

Contents

1	Introduction	4
2	Basic Operation.....	4
3	Front Panel Indicators.....	5
3.1	LCD Display	5
3.2	AUTO LED	5
3.3	MANUAL.....	5
3.4	ALARM LED.....	5
3.5	Battery.....	5
3.6	CHARGING.....	5
3.7	Pump.....	5
3.8	Nutrient	5
3.9	Gate Valve	6
3.10	Remote.....	6
3.11	Water.....	6
3.12	Alarm Relay.....	6
4	Front Panel switches.....	6
4.1	ESC button.....	6
4.2	Enter Button	6
4.3	Up and Down arrows	6
4.4	Prime Button	6
4.5	Reset Button	6
5	Menu Selection	8
6	Connections	12
6.1	Solar Panel	12
6.2	Battery.....	12
6.3	Pump.....	12
6.4	Nutrient Meter	12
6.5	Gate Valve	12
6.6	Power Relay.....	13
6.7	Water Meter	13
6.8	Water Meter Slave	13
6.9	Alarm.....	13
6.10	Alarm Tone.....	13
6.11	Serial Interface	14
7	Connection as a Controller.....	15
8	Connection as a Monitor	16
9	Telemetry – Tone Pulse sequence	17
10	Telemetry – Tone Pulse sequence GME TX3200.....	18
11	Telemetry – Connection to a Telemetry System	19
12	Serial Remote Control	19
12.1	Protocol Format.....	19
12.2	Checksum	20
12.3	Commands.....	20
12.4	Responses	20

Document Revision History

Rev	Details	Date	Who
A	Original Issue	23-SEP-2001	Frank Thomson
B	Changes for REV B hardware including new front panel	13-NOV-2001	Frank Thomson
C	Battery & Charging labels on front panel drawing fixed. Software rev changed to 2.05 Option to change the mode of operation of the alarm relay added. (Pulse or latch). Wiring diagram for connection to TX3200 added. Section on Telemetry added	27-NOV-2001	Frank Thomson
D	Wiring Diagram Changed to implement reverse polarity Protection	31-MAY-2002	Frank Thomson
E	Serial port added. Section 12 serial protocol added. Menu system changed.	31-OCT-2002	Frank Thomson
F	Letterhead and address changed to the Hyde Rd address	12-MAR-2003	Frank Thomson

1 Introduction

This document is user manual for the Nutridose controller.

This version of the manual refers to Revision D of the hardware and software version 4.01

The information in this manual is not relevant for Rev B or Rev C hardware.

This manual relates to the installation and operation of the controller and does not contain information to enable the user to determine how to select the appropriate dosage level.

2 Basic Operation

Using the keyboard and the LCD display as described later, the user can set the desired proportion of nutrient to water to be injected. The user must also set an alarm threshold. If the proportion exceeds the alarm threshold then the system will enter an alarm state.

In the alarm state, the gate valve is closed and a Relay is opened removing power from the pump and the solenoid.

To prevent uncontrolled operation, the unit powers up in the alarm state.

Once the desired proportion and the alarm threshold have been entered, the user presses the RESET button to start operation.

Each time the controller receives a pulse from the water meter the controller switches on the pump for a short time to inject nutrient into the water supply. The unit counts the pulses from the nutrient meter until a preset level is reached and then it switches the pump off. To cater for run on, the system continues to count pulses until the next water meter pulse. The unit then adjusts the switch off point to inject either more or less nutrient to obtain the desired proportion. This process is averaged over several cycles.

The monitoring system monitors averages the nutrient proportion over several cycles. If the average proportion is greater than the alarm threshold, then the unit removes power from the pump and solenoid and closes the gate valve. The system must be manually reset to re start operation.

3 Front Panel Indicators

This section describes the function of each indicator on the front panel of the controller.

3.1 LCD Display

The LCD display is used to display the status of the system. More detail is given in section 5

3.2 AUTO LED

GREEN LED.

ON indicates that the system is in automatic mode and that nutrient is being injected at the correct level.

3.3 MANUAL

RED LED

ON indicates that an operator has forced to unit to perform a manual operation. For example they may have pressed the PRIME button. Press the RESET button to place the unit back into automatic mode.

3.4 ALARM LED

RED LED

ON indicates that there is a problem either with this box or with the system being monitored. The reason for the ALARM LED being ON will be displayed on the LCD. This LED is a latched alarm and the user must either reset the system or enter manual over ride mode to clear it.

3.5 Battery

GREEN LED

On indicates that +12V the battery is connected to the system.

3.6 CHARGING

GREEN LED

The unit contains a solar panel regulator circuit to control the charging of a lead acid battery from a solar panel. The LED is on when the internal FET switch is closed and the solar panel is connected to the battery and therefore charging it. The unit measures the battery voltage and switches OFF when the voltage reaches 13.8V.

ON means the battery is being charged at the full rate.

FLASHING means the battery is being float charged at 13.8V.

3.7 Pump

GREEN LED

On indicates that +12V is being supplied to the Pump and or solenoid.

3.8 Nutrient

GREEN LED

On indicates that the signal from the nutrient meter (pin 9) is high.

This LED will flash as nutrient is injected.

3.9 Gate Valve

GREEN LED

On indicates that the Gate Valve is OPEN.

3.10 Remote

GREEN LED

On indicates that Power Relay is energised and power. If the unit is acting as a stand alone controller the power is switched through to the power FET, PUMP and SOLENOID. If the unit is monitoring a second system, power will be switched through to that other system.

3.11 Water

GREEN LED

On indicates that the reed switch in the main water meter is closed. This LED normally flashes as the water flows through the meter. At the same time the slave relay connected between pins 18 and 19 is closed.

3.12 Alarm Relay

RED LED

ON means that the Alarm Relay is ENERGISED and that pin 22 is connected to Pin 20. This would normally be used to key a telemetry transmitter.

4 Front Panel switches

4.1 ESC button

This button is used when changing a value to abort input and to retain the old value.

4.2 Enter Button

If the up and down arrows are being used to select different menus, then pressing the ENTER button will in some cases allow the operator to change the parameter being displayed. When the correct value has been selected using the up and down arrows, the ENTER button is used to store the value.

4.3 Up and Down arrows

These buttons are used to change between menus and also to change the value of parameters in some menus.

4.4 Prime Button

Pressing this button will run the pump continuously while it is held on provided the gate valve is open.

Pressing this button places the system into a manual over ride mode. Once the pump is primed, the user must press the RESET button to re start normal operation.

4.5 Reset Button

If the unit is operating, pressing the reset button, turns the unit OFF.

If the unit is not operating, pressing this button places the unit into automatic operation.

If there is an alarm present, the system will shut down again shortly after once the problem is detected.

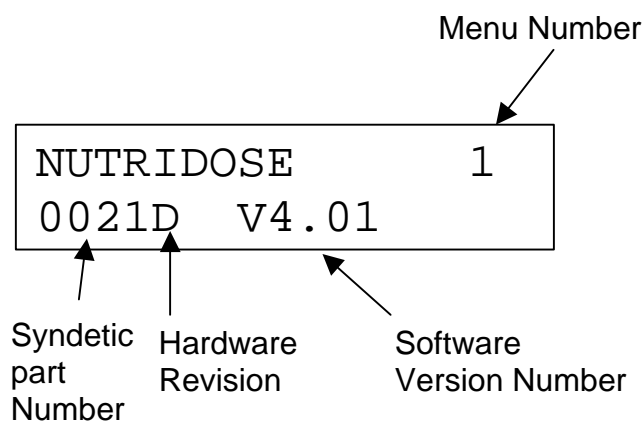
5 Menu Selection

This chapter describes the operation of the LCD display and the meaning of the various messages that are displayed.

The up and down arrows are used to move up and down through the menu items displayed on the LCD display.

If you wish to change a value, then press ENTER. The up and down arrows will then change the value. Pressing Enter will store that value. The arrow keys will then allow the user to move up and down the menu structure again.

When power is applied, the unit will display a start up screen as shown below. Press the down arrow to get to the next menu item



```

NUTRIENT : WATER
      0ml : 10L
  
```

This menu item displays the proportion of nutrient to water for the current dose cycle. It starts from zero when the pulse is received from the main water meter. The unit displays the amount of nutrient injected in milliliters.

```

ALARMS      PULSE 3
NO ALARMS
  
```

Press the MENU button to move to the next screen

If an alarm is present, this menu item displays the reason for the alarm. Possible displays include

- CPU RESTART
- PROPORTION HI
- LOW VOLTAGE
- PUMP ON TOO LONG

PULSE or LATCH is displayed to advise the mode of operation of the Alarm Relay.

To change the mode of operation of the alarm relay, Press ENTER then use the up and down arrows. Press ENTER to store the value or ESC to cancel. The value stored is retained even if the battery is disconnected from the unit.

SET POINT	4
xx ml : 10 L	

This is the target level that the controller will attempt to inject to.

To change the level, press Enter then use the up and down arrow keys to set a new level. Press ENTER when you have set the level. If you wish to retain the old level press ESC.

The level is retained even if the battery is disconnected from the unit

SET ALARM LEVEL	5
XX ml : 10 L	

This is the alarm threshold setting. The unit will compare the measured proportion against this setting. If the measured proportion is greater than this setting then the unit will enter the alarm state.

To change the setting, Press ENTER then use the up and down arrows to set a new level. Press ENTER to store the new value or press ESC to go back to the old value.

This value is retained if the battery is disconnected

SERIAL	01	6
--------	----	---

This menu is used in conjunction with the serial remote control interface.

01 is the address of the unit. See section 12.

To change the address of the unit, Press Enter. Then use the up and down arrows to set the address. The address is a two digit hex number. Press Enter again to store the new address.

Once stored, the address is retained even when power is removed from the unit.

The bottom line is used to display the serial input buffer. As characters are received they are displayed in the left most position. Once a start of message character "{" is received, the message received will be displayed on the bottom line as the characters are received.

GATE VALVE	7
OPEN	0

This menu displays the state of the gate valve

To manually control the gate valve press ENTER. The system will enter a manual over ride state and the gate valve can be manually set OPEN or CLOSED using the arrow keys.

Press ESC to return to the menu system

The only way to return to automatic operation is to press the RESET key on the front panel.

Note that when ever the Gate valve is operated there is a 3 second delay to allow the valve to fully open or fully close.

NUTRIENT CAL	8
1278	Pulse/L

This menu displays the calibration value for the nutrient meter. The default is 1278 however this value is adjusted during manufacture for optimum performance with the particular nutrient meter

BATTERY VOLTAGE
12

This menu displays the Battery voltage.

WATER PULSE	123
NUTRIENT PLS	1234

This menu displays the pulses as they are received. This information can be useful when fault finding. The numbers increases by one each time a pulse is received on the respective input.

Internally 16 bit counters are used. The maximum counts for water and nutient that will be displayed are 65535. The counters then roll over to zero.

Note that RAW PULSE COUNT is displayed NOT proportion and NOT litres.

```
RESET NUTRIENT11
LOGGING
```

This menu is used in conjunction with the next menu to log the total quantity of nutrient used in a given time.

Press ENTER to reset both the time count and the nutrient usage count to zero.

The system will respond asking you to confirm the reset. Press ENTER to confirm or ESC to cancel.

```
D:HH:MM NUTRIENT
0: 1:24 1105 mL
```

This menu displays the duration in Days, Hours and minutes and the total volume of Nutrient injected during that time.

The time and the nutrient volume are both reset to zero by the preceding menu item. They are also set to ZERO when the CPU re starts.

The information is not retained if the power is lost from the system.

The example display shows that 1105 millilitres of nutrient have been injected in the last 1 hour and 24 minutes.

6 Connections

This chapter describes the physical interfaces on the unit.

6.1 Solar Panel

These two connections connect to the solar panel.

Pin

- 1 Solar Panel Negative
- 2 Solar Panel Positive

The unit can tolerate the solar panel being connected the wrong way round for a short time without damage. During that time the CHARGE LED will be twice the normal brightness.

6.2 Battery

These two terminals connect to the battery.

Pin

- 3 Battery Negative - (Also referred to as Ground and GND)
- 4 Battery Positive +

The unit can tolerate the battery being connected the wrong way round for a short time without damage.

6.3 Pump

A +12 V pump and/or solenoid valve can be connected across these terminals.

In a venturi injection system a solenoid only with no pump would be fitted.

Pin

- 3 +12V direct from the battery. (Normally connected to pin 15 with the pump connected to pin 13)
- 4 Momentarily switched to Ground to turn on the pump. The duration is controlled to obtain the required proportion of nutrient to water.

6.4 Nutrient Meter

These three connections connect to the nutrient flow meter. The meter requires positive voltage supply and ground. It returns a digital (0-5V) signal that is read by the microprocessor.

It is designed to interface to a RS 256-225 flow meter.

Pin

- | | | |
|---|----------------------|-----------|
| 7 | GND | Braid |
| 8 | +5V Supply to Meter. | RED Wire |
| 9 | Pulses | BLUE wire |

6.5 Gate Valve

A Spray Flow series 2400 or equivalent gate valve is connected across these three terminals.

Pin

- 10 GREEN +12V is +12V supply straight from the battery to the gate valve
- 11 WHITE Gate Valve GND is the ground connection to the gate valve.
- 11 BLACK Gate Valve Control is the control for the gate valve. When this is at +12V the valve opens. When this is at 0V, the valve closes.

6.6 Power Relay

This is a relay output that is used to switch the power of the controlling system to the pump and solenoid..

It can switch 12V DC 10A.

Pin		
13	NO	Connected to Pin 16 when all OK
14	NC	Connected to Pin 16 when an alarm is present
15	Common	

6.7 Water Meter

This input is designed to monitor the reed switch detector in the main line water meter.

Pin	
16	GND
17	Data Input from Reed switch.

6.8 Water Meter Slave

These pins connect to a small relay that mimics the operation of the reed switch in the main water meter. It is used when this monitor is used to monitor the operation of a separate controller to permit both units to share the one water meter.

Pin	
18	These two pins are connected when the reed switch in the main water
19	meter is closed and open when the reed switch is open.

6.9 Alarm

These 3 pins connect to a relay that is used to indicate an alarm condition to a telemetry system

The relay operates in one of two modes depending on the setting in the ALARM menu.

If the mode is set to PULSE then

When the system is in the alarm state, the relay closes for 5 sec every minute.
It is intended to key a CB radio transmitter to transmit the alarm condition as a tone.

If the mode is set to LATCH then

When the system is in the alarm state, the relay is permanently closed.
In this mode, the alarm would be transmitted via a telemetry system.

Pin	
20	NO Connects to pin 22 when an alarm is present.
21	NC Connected to pin 22 if no power on the system.
22	Common

6.10 Alarm Tone

This output provides a tone sequence that can be transmitted over a two way radio to alert the user to a problem with the system. The radio is keyed to the transmit condition using the alarm relay output on pins 21 and 22.

Pin	
23	Tone
24	Ground

6.11 Serial Interface

Connector	D9(M)
Interface	RS232
Bit Rate	9600
Data Bits	8
Parity	None
Start Bits	1
Stop Bits	1

Serial Interface Pin out:

The D9 connector is wired the same as a PC. This means that a straight through cable would be used to connect to a modem and a null modem should be used if a PC is to be connected directly to the unit.

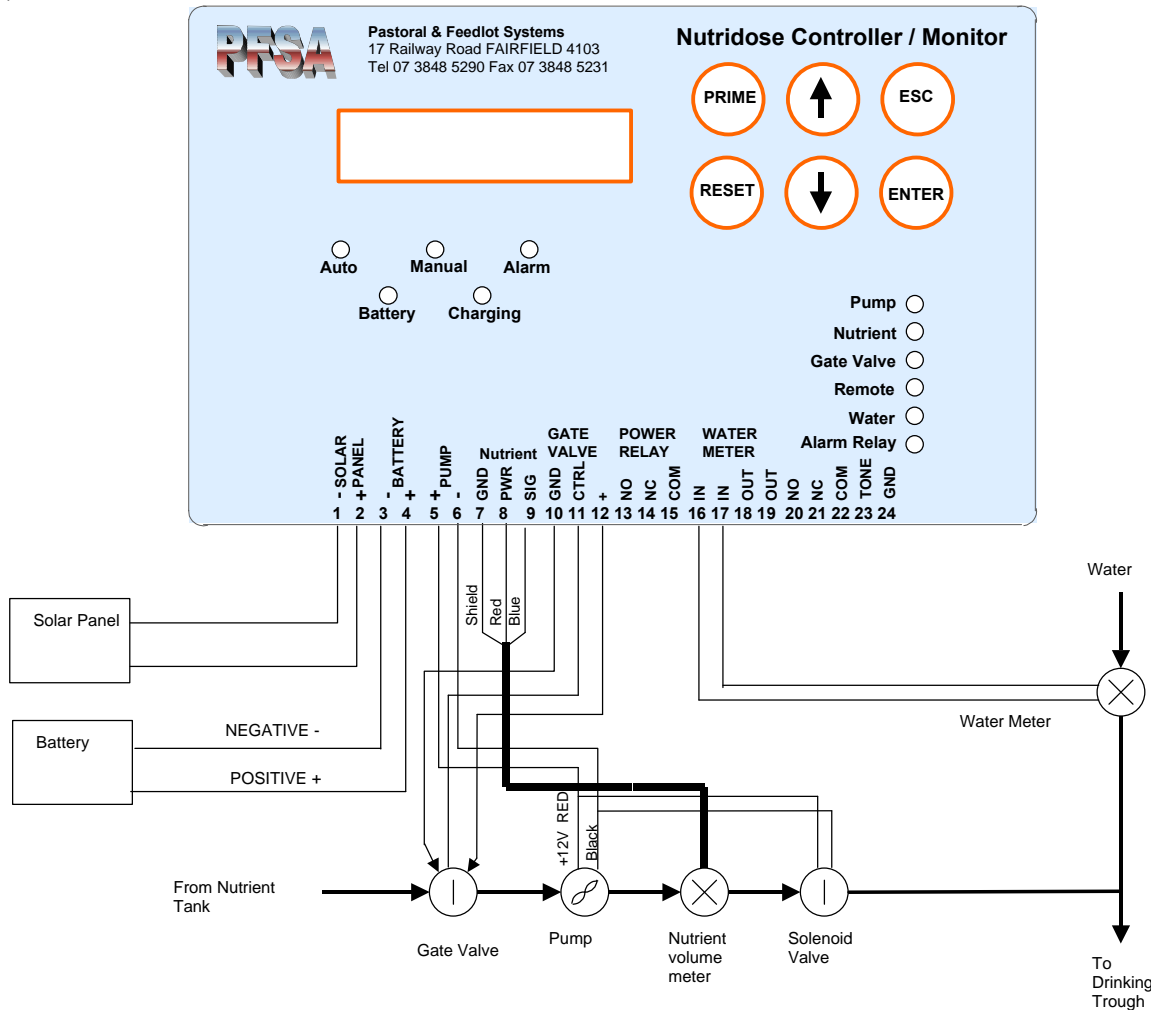
To allow for future expansion, only the pins that are required for a certain interface should be connected to. In future units other signals such as RS422 and RS485 that may use pins that are currently not used for RS232.

Pin	Function	Direction
1	*	
2	Received Data	(IN TO Nutradose)
3	Transmitted Data	(OUT of Nutradose)
4	*	
5	Ground	
6	*	
7	*	
8	*	
9	*	

* = Reserved – Do not connect to this pin

7 Connection as a Controller

p



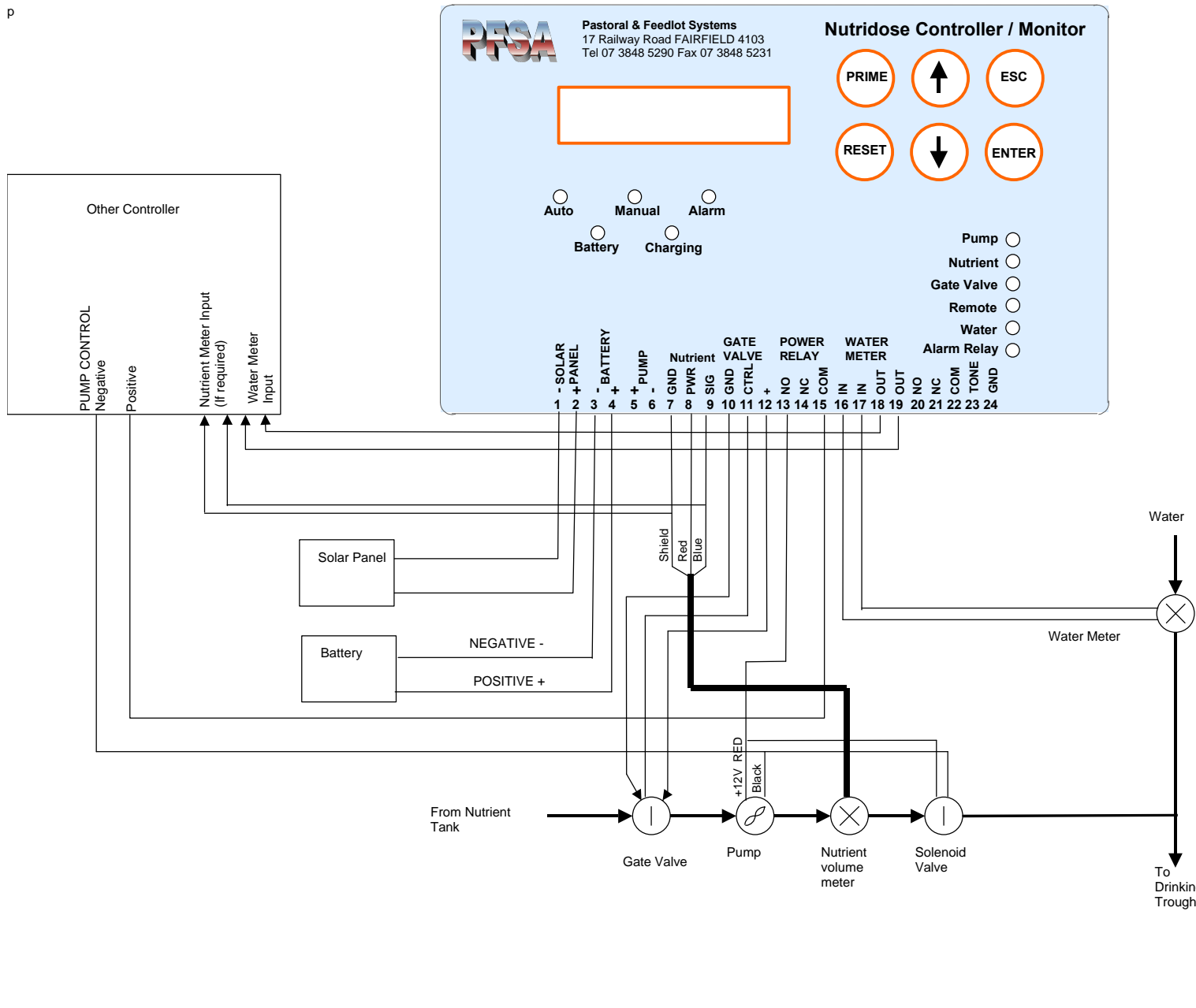
The 0021 is connected to operate as a controller as shown.

Note this drawing is applicable to Rev C hardware only.

For Rev A & B Hardware, see rev C of the manual to ensure continued protection.

8 Connection as a Monitor

p



To modify an existing system to be monitored by the 0021 unit follow these instructions.

Leave the negative pump wire connected to the existing system. Connect the positive pump wire to pin 13 on the 0021. Connect a wire from pin 15 on the 0021 to the terminal on the existing controller where the pump used to connect to.

Disconnect both water meter wires from the existing controller and connect them to pins 16 and 17 on the 0021.

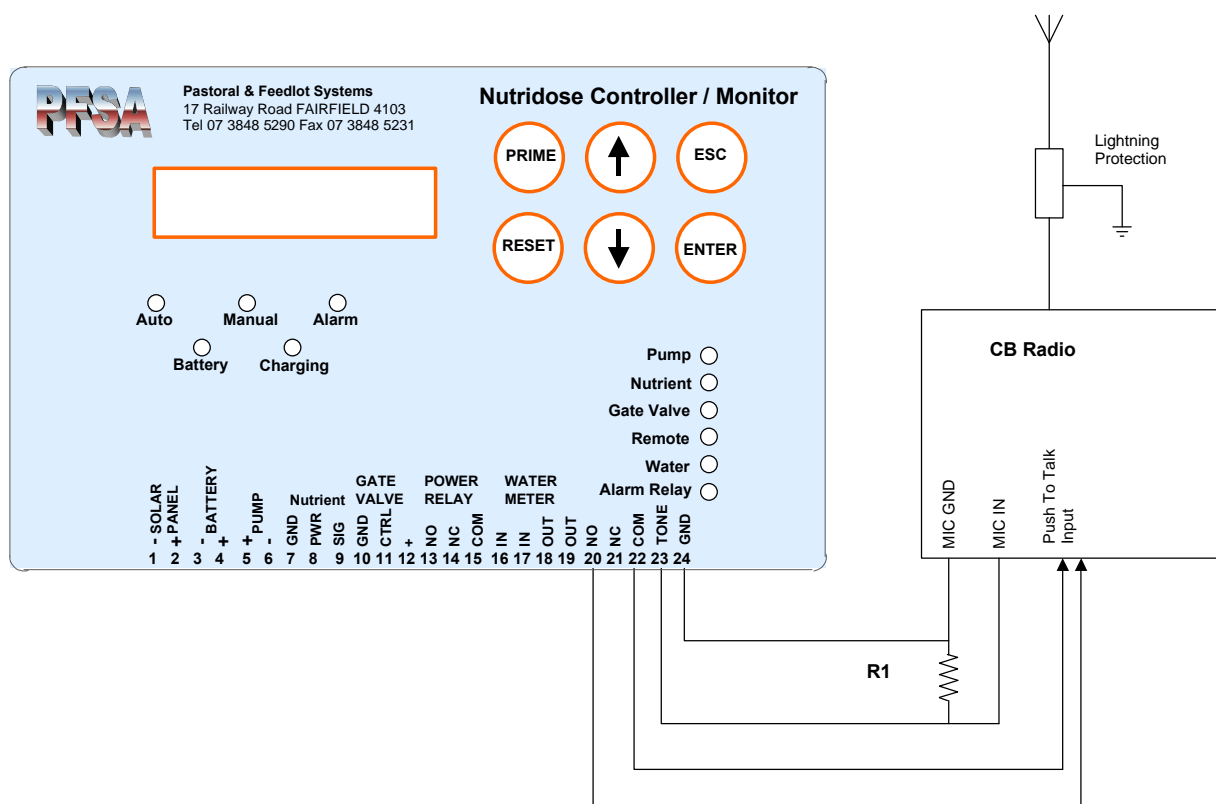
Connect two new wires from the terminals on the existing controller where the water meter was disconnected from, to pins 18 and 19 on the 0021.

If the existing controller uses an RS256-225 flow meter to monitor the nutrient flow, then connect it as shown. Parallel the ground and the blue signal line but do not parallel the RED power lead. If the existing controller does not use the RS250-225 then one must be integrated into the system as shown (without connection to the controller).

The existing controller will already have its own solar panel and battery. Do not disconnect these.

The 0021 should have its own battery so that there is independent power available to close the gate valve should the main power fail. If the 0021 is to share the solar panel then parallel the existing solar panel into pins 1 and 2 on the 0021. If it is to share the battery then connect the battery to pins 3 and 4 on the 0021. If the 0021 is sharing the main controllers battery then do NOT connect anything to pins 1 and 2 on the 0021.

9 Telemetry – Tone Pulse sequence



Note that the operation of the alarm relay can be set to either pulse or latching mode. See the information on ALARM display in 5. To transmit a tone sequence, the mode of operation of the alarm relay must be set to PULSE.

The 0021 can be connected to a CB radio to transmit a tone in the event of the 0021 entering the alarm state.

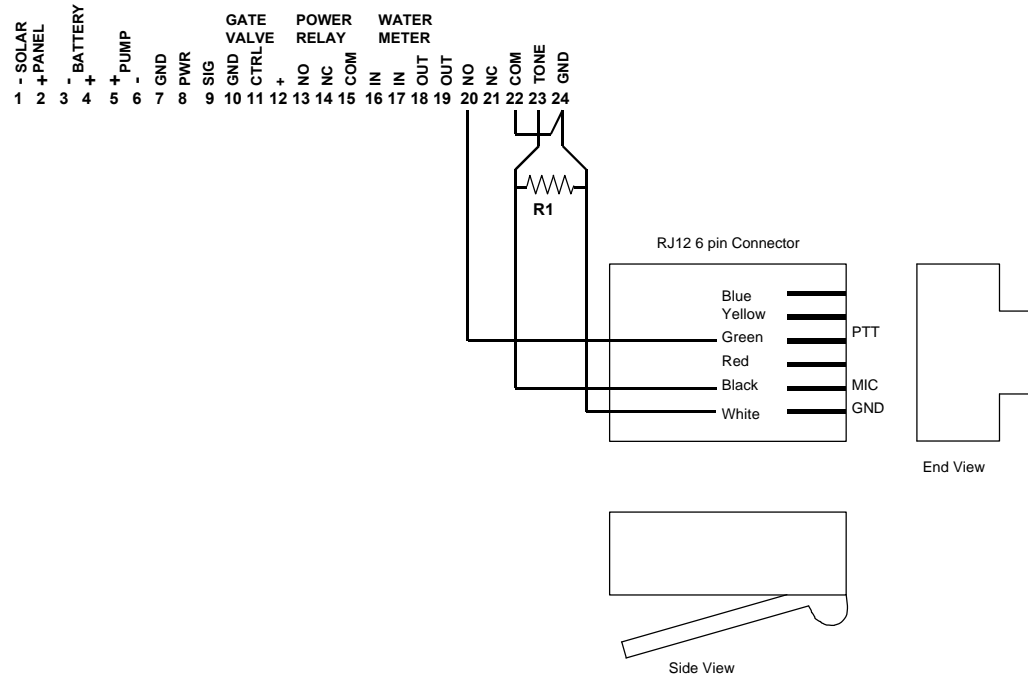
The +12V power for the radio can be connected directly from the battery. If the 0021 is being used as the controller then to conserve power, the radio can be connected so that it only receives power when the 0021 is in the alarm state. In order to do this connect the ground of the radio to the battery negative and the positive supply for the radio to pin 14 of the 0021. In order to do this, the radio must be able to retain its channel settings with the power removed.

When the 0021 is in the alarm state the tone sequence is generated on pin 23. Once per minute a relay is closed for about 5 seconds across pins 20 and 22. This keys on the transmitter and transmits the tone sequence.

Radios vary in the audio level required. The level out of the 0021 is fairly high. There is a 100k resistor in series with pin 23 inside the 0021. Resistor R1 is selected to reduce the audio level to that required by the particular radio used. The smaller the value of R1 the lower the volume. R1 should ideally be soldered inside the microphone connector but it could also be inserted in the terminal block on the 0021 between pins 23 and 24.

A strobe or other +12V indicator can be connected between pin 14 on the 0021 and the battery minus to provide a visual indication of the alarm. The output is switched to +12V when the 0021 is in the alarm state but choose the indicator

10 Telemetry – Tone Pulse sequence GME TX3200



The 0021 has been tested with a GME Electrophone TX3200 with the 0021 set for tone mode of operation.

The connection between the 0021 and the TX3200 is made using a length of 6 wire flat phone lead crimped into a 6 pin RJ12 connector. Note that some RJ12 connectors only have 4 pins fitted but that the full 6 pin version is required in this application.

The value of R1 used in the trial was 470R however the value will still have to be selected to set the desired volume in each application. A small leaded trim pot can also be used.

The RJ12 cable plugs into the front of the TX3200 in place of the microphone.

11 Telemetry – Connection to a Telemetry System

The normal method of connecting the 0021 to a telemetry system is to set the mode of operation of the alarm relay to latching. See section 5.

The telemetry system is then connected between 20 and 22. These two pins are open circuit during normal operation and closed when an alarm is present.

The water meter OUT – OUT on pins 18 and 19 is a slave output of the water meter input and can also be connected to a telemetry system to record water flow.

12 Serial Remote Control

This section described the remote control and monitoring protocol.

This interface is only available on Rev D hardware. Even though Rev C hardware has an internal serial port, the 8535 processor used on the Rev C hardware does not contain enough program (flash) memory to support the remote control routines. Rev D hardware is identified by having an ATMEGA 16 processor fitted to the board. The unit will also display 0021D on the LCD when it is powered up.

The details of the serial port interface are described in section 6.11

12.1 Protocol Format

[lead-in][Address][Message][Checksum][Terminator]

Both transmit and receive messages fit this format.

All characters transmitted are printable ascii with the exception that a CR LF is appended to each response generated by the unit.

The various message elements are defined as follows

[lead-in]	The open curly bracket character '{'
[Address]	The address of the unit in Hex. Addresses can range from 00Hex to FFHex. Two asterisks '**' are recognised as a wild card address.
[Message]	Message characters. Printable ASCII characters.
[Checksum]	Cchecksum as defined below
[Terminator]	The closed curly bracket character '}' This character terminates the transmission.

12.2 Checksum

The checksum operates on the address and message bytes only. It is a single character and is calculated as follows:-

$$((\text{SUM AND } 63) \text{ XOR } (\text{SUM DIV } 64)) + 32$$

Where:

SUM is the modulo 256 sum of the address and message bytes.

AND is the bitwise AND operator.

XOR is the bitwise exclusive OR operator.

DIV is the divide operator.

This is equivalent to saying that the checksum is the eight bit sum of the ASCII values of the address and message characters, with the most significant bits of the result shifted down and exclusive ORed with the two least significant bits of the result. The 32 (space) is added to make the result printable.

12.3 Commands

Two commands are defined:

S – Status

X – Switch Off

12.4 Responses

All numbers are in Hex.

All numbers are preceded by a letter that describes the function

S – Status

The Status command requests that the Nutridose return a message providing it's status

Example: {01SV}

Response:

{01 V0401 C000000F A05 S01 G01 R00 W0000 N0083D5FF P0064 B2606 T00FB 5}

Character	Description
{	Start of message Character
01	The address of the unit sending the message. 01 in this example.
S	the command received is echoed. Note the space between the address and the echoed command distinguishes a response from a command.
V0401	The Software version number
C00000131	The time count in seconds since logging was reset.
A05	The Alarm Code. One byte transmitted in HEX. ' Each bit of the alarm code has a certain meaning. When all bits are zero, there are no alarms. Ie A00 means no alarms Bit 0 = 1 = cpu restart Bit 1 = 1 = proportion high Bit 2 = 1 = low battery voltage detected. Bit 3 = 1 = high battery voltage detected. Bit 4 = 1 = pump on too long.

S02	The unit State The State byte determines how the unit responds. The state of the unit is reflected in the three LED's immediately below the LCD. The three states are
	00 = Auto mode. AUTO LED ON This is the normal operating mode
	01 = unit has tripped out ALARM LED ON
	02 = manual over ride. MANUAL LED ON
G01	Gate Valve Status 01 = Gate Valve Open 00 = Gate Valve Closed
R00	Remote Power Relay Status 01 = Energised 00 = De energized.
W0000	Water Usage logged in the duration indicated in litres.
N0083D5FF	The Amount of nutrient logged in ml.
P0064	Set Point for each Nutrient injection dose in ml
B262F	Battery Voltage in milli volts.
T0100	Temperature in tenths of a degree C.
5	The checksum character.
}	End of message character.

X – Switch OFF

The Switch OFF command caused the Nutradose to stop injecting Nutrient. The gate valve is closed, The pump and the solenoid are switched OFF. The Power Relay is de-energized.

The unit responds by providing its status. Note that the Command X is echoed.

Example: {01X{}

Response:

{01 X V0401 C00000719 A05 S02 G01 R00 W0000 N0083D5FF P0064 B261B T0105 !}