M1 User and Installation Guide

OBSERVANT®

Observant M1 user and Installation Guide

Document history

Issue	Date
1	February 2008
2	June 2008
3	September 2008
4	March 2009

Acknowledgement

Observant would like to thank the many customers who have offered valuable feedback and suggestions for content, both in this Guide and in the Observant Desktop software.

This guide is updated on a regular basis and your feedback is appreciated and included in each edition. Please contact us if you require the latest version or have any questions.

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About this guide

This guide contains information about the Observant M1 Engine Controller and describes how to install the equipment on an existing engine.

All engines are designed differently and it is impossible to cover all models and brands. Observant welcome any feedback about about the installation of the M1 with engines not covered by this guide. Please contact us if you are attempting to install the M1 with an engine that is not covered by this guide, as someone else may have already completed the process and provided feedback.

Where to find more information

If you require any further information please contact your supplier or Observant directly on 1300 224 688.

We also have a fully featured online forum that many people use to share ideas and ask questions. Many of our clients have used the Observant system for an extended period of time and are only too happy to provide help. Observant support staff constantly monitor the forum and provide feedback to help provide effective solutions to your individual problems.

The forum can be found by following the Forum link at the bottom of the Observant website at www.observant.com.au

The forum also contains a number of PDF documents that provide an outline of the installation and selection processes that may also be of assistance.

Before you start

Symbols and notation conventions

The following symbols are used throughout this guide:

Notes providing additional or vital information to the topic being discussed.

Helpful hints, suggestions and short cuts.

A **caution** indicates a condition that may lead to equipment damage, malfunction or inaccurate operation.

Electrical safety

- There are no voltages present in the M1 capable of causing injury. However, to prevent electrical shocks and damage to equipment, disconnect all power inputs from the M1 and battery before commencing any work on the system.
- Before commencing any work on the equipment, ensure the engine and the M1 are completely isolated from all sources of power and the engine is not operating.
- Always check that there are no loose items in the vicinity of any equipment. This will help prevent short circuits and injury from ejected objects.
- Seek Observant or professional advice before attaching any high voltage devices to the M1 or any connected equipment.
- Always use a licensed electrician when working on any mains or high voltage system over 36V. It may be illegal in your state to do otherwise.

Operational safety

- Read this manual prior to commencing an installation.
- Before using this product always inspect cables and attached mechanical devices for damage or unserviceable parts.
- All attached devices need to be securely mounted.
- Do not expose any electrical item to moisture. This can be difficult when working around pumps and requires care to prevent damage.
- Do not place objects or body parts within range of the engine's moving parts. Injury may occur.

Before commencing any work with the engine or the M1, ensure that any remote control features have been disabled. This can be achieved by pressing the Emergency Stop button and disconnecting the positive battery terminal.

Before commencing any welding, ensure that all electrical connections have been disconnected from the engine and the M1. Damage may result to both the engine and the M1.

Package contents

Standard M1 package:	• M1 Engine Controller • hall effect RPM sensor • installation guide • 3” Hose clamps for mounting • C1 interface cable (W4L-A-EN3) • RS485 Device tail cable (W4L-A-EN3) • spare fuse pack • wiring diagram
Optional supplementary power kit:	• field mount with solar panel • 2 x mounting stays • birdhoff • kelco paddle-style flow switch • hardware pack containing bolts and 'tech' screws
Optional wiring harness to suit limited models:	• harness and RPM sensor bracket to suit a range of commonly used agriculture engines.

Introduction

The Observant M1 Engine Controller is a microprocessor-based engine protection and control system designed with agricultural diesel and petrol engines in mind. Able to work as a stand-alone system or as an integrated part of the Observant Remote Management System, the M1 offers a fully-functional engine control and monitoring package. The M1 includes a full suite of engine protection features, providing peace of mind for unattended operation.

The Observant M1 engine contoller.

Safety is a high priority and the M1 has an easily accessible emergency stop (E-Stop) switch for complete electrical cut-off and isolation, and a pre-start warning siren. The M1 can manage the smallest to the largest engine with efficiency and safety.

Running in stand-alone mode, the M1 can be completely operated from the front panel, with comprehensive diagnostic features available.

Equipped with a fully-featured, industry standard RS485/Modus serial interface, the M1 can be integrated into any modern automation environment.

As part of the Observant Remote Management System, the M1 can be used to automatically control pumps and generators using information from water level sensors at other sites as a trigger to start and stop the engine.

Designed to operate in remote locations, the M1 is mainly of stainless steel and aluminium construction. The M1 features robust environmental protection (weather & UV) and easy access to wiring and fuses.

Controller features *(M1 Revision B)*

- Weather/UV proof stainless steel enclosure with single sealed 25 mm conduit entry
- Front panel indication and control:
  - Latching E-Stop button (complete isolation of power to control relays)
  - Start/stop pushbutton (control of start/stop and automatic/manual modes)
  - Four 3-colour LEDs indicating:
    - Communications
    - Power
    - Status
    - Engine
- 6 x Contact inputs:
  - Flow present (as standard)
  - Auxiliary control (for interface to other control systems or inputs, optional)
  - Oil pressure contact (optional)
  - Water temperature contact (optional)
  - Pump prime (optional)
  - General unassigned input (float, pressure etc.)
- 2 x 20 Amp relay outputs
  - Starter control (direct connection to starter motor terminals, fixed assignment)
  - Ignition/Fuel solenoid or rack puller (fixed assignment)
- 2 x 7 Amp relay outputs
  - Glow plug
  - Pre-start electric prime pump
- Warning siren
  - 103dB, activated prior to any remote start
- Solar charger
  - Trickle charging of engine battery
  - Suitable for solar panel up to 40W
- RS485/Modbus interface
  - Remote start, stop and timed run
  - Engine hour counter
  - Full diagnostics, including:
    - Relay and siren currents
    - Battery voltage
    - Solar voltage
    - Battery charge current
    - Fuse blown detection
    - E-Stop status
    - Engine faults
- 3 wire RPM sensor connection
  - Suitable for a powered open drain hall effect sensor as supplied
- 2 x Resistive analog input channels
  - Oil pressure sender
  - Water temperature sender

- Fuel level sensor

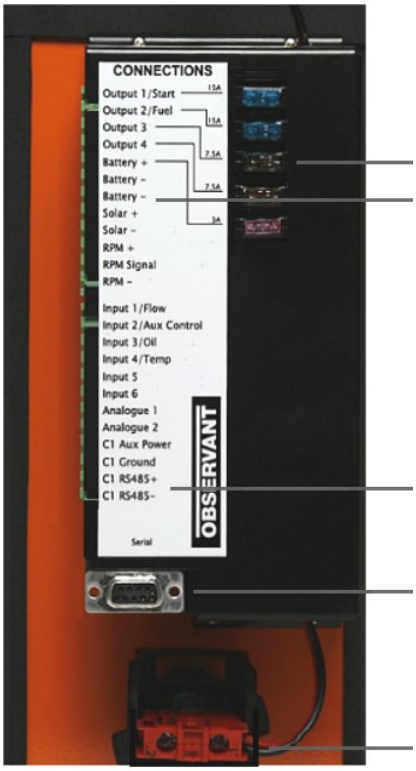
Front panel and internal connections

Door latch: turn anticlockwise to open, using a coin or screwdriver.

E-Stop button: safety feature that quickly stops the engine and isolates all power.

Status indicators: show the current state of the engine controller, including any warnings (e.g. low oil pressure)

Start/stop button: provides manual control of the engine. Also used to switch between manual and automatic modes.



Fuse block

Engine and sensor connections

RS485 connection to field unit

RS232 port (not currently used)

E-Stop button

Operation

The M1 can operate the engine in either stand-alone mode or via the Observant C1 Manager software. All functions can be adjusted to suit individual requirements and additional optional sensors can be added at anytime to give a clearer picture on the performance and operation of the engine.

A typical engine start sequence is as follows:

- M1 receives a command to start the engine via the serial interface, auxiliary control input or the front-panel pushbutton
- Any auxiliary outputs that are configured will operate
- If the source of the start command is NOT the push button the siren will sound for approximately 10 seconds
- The M1 then provides a voltage to engage the fuel solenoid
- The starter motor is then activated
- The M1 then checks if the starter motor is turning the engine over by checking the status of the RPM sensor if it is enabled
- Once the preset starter time or RPM threshold has been reached the starter motor is disengaged
- Once all configured shutdown inputs read OK the engine start sequence is complete

If during the start up process or during operation the M1 finds any parameter is out of the user defined boundaries then a warning is issued or a shut down is initiated depending on how the M1 is configured. Typical engine shutdown timeouts will occur if a configured:

- pump flow switch indicates no flow for more than the configured amount of time (default: 30 seconds)
- oil pressure sender/switch indicates low pressure for more than 5 seconds
- water temperature sender/switch indicates high water temperature for more than 20 seconds
- pump prime switch indicates no prime for more than 5 seconds

The M1 is also able to be controlled by any telemetry system that is capable of providing an output suitable to drive its Auxiliary input. This input can also be driven from a sensor switch, for example to provide a simple float control system.

Optional hardware

Supplementary Power Kit

The optional supplementary power kit consists of a solar panel that is used to offset the power drain caused by such things as fuel rack solenoids, alternator excitement lamps, battery self-discharge and the M1 itself.

The charging systems of some small agricultural engines, in particular the Kubota RK series, do not operate effectively at moderate engine speeds. This can result in a net current draw on the battery by the fuel solenoid and any other electrical loads that are active while the engine is running. As an example, an RK series engine running at 1800 RPM will only produce around 1 amp; this is not enough current to offset the effect of some fuel solenoids which can draw 1.5 Amps.

The Yanmar TF series engines have a similar issue but to a lesser extent. The charge lamp that is attached to the engine panel is lit whenever the alternator is not producing a charge current. This light serves two purposes: it acts as a simple warning device and also produces a power drain that excites the alternator, enabling it to operate effectively. This globe will completely discharge a car battery within around 4 days.

The supplementary power kit provides a topping charge to the engine battery thus always insuring that the battery always has enough charge to start the engine.

Wiring Harness Kit

Observant manufactures a wiring harness to suit Yanmar factory supplied TF series engines. These engines need to have the ACP (auto start and stop) kit installed in order to gain the benefits of the M1. This wiring loom can reduce the installation time to as little as 25 minutes with only a minor addition required to the engine.

The wiring harness kit also includes an RPM sensor bracket to suit the TF-ACP range of engines.

Minimum system requirements

The M1 is capable of supporting most internal combustion engines but they must meet a minimum set of requirements to make the most of the product.

The following items are mandatory for operation of the stop and start features:

- fuel shutoff rack puller solenoid* on diesel engines.
- speed (RPM) sensor
- electrically controlled starter motor

The following items are recommended to provide the additional engine protection features of the M1:

- Pump flow switch mounted on outlet to detect pump/belt failures (Highly recommended)
- Engine oil pressure switch or sender
- Engine water temperature switch or sender
- Load switch relays on generators to prevent loading whilst starting and stopping

The following items are supported but not required for complete remote operation:

- Pump priming systems
- Prime detection switch
- Fuel level sensor
- Oil level sensor

If you require assistance in designing a solution for your remote engine system please contact Observant or your dealer. We have a range of solutions that may suit your situation, and can customise them if necessary. Most installations can be performed by anyone with a basic knowledge of electrical wiring.

	Any solenoid that operates via the M1 directly must have a total power draw of less than 15 Amps. If your solenoid operates using more than 15 Amps then a secondary relay/fuse combination will be required.

	If an engine runs on a 24V system some measures need to be taken to ensure compatibility with the M1. The M1 on-board relays can switch 24V directly, however the M1 controller power supply must be no greater than a nominal 12V. This means the M1 power must be supplied from a the terminal of the first (ground connected) 12V battery in a dual battery system, or a 24V to 12V regulator must be used in the case of a system than uses a single 24V battery.

Common agricultural engine configurations

Engine	Specific requirements
Kubota RK series (see note below)	• Electric start • Factory Murphy shutdown system fitted as a minimum • Kubota model RK-KOT – Murphy protection kit needed, control panel is not required • RPM sensor needs to be fitted
Yanmar TF series	• Factory fitted Yanmar auto stop/start kit • Yanmar TF-ACP kit as a minimum • Protection control box is not required. Direct ordering is available to suit the observant M1 by simply quoting observant wiring when placing your order • Alternator RPM sensor needs to be fitted • Wiring loom and the required RPM sensor brackets to suit the Yanmar TF-ACP are available from Observant
Generic Diesel engines	• Electrically startable • Fuel shutoff solenoid • Water and oil pressure switches recommended as a minimum • Water and pressure resistive sensors are supported • 12V DC supply • 24V based engines can be supported with additional hardware • RPM sensor may need to be added
Generic Petrol engines	• Electrically startable • Oil pressure switch recommended • M1 is used to simulate the key switch attached to most engines • RPM sensor may need to be added • Ignition system may require the use of a relay to provide protection for the M1.
Hatz Diesel Generators	• Electric start • M1 is used to simulate the key switch as the voltage regulator is part of the standard supplied control equipment and it's use is integral to the operation of the charging system fitted to the engine • RPM sensor needs to be fitted
Perkins 400 seriesvc	• As per the standard crate engine specifications • RPM sensor needs to be fitted • Additional relay may be required for glow plug operation (if fitted)
Kubota ER series (see note below)	• RPM sensor needs to be fitted • Rack puller solenoid must be fitted • Oil and water temperature switches should be fitted

Engine	Specific requirements
Yanmar TNE series engines	• Factory RPM sensor needs to be fitted • Most connections can be made using the standard ten pin plug supplied with the ASP kit

Observant recommends the factory fitting of any rack-pulling solenoids fitted to single cylinder engines. The correct positioning and alignment of these solenoids is essential to the reliable operation of the motor.

A set of installation notes for specific engines is available on request.

Hardware installation

The following notes apply to all installations; please refer to the appropriate application note for additional information related to your model of engine.

Equipment

The items you will need:

- large ring type insulated crimp connectors to suit your battery terminals
- an assortment of small ring type crimp connectors
- spiral wrap, conduit and fittings to protect cables
- cable ties
- 2 core cable for flow switch connection
- tools such as a 8mm 'tech' screw driver, wire cutters, screwdrivers and a drill with the required bits

If not using a factory wiring harness:

- lengths of AWG18-20 or 3mm Trailer wire for signal wiring
- lengths of AWG10-12 or 4mm Trailer wire for power wiring

Mounting

Remove the M1 unit from the stainless steel shroud (held in by 2 hex socket screws) and mount the shroud securely within 2m of the engine (as the cable lies) using one of the following methods:

- Standard hose clamps in conjunction with the pipe clamp bracket to fix to a 50mm+ diameter pipe (which in turn is securely mounted to another structure, driven or concreted into the ground).
- Remove the pipe bracket and fix directly to a wall or flat section via the four screw holes

Wall mounted installation.

The supplementary power kit solar panel can be mounted on the same pole as the M1, or on any sturdy structure. If mounting on a pole, take care not to burr the end of the pipe when driving it into the ground as the solar mount tube needs to be inserted into the top of the pipe.

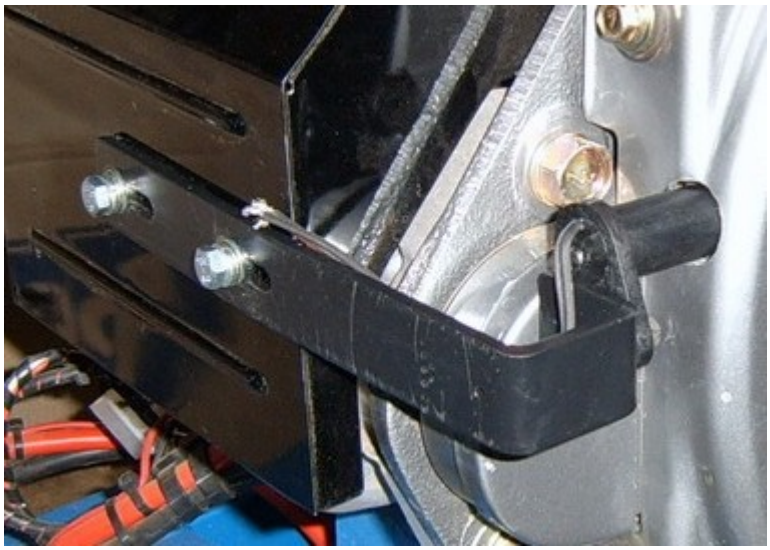
Outdoor pole mounted installation with supplementary power kit.

> **!** Ensure that the mounting structures are adequately isolated from engine vibrations as this will cause equipment damage over time.

RPM sensor

Drill and tap a hole in the engine flywheel to take a suitably-sized bolt. This bolt is detected by the RPM sensor and should be in a location where the RPM sensor can be mounted with the sensor face within 2mm of the bolt head.

Trigger bolt installed on flywheel edge.



RPM sensor and mounting bracket on Yanmar TF series.

Mount the RPM sensor using the optional Observant-supplied mounting bracket or a custom version. Special care must be taken to avoid the protrusion of the starter motor gear when in operation and to route the cable away from any moving parts.

The RPM sensor uses a magnetic field to detect the bolt as it passes. The trigger bolt must be of a ferrous material, i.e. it must stick to a magnet. Most stainless steel bolts have little or no magnetic properties and will not work as a trigger bolt.

Fuel solenoid

The M1 ignition relay can drive a load up to 15 Amps. Most in-built fuel pump solenoids and rack pullers draw less than 5 amps, however if higher loads need to be connected a secondary external relay can be driven from the M1 ignition relay. It is recommended to use the factory version of any rack pulling solenoid where possible as these tend to be more reliable and easier to adjust than a third-party add-on.

Factory installed rack puller on a Yanmar TF series.

All M1 relays output a positive voltage approximately equal to the battery voltage eg. 12V.

3-wire type rack pulling solenoids must be connected such that the pull-in coil is driven directly from the starter motor contactor. The hold-in coil is connected to the M1 ignition/fuel relay as per the 2-wire type.

Flow switch

Please check the included manufacturer's instructions for the flow switch as the model may vary depending on the type of pump or engine being used. The optional flow switch supplied by Observant is a Kelco F25 paddle style.

Kelco F25 flow switch.

Hardware required

- T-piece to suit the outlet pipe size
- 25mm female reducer to suit the T-piece
- a length of 2-core light duty electrical cable
- electrical conduit and fittings to suit

It is best to mount the flow switch at some point greater than 1m downstream of the pump outlet. The paddle can be cut to suit the diameter of the pipe and need not protrude further into the flow than the midpoint. The use of a thread sealant such as Locite 577 or thread tape is recommended to prevent leaks.

Connection to the M1 is made via a single connection (generally NO – normally open) to the input, the common connection needs to be securely connected to ground via one of the M1 ground connections, or on the engine wiring harness.

If required, the sensitivity of the flow sensor can be adjusted using the adjustment screw located under the removable cover on the top of the switch. Refer to the manufacturer's instructions included with the switch as different models or types of switches may be supplied to suit your engine or pumping system.

The functionality of the flow switch is to provide a high level of feedback that the engine/pump is operating correctly. As such the flow switch could be replaced with something that serves the same purpose, for example a pressure switch.

Wiring

See Appendix A for connection functions, minimum cable specifications and Appendix B for a general wiring diagram.

Connections required for basic M1 operation

Terminal	Function	Destination
Output 1/Start	Starter motor driver	Starter motor contactor terminal
Output 2/Fuel	Ignition/Fuel supply control	Fuel solenoid or rack puller (hold-in coil on three terminal units)
E-Stop terminal (back of E-Stop switch)	Relay contact power supply	Battery terminal positive
Battery +	M1 logic power supply	Battery terminal positive
Battery –	M1 logic power supply	Battery terminal negative
Solar +	Battery charger power	Solar panel +
Solar –	Battery charger power	Solar panel –
RPM +	RPM sensor power	RPM sensor +
RPM Signal	RPM sensor output	RPM sensor signal
RPM –	RPM sensor ground	RPM sensor ground
Input 1/Flow	Flow sensor	Flow switch (NO)

Connection to a field unit can be made via the supplied W-4BC cable as follows:

Terminal	Wire colour
C1 Ground	Green
C1 RS485+	Blue
C1 RS485–	Yellow
C1 Power	Red

When installing the M1 the use of automotive crimp plugs with a professional crimping tool is suggested. All wires should be of a type and size to suit the task. Any wires running between the Starter motor, Solenoid, Battery and the M1 should be of at least 4mm size to ensure maximum reliability.

Ensure that the battery is **disconnected** at all times when installing and wiring any hardware.

Ensure that the battery is **connected** at all times when the engine is **running** or the ignition switch is in the 'on' position. A disconnected battery may cause damage to the voltage regulator on some models of engine.

Additional hardware

Engine sensors

The M1 supports both switch style and analog style (sender) oil pressure and water temperature sensors. These sensors can be used to shut the engine down when oil pressure drops or temperature gets too high.

Switch style sensors can be wired directly to the M1 inputs and configured in software to be inverting or non-inverting. Analog senders can be connected to one of two analog channels on the M1. The type and shutdown threshold for these measurements can be set via software. Standard automotive sensors that are currently supported include:

Type	Output	Example VDO part number
Oil pressure 3 BAR resistive	10–184 Ohm (zero–FSO)	360-081-029-xxxx
Oil pressure 5 BAR resistive	10–184 Ohm (zero–FSO)	360-081-029-xxxx
Oil pressure 10 BAR resistive	10–184 Ohm (zero–FSO)	360-081-029-xxxx
Water temp 120 degree resistive	90° = 36.5 ohm (120° ~ 0 Ohm)	323-801-001-xxxx
Water temp 150 degree resistive	90° = 36.5 ohm (150° ~ 0 Ohm)	323-801-004-xxxx

Some engines come pre-fitted with oil pressure and water temperature switches whose outputs are connected to a single wire for shutdown purposes. If this is the case the switch outputs should be separated and re-wired individually to the M1.

Fuel level sensor

Connection of a fuel level sensing device can be made to one of the two analog input channels (See appendix B for wiring). The sensor must be a resistive type and usually consists of a short arm with a small float on the end. Once the sensor is installed a measurement of the “full” and “empty” resistances needs to be taken, these two values are then entered into the configuration of the M1, the measurement is then calibrated.

Prime detection switch

A simple float switch arrangement can be used to detect whether a pump is primed prior to starting the engine. This switch is connected to an input and will cause the engine to shutdown in a similar fashion to the flow switch.

Automatic pump priming

It is possible to automatically prime small pumps prior to starting the engine by the use of a small electric pump driven from one of the auxiliary relay outputs of the M1. The software can be configured to operate the pump for a pre-determined amount of time before starting the engine.

Auxiliary control input

The engine can be started and stopped via the auxiliary control input, this input can be configured to be either “close to run” or “open to run”. A run request from the auxiliary input is treated in the same manner as a Modbus start command, ie. the siren will sound, and it is disabled if the controller is not in automatic mode. This input can be connected to other telemetry systems, or to a passive device such as a pressure switch.

In the case where both auxiliary input and Modbus control are used the Modbus commands will override the auxiliary input.

Testing procedures

The M1's simple on site user interface and diagnostic tools are complemented by a fully featured interface that is available by using the Observant desktop software with the M1 connected to an Observant C1 or C2 field unit.

Information such as charging currents, first out details, sensor states, and user definable start up and shut down procedures displayed in a user friendly style come together to provide a highly adaptable engine control and fault diagnosis system.

For remote area operations the following items should be checked once installation is complete to ensure ongoing reliability.

- Solenoid power consumption is within the specifications. Most charging issues can be traced back to the the solenoid as this is the major consumer
- Voltage regulator's require checking before leaving the site. Follow the manufactures procedures to check this item as the procedures may vary from model to model
- Flow switch functionality: the timeout for this function is 30 seconds by default
- Field unit communications
- RPM sensor – by default the engine will not start if the RPM signal is not being received
- Oil pressure and water temperature switch actions can be tested by simply grounding the lead attached to the sensor while the engine is running – these inputs are not active in the default configuration
- Fuses
- Battery condition and state

A significant side effect of using a remote control system for an engine is a reduction in maintenance, particularly of the battery, poor battery maintenance accounts for a large number of the problems seen with such systems. We recommend the use of low maintenance type batteries to ensure reliable operation and always ensure that a battery is connected to the engine whilst it is running. Battery acid levels and corrosion level of terminals should be checked on each visit.

User operation

The M1 is designed to have a simple intuitive user interface that requires no specialised training.

Initial power up

Ensure that power is connected from the battery. Press and Hold the Start / Stop button for around 2 seconds. The M1 will perform a series of internal tests (LEDS will perform a series of indications) and it will then be ready to operate.

Power down

Remove the power connections from the battery to power off the M1.

Manual start/stop

The engine can be started and stopped by the front panel pushbutton, press and hold until a double beep is heard, then release, if the engine is stopped it will attempt to start and if running will stop.

If a manual start/stop is conducted whilst the controller is in automatic it will drop to manual mode. If the M1 is being controlled via automation it will not be active until the controller has been restored to automatic mode, this can be done remotely via the software or locally via the pushbutton. The controller will also drop to manual mode if the E-Stop is activated or the engine is in a fault condition.

Auto/manual modes

In manual mode, the M1 will only respond to the front panel stsrt/stop button andwill not respond to any commands from the C1 Manager software, or control via the auxiliary control input.

To toggle the mode between auto and manual, press and hold the start/stop button for approximately 5 seconds until you hear a single beep, double beep and finally a triple beep.

Confirmation of the mode can be seen on the mode LED.

Mode indicator	Mode
Green flashing	Automatic
Amber flashing	Manual

Be aware that an outstanding run request will cause the M1 to attempt to start the engine once put into automatic mode. You can check for a run request before setting the mode by checking the mode LED – a triple blink indicates run request pending

M1 status indicators

Comms (upper left)		
Three Green Flashes		Receiving data
Three Yellow Flashes		Data transmitted and OK
Three Red Flashes		Incorrect data received
Three Green, Three Red		Data received, failed
Three Green, Three Amber		Data received, OK

Power (upper right)		
Single Green flash		Healthy battery, no charge current
Orange Single Flash		Battery low, no charge current
Red Single Flash		Battery very low, no charge current
Double Green Flash		Healthy battery, charging
Double Orange Flash		Battery low, charging
Double Red Flash		Battery very low, charging

Status (lower left)		
Single green flash		Auto mode, auxiliary input control disabled
Double green flash		Auto mode, auxiliary input control enabled but inactive
Triple green flash		Auto mode, auxiliary input control enabled and aux input active OR modbus run request active (should attempt to run)
Single orange flash		Manual mode, auxiliary input control disabled
Double orange flash		Manual mode, auxiliary input control enabled but inactive
Triple orange flash		Manual mode, auxiliary input control enabled and aux input active OR modbus run request active

Engine (lower right)		
Single green flash		Flow switch activated (for wiring/polarity test)
Continuous green flash		Engine starting
Solid Green		Engine running, all OK
Flashing amber		Engine stopping
Flashing amber, green		No-flow fault, shutdown imminent
Solid red		Low oil pressure fault, shutdown imminent
Solid amber		High water temperature fault, shutdown imminent
Continuous flashing red		No prime fault, shutdown imminent
Off		Engine stopped

The Engine LED status will be held until the error is reset by either resetting the alarm via the C1 Manager software or the engine is restarted by pushing the manual start/stop button.

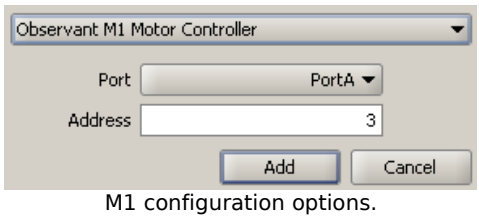
Overrides	
Status flashing orange when engine stopped	Fault shutdown occurred, engine LED displays type
Status and Engine both flashing red with a periodic beep every five seconds	E-Stop button active

Managing the M1 from the C1 Manager software

Adding the M1

Before the M1 can be controlled from the C1 Manager software, it must be added to the field unit. To do this:

- Enter Advanced Mode
- select **C1, Add Device** from the menu
- select **Observant M1 Motor Controller** from the list, set the appropriate configuration options and click **Add**:



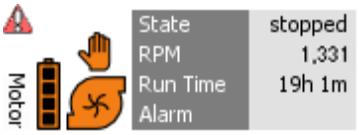
M1 configuration options.

- Click **Close** to complete the process, or select another device to add.

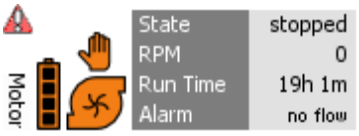
Note

- To enter Advanced Mode, select **File, Enter Advanced Mode** from the C1 Manager menu, and enter the password *look4water*.
- The **Port** setting must match the physical connections to the field unit.
- The address of the M1 is set to 3 in the factory. Should you need to attach more than one M1 to a single C1 port, it must be configured with a unique address. This process requires the unit to be returned to Observant. When ordering additional M1s, a unit can be set to a specific address on request.

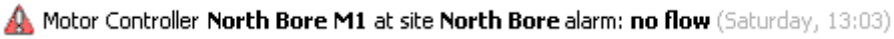
Monitoring the engine



Once installed and configured, the site view will show the M1 and its status. This engine is currently running and has generated no alarms. The battery status is shown to the left of the M1 icon.



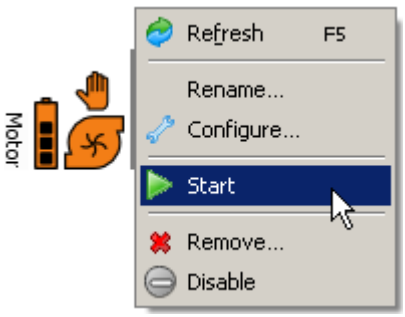
This engine has stopped because the flow switch is reporting no flow. This could be due to a blocked inlet, faulty pump or empty water source. When this occurs, an alarm will be displayed in the notifications list:

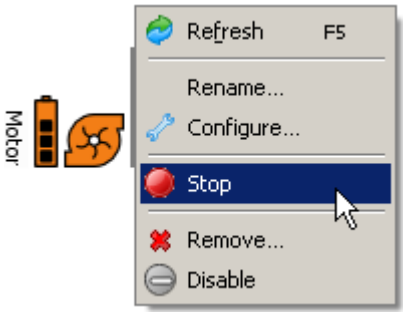


In this case, the engine has stopped without any errors. This indicates that it was stopped either by using the C1 Manager software, or using the start/stop switch on the M1 unit.

Manual control

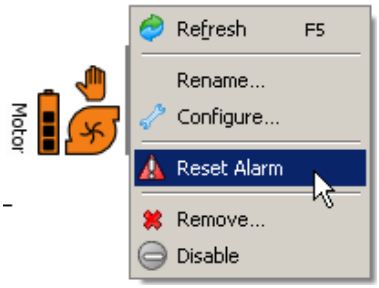
In standard mode, the C1 Manager software provides the ability to monitor the pump status and view any alarms raised. In Advanced mode, the software allows full remote control of the engine. To enable this, enter Advanced mode by selecting **File**, **Enter Advanced Mode** from the menu. The engine can be controlled by right-clicking its icon and selecting the appropriate action:





Hint

If the M1 is reporting an alarm such as “No Flow”, the alarm must be reset before the engine will be allowed to start. To do this, right-click on the M1 icon and select **Reset Alarm:**

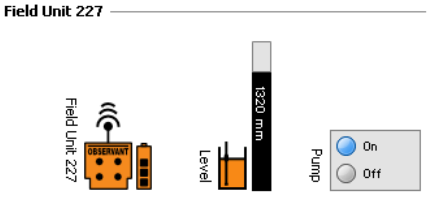


Automatic control

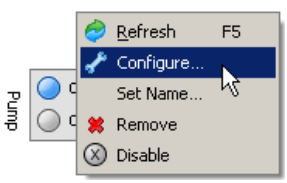
The C1 Manager software can be configured to automatically control a pump when the water level drops below a pre-set point, and to continue running the pump until the water level is restored to an acceptable level.

Configuration

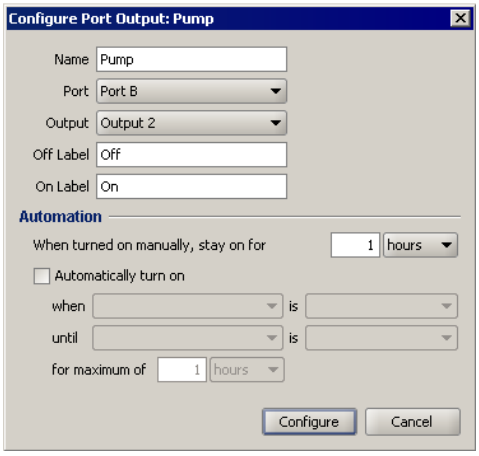
In this example, the reading from the level sensor will be used to control an electric pump attached to a port output:



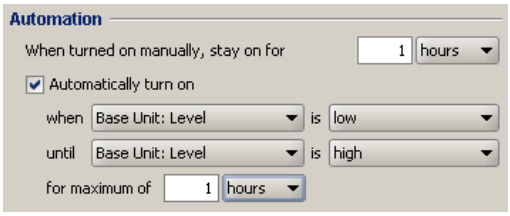
To configure automatic pump control, right-click on the port output icon and select **Configure.**



This opens the configuration window. By default, automatic control is turned off.



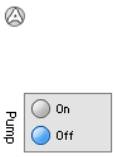
Select the **Automatic Control** option and then select the level sensor that will be used to control the pump.



Select the levels where the pump will turn on and off, then click **Validate** to check that the selected settings are correct.

Click **Configure** to save the settings and return to the site view.

Note that the pump control now has an icon above it to indicate it is under automatic control:



- The C1 Manager software must be running for the pump automation to operate.
- The 'very low', 'low', 'high' and 'very high' water levels are set in the **Configure** window for the level sensor.
- The option *Automatically turn on for a maximum of...* is a fail-safe option to limit the time the pump will run. This allows for any fault that might stop radio communications, such as low field unit battery, damage to the field unit antenna or the unit entering night mode. Select this time so that it will prevent over-filling of the dam or tank. For example, if the pump normally takes 4 hours to fill the nest from the 'low' water mark, set the maximum pump time to 240 minutes.
- As a safeguard, if the level sensor controlling a pump develops a fault, the pump will be immediately stopped. This happens to prevent overfilling in cases where damage to cabling stops a sensor from operating.

As configured in this example, the system will operate as follows:

1. The pump will switch on when the level sensor shows a 'low' reading.

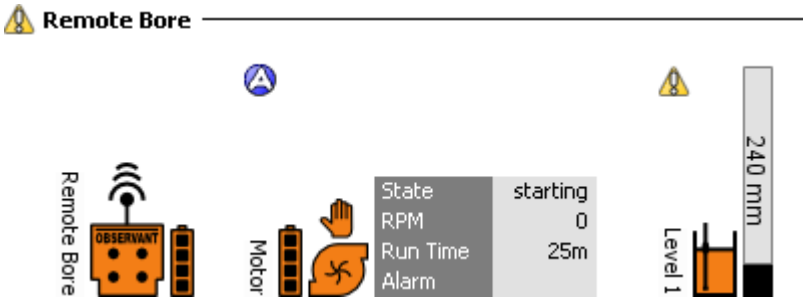
2. The pump will remain on for 1 hour, unless the level reaches 'high', in which

case it will turn off immediately.

3. After 1 hour, the pump will switch off. If the water level is still reading 'low', the pump will be switched back on and the process continues.

Manual operation during automatic mode

The pump can be manually operated while in automatic mode. In this example, clicking “On” will start the pump for 1 hour. The pump can then be left to run for that duration, or can be manually turned off before then. If the level reaches the pre-set “off” level, the pump will automatically switch off.



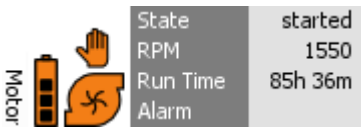
M1 starting in response to a low tank level. The automation icon has changed to blue to show the pump is starting or running under automation.

Engine States

While starting, running and stopping, the engine goes through a number of states:

Stopped:
In the stopped state, the engine can be manually started from the software, or may be unser automatic control and will start when triggered by a level sensor reading.

Starting:
The engine is in the process of starting.



Started:
The engine has been successfully started. A final check of enabled shutdown inputs will occur before transition to running.

Running:
The engine has started and no faults have been detected.

Alarms

A number of alarms are generated by the M1 to indicate a fault condition:

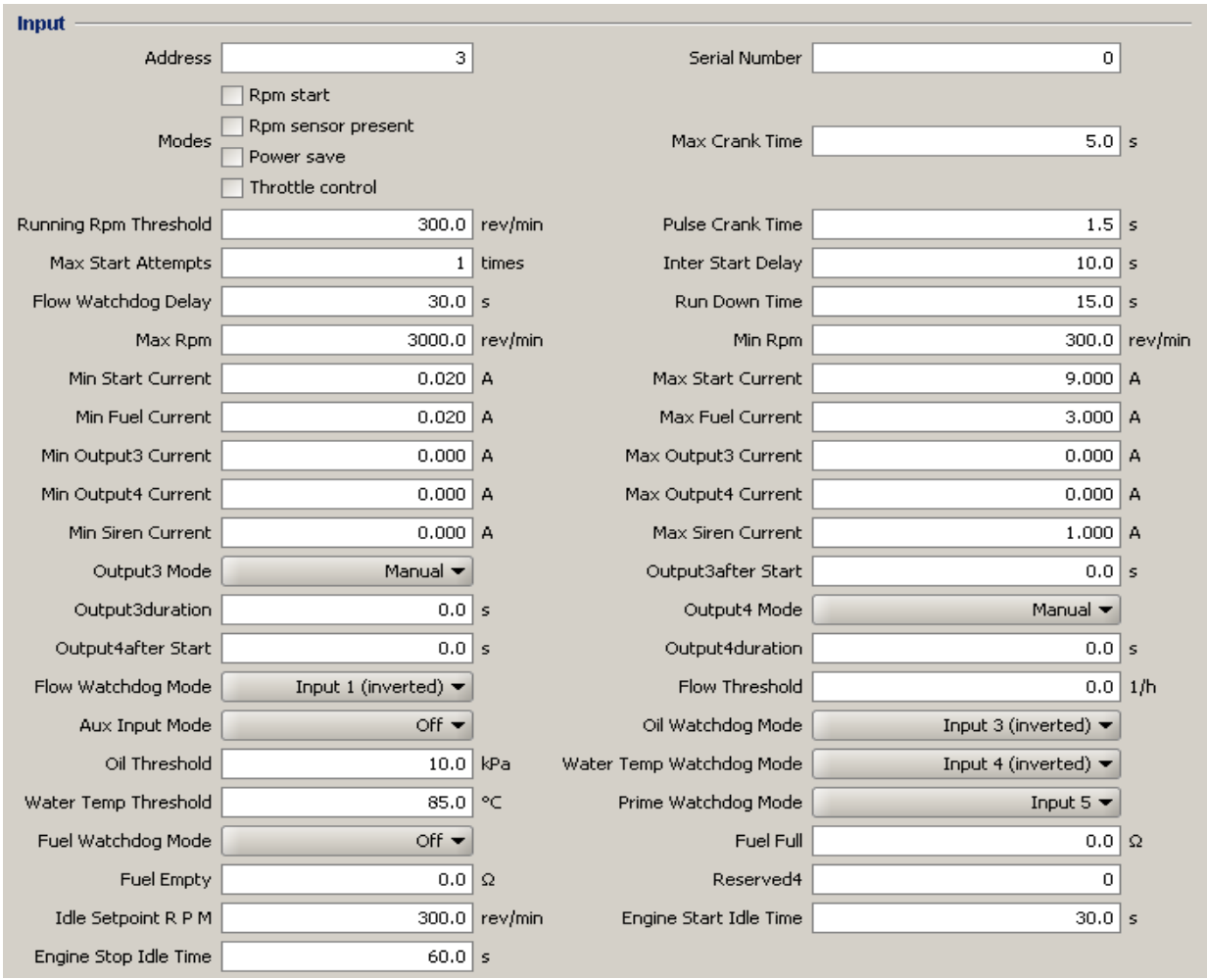
Alarm	Description	Likely cause and resolution
Start fail	The engine did not start as expected	• No fuel • Mechanical fault • Throttle lever set in incorrect position • Damaged wiring to solenoid or starter motor, check relays currents are in range • RPM sensor fault
Stop fail	The engine continued running when it is expected to stop	• Incorrect throttle adjustment preventing throttle from returning to stop position • Solenoid wiring fault
No flow	The flow switch is not detecting any flow	• Pump drive has failed (eg. belt) • Outlet has disconnected upstream of flow switch • Blocked pump inlet • Pump prime lost • Flow switch incorrectly adjusted • Damaged flow switch wiring
Over rev	Engine speed has exceeded the configured maximum RPM	• Throttle requires adjustment or has jammed • Unexpected reduction in load eg. drive belt broken
Under rev	Engine speed has dropped below the preset minimum RPM	• Throttle requires adjustment • Engine has a mechanical fault • Unexpected increase in load
E-Stop	E-Stop button has been used to shut the engine down	• Personnel have had reason to urgently shut the engine down • Release the e-stop button to allow normal operation of the engine
Low oil pressure	Engine has been shut down in response to low oil pressure	• Low oil level • Oil pump fault • Oil pressure sensor or wiring fault
High water temperature	Engine has been shut down in response to high water temperature to prevent damage	• Low water level • Stuck thermostat • Blocked radiator • Broken fan belt • Sensor or wiring fault
Loss of prime	No water present in the inlet pipe side of the pump, pump sump dry	• Leaking foot valve • Damaged pipes • Wiring fault
Siren fault	Siren is disconnected or faulty	• Check siren connections and operation
Low fuel	Engine has shut down unexpectedly and fuel level is reading low	• Check fuel level • Level sensor stuck • Sensor wiring fault

Advanced M1 configuration

In its standard configuration, the M1 performs basic functions of starting, stopping and monitoring the engine. More advanced settings are available that enable or adjust advanced functions.

To view advanced configuration options:

- In C1 Manager, enter Advanced Mode.
- In the Navigator at the left of the screen, select the field unit, select **User Devices** then **Observant M1 Motor Controller**.
- At the right of the screen, select the **Commands** tab.
- From the list of commands, select **Get Remote Config** and click **Execute**. This retrieves the current settings from the M1:



Some of these settings are reserved for future development but many can be used to enable advanced functionality. Some examples are:

- a diesel engine that requires glow-plug power prior to starting
- an engine needs to have power removed from the starter as soon as the engine is detected running
- a priming pump needs to be running for a period before starting the main pump
- a generator needs to be run for some time to bring it up to operating speed prior to powering a submersible pump

M1 advanced configuration options

Option		Description
Modes:	RPM start	Turns the starter motor off after the RPM reaches a certain threshold OR after the Max Crank Time has passed. If this option is not selected, the starter is run for the designated *Pulse Crank Time*. **Note:** this mode is essential for larger engines to prevent starter motor damage due to being engaged for a period after the engine has started.
	RPM sensor present	RPM sensor is installed.
	Power save	Reserved for future use.
	Throttle control	Throttle controller is installed. (under development)
Max Crank Time		Maximum time starter motor is allowed to be on continuously.
Running RPM threshold		If *RPM Start* is selected: the RPM threshold at which the controller disengages the starter motor.
Pulse Crank Time		The time for which the starter motor is engaged during a normal start sequence.
Max start attempts		The number of attempted starts before declaring a start failure fault.
Inter Start Delay		The elapsed time between attempted starts: Note the controller will not attempt to start the engine if the RPM does not equal 0 even if the time has elapsed.
Flow Watchdog Delay		The elapsed time before a no flow shutdown or failed start is declared when engine is running and there is no registered flow. (only if flow input enabled)
Run Down Time		The elapsed time before a failed stop is declared after stopping and whilst still registering a non-zero RPM.
Max Rpm		RPM over which an over speed fault is declared.
Min Rpm		RPM under which an under speed fault is declared.
Min/Max Start Current		Defines the expected range of current drawn by the starter solenoid. A fault will be generated if the start current is detected outside this range.
Min/Max Fuel Current		Defines the expected range of current drawn by the fuel solenoid. A fault will be generated if the fuel current is detected outside this range.
Min/Max Output 3 Current		Defines the expected range of current drawn by output 3 (normally used for powering glowplugs prior to starting). A fault will be generated if the current is detected outside this range.
Min/Max Output 4 Current		Defines the expected range of current drawn by output 4. A fault will be generated if the current is detected outside this range.
Min/Max Siren Current		Defines the expected range of current drawn by the siren. A fault will be generated if the current is detected outside this range.

Option	Description
Output 3 Mode	Defines operation of output 3: Manual: Only controllable via commands from software Start relative: Turns on *Output 3 after Start* seconds after start. To have output 3 turn on before the engine starts, set *Output 3 Duration* to a negative value. Active on alarm: On when the M1 is in alarm. Active on available: On when the M1 is not in alarm Start relative on until stop: Turns on *Output 3 after Start* seconds after start. To have output 3 turn on before the engine starts, set O*utput 3 Duration* to a negative value.
Output 3 after Start	see above
Output 3 duration	see above
Output 4 Mode	Defines operation of output 4: Manual: Only controllable via commands from software Start relative: Turns on *Output 4 after Start* seconds after start. Active on alarm: On when the M1 is in alarm. Active on available: On when the M1 is not in alarm Start relative on until stop: Turns on *Output 4 after Start* seconds after start, turns off when the engine stops.
Output 4 after Start	see above
Output 4 duration	see above
Flow Watchdog Mode	engine shutdown after watchdogDelay if not active Off: Flow is not monitored input1: flow input active open (or voltage applied) input1invert (default): flow input active closed to ground
Flow Threshold	Reserved for future use
Aux Input Mode	If engine is available, it will run when this input is active Off: Aux input ignored input2: active when input 2 not grounded input2invert: active when input 2 grounded
Oil Watchdog Mode	Off: oil watchdog mode disabled input3: active when input 3 not grounded input3invert: active when input 3 grounded analog1: active when above *Oil Threshold* (uses analog input not implemented in 1.3)
Oil Threshold	see above
Water Temp Watchdog Mode	engine shutdown after 20 seconds if not active Off: water temp watchdog disabled input4: active when input 4 not grounded input4invert: active when input 4 grounded analog2: active when below Water Temp Threshold (uses analog input not implemented in 1.3)
Water Temp Threshold	see above
Prime Watchdog Mode	Off: Prime watchdog mode disabled Input 5: active when input 5 not grounded Input 5 (inverted): active when input 5 not grounded
Fuel Watchdog Mode	Off: Fuel watchdog mode disabled Analogue 1: Fuel level provided by analogue 1 input Analogue 2: Fuel level provided by analogue 2 input
Fuel Full	Analogue “full” reading from fuel level sensor
Fuel Empty	Analogue “empty” reading from fuel level sensor
Reserved4	Reserved for future use

Option	Description
Idle Setpoint RPM	Setpoint for engine idle during start/stop idle time. (not implemented in 1.3)
Engine Start Idle Time	Time engine runs at setpointIdleRPM before ramping to setpointRPM (not implemented in 1.3)
Engine Stop Idle Time	Time engine runs at setpointIdleRPM prior to stopping (not implemented in 1.3)

To change any settings, click the copy icon then select **Set Remote Config** from the list and click the paste icon. Change settings as required, then click **Save**.

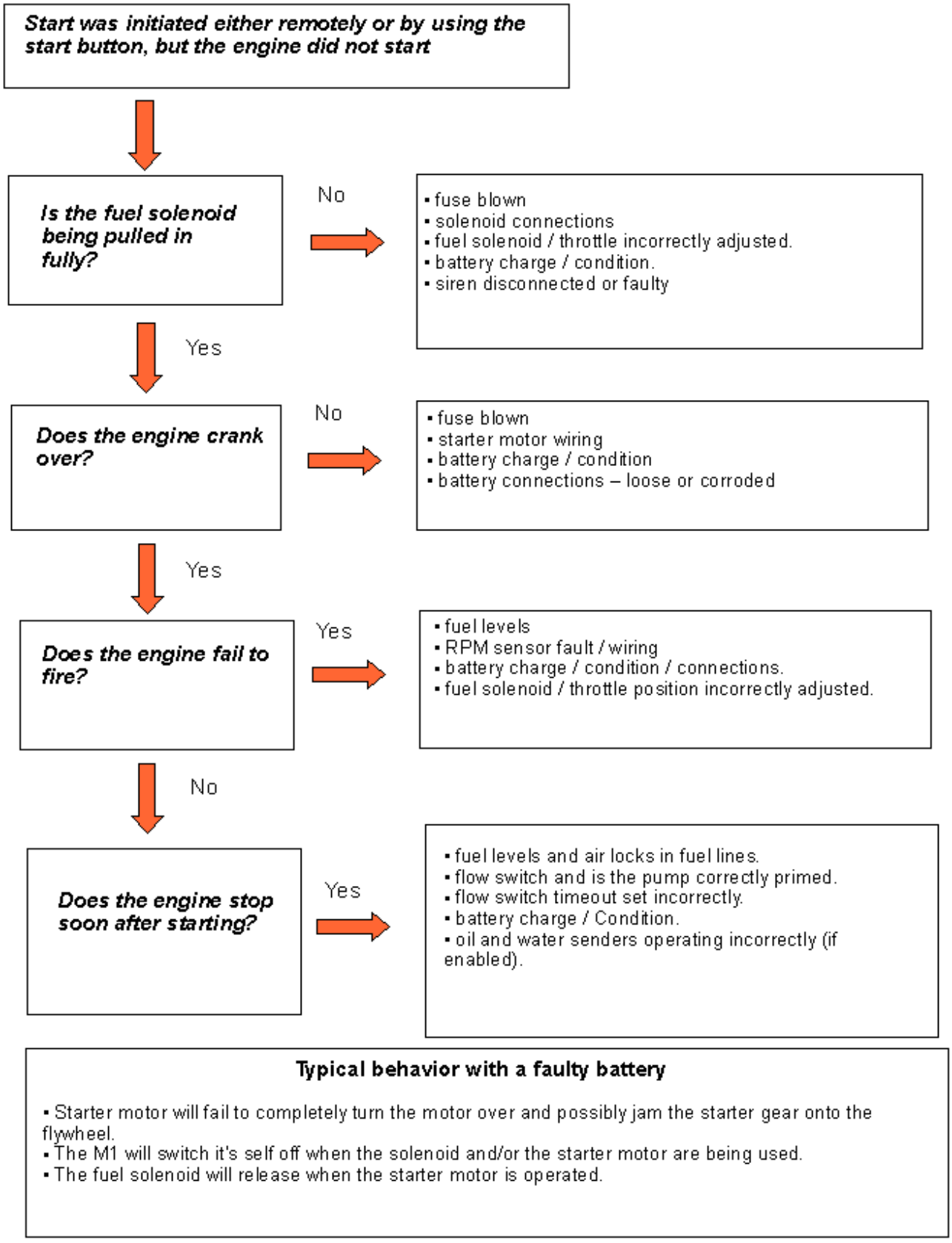
These options are for advanced configuration of the engine controller and should be carefully tested after a change. If you require any assistance setting appropriate options for your application, please contact Observant support.

Firmware Updates

The firmware update procedure should only be conducted by Observant support staff. If your M1 requires a firmware update please contact Observant for the current procedure. Please have your M1 serial number handy as this will aid the correct model identification.

Troubleshooting flowchart

This flowchart provides some guidance in troubleshooting problems with the M1 or engine.



Appendix A: M1 connections (Build B)

Pin	Description	Function
1	Relay 1 output	Open source E stop voltage 15A fused – Start motor solenoid
2	Relay 2 output	Open source E stop voltage 15A fused – Fuel solenoid
3	Relay 3 output	Open source E stop voltage 7.5A fused – Glow plug
4	Relay 4 output	Open source E stop voltage 7.5A fused – Option (Priming pump)
5	Battery +	12VDC
6	Battery –	3A fused to ground
7	Battery –	3A fused to ground
8	Solar +	Suits up to 40W panel
9	Solar –	Ground
10	RPM sensor supply (+)	8VDC current limited sensor supply
11	RPM sensor signal	Open-drain connection 1K pull up to 8V
12	RPM sensor ground (–)	Ground

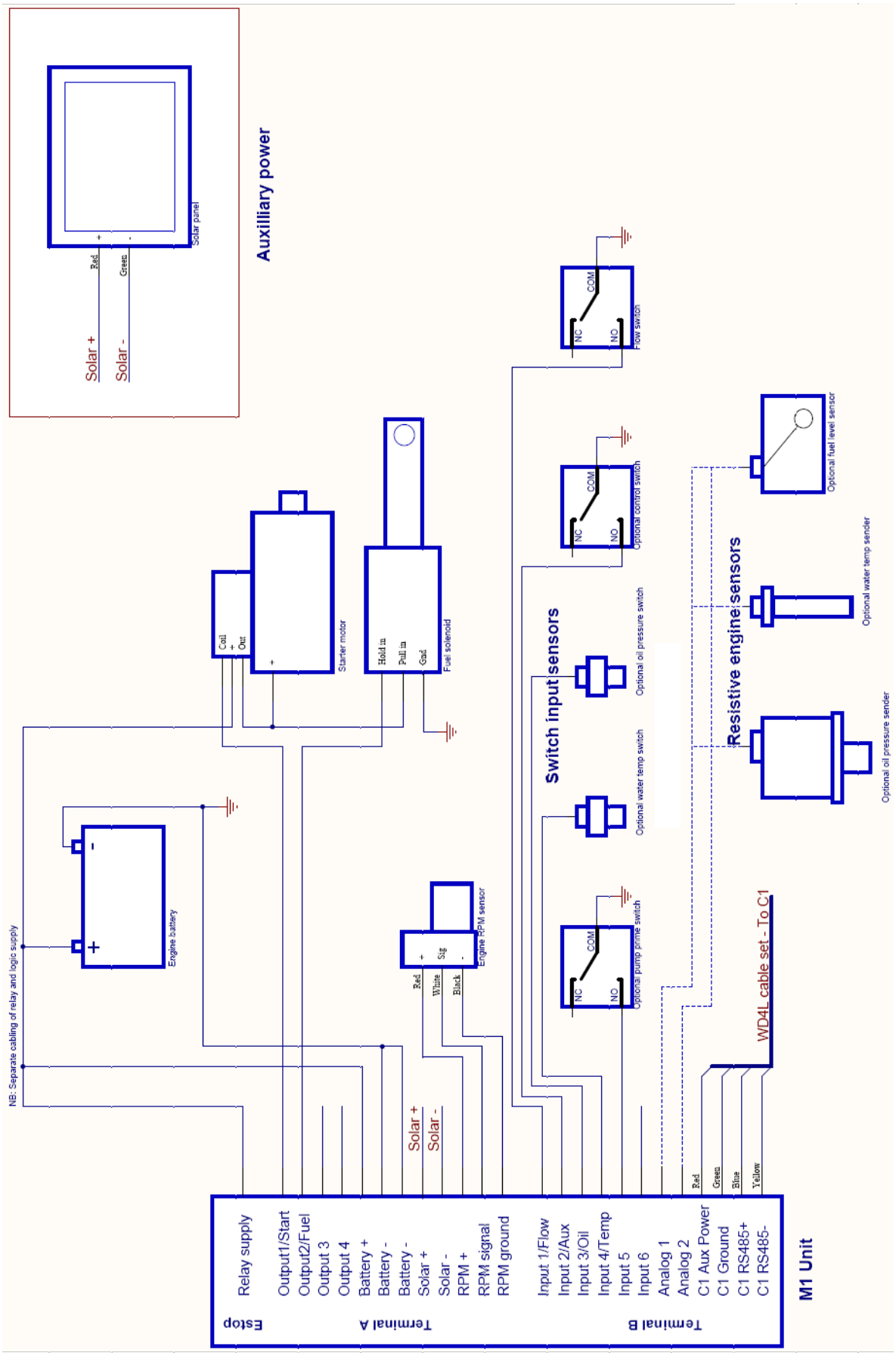
Engine and power connections

Pin	Description	Function
1	Input 1	Open-drain connection – Flow switch
2	Input 2	Open-drain connection – External Control
3	Input 3	Open-drain connection – Oil pressure switch
4	Input 4	Open-drain connection – Water temperature switch
5	Input 5	Open-drain connection – Pump prime
6	Input 6	Open-drain connection – Configurable
7	Analogue 1	Configurable – Temp, pressure, fuel level
8	Analogue 2	Configurable – Temp, pressure, fuel level
9	Auxilliary power input +	12V from field unit
10	Auxilliary power input –	Ground to field unit
11	RS485+	Field unit comms
12	RS485–	Field unit comms

Sensor and communications inputs

A separately cabled supply must be connected to the E-Stop terminal. This provides power for the relay contacts used to drive ignition and starting.

Appendix B: M1 typical wiring diagram



Appendix C: Fuse Ratings

Fuse	Rating
Output 1 / Fuel Solenoid	15 Amps
Output 2 / Starter	15 Amps
Output 3 / User configurable	7.5 Amps
Output 4 / User configurable	7.5 Amps
Battery	3 Amps

Contact details

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