sloping dashed line indicates the maximum possible power achievable for each altitude.

Figure 1.2: Power Display Altitude Correction for 912/912S



When using the MPS-1/D differential pressure sensor, the percentage power display is not affected to any great extent by the altitude.

### 1.5.2 Jabiru engine power display

The displayed values are calculated from the current manifold pressure and RPM. One profile (called Jab) is currently available and this is based on data for the 3300 engine. It is

likely that the profile will also give reasonable results with the smaller 2200 engine.

Although the percentage power values displayed are consistent inasmuch that the same value is always shown for a given combination of RPM and manifold pressure, it should be remembered that the displayed values are only an approximation to the actual engine power level. In particular, as altitude is gained, the power display progressively undereads.

### 1.5.3 Fuel injected engine power display

The displayed values are calculated from the current RPM and fuel injector pulse width. For the CSC-1/P to be able to do this, its tachometer input must be connected to one of the fuel injector drive signals and a configuration parameter (**WOT Inj Time**) must be set to the correct value for your engine.

## 1.6 Safety Features

The CSC-1/P's hardware and software has been carefully designed to provide reliable and safe operation. Safety related features of the design are:

- A front panel switch that completely isolates the computer control from the pitch motor drive circuitry. In the unlikely event of a hardware or software failure, the computer control can be disabled and manual control used instead.
- Propeller pitch motor output protected against short-circuit and overload.
- Software is designed to reduce pilot workload to a minimum.
- Utilises a single-chip microcontroller that is specifically designed for embedded control applications. By using a single-chip solution, the controller is more reliable and less likely to either produce or be affected by electrical noise.
- On powering up, the microcontroller verifies the integrity of its program memory to ensure that it has not become corrupted.
- A built in 'watchdog timer' resets the microcontroller to a safe known state within a fraction of a second if the software fails to operate correctly.
- The CSC-1/P's software can easily be upgraded should a safety critical problem be identified or the product is significantly enhanced.

## **1.7 Product Support**

Product support information (including the latest version of this document) is available from the Smart Avionics web site, [www.smartavionics.com](http://www.smartavionics.com).

If you have a problem installing or operating the CSC-1/P that is not covered by this document, please send email to [support@smartavionics.com](mailto:support@smartavionics.com).

Smart Avionics is committed to providing high quality, good value products. To that end, we would very much like to receive your feedback. If you have any comments or suggestions for product improvements please send them to us at the above email address.



# Chapter 2

## Installation & Setup

This chapter describes how the controller should be installed in your aircraft and how to set up the controller to match your particular propeller. The installation is not difficult and should not present any problems as long as the recommendations below are observed.

For details of the installation of the propeller and the associated wiring, please refer to the documentation supplied with the propeller.

Please read all of this chapter before proceeding.

### 2.1 Mechanical Considerations

The controller is designed to fit in a standard 57mm instrument panel cutout. Four M4 screws (supplied) attach the controller's enclosure to the instrument panel. No other support is required.

The length of the M4 screws should not be greater than 10mm + the thickness of the instrument panel.

### 2.2 Environmental Considerations

The controller is robust but should be protected against excessive vibration.

## 2.3 Electrical Considerations

Please refer to Appendix B (*Connections*) for a full list of the controller's external connections and a connection diagram.

To ensure trouble free operation of the controller, it is important that the following points are observed:

1. Preferably, fuses should be used to protect the CSC-1/P and its associated wiring. Alternatively, circuit breakers can be used but they do not provide as good protection as fuses and the voltage drop across them can be twice that of a fuse.
2. The pink wire from the PV50/PV55 is connected to pin 2 of the D-type connector. The brown wire from the PV50/PV55 is not used because the PV50/PV55 motor return current is carried through the engine which is grounded. You can either disconnect the brown wire and leave it in place or remove it completely.
3. The controller's pitch motor power supply (pin 1 of the D-type connector) must be connected to +12V using wire no thinner than 20 AWG and protected with a 3A fuse. The best protection is provided by a quick blow (F type) fuse.
4. The controller's logic ground connection (pin 14 of the D-type connector) must be connected to a high quality ground using wire no thinner than 20 AWG. If the instrument panel is fitted with a ground bus-bar or common ground connection, that would be a suitable ground.
5. The controller's logic power supply (pin 8 of the D-type connector) should be connected to +12V via a fuse. As the amount of current drawn from this supply by the controller is quite small ( $< 100$  mA), the fuse rating (and the wire gauge) is not critical. A fuse of 1A to 3A would be adequate as the fuse is really there to protect the wiring.

The controller's logic and pitch motor power supplies can be combined and connected to +12V via a single fuse. The advantage of doing this is simply that only one fuse is required. The disadvantage is that, if the fuse failed, the controller will not function at all. In practice, the fuse is unlikely to

fail as the pitch motor output is internally protected against overload (short-circuit). Therefore, even if the pitch motor developed a fault or the pitch motor output was shorted to ground, the pitch motor supply fuse should not blow.

## 6. Rotax engine

The tachometer input (pin 4 of the D-type connector) should be connected to one side of the Rotax tachometer pickup. The other side of the tachometer pickup is connected to ground. If you wish to use an additional tachometer instrument (for example, the Rotax analogue unit), simply connect the tachometer pickup signal to both units. If you find that connecting an additional tachometer stops the controller from measuring RPM, it is most likely that the additional tachometer is loading the signal excessively. To compensate for this, you will need to adjust the controller's tachometer sensitivity as described in Section 2.5.4 on page 29. Connecting a Rotax analogue tachometer does not require the sensitivity to be adjusted.

## Non-Rotax engine

The tachometer input (pin 4 of the D-type connector) should be connected to a suitable signal that provides one or more pulses per revolution of the engine. Please consult the documentation provided by the engine manufacturer to determine the correct signal to use. If your engine is fuel injected, one of the fuel injector drive signals can be used and this will allow the CSC-1/P to calculate percentage power.

If a suitable signal is not available, you can generate a tachometer signal by wrapping a few (3-6) turns of insulated solid core copper wire around an ignition lead and then connecting one end to the CSC-1/P's tachometer input. In this case, it is likely that the **Tacho Div** parameter will need to be set to 0 to multiply the RPM by 2.

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### Important

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Do not connect the tachometer input directly to any high voltage signal (such as an ignition lead!)

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By default, the controller's tachometer sensitivity is set for use with a Rotax tacho signal. You will almost certainly need to change the sensitivity (as described in Section 2.5.4 on page 29) to obtain correct operation. For 12V tachometer signals, set the tachometer sensitivity value to 55.

If the signal pulses more than once per revolution of the engine, the **Tacho Div** parameter must be set to the appropriate divisor value to ensure the RPM measurement is correct.

## 7. PV50

Because of the small signal levels involved, it is beneficial to shield the three wires that go to the propeller pitch sensor. This can easily be done by threading a braided sleeve over the wires and then grounding one end of the sleeve. By reducing the electrical noise picked up by these wires, the pitch display stability will be improved. Electrical noise can also be reduced by looping the wires through a ferrite core.

## PV55

As a propeller pitch sensor is not fitted, the Pitch Sense In connection (pin 6 of the D-type connector) should be connected to Pitch Sense Ground (pin 7). The **Sense Pitch** parameter must be set to 0 to tell the controller to ignore the pitch information.

8. If external switches are to be connected to the Pitch -, Pitch + or Mode inputs (pins 11, 12 and 13 respectively of the D-type connector), these must be good quality, normally open switches that connect the respective input to ground when pressed. To stop the controller being affected by electrical noise it is important that shielded cable is used to connect the switches (the shield being connected to ground).

## 9. MAP sensor fitted

The manifold pressure sensor output should be connected to MAP Sensor In (pin 10 of the D-type connector). Power for the MAP sensor can be taken from Auxiliary Supply Out (pin 3). For your convenience, pin 9 (MAP Sensor Ground) is internally

connected to ground and can be used as the ground for the MAP sensor.

For software revisions 1.157 onwards, the **MAP Type** parameter must be set appropriately to match the type of MAP sensor fitted. For software revisions 1.143 onwards, the **Have Map** parameter must be set to 1 to enable the MAP display.

#### **No MAP sensor fitted**

For software revisions 1.157 onwards, the **MAP Type** parameter must be set to None to disable the MAP display. For software revisions 1.143 onwards, the **Have Map** parameter must be set to 0 to disable the MAP display. For software revisions before 1.143, MAP Sensor In must be connected to MAP Sensor Ground (pin 9 to pin 10) to disable the MAP display.

10. If a pitch motor active indicator is to be fitted, it must be wired between +12V and the Pitch Changing connection (pin 15) of the D-type connector. The indicator should not consume more than 250mA. If you use a LED indicator, make sure that either the indicator is rated for 12V operation or that an external resistor is wired in series to limit the current (typically, a value between 470 and 1000 ohms is suitable). The LED supplied with the PV50 can be used if an external resistor is added. To protect the wiring and the controller, it is recommended that the positive side of the indicator should be connected to either +12V via a quick blow fuse of not more than 1A rating or directly to the Auxiliary Supply Out (pin 3).
11. Pin 3 of the D-type connector (Auxiliary Supply Out) provides an auxiliary power output that can be used to supply +12V for both the pitch motor active indicator and the manifold pressure sensor. This output is internally connected to the logic power supply (pin 8) via a protection device that limits the current that it can supply to less than 250mA.
12. If the D-type plug used is of the solder type (as supplied), make sure that the soldered connections are of good quality

and that the individual connections are sleeved (heat-shrink sleeving supplied).

13. A D-type connector shell (supplied) must be used to provide mechanical protection and cable strain relief. Furthermore, it is important that the screws that hold the D-Type plug in its socket are tightened. This will ensure that the plug is securely attached.

## 2.4 Installation Approval

Before the aircraft can be flown with the CSC-1/P installed, the installation has to be approved. Exactly how this is achieved differs from country to country.

In the UK, the installation must be inspected and approved by your LAA inspector, entries made in the airframe, engine and propeller log books and a new Flight Release Certificate issued before the aircraft is flown with the CSC-1/P installed.

Appendix C (*LAA Inspection Checklist*) lists the items the inspector should check before approving your installation.

If yours is the first installation of a particular combination of propeller type, engine type, aircraft type and controller, the LAA may require you to carry out an initial evaluation to ensure the controller works satisfactorily before approving the usage of the controller in that aircraft. If problems arise, please contact Smart Avionics.

## 2.5 Controller Setup

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### Important

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Once the controller has been satisfactorily installed in the aircraft, the controller parameters must be checked and, if necessary, adjusted to the correct values before the aircraft is flown. See Section 3.1 on page 31 for directions on how to set controller parameters.

- The default values for the various RPM parameters are suitable for Rotax engines and must be changed if you are using another type of engine.
- If controlling a PV50, the pitch calibration procedure must be carried out. When the pitch has been calibrated, the controller will no longer ask whether to do the pitch calibration after it is powered up.
- If controlling a PV55 you must set the value of the **Sense Pitch** parameter to 0 to disable the pitch sensing. When you first apply power to the controller it will ask whether to carry out the pitch calibration procedure. Cancel this by pressing the MODE button and then enter setup mode (see Section 3.1 on page 31 for details of how to do this) and set **Sense Pitch** to 0. Once this is done, the controller will no longer ask if you want to carry out the pitch calibration procedure.
- If you have fitted a MAP sensor and you wish to display percentage engine power, you will need to select the correct engine type.

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The following sections provide detailed information on specific aspects of controller setup

### 2.5.1 Pitch calibration procedure (PV50 only)

The purpose of this procedure is to determine the limit values reported by the pitch sensor when the propeller has been driven to the ends of its pitch adjustment range.

Although it is possible that this procedure can be carried out with the engine stopped, it is much better to carry out the procedure with the engine running. There are two reasons for this: it reduces the load on the PV50 motor and it yields a slightly more accurate calibration. The RPM used is not particularly critical, somewhere around 2000–3000 is about right. If too low an RPM is chosen, the engine will labour when the propeller pitch goes fully coarse. If too high an RPM is chosen, the engine may exceed the red line RPM if the propeller's fine pitch limit (as determined by the microswitches in the propeller hub) is very fine. However, if during the procedure, the engine RPM becomes excessively low or high you can adjust the throttle accordingly without it affecting the calibration.

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**Important**

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As with any ground testing, make sure that the aircraft is safely positioned and that the brakes are adequate to stop the aircraft moving. If in doubt, use chocks. You do not need to use a lot of power to carry out the pitch calibration, just enough to stop the engine labouring badly when the pitch goes fully coarse.

It is essential that the PV50 limit switches are set correctly such that the propeller can be driven to both the fully coarse and fully fine positions (as determined by the limit switches) without the pitch change mechanism reaching the end of its travel. Check also that the spinner does not restrict the range of blade pitch movement.

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The pitch calibration procedure firstly drives the propeller to the fully fine position; after a few seconds it drives the propeller to the fully coarse position. The propeller is then returned to the 50% pitch position as determined by the pitch sensor.

At any time, the procedure may be interrupted by moving the OK/DISABLE switch to the DISABLE position.

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**Note**

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The numbers that are displayed in the bottom right hand of the display are the raw values that are measured by the pitch sensor. Although the displayed values can be anywhere between 0 and 1023, the actual range of val-

ues displayed will be quite small. As long as the pitch measurement potentiometer does not reach either end of its travel, the actual position of the actuating arm on the potentiometer spindle is irrelevant.

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To carry out the calibration, do the following:

1. With the controller OK/DISABLE switch in the OK position, apply power to the controller. When asked whether to calibrate the pitch, initially select 'No' by pushing the MODE button briefly.
2. Start the engine and run it at the normal warm up speed. If the display does not show the correct RPM then it is possible that the tachometer level needs to be adjusted as described in Section 2.5.4 on page 29. However, the default value for the tachometer level should be fine for most installations and if the RPM is not correctly displayed then a more likely cause is a wiring problem.
3. Once the engine is warmed, set the RPM to approximately 2500 and the controller's OK/DISABLE switch to the OK position. Now, either cycle the power to the controller and when it asks whether to calibrate the pitch select 'Yes' by pressing the +/- switch in any direction, or invoke the pitch calibration procedure via setup mode (described in Section 3.1 on page 31).

If you wish to repeat the calibration in the future, you can invoke the calibration procedure from setup mode (see Section 3.1 on page 31). Reasons for recalibration would be that the propeller pitch limit switches have been moved or that the pitch sensor potentiometer has been altered in some way.

Initial setup of the controller is now complete. However, it is likely that the fine pitch limit values will have to be adjusted. The need to carry out this adjustment is determined by a test flight and the adjustment procedure is described in the next section.

### 2.5.2 Fine pitch limit adjustment (PV50 only)

The reason for having a fine pitch limit (FPL) is to stop the controller driving the propeller pitch to fully fine in a futile attempt to maintain the RPM when the throttle is closed or reduced. If this was not done, the engine would very likely exceed the red line RPM when the throttle is opened again.

Unless specified otherwise, ‘fine pitch limit’ in this document refers to the CSC-1/P’s soft limit rather than the hard limit that is imposed by the PV50’s limit microswitches.

The PV50’s microswitches determine the minimum and maximum achievable pitch settings. Once the pitch calibration has been carried out, these hard limits correspond to displayed pitch values of 0% and 99% respectively. The controller’s fine pitch limit is the minimum percentage pitch value to which the controller will drive the propeller while it is trying to increase the RPM. When the measured pitch reduces to the fine pitch limit value, the controller stops trying to reduce the pitch even though the target RPM has not been achieved.

There are two fine pitch limit values: one is used when cruise mode is selected, the other when climb mode is selected. There are separate fine pitch limits for climb and cruise modes because of the relatively large difference in airspeed used in these modes. Because the aircraft is flown with a higher airspeed while cruising compared to when it is climbing, a higher value for the fine pitch limit can be used for cruise mode. This will provide better protection against exceeding the red line RPM when the throttle is opened quickly.

As the pitch limit microswitches will almost certainly be positioned differently for each propeller installation, it is necessary to carry out this adjustment procedure to ensure that the desired RPM can be achieved in the climb.

**The pitch calibration procedure (see Section 2.5.1 on page 23) must be carried out before trying to set the fine pitch limit values.**

The correct value for the climb mode fine pitch limit is easily determined from a test flight as follows:

1. Using manual mode, adjust the pitch such that the desired

climb RPM is achieved at the normal climb airspeed and throttle setting, e.g. for a Europa that could be 5700 RPM, 75 kts airspeed and full throttle. Note the percentage pitch displayed.

2. When back on the ground, set the **CLM FPL** parameter to a value that is either the same as, or slightly less than, the value noted in flight. This will ensure that the propeller pitch can be reduced to a value that will give good climb performance while still providing some protection against over-speeding the engine. Section 3.1 on page 31 describes how to set controller parameters.

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**Note**

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It may be that the actual RPM achieved is less than the desired value. If this is the case (assuming that the engine is producing the correct amount of power and that the airspeed is not too low), this indicates that the propeller's fine pitch limit microswitch needs adjusting to allow the pitch to become finer.

Alternatively, if the target RPM is achieved in the climb but the percentage pitch displayed is larger than 15% then it may be that the fine pitch microswitch is positioned such that the propeller pitch can be reduced to a value that is somewhat finer than is desirable in terms of reducing the chance of exceeding the maximum allowed RPM.

Another reason why the percentage pitch displayed is relatively large is because the coarse pitch limit microswitch is incorrectly set too fine. If this is the case, it will become apparent when using cruise mode because the controller will be unable to reduce the RPM to the cruise mode target value since it cannot make the propeller pitch coarse enough.

Please remember that if you move the PV50's limit microswitches, the CSC-1/P's pitch calibration procedure must be repeated.

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When the fine pitch limit is reached while the controller is trying to increase the RPM by reducing the pitch, the display

shows an 'L' character instead of a '-'. This limiting action is to be expected when either the throttle is not at a high setting or the airspeed is low. However, if the 'L' is displayed at full throttle and the airspeed is greater than  $V_x$  (or the minimum airspeed expected to be used while climbing), the climb mode fine pitch limit is too large and needs to be reduced.

**It is recommended that your first use of climb mode is carried out at altitude rather than during an actual takeoff.** This is because if the climb mode fine pitch limit is too coarse, the necessary climb RPM will not be achieved and this could be hazardous during a real takeoff. Once you are happy that the correct climb RPM is being achieved, you can use climb mode for takeoff.

The cruise mode fine pitch limit should be such that the cruise mode target RPM is achievable while flying either at the lowest airspeed to be used in cruise mode or with the lowest throttle setting to be used in cruise mode.

If desired, either of the controller's fine pitch limits can be disabled by setting the respective parameter to 0. However, if this is done, the pilot must take care to open the throttle more slowly to ensure that the red line RPM is not exceeded.

### 2.5.3 Throttle closed sensing

[Revision 1.148 and later] If a MAP sensor is fitted, the CSC-1/P can detect when the throttle has been closed (or nearly closed) and it will inhibit the propeller pitch change that would otherwise occur in a futile attempt to maintain the target RPM. If this was not done, the propeller pitch would be reduced all the way to the fine limit and then the throttle would have to be opened with care to avoid exceeding the red line RPM. This feature is only active in cruise mode and is most useful when descending from the overhead to circuit height. The pitch indicator displays a T when this feature is active.

The throttle has to be reduced quite quickly for the controller to detect the change. Don't slam the throttle shut, but don't take too long either. In practice, when the throttle is closed, the RPM decreases and for a short while the propeller pitch

is reduced. However, after a very short delay, the controller detects the throttle closure and inhibits any further pitch reduction. Subsequently, when the throttle is opened again (or climb mode is selected) the propeller pitch changes again.

For this feature to work correctly, the **Idle MAP Diff** parameter must be set to an appropriate value for the type of engine you are using. This parameter specifies the maximum amount the MAP can reduce from the current value before the controller detects that the throttle has been closed. Put another way, if the MAP reduces more than the value of **Idle MAP Diff** then the controller considers the throttle to have been closed and it inhibits the pitch drive. If the value of this parameter is set too low, the pitch change will be inhibited too often, i.e. when the power level is being reduced in the cruise. If, on the other hand, the value of this parameter is too high, the pitch change will not be inhibited even when the throttle is smartly closed.

For Rotax 912, 912S and 914 engines, setting **Idle MAP Diff** to a value of 3.0 works well. By default, this parameter is set to 0.0 which disables the throttle closed sensing.

What this feature achieves is very similar to the effect of the fine pitch limit feature available when controlling a PV50. Both features are trying to stop the propeller from being driven to fully fine when the throttle is closed. However, detecting when the throttle has been closed has the advantage of reducing the total amount of pitch change the propeller goes through compared to simply stopping when the cruise mode fine pitch limit is reached.

#### 2.5.4 Tachometer sensitivity adjustment

The tachometer input sensitivity is preset to a value that should be suitable for most installations (Rotax engines). However, if necessary, the sensitivity can be adjusted to cater for tachometer signals that are either smaller than average or suffering from electrical noise. The adjustment is best carried out with the engine running so that the result of the adjustment can immediately be tested. Please observe ground running safety precautions.

The tachometer sensitivity is adjusted as follows:

1. Enter setup mode (see Section 3.1 on the next page for instructions on how to do this) and cycle through the options (using the MODE button) until the **Tacho Level** option is displayed.

2. To make the tachometer input more sensitive (perhaps because the RPM display is ‘dropping out’ at low RPM), decrease the value of the **Tacho Level** parameter using the +/– switch.

Conversely, to make the tachometer input less sensitive (perhaps because the RPM display is being affected by electrical noise), increase the value of the **Tacho Level** parameter using the +/– switch.

To have much effect, you will probably have to change the parameter value by quite a large amount.

3. Leave setup mode by moving the OK/DISABLE switch to DISABLE and then back to OK again.
4. Check that the RPM display is indicating correctly across the full RPM range and that the displayed value does not vary when the RPM is steady. If necessary, repeat the adjustment process.

# Chapter 3

## Adjusting Controller Parameters

The controller's behaviour can be modified by altering the values of various parameters. The controller is supplied with sensible default values for these parameters and so it is unlikely that you will need to change many of them.

### 3.1 Entering Setup Mode

The controller's parameters are changed via a 'setup mode'. To enter setup mode do the following:

1. Ensure the OK/DISABLE switch is in the OK position.
2. Ensure manual mode is selected (MAN displayed).
3. If the engine is running, ensure the RPM is less than half of the red line RPM.
4. Hold the +/- switch either up or down and while doing so, press the MODE button and then release both switches.

The controller will now enter setup mode and the screen will display the name of a parameter and its current value.

When the controller is in setup mode, pressing the MODE button will cycle to the next parameter and operating the +/- switch will adjust the displayed parameter value. The parameter value will be either incremented or decremented depending on the direction the +/- switch is operated.

When adjusting a numeric parameter, its value will be continuously adjusted as long as the  $+/-$  switch is held up or down (and the parameter has not reached its maximum or minimum allowed value).

If, when entering setup mode, you held the  $+/-$  switch down (+), you will cycle forwards through the parameters and if you held that switch up (-) you will cycle backwards through the parameters. While in setup mode, you can change the parameter cycling direction by holding the MODE button and pressing the  $+/-$  switch in the desired direction.

To leave setup mode, simply move the OK/DISABLE switch to the DISABLE position and then back to the OK position again.

Unless the power to the controller is removed, it will remember which parameter is currently being adjusted so that, when setup mode is entered again, the same parameter is displayed.

**It is not recommended that you use setup mode in flight.**

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### Important

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The default values for engine related parameters are suitable for Rotax engines. If you are not using a Rotax engine you will almost certainly need to change these values.

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## 3.2 Parameter Descriptions

### CLM RPM

This is the initial target RPM that is always used when climb mode is selected (default 5600). While climb mode is select, the target RPM may be adjusted using the  $+/-$  switch.

If this parameter is set to a value that is less than the stored value of the cruise mode target RPM (default value 5000), the cruise mode target RPM will be reduced to make it the same as the climb mode target RPM<sup>1</sup>.

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<sup>1</sup>The cruise mode target RPM can be altered using the  $+/-$  switch while flying in cruise mode.

### **CLM Dead Band**

This is the dead band that will be used when climb mode is selected. Using too low a value will make the controller 'nervous' and it will tend to adjust the propeller pitch too often. Using too high a value will make the controller unresponsive.

If the climb mode target RPM is near to the red line RPM (e.g. using a climb mode target RPM of, say, 5700 with a red line RPM of 5800), a small dead band will be required to ensure that the RPM is kept below the red line RPM. Using a small dead band will make the controller work a bit harder in the climb but as this phase of flight does not last for a long time it's unlikely to be a problem.

### **CRS Dead Band**

This is the dead band that will be used when cruise mode is selected. Using too low a value will make the controller 'nervous' and it will tend to adjust the propeller pitch too often. Using too high a value will make the controller unresponsive.

### **Sense Pitch**

When set to 1 (the default value), the controller senses the current propeller pitch. The displayed value is a percentage that ranges from 0 (fully fine) to 99 (fully coarse). When set to 0, the controller does not sense or display the propeller pitch and all other parameters related to pitch sensing are hidden. This parameter must be set to 0 when controlling a PV55 and set to 1 when controlling a PV50.

### **CLM FPL (PV50 only)**

This is the fine pitch limit used in climb mode (default 10%). It is likely that you will need to change this value to match your propeller setup. See Section [2.5.2](#) on page [26](#) for details of how to do this.

### **CRS FPL (PV50 only)**

This is the fine pitch limit used in cruise mode (default 20%). It should be less than the minimum pitch required in cruise mode.

**CPL (PV50 only)**

[Revision 1.151 and later] This is the coarse pitch limit. The default value is 100% which allows the pitch to be coarsened until the coarse pitch limit switch is reached. If desired, the coarse pitch limit can be set to a value less than 100% to stop the pitch from becoming fully coarse in either climb or cruise modes.

**Inactive Time**

[Revision 1.154 and later] If no pitch motor activity is detected for this amount of time (default 200 mS), the controller assumes that the propeller has reached one of the limit stops.

**MAP Type**

[Revision 1.157 and later] This parameter sets the type of MAP sensor fitted. The +/- switch selects between the following options:

- None** Select this option when no MAP sensor is fitted. All other MAP parameters are hidden.
- MPS-1A** A Smart Avionics MPS-1A sensor is fitted.
- MPS-1D** A Smart Avionics MPS-1D differential sensor is fitted.
- GR** A Grand Rapids MAP sensor is fitted.
- \*** Select this option for all other MAP sensor types. For this option, the **MAP1**, **MAP2**, **MAP3** and **MAP4** parameters must also be set to match the sensor's characteristics. Please contact Smart Avionics for help in setting these values.

**Have MAP**

[Revisions 1.143 to 1.156] This parameter should be 1 (the default value) if a MAP sensor is fitted. If you do not have a MAP sensor, you must set this parameter to 0 to disable the MAP portion of the display. Setting this parameter to 0 will hide all the other MAP parameters.

**MAP 1**

[Before revision 1.157 or when MAP Type = \*] This is 1/4 of the ADC (Analogue Digital Converter) value that will

be produced when the MAP sensor is sensing the smallest pressure it can handle. Each ADC count is equivalent to  $5V/1024 = 4.8828$  mV.

### MAP 2

[Before revision 1.157 or when MAP Type = \*] This is 1/4 of the ADC value that will be produced when the MAP sensor is sensing the largest pressure it can handle.

### MAP 3

[Before revision 1.157 or when MAP Type = \*] This is the smallest pressure the MAP sensor can handle in units of 1/5" Hg.

[Before revision 1.157] If necessary, this parameter can be adjusted to remove any offset between the ambient air pressure and the manifold pressure displayed when the engine is not running. Increasing the value of the parameter, increases the displayed manifold pressure. For example, if the real ambient pressure is 29.8 and the MAP display shows 29.4 then **MAP 3** needs to be increased by  $(29.8 - 29.4) \times 5 = 2$ .

### MAP 4

[Before revision 1.157 or when MAP Type = \*] This is the largest pressure the MAP sensor can handle in units of 1/5" Hg.

### MAP 5 [Before revision 1.157]

### MAP Smoothing [Revision 1.157 and later]

This sets the level of smoothing applied to the MAP sensor readings. Small changes to this parameter have a big effect on the smoothing. Increasing the value by 1 doubles the amount of smoothing. If you increase the smoothing, the MAP display is less jittery but takes longer to reach its final value.

### MAP Offset [Revision 1.157 and later]

If necessary, this parameter can be set to remove any offset between the ambient air pressure and the manifold pressure displayed when the engine is not running. This

parameter is in units of 1/10" Hg and it can be either positive or negative. Positive values will increase the displayed pressure, negative values will decrease the displayed pressure. For example, if the real ambient pressure is 29.8 and the MAP display shows 29.4 then **MAP Offset** needs to be set to  $(29.8 - 29.4) \times 10 = 4$ .

If you have a Smart Avionics differential sensor (MPS-1D), do not match the displayed value to the ambient pressure. Instead, a value of 29.0 should be displayed when the engine is not running (irrespective of the ambient pressure). If the value is not 29.0, adjust **MAP Offset** accordingly.

### **MAN MAP**

### **CRS MAP**

### **CLM MAP**

Specifies the MAP display style to be used in manual, cruise and climb modes. The +/– switch selects between the following options:

#### **Pressure**

Displays pressure in inches of mercury (default).

#### **% Power**

Displays approximate percentage power.

#### **Toggle**

Toggles between the Pressure and % Power display styles every 6 seconds.

Irrespective of the selected MAP display style, if the engine is not running, the MAP will be displayed as a pressure.

### **Engine Type**

Specifies the engine profile to be used when displaying MAP as percentage power. The +/– switch selects between the following options:

**912** Selects the Rotax 912 profile (default).

**912S** Selects the Rotax 912S profile.

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- 914** Selects the Rotax 914 profile.
- Jab** [Revision 468 and later] Selects the Jabiru profile.
- Inj** [Revision 1.157 and later] Specifies that the engine is fuel injected. The percentage power will be calculated from the tacho signal duty cycle.
- \*** [Revision 1.153 and later] Specifies that the engine is not a Rotax or Jabiru and, therefore, the percent power display is not available.

### **WOT Inj Time**

[Revision 1.157 and later] For fuel injected engines, this is the duration of the fuel injector pulse when the throttle is wide open. It is in units of 100  $\mu$ S and the default value is 80 which equates to 8 mS.

### **Max Fuel Flow**

[Revision 1.157 and later] For fuel injected engines or when using a MPS-1D differential MAP sensor, this can be set to the full power fuel flow rate per hour. By setting this parameter to a non-zero value, the percentage power display will be replaced with an estimated fuel flow of the form  $x/H$  where  $x$  is the calculated fuel flow.

### **Idle MAP Diff**

[Revision 1.148 and later] This is the maximum amount that the MAP can be reduced (" Hg) without the controller assuming that the throttle has been closed. If the MAP is reduced by more than this amount and the controller is in cruise mode, the propeller pitch will not be reduced in an attempt to achieve the target RPM. Setting the value to 0 (the default value) disables this feature. See Section [2.5.3](#) on page [28](#) for more information.

### **RPM Warn Time**

This is the amount of time the RPM can be above the maximum continuous RPM (yellow line) before the RPM! indicator display flashes red. The default is 240 seconds

which is 60 seconds less than the maximum time allowed by Rotax.

[Revision 1.153 and later] Setting this parameter to 0 disables the warning feature.

### **Yellow RPM**

This is the yellow line RPM (default 5500, which is suitable for Rotax 912/912S/914). This only determines when the RPM! indicator displays yellow and has no effect on the automatic pitch control.

### **Red RPM**

This is the red line RPM (default 5800, which is suitable for Rotax 912/912S/914). This only determines when the RPM! indicator displays red and has no effect on the automatic pitch control.

### **Limit RPM**

This is the RPM at which rev limiting (automatic pitch coarsening) is activated when manual mode is being used (default 5700, which is suitable for Rotax 912/912S/914).

### **Low RPM**

This is the threshold RPM below which the RPM! indicator will flash red when cruise mode is selected (default 4000). The purpose of this is to alert the pilot to the fact that cruise mode is still selected but they have closed the throttle.

### **TT Mins**

[Revision 1.143 and later] The number of minutes the engine has run (Tacho Time) since this parameter was last set to 0. This is automatically advanced once a minute when the engine is running. When the value gets to 60, it is reset to 0 and the **TT Hours x1** parameter is advanced.

### **TT Hours x1**

[Revision 1.143 and later] The number of hours the engine has run since this parameter was last set to 0. This is automatically advanced when each hour of engine time is accumulated. When the value gets to 100, it is reset to 0 and the **TT Hours x100** parameter is advanced.

**TT Hours x100**

[Revision 1.143 and later] The number of hundreds of hours the engine has run since this parameter was last set to 0. This is automatically advanced when each hundred hours of engine time is accumulated.

**Sampling Time**

This is the amount of time (in mS) needed to capture each RPM measurement. Larger values produce a more stable RPM reading but also increase the controller's response time which has the effect of reducing the accuracy of the pitch adjustments and can lead to hunting (pitch cycles back and forth).

For revisions  $\geq 601$ , a value of 0 automatically adjusts the sampling time to achieve the best results. 0 is now the default, for earlier revisions, the default is 100.

**Contrast**

This sets the contrast of the LCD display (default 30). Smaller values increase contrast, larger values decrease contrast.

**Tacho Level**

This is the sensitivity level of the tachometer input (default 100). Smaller values increase the sensitivity. See Section 2.5.4 on page 29 for information on adjusting the tachometer level.

[Revision 1.153 and later] For non-Rotax engines, you should also set the **Engine Type** parameter to Jab, Inj or \* to inhibit the automatic tacho level adjustment function that matches the controller's response to the characteristics of the Rotax tacho signal.

**Tacho Div**

[Revision 1.148 and later] This is the tachometer input divider. The CSC-1/P divides the incoming tachometer signal frequency by this value. The default value is 1 which is suitable for Rotax engines as they produce one pulse per revolution.

Setting this parameter to 0 multiplies the tachometer signal frequency by 2 which may be required when the tachometer signal is being generated by wrapping a pickup wire around an ignition lead.

### CalPitch (PV50 only)

This is not really a parameter as such but selecting this option (using the +/– switch) will invoke the propeller pitch sensor calibration procedure as described in Section 2.5.1 on page 23.

If you select this option by mistake, the procedure can be aborted by moving the OK/DISABLE switch to the DISABLE position before the calibration has completed.

Table 3.1 lists the controller’s parameters along with their minimum, maximum and default values. If a parameter is not supported in all revisions of the controller’s software, the revisions that support it are noted.

Table 3.1: Controller Parameters

Parameter Name	Default	Minimum	Maximum	Increment	Revision
CLM RPM	5600	50	9950	50 RPM	
CLM Dead Band	50	10	990	10 RPM	
CRS Dead Band	100	10	990	10 RPM	
Sense Pitch	1	0	1	1	
CLM FPL (PV50 only)	10	0	100	5%	
CRS FPL (PV50 only)	20	0	100	5%	
CPL (PV50 only)	100	0	100	5%	≥ 1.151
Inactive Time	200	10	2550	10 mS	≥ 1.154
MAP Type	MPS-1A	None, MPS-1A, MPS-1D, GR or *			≥ 1.157
Have MAP	1	0	1	1	< 1.157
MAP 1	1	0	255	1	
MAP 2	162	0	255	1	
MAP 3	15	0	255	1	
MAP 4	250	0	255	1	
MAP 5	5	1	255	1	< 1.157
MAP Smoothing	5	1	255	1	≥ 1.157
MAP Offset	0	-127	127	1	≥ 1.157
MAN MAP	Pressure	Pressure, % Power or Toggle			

(continued on next page)

Table 3.1: Controller Parameters (cont.)

Parameter Name	Default	Minimum	Maximum	Increment	Revision
CRS MAP	Pressure	Pressure, % Power or Toggle			
CLM MAP	Pressure	Pressure, % Power or Toggle			
Engine Type	912	912, 912S, 914, Jab, Inj or *			
WOT Inj Time	80	0	255	100 $\mu$ S	$\geq$ 1.157
Max Fuel Flow	0	0	255	1	$\geq$ 1.157
Idle MAP Diff	0.0	0.0	25.0	0.5 "Hg	$\geq$ 1.148
RPM Warn Time	240	0	500	5 seconds	
Yellow RPM	5500	50	9950	50 RPM	
Red RPM	5800	50	9950	50 RPM	
Limit RPM	5700	50	9950	50 RPM	
Low RPM	4000	50	9950	50 RPM	
TT Mins	0	0	59	1	$\geq$ 1.143
TT Hours x1	0	0	99	1	$\geq$ 1.143
TT Hours x100	0	0	255	1	$\geq$ 1.143
Sampling Time	0	0	500	25 mS	
Contrast	30	0	255	1	
Tacho Level	100	0	255	1	
Tacho Div	1	0	255	1	$\geq$ 1.148



# Chapter 4

## Pilot's Notes

Please read all of these notes before you try using the CSC-1/P in flight. If you are not familiar with the controller's features and modes of operation, please read Chapter 1 (*Introduction*) first.

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### Important

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These notes assume that the pilot already has some experience of operating a variable pitch propeller manually. If you are not familiar with how your propeller is operated in flight manually, it is strongly recommended that you gain some experience of manual operation before using the CSC-1/P's constant speed modes.

Some countries (including the UK) require pilots to undergo 'differences training' before they are allowed to operate aircraft with variable pitch propellers.

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## 4.1 Coping with Malfunctions

### 4.1.1 Coping with a controller malfunction

In the unlikely event that the controller suffers a hardware or software failure and you believe it to be untrustworthy, disable the computer control by setting the OK/DISABLE switch to the DISABLE position and use the +/− switch to manually adjust the propeller pitch.

### 4.1.2 Coping with an engine malfunction

If an engine malfunction causes the RPM to fluctuate, the controller will continuously change the propeller pitch in a futile attempt to keep the RPM constant. If this occurs, select manual mode and use the  $+/-$  switch to manually adjust the pitch to a suitable setting.

## 4.2 Recommended Usage of Controller

The following sections suggest how the controller should be used in various phases of flight. Remember, at any time, manual mode can be selected and the pitch controlled manually. This would be appropriate when carrying out manoeuvres that involve rapidly changing airspeed e.g. stalls or flying in very rough air.

The RPMs mentioned in the following notes are suitable for a Rotax engine. If you do not have a Rotax engine, you will need to substitute the correct values for your engine type.

### 4.2.1 Engine start

When starting the engine, the OK/DISABLE switch can be in either position. Until the engine is running, pressing the MODE button will not change the controller's mode but it will make the controller display the current mode, pitch and manifold pressure instead of the total engine hours.

Before you start the engine, it is a good idea to make sure that the propeller pitch is not particularly coarse. This will reduce the load on the engine while starting and idling. If necessary, reduce the pitch using the  $+/-$  switch. However, unless the pitch has been manually changed, it is likely to be still fine from the previous landing. As soon as the engine runs, the current RPM will be displayed.

### 4.2.2 Runup

For the engine runup, the propeller pitch should be fairly fine. This can be achieved either by selecting manual mode and adjusting the pitch using the  $+/-$  switch or by selecting climb mode. It is likely that the propeller pitch will still be fine from the previous landing. For taildragger aircraft (Europa mono-wheels etc), take extreme care when using large amounts of throttle with fine pitch on the ground as it is possible for the tail to rise unexpectedly (especially if the wind is strong and gusty). For all aircraft, make sure the brakes are applied or the aircraft is chocked.

### 4.2.3 Takeoff

For takeoff, select climb mode (by pressing the MODE button for at least 3/4 of a second) as part of the pre-takeoff checklist and verify that the displayed pitch reduces to the expected climb mode fine pitch limit (PV50) or that the pitch limit indicator shows -- (PV55). When climb mode is selected, the climb mode target RPM is set to the preset value and displayed for a few seconds. If desired, use the  $+/-$  switch to adjust the target RPM.

When the throttle is opened, check that the static RPM rises to a sensible value. The exact figure will depend on how fine you have set the climb mode fine pitch limit (PV50) or how fine the limit switch has been set (PV55) but should be around 5000 RPM.

The RPM should quickly rise as the aircraft accelerates. When the RPM exceeds the climb mode target RPM (+ dead band), the pitch will automatically be coarsened to bring the RPM back into the dead band. This automatic 'gear changing' can be slightly unsettling at first because the pilot may not be used to hearing the RPM changing quickly without their intervention.

If there is a strong wind gradient, the RPM may increase quickly as the aircraft flies through the gradient. In this situation it is possible that the maximum allowed RPM will momentarily be exceeded if the target RPM is high (say 5700). To avoid this, reduce the target RPM by 100 using the  $+/-$  switch before tak-

ing off into a strong wind gradient. Strong gusts and turbulence can have the same effect.

The target RPM may be altered at any time in the climb using the  $+/-$  switch. Many pilots like to reduce the RPM once a safe height has been achieved to prolong engine life.

If the target RPM is greater than the maximum continuous RPM, care must be taken not to exceed the high RPM time limit specified by Rotax. To alert the pilot to the possibility of the time limit being exceeded, the controller flashes the RPM! indicator red when the RPM has been above the yellow line RPM for more than 4 minutes (the time limit is configurable).

To summarise, it would be fine to select climb mode with a target RPM of 5700 before takeoff as long as the target RPM is reduced to below 5500 before the time limit is reached. **It is the pilot's responsibility to ensure that the recommended time limit is not exceeded.**

Throughout the takeoff and climb out, the pilot should concentrate on airmanship and accurate flying; very little thought has to be given to the controller.

#### 4.2.4 Climb

To enter a climb while cruising, the following sequence of actions should be carried out:

1. raise the nose to start the climb
2. as the airspeed reduces, engage climb mode
3. progressively open the throttle to the desired setting

The amount of time between raising the nose and engaging climb mode depends on how fast the aircraft was cruising. If the cruise airspeed is low, engage climb mode at the same time as the nose is raised and start opening the throttle immediately afterwards. To reduce the chance of over-revving the engine, avoid quickly opening the throttle whenever the airspeed is high.

The target RPM in the climb may be adjusted using the  $+/-$  switch.

---

**Note**

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Although the switch actually adjusts the target RPM, it is labelled in terms of propeller pitch adjustment, so pressing it towards + increases the pitch and reduces the RPM (and vice versa). This may seem confusing but it is consistent with how the +/- switch is used to adjust the pitch in manual mode.

---

#### 4.2.5 Cruise

When the aircraft, in climb mode, reaches the required cruising level, select cruise mode by pressing the MODE button briefly. Simultaneously, adjust the throttle to the desired power level. The airspeed is then controlled by the throttle. The target RPM can be adjusted using the +/- switch as described above.

Gentle climbs and descents can easily be made in cruise mode without adjusting the throttle as the controller will adjust the pitch appropriately when the airspeed changes.

As a climb is steepened, the propeller pitch will be reduced to maintain the RPM. With a PV50 propeller, the pitch will not be reduced below the cruise mode fine pitch limit. If this limit is reached, the pilot should reduce the rate of climb or increase the throttle setting or select climb mode with an appropriate throttle setting.

As a descent is steepened, the propeller pitch will be increased to limit the RPM. At some point, the propeller will become fully coarse and the RPM will continue to rise if the airspeed is not reduced. The pilot can either reduce the throttle setting or reduce the rate of descent.

If the air is very turbulent, the controller may adjust the propeller pitch a lot more frequently than normal. In this situation, it is better to select manual mode and suffer the RPM changes rather than overworking the propeller pitch change mechanism.

### 4.2.6 Descent

When descending, reduce the throttle as normal and, if necessary, change the controller mode. For example, when descending from the overhead to circuit height, you can keep cruise mode selected as this is appropriate for the downwind leg. When descending on base leg, select climb mode so that you will be ready for a possible go-around.

### 4.2.7 Approach

Ensure that climb mode has been selected by the time the approach starts and check that the indicated pitch reduces to the climb mode fine pitch limit (PV50) or that pitch limit indicator shows -- (PV55) within a few seconds and that the RPM is reasonable given the airspeed and the throttle setting.

### 4.2.8 Engine shutdown

The controller can be in any mode and the OK/DISABLE switch can be in either position when the engine is shutdown.

## 4.3 Limitations

The pilot should be aware of the following limitations of the controller:

1. The PV50/PV55 cannot react quickly enough to stop the red line RPM being exceeded if the propeller pitch is too fine for the current airspeed and the throttle is opened quickly.  
To reduce the chance of this occurring, avoid quickly opening the throttle, especially when the airspeed is high and the propeller pitch is fine.
2. (PV50 only) The controller depends on the PV50 pitch measurement device to indicate the propeller pitch reliably. If (because of some malfunction), the pitch measurement is

incorrect, the controller may believe that the fine pitch limit has been reached even though the propeller pitch is actually much coarser. This could be critical in a go-around situation if the pitch was actually quite coarse.

To avoid being taken by surprise, the pilot is advised to 'sanity check' the indicated pitch against the current RPM and airspeed on approach to confirm that fine pitch has been achieved.

If you have any reason to doubt that the propeller pitch has actually become fine, carry out the following simple check: once the airspeed has fallen to around  $V_y$ , briefly open the throttle fully (or nearly fully) to verify that a sensible RPM can be achieved. If the RPM achieved is far too low, it probably indicates that the pitch is too coarse; you should disable the automatic control using the OK/DISABLE switch and reduce the pitch manually.



# Chapter 5

## Troubleshooting

This chapter provides answers to problems you may encounter when installing and operating the CSC-1/P.

### 5.1 Installation and Hardware Problems

#### 5.1.1 Controller completely dead

This is most likely caused by either a wiring problem or a blown fuse. When power is applied to the controller, the RPM! indicator flashes a couple of times and the LCD display shows a banner and the software revision number for a few seconds. If, when power is turned on, absolutely nothing happens, check the supply fuse, wiring and the D-type plug connections.

#### 5.1.2 Pitch motor does not operate

One possibility is that the pitch motor output has been shorted to ground. This would most likely be caused either by a wiring fault or by the stiff wire that supplies the current to the pitch motor touching the inside of the propeller shaft. Other possibilities are: the pitch motor output could be open-circuit or the pitch motor supply fuse could have blown or even that the pitch motor itself is faulty.

### 5.1.3 +/– switch always makes the pitch go fine

If the +/– switch always makes the propeller pitch reduce no matter which direction it is pressed, this indicates that the Pitch – and the Pitch + connections have been shorted together. This can be due to either a wiring fault or through the use of an external +/– switch that (erroneously) connects those wires together when it is not being activated.

### 5.1.4 Pitch display does not work correctly (PV50 only)

If the propeller pitch display does not work correctly (it should indicate the percentage pitch of the propeller between 0% and 99%), this indicates a problem with either the pitch sensor or the wiring between the sensor and the controller. The sensor is simply a potentiometer whose spindle rotates when the propeller's pitch changes. Possible problems with this system are that the potentiometer reaches the end of its travel and 'wraps around' or that the lever can rotate on the spindle or that the potentiometer body can rotate.

When the controller is installed, the pitch calibration procedure must be carried out (see Section 2.5.1 on page 23). This procedure must be repeated if the propeller's pitch limit microswitches are adjusted or if the pitch measurement potentiometer and its associated lever are altered in any way.

### 5.1.5 Controller produces radio interference

If, when the pitch motor is being driven by the controller, interference is heard on the radio (or some other instrument is affected) it is likely that a wiring problem may exist. Check that both the controller and the radio (or affected instrument) have adequate power supply and ground wiring,

### 5.1.6 Controller affected by other equipment

The controller could be affected by other equipment in several ways. In the most severe case, operating other equipment causes the controller to be reset. This could indicate a problem in either the controller's ground or supply wires or even a more general problem with the aircraft's +12V supply or ground connections.

Another possible problem is that operating other equipment has an effect similar to the MODE button or the +/– switch being pressed. This could happen if the optional external switches have been connected using inadequately shielded wires.

### 5.1.7 Spurious MAP display with no MAP sensor fitted

If you find that spurious MAP values are displayed even though you have not fitted a manifold pressure sensor, it is likely that you omitted to connect the MAP sensor input to ground when you installed the controller. Please see Section 2.3 on page 18 for details. For software revisions 1.143 and later, the **Have MAP** parameter must be set to 0 when a MAP sensor is not fitted. Alternatively, for software revisions 1.157 and later, the **MAP Type** parameter must be set to None when a MAP sensor is not fitted.

## 5.2 Operational Problems

### 5.2.1 Display goes blank with engine running

If the display (RPM, MAP etc.) momentarily blanks, or drops out completely and, instead, shows the total tachometer time, this indicates that the tachometer input needs to be adjusted to make it more sensitive. Section 2.5.4 on page 29 describes how to do this. If the sensitivity is slightly too low, you may find that the display is OK at low RPM but starts blanking at higher RPM.

### 5.2.2 Controller drops out of cruise or climb modes

When the RPM becomes zero, the controller automatically drops out of cruise and climb modes and returns to manual mode. If this happens in flight it indicates that the RPM measurement is not completely reliable. If this occurs, it is likely that the tachometer input needs to be adjusted to make it more sensitive. Section 2.5.4 on page 29 describes how to do this.

### 5.2.3 Wrong RPM displayed for non-Rotax engine

If you are not using a Rotax engine and the displayed RPM is a multiple ( $\times 2$ ,  $\times 3$ , etc.) or  $1/2$  of the real RPM then you should set the **Tacho Div** parameter to the correct divider value. For example, if the tachometer signal you are using pulses twice per revolution, set the value to 2. If you are using an ignition lead pickup or the tachometer signal pulses only every other revolution, you must set the value to 0. You may also need to adjust the tacho sensitivity value. Section 2.5.4 on page 29 describes how to do this.

### 5.2.4 RPM display over-reads or is unsteady

If, as the throttle is increased, the RPM display jumps from a reasonable value to a value that is much too high, this indi-

cates either that the tachometer sensitivity is too high or that the RPM measurement circuitry is being affected by electrical noise. Electrical noise can also make the RPM display unsteady. Section 2.5.4 on page 29 describes how to adjust the tachometer sensitivity level.

If electrical noise is badly affecting the tachometer signal, it may not be possible to adjust the tachometer sensitivity such that the RPM measurement does not over read at high RPM and the RPM measurement does not drop out at low RPM. If this is the case, you should investigate the routing of the tachometer pickup wiring and whether it should be shielded.

### 5.2.5 RPM is less than target RPM

There are several reasons why the target RPM may not be achieved. Normally, when the controller is trying to increase the RPM by reducing the pitch, the LCD display will show a – next to the pitch value. If the display shows an  $\perp$  instead of a –, this indicates that the controller has reached its fine pitch limit (PV50 only) and will not reduce the pitch any more. You can reduce the value of the fine pitch limit. See Section 2.5.2 on page 26 for details of how to do this.

Another reason for not achieving the target RPM could be that the propeller has reached the fine pitch limit microswitch (PV50 or PV55). If this is the case, consider adjusting the position of the fine pitch limit microswitch to allow the pitch to be reduced further. Please consult the Arplast documentation for details of how to do this and observe any limitations regarding the minimum pitch setting allowed for your propeller/engine/aircraft combination.

Other reasons for the achieved RPM being less than you expect could be that either the airspeed is very low or the engine is not producing full power.

### 5.2.6 RPM is greater than target RPM

If the controller cannot reduce the RPM to the target RPM, this indicates that the propeller has reached the coarse pitch

limit microswitch. When this happens, the controller will continuously display a + next to the pitch value. This may happen because either the coarse pitch limit is too fine or one or both of the throttle setting or the airspeed are too high. The coarse pitch limit microswitch can be adjusted to allow the propeller pitch to become coarser. Please consult the Arplast documentation for details of how to do this and observe any limitations regarding the maximum pitch setting allowed for your propeller/engine/aircraft combination.

### 5.2.7 Controller changes pitch too often

If during automatic operation (climb or cruise modes), the controller adjusts the propeller pitch more often than appears necessary, it is possible that the respective dead band is too small. The dead band values are adjustable via setup mode (see Section 3.1 on page 31).

Another reason could be that the RPM measurement is being affected by some electrical or mechanical problem. Try selecting manual mode and see if the RPM still varies. If it does, the problem is probably not with the controller.

Remember, the RPM will vary because of airspeed changes and turbulence. If the air is very rough it is better to use manual mode rather than the constant speed modes.

### 5.2.8 Controller does not change pitch often enough

If during automatic operation (climb or cruise modes) the controller adjusts the propeller pitch less often than appears necessary, this most likely indicates that the dead band is too large. The dead band is adjustable via setup mode (see Section 3.1 on page 31).

If the pitch is not being reduced when the throttle is reduced in cruise mode and a MAP sensor is fitted it is possible that the value of the **Idle MAP Diff** parameter is too small. See Section 2.5.3 on page 28 for more information.

### 5.2.9 MAP display does not match ambient pressure

Due to variations in the MPX4250 pressure sensor device used in the MPS-1, it is possible that the manifold pressure displayed when the engine is not running is different from the ambient air pressure. You can remove this error by adjusting the value of the **MAP Offset** or **MAP 3** (depending on the CSC-1/P software revision) parameter (for details of how to do this, see Section 3.1 on page 31).

### 5.2.10 MAP display very unsteady

If the MAP display (or the percentage power display) is very unsteady, adding a restriction to the tube that connects the MPS-1 to the manifold can be beneficial. The hole in the restriction should not be larger than 1mm diameter. Furthermore, if the restriction is situated close to the manifold, it will provide protection in the case of a leak in the tube.

If adding a restriction does not steady the display, you can increase the value of the **MAP Smoothing** or **MAP 5** (depending on the CSC-1/P software revision) parameter to increase the amount of smoothing applied to the MAP readings.

Another possible cause of a jittery MAP display is electrical interference. Check that the wiring from the MAP sensor to the CSC-1/P is not routed near to sources of electrical noise (ignition wires, etc.) Shielding the MAP sensor wires will be beneficial.

### 5.2.11 Controller display shows 'BAD MEM'

This indicates that the controller has failed the program memory integrity test that is carried out each time power is applied. In the unlikely event of this occurring, please contact Smart Avionics. However, if you need to use the aircraft before the controller can be repaired and you have an alternative means of displaying the engine RPM, it is acceptable to disable the computer using the OK/DISABLE switch and then use the +/- switch to control the pitch manually .



# Appendix A

## Specifications

Table A.1: Mechanical Specifications

Parameter	Value	Units
Weight	270	gm
Width	63	mm
Height	63 (ex screw heads)	mm
Depth behind panel	106 (ex connector)	mm
Panel hole diameter	57.5	mm
Mounting screw hole diameter	4.5	mm
Mounting screw pitch diameter	66.7	mm
Max length of mounting screw	10 + panel thickness	mm

Table A.2: Display Specifications

Quantity	Min	Max	Resolution	Units
RPM	0	9990	10	RPM
Pitch	0	99	5	%
MAP	3-6 <sup>1</sup>	50	0.1	"Hg

Table A.3: Environmental Specifications

Parameter	Min	Max	Units
Operating temperature range	0	+50	°C

<sup>1</sup>Actual value determined by the MPS-1 sensor.

The operational temperature range is limited by the specification of the LCD display. The colder the display becomes, the slower it reacts. In testing, the display was found to be still usable at ambient temperatures below 0 °C. The controller itself will operate over a range of -40 to +70 °C.

Table A.4: Electrical Characteristics

Characteristic	Min	Max	Units
Logic supply voltage	10	15	V
Logic supply current	30	40 <sup>2</sup>	mA
Pitch drive supply current	40	< 1500 <sup>3</sup>	mA

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<sup>2</sup>To this must be added any current drawn by the Auxiliary Supply Output (250 mA max)

<sup>3</sup>Determined by PV50/PV55 motor.

# Appendix B

## Connections

The following table and Figure B.1 on page 63 specify how the 15 way D-type connector on the rear of the controller is wired. The colours referred to in the 'Connected To' column are the colours of the wires supplied by Arplast.

Table B.1: CSC-1/P D-Type Connections

Pin	Name	In/Out	Connected To	Notes
1	Pitch Motor Supply	In	+12V supply	Protect with 3A fuse
2	Pitch Motor Drive	Out	To PV50/PV55 motor (pink)	Internally short-circuit protected
3	Auxiliary Supply Out	Out	+12V power to MAP sensor and pitch drive LED	Maximum available current 250mA (internally protected)
4	Tacho	In	Tacho signal	For Rotax, connect to one side of tacho pickup, ground other side of pickup
5	Pitch Sense Feed	Out	PV50 pitch sensor (yellow)	Leave open if pitch sensor not fitted
6	Pitch Sense In	In	PV50 pitch sensor (purple)	Connect to ground (pin 7) if pitch sensor not fitted (PV55)
7	Pitch Sense Ground	-	PV50 pitch sensor (grey)	Internally connected to pins 9 &14

(continued on next page)

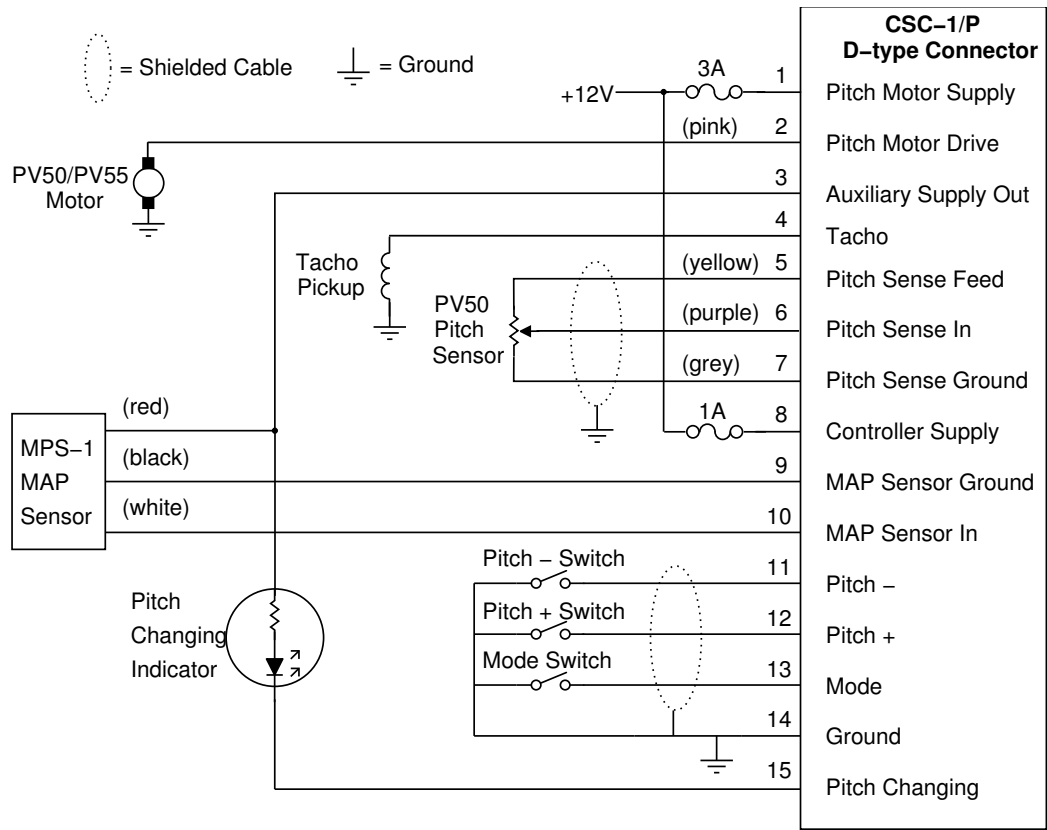
Table B.1: CSC-1/P D-Type Connections (cont.)

Pin	Name	In/Out	Connected To	Notes
8	Controller Supply	In	+12V supply	Protect with fuse (3A or less)
9	MAP Sensor Ground	–	MAP sensor ground	Internally connected to pins 7 & 14
10	MAP Sensor In	In	MAP sensor output	If MAP sensor not fitted and revision before 1.143, connect to ground (pin 9)
11	Pitch –	In	Switch to ground	Optional (use shielded wire)
12	Pitch +	In	Switch to ground	Optional (use shielded wire)
13	Mode	In	Switch to ground	Optional (use shielded wire)
14	Ground	–	Ground	Internally connected to pins 7 & 9
15	Pitch Changing	Out <sup>1</sup>	Ground end of pitch changing indicator	Max sink current 250mA

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<sup>1</sup>Technically, it's an open-collector type output.

Figure B.1: CSC-1/P Connection Diagram





# Appendix C

## LAA Inspection Checklist

Your LAA inspector should check the following items before approving the CSC-1/P installation:

1. The propeller has been installed in accordance with the manufacturers instructions.
2. The controller is securely mounted in the instrument panel in a position that allows the pilot to easily view the display and operate the switches.
3. If external switches have been fitted, they should be labelled so that their purpose is clear. If an external  $+/-$  switch is fitted, it should be oriented such that pushing the switch forward or up (depending on the orientation of the switch) reduces the propeller pitch (increases RPM).
4. All wiring has been carried out to an acceptable standard for a permit aircraft.
5. If a MPS-1 manifold pressure sensor has been fitted, it must be securely mounted in a sensible position inside the engine compartment. The tube that connects the sensor to the manifold<sup>1</sup> must be adequately restrained and should not be able to flex so much as to strain the connection on the MPS-1.

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<sup>1</sup>The MAP take-off is normally fitted to the balance tube between the carburettors.



# Appendix D

## Use with a Jabiru Engine

This Appendix lists the parameter values to be used when the controller is used with a Jabiru 2200 or 3300 engine.

To detect the engine RPM, the controller's tacho input (pin 4 of the D-Type connector) should be connected to either of the Jabiru engine's permanent magnet generator outputs.

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### Important

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To ensure reliable RPM detection, the Jabiru regulator must be supplying power to some load. When the regulator's output current is very low, the displayed RPM will become erratic or not be displayed at all.

---

Table [D.1](#) on the next page lists the recommended parameter values to be used with Jabiru 2200 and 3300 engines. All other parameters can be set to their default values (listed in Table [3.1](#) on page [40](#)).

If the throttle closed sensing as described in Section [2.5.3](#) on page [28](#) is to be used, set the [Idle MAP Diff](#) parameter to 3.

Table D.1: Jabiru Engine Parameter Values

<b>Parameter</b>	<b>Value</b>
CLM RPM	3200
Sense Pitch	0
Engine Type	Jab
RPM Warn Time	0
Yellow RPM	3000
Red RPM	3300
Limit RPM	3200
Low RPM	2000
Tacho Level	70
Tacho Div	5 for 2200, 6 for 3300

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