MICRO RTU HANDBOOK

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1 INTRODUCTION

1.1 General Description

The Micro is a small low powered 'Remote Terminal Unit' (RTU) that can read analogue and digital values[1] and communicate status and alarms via 'Mobile Data' and/or SMS.

Power options include: Loop Powered, Bulk-Battery Powered and Solar Powered.

1.1.1 Features:

- Small
- Low cost
- Low powered
- Robust
- Wakes up periodically to read the input value(s).
- Reports directly to users' phone by SMS
- Reports to Servers (e.g. Lee-Dickens' Sitewatch Data-Centre) by 'Mobile Data'
- Single Analogue Input Channel
- Built-in Ambient Temperature measurement
- Real Time Clock
- Expansion options include:
    - One extra General Purpose Analogue Input
    - Three General Purpose Digital Inputs / Outputs
    - Serial Port to talk to PLCs via Modbus
- Very cheap to install, typically requiring a single low power signal cable
- Allows 'over the air' (OTA) firmware updates.

[1] Depending on expansion options.

1.2 Electrical Specification

- Single 4-20mA Analogue Input – 0.5% resolution
- Simple 2-wire signal interface
- Integral Rechargeable 'Reservoir Battery'
- Loop Powered from the 4-20mA signal
- Loop voltage drop of less than 5V
- Options for supplementary DC charging supply
- Three Indication LEDs[2]
    - 'Awake' (Green) - indicates the Micro is Awake
    - 'SMS RX' (Red) - indicates an SMS has just been Received
    - 'Sig' (Yellow) - indicates the Micro has a valid Network Signal

1.2.1 Maximum Ratings

Parameter	Terminations	Ratings	Notes
V1	L+ to L-	I_{Pos} = 200 mA I_{Neg} = -20 mA	Current Loop signal. +20mA is V1 full scale *200mA fuse installed.*
C1	C+ to 0V	V_{max} = 19.8 Vdc[3]	DC Charger signal. +16.56 is C1 full scale.
V_{REF}	C03.1	I_{out} 200mA	2.75V regulated output. Supplies external circuits up to 200mA.
GND	C03.8 & C03.10		Ground. Battery 0V connection.
B1 V_{CC}	C03.9	V_{Min} = 3.2V V_{Max} = 4.3V	Voltage of Micro Battery pack. 3.2V = 0%; 4.3V = 100%

[2] The LEDs will typically only be illuminated if a user has pressed the 'Wake Up' button, or if an SMS has just been received.

[3] For applications requiring higher C1 Charging Voltages, please specify when ordering.

1.3 Physical

- Painted Diecast Aluminium
- IP65
- Width 80mm
- Height 125mm (enclosure only)
    - 245mm (including gland & antenna)
- Depth 60.5mm

1.4 Environmental

- Operational temperature: -20°C to +75°C
- Storage temperature: -40°C to +85°C

2 INSTALLATION GUIDE

2.1 Before Installing

- ✓ Before going to site it is advisable to give the Micro's Integral batteries a good charge. Measure the battery volts (C03.9 is positive, C03.10 is negative). When fully charged the batteries should measure above 4.10V.

In order to charge the batteries there are several options:

a. Wire in an external power source (5 to 16.5Vdc) to C01 (between C+ and 0V)

b. Connect a USB serial lead (plugged into a computer) into C02 (available from Lee-Dickens)

c. Replace the Batteries (3x AAA 1000mAh NiMH)

- ✓ Check that the SIM card[4] to be used is active and has a suitable contract or credit available.
- ✓ Place the SIM in a suitable mobile phone handset. At the proposed installation location confirm that a valid GSM signal is available.
  - Check the phone's signal strength indication
  - Send a test SMS message
  - Make a test phone call

If the GSM signal strength is poor, try relocating the Micro. (Voltage drop is typically less than 1 volt per kilometre!)

2.2 Mounting

- ✓ Remove the lid of the Micro by unscrewing the four screws.
- ✓ Mount the Micro onto a suitable flat surface using the two mounting holes in the thick wall of the enclosure[5], allowing suitable space above the enclosure for the antenna and below it for the cable entry and gland.

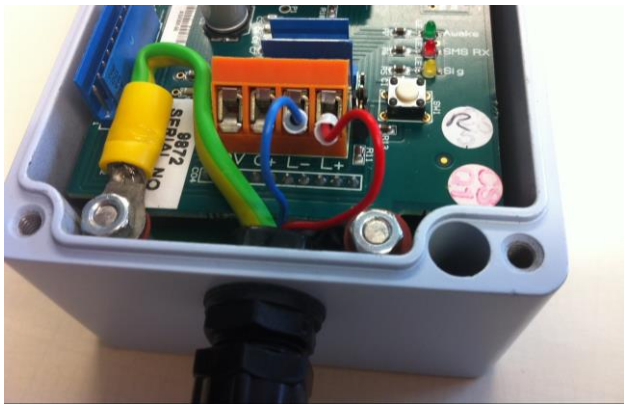
[4] Most SIM cards can be used with your Micro. To order a SIM from GiffGaff you may wish to use the link below: http://giffgaff.com/orders/affiliate/sitewatch **NOTE:** The Micro uses a Standard SIM (NOT a 'Micro SIM'!).

[5] Drilling detail is included in Appendix 4

2.3 SIM Card

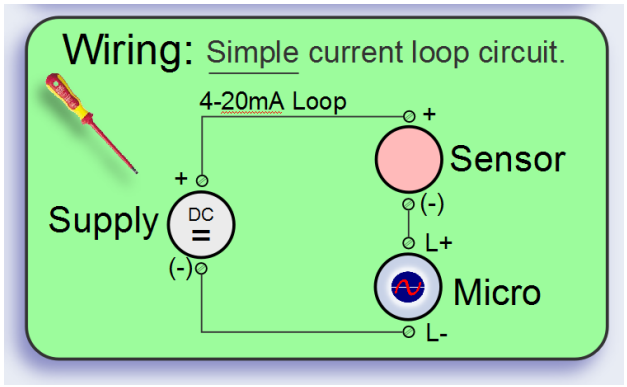
- ✓ Insert a suitable SIM card into the SIM card holder (C05).

2.4 Wiring



- ✓ Bring all signal wiring through the cable entry gland[6] into the Micro enclosure.
- ✓ Ideally the cable should be a multi-core screened cable and this can be grounded on any of the internal mounting studs

2.4.1 Current Loop



- ✓ Wire in your Analogue Input Signal by bringing the 2-wire current-loop into connector C01:
  - L+ (positive signal)
  - L- (negative signal)

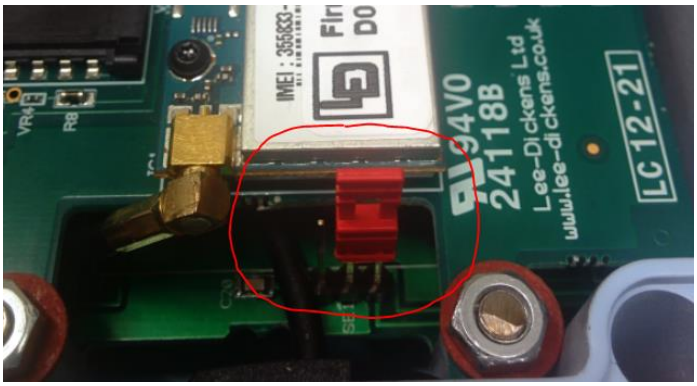
2.4.2 Supplementary Charger

- ✓ If you wish to use a Supplementary Charger then it should be wired to connector C01:
  - C+ (positive: 5 to 16.56V))
  - 0V (negative)

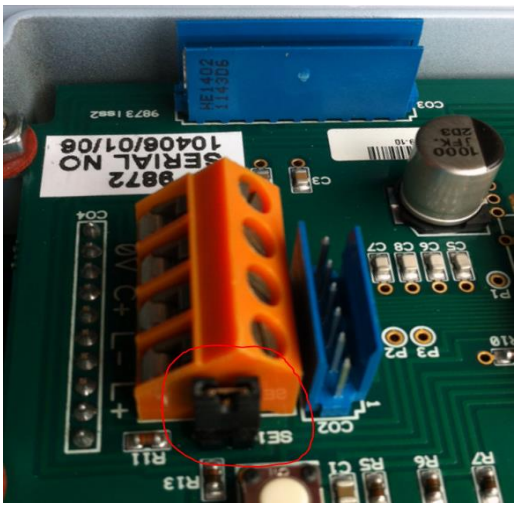
[6] The gland accepts cable diameters between 5mm and 7mm

2.5 Powering Up

- ✓ **Battery Circuit:** Insert the Bottom board link into pins 2&3 which will connect the RTU's battery. *Note that this link has 3 pins - pins 1&2 are for disconnecting the* RTU's *battery for long-term storage.*



- ✓ **GSM Module Power:** Insert the Top board Battery link – this applies power to the GSM module [7].



- ✓ Press the Wake-up button (SW1) for 3 seconds[8].
- ✓ After 30 seconds the Green and Yellow LEDs should illuminate – the Micro installation is now complete[9].

[7] IMPORTANT: the links must be applied in the correct order to avoid possible damage to the unit. The batteries must be in circuit BEFORE the GSM module link is applied.

[8] Check that all cables are clear of the wake-up button (SW1). Typically cables should be dressed to the left of the unit.

[9] If the LEDs do not illuminate as expected, please refer to the Fault Finding section found in Section 10.

2.6 Installation Checking

In order to test that the Micro is working, use a Mobile phone to send a 'Get Status' SMS (text message) to the Micro.

The Micro will typically wake up within 15 minutes, but can also be woken by pressing the 'Wake Up' button (SW1). When the Micro is next awake it will reply by sending a Status SMS report. It will then stay awake for 15 minutes allowing further SMS messages to be more quickly exchanged.

This would be a good time to configure the Micro.

3 CONFIGURING THE MICRO

The Micro offers numerous User Settings which can be remotely viewed and adjusted via SMS. The full list of User Settings is included in the Section 6.2.

In order to explain the use of the User Settings, we will use examples.

3.1 Example 1 – Monitoring Water level using SMS.

Firstly you need to adjust some User Settings relating to the Analogue Input Signal:

- You need to give it a name – the setting you need is `V1Name`. For example:
  - `V1Name=Water Level;`
- You need to enter the range of your analogue input. So, if your 4-20mA represents a water level of 0 to 10 Metres you would enter the following settings:
  - `V1Z=0;`
  - `V1F=10;`
  - `V1U=Metres;`

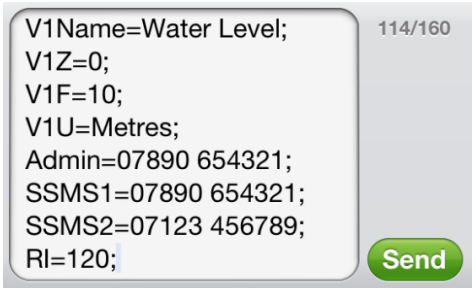
Next you will also need to set up the Micro's Contacts:

- It is advisable to setup an administrator contact[10] [11]. For example:
  - `Admin=07890 654321;`
- You may want the Micro to send SMS status reports to a contact or two. For example:
  - `SSMS1=07890 654321;`
  - `SSMS2=07123 456789;`

Finally, you need to tell the Micro how often to report:

- The Micro wakes up every 15 minutes so the report interval should be in multiples of 15 minutes. For example, the following would produce a report every two hours:
  - `RI=120;`

The settings above need to be sent to the Micro using SMS. You can send each setting in its own SMS message, but it's normally more convenient to put them all in one message. For example:

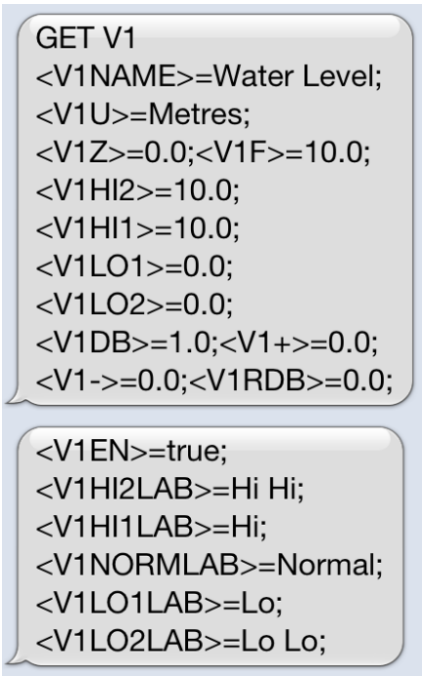


[10] It is advisable to configure the administrator's GSM phone number into the `Admin` contact in order to make the Micro's settings secure. If the `Admin` contact is left blank (default) then User Settings can be adjusted by any SMS contact. All changes to User Settings will be reported to the ADMIN contact.

[11] If an Admin contact is added, then the Micro will send it a "Micro RTU manually woken by Power Button press!" alert SMS every time that the Micro is manully woken.

3.2 Example 2 – Adding Alarm Level Monitoring.

In order to view all the existing settings for your Analogue Input you can send a `Get V1` SMS command to the Micro. The Micro will reply with a sequence of SMS messages containing the relevant User-Settings. Each message will contain a series of User-Settings, for example:



The full list of User Settings for V1 includes settings to allow you to choose High and Low alarm limits and 'Maximum Hourly Change'.

In order to add a 'High Alarm' limit the `V1Hi1` setting needs to be adjusted, for example let's set a limit of 8.5 Metres:

- `V1Hi1 = 8.5;`

Similarly, if a 'Low Alarm' limit of 2.5 Meters is required then you would set the following:

- `V1Lo1 = 2.5`

And if a second 'Low Alarm' is required, then V1Lo2 should also be set, for example:

- `V1Lo2 = 1.0;`

Finally, we need to tell the Micro which contacts to send the SMS alarm reports to. For example:

- `ASMS1=07890 654321;`

Basic Setup is now complete!

For more advanced setup, please continue to explore the handbook.

4 OPERATION

The Micro spends most of the time 'asleep' but periodically wakes up.

All key aspects of the Micro operation can be configured with User-Settings. These User-Settings are configured by sending SMS messages to the Micro.

The Micro can be configured to send 'Status Reports' at regular intervals and 'Alarm Reports' as and when Alarms are detected. The messages can be sent via SMS and 'Mobile Data'.

During each wake-up, the input signals (e.g. the Analogue Input, Charging Voltage and Ambient Temperature) are measured and compared against their Alarm Limits (User-Settings):

- Two Low Limits
- Two High Limits

Every hour 'Maximum Hourly Change' is also checked.

Status reports can be sent at regular intervals using the 'Reporting Interval' setting, or as the input signals change value by using the 'Reporting Deadband' settings.

The format of the SMS reports can be configured with User-Settings.

The format of the 'Mobile Data' message is not user configurable.

4.1 Modes of Operation

The Micro is normally awake for around 60 seconds and performs the following tasks:

- reads its inputs signals
- sends status and alarm reports as appropriate
- checks for received SMS messages

Once these tasks have been completed the Micro will typically go back to sleep. If the Micro's battery is healthy then it will sleep for 15 minutes, but if the battery is low then it will sleep for 60 minutes.

The Micro will sometimes stay awake for up to 15 minutes if:

- an SMS message has been received
- or the 'Wake up' button has been pressed.

When the Micro is asleep it is unable to respond to SMS messages or measure its values.

IMPORTANT: If an SMS is sent to a Micro while it is asleep, then the GSM/cellular providers should store the SMS and forward it to the Micro when it next wakes. However, some providers do not satisfy this requirement: sometimes messages can be significantly delayed or lost. For best performance, it is recommended that SMS messages are only sent while the Micro is awake.

4.1.1 Full Power Mode

Note that if the Charging Voltage (`C1`) is higher than the High Limit (`C1Hi1`) then the unit will go into Full Power Mode – in this mode the Micro does not go to sleep. This mode is designed for Micros with a permanent DC supply and provides the following benefits:

1) Immediate response to Users' SMS messages
2) The Reporting Interval can be made less than 15 minutes
3) Internal Indication LEDs operate (see section 11)

5 USING SMS TO TALK TO THE MICRO

SMS (Text messaging) is a very convenient way to talk to the Micro. It is worth noting that the Micro is designed to be asleep most of the time, and typically wakes up every 15 minutes. This means that if you send it a text message it can take a while for the Micro to respond. However, once the Micro has received a text message from a contact it recognises[12] it will stay awake for up to 15 minutes in case further text messages need to be exchanged[13].

5.1 SMS Rules:

1) Settings will only be accepted from the `ADMIN` contact (if configured).
2) One SMS message can contain several settings and commands.
3) Each setting must be in the form

   `Setting=Value` or

   `Setting = Value`
4) Several Settings and commands can be included in one SMS message, but they must be separated by the ';' (semicolon) character. (e.g. '`RI=240;Get Status`')
5) Commands are not case sensitive.
6) An SMS message is limited to 160 characters.

[12] The Micro recognises the contacts stored in its `Admin, SSMS1, SSMS2, ASMS1, ASMS2` user settings

[13] If a text message contains a 'sleep' command then the Micro will go into sleep mode, unless it is in Live Mode

5.2 SMS Commands

There is a small list of commands that the Micro will respond to:

Getting Settings	
`Get Contacts`	Ask for a list of all the Micro's Contacts
`Get V1`	Ask for all settings related to V1 (the Analogue Input)
`Get C1`	Ask for all settings related to C1 (the Supplementary Charger Input)
`Get T1`	Ask for all settings related to T1 (the Micro's Ambient Temperature Input)
`Get Options`	Ask for a list of all the Micro's Options settings
`Get StatForm`	Ask for an SMS containing the Status Report Format
`Get AlmForm`	Ask for an SMS containing the Alarm Report Format
`Get Settings`	Ask for an SMS containing every active setting.

Getting Values	
`Get Status`	Ask for an immediate Status Report
`Get Alarm`	Ask for an immediate Alarm Report
`Get Values`	Ask for a list of all the measured values
`Get Ver`	Ask for the Micro's Firmware Version
`Get NRT`	Ask for the Next Report Time
`Report`	Ask for an immediate Status Report to be sent to the SSMS contacts, and also to the configured server via mobile data.

Factory Defaults	
`Set Default`	Restore Micro to Factory Default settings

Special Functions	
`Sleep`	Tell Micro to go back to sleep (unless it is in Live mode)

6 USER SETTINGS

The operation of the Micro can be configured using 'User Settings'. These settings can be easily changed by the `Admin` User using SMS messages.

Each User Setting has a Tag name[14]. A User Setting can be changed by giving its Tag a new value, using the format:

```
Tag=Value;
```

For example:

```
V1Name=Water Level;
```

6.1 Changing User Settings

One SMS message can contain several User-Settings. It is of course permissible to send several SMS messages if many User-Settings need to be adjusted.

In order to view all the User Settings in use you can send a '`Get Settings`' SMS command to the Micro. The Micro will reply with a sequence of SMS messages containing all of the relevant settings[15].

It can be convenient to then send a similar format message back to the Micro to containing adjusted User-Settings.

Tip – most smart phones include a copy and paste feature - this can be really helpful when adjusting your Micro settings.

6.2 User Setting Descriptions

6.2.1 Contacts Settings

In order for the Micro to sends SMS messages to its contacts, it is important to give a mobile telephone number[16] to each of the Contacts that you intend to use.

Setting	*Description*	*Default*
`Admin`	It is strongly advised that the Admin contact is provided with a valid mobile telephone number. If a valid Admin contact is configured, then the Micro will only accept settings from that contact and keeps the Micro secured.	blank
`SSMS1`	The Micro allows two Status contacts (`SSMS1` And `SSMS2`) to be configured. Whenever a status report is due, a copy will be sent to any valid status contact.	blank
`SSMS2`		
`ASMS1`	The Micro allows two Alarm contacts (`ASMS1` and `ASMS2`) to be configured. Whenever an Alarm is detected, a suitable Alarm report will be sent to any valid Alarm contact.	blank
`ASMS2`		

[14] A 'Cheat Sheet' containing a list of all the Tags is included in Appendix 5

[15] Note that the response to the 'Get Settings' command can include several SMS messages.

[16] The telephone numbers entered into these contacts may include spaces as desired. The number should either start with a zero or with a country code (including a '+' character; e.g. +44).

6.2.2 V1 Settings

The V1 settings relate to the Analogue Input monitoring. The V1 settings are used by the Micro when monitoring the V1 input. The Micro stores the status of the Analogue input in two 'Status Tags':

Status Tag	*Description*
V1	Contains the latest reading (scaled between V1Z and V1F)
V1State	Indicates if the input is in the normal range, or is now a Low or High Alarm etc.

V1 Basic Settings

Setting	*Description*	*Default*
V1Name	This allows you to enter a name for your Analogue Input, such as "Water Level", "Pressure", "Silo Level" etc.	"Measured Signal"
V1Units	This allows you to indicate the units of measure represented by your Analogue Input, such as "Metres", "Bar", "Tonnes" etc.	"mA"
V1F	This value must be a valid number representing the Measured value when the Analogue input measures 20mA	20
V1Z	This value must be a valid number representing the Measured value when the Analogue input measures 4mA	4
V1DP	This value must be a valid number telling the Micro how many decimal places to use when reporting the measured value.	2

V1 Alarm Limit Settings

The Micro has a number of settings that allow Alarm Reports to be sent when the Analogue input value goes too high or too low. The table below details each of these settings and their default values.

Setting	*Description*	*Default*
V1Hi1	This value must be a number representing a High Alarm Limit. If the Analogue Input goes higher than this High Limit, then an SMS Alarm Report is made.	Same as V1F
V1Lo1	This value must be a number representing a Low Alarm Limit. If the Analogue Input goes Lower than this Low Limit, then an SMS Alarm Report is made.	Same as V1Z
V1Hi2	This value must be a number representing a 'Very High' Alarm Limit. This value must not be lower than the V1Hi1 value. If the Analogue Input goes higher than this 'Very High' Limit, then an SMS Alarm Report is made.	Same as V1F
V1Lo2	This value must be a number representing a 'Very Low' Alarm Limit. This value must not be higher than the V1Lo1 value. If the	Same as V1Z

	Analogue Input goes lower than this 'Very Low' Limit, then an SMS Alarm Report is made.	
V1DB	This value must be a number defining the Micro's alarm recovery deadband. The Recovery Deadband is used after a Limit alarm has been made; the Analogue Input must recover by at least the Recovery Deadband value before the Limit alarm is 'cleared' (allowing another Alarm to be created in due course).	1
V1Hi1Lab	This setting is used to describe the state of the Analogue Input when it is higher than the V1Hi1 level.	"Hi"
V1Lo1Lab	This setting is used to describe the state of the Analogue Input when it is lower than the V1Lo1 level.	"Lo"
V1NormLab	This setting is used to describe the state of the Analogue Input when it is Normal	"Normal"
V1Hi2Lab	This setting is used to describe the state of the Analogue Input when it is higher than the V1Hi2 level.	"HiHi"
V1Lo2Lab	This setting is used to describe the state of the Analogue Input when it is lower than the V1Lo2 level.	"LoLo"

Note that for correct operation the four Alarm Limit Settings should be in Descending numerical order:

- V1Hi2
- V1Hi1
- V1Lo1
- V1Lo2

Such that: V1F >= V1Hi2 >= V1Hi1 >= V1Lo1 >= V1Lo2 >= V1Z

V1 'Report on Change' Settings

As well as sending the Alarm Reports detailed above, the Micro also has settings which allow Alarm Reports to be sent when the Analogue Input changes.

The table below details each of these settings and their default values.

Setting	*Description*	*Default*
V1RDB	The Micro uses this Reporting Deadband setting to send Status Reports if the Analogue Input changes significantly. If the Analogue Input value changes by more than this V1RDB setting since the last Status report then a new Status Report is made. *This feature is disabled by setting a value of 0.*	0
V1+	If the Analogue Input value increases by more than this V1+ setting in an hour then an SMS Alarm Report is made. *This feature is disabled by setting a value of 0.*	0

V1–	If the Analogue Input value decreases by more than this V1– setting in an hour then an SMS Alarm Report is made. *This feature is disabled by setting a value of 0.*	0

6.2.3 C1 Settings

The C1 Settings relate to the Supplementary Charger Input monitoring. The Settings for C1 are identical to the V1 settings above, substituting C1 for V1 in all cases. Note that some defaults will vary.

6.2.4 T1 Settings

The T1 Settings relate to the Micro's Ambient Temperature Input monitoring. The Settings for T1 are identical to the V1 settings above, substituting T1 for V1 in all cases. Note that some defaults will vary.

6.2.5 Disabling Alarm and Status Reporting

The Micro includes a number of channels that it can monitor:

- Analogue Input (V1).
- Supplementary Charger Input (C1)
- Ambient Temperature Input (T1).

By default, the Micro monitors V1 but does NOT monitor C1 or T1. The reasons these channels are disabled are that:

1) the monitoring of unused channels wastes the Micro's internal reservoir battery
2) it reduces the number of settings reported in the 'Get Settings' response.

Setting	*Description*	*Default*
V1EN	If this Setting has a value of '1' then the Micro will enable monitoring. If a value is '0' then no monitoring will take place on that input.	1
C1EN		0
T1EN		0

Notes:

1) If an input is disabled, then none of its User Settings will be included in a 'Get Settings' response.
2) If an input is disabled, then any status tags for that input will be invalid and may not be included in Alarm or Status Reports.

6.2.6 Reporting Interval

The previous sections have described how the Micro can be configured to send Status Reports when an Inputs changes by more than a specified deadband. However, it is sometimes more useful to simply have a report sent at regular intervals:

Setting	*Description*	*Default*
RI	Reporting Interval: This setting tells the Micro how many **minutes** to wait between sending regular Status Reports. *A value of 0 stops the Micro from sending regular Status Reports.*	60

Notes:

1) Typically, the Micro will only be awake once every 15 minutes, so it is good practice to set the RI setting to a multiple of 15 (i.e. 30, or 60, or 120 etc).
2) If the Micro is in low power mode, then it will wake up once each hour; if the RI setting has a value less than 60, then some reports will not be made.

6.2.7 Wake Times

The Micro is organised to wake up at the same time(s) each hour, and by default the wake times are at 15 minute intervals starting exactly 'on the hour'.

However, in some applications it might be useful to change this behaviour so that the wake times are offset:

Setting	*Description*	*Default*
WO	Wake Offset: This setting tells the Micro (in minutes) at what time it should typically wake-up. Valid values are from 0 to 59. If WO is zero then it will wake up 'on the hour' and then every 15 minutes. Example: A value of 10 would cause the Micro to wake up at 12:10, 12:25, 12:40, 12:55, 13:10 etc…. The Wake Offset also determines when the 'Max Hourly Change' checks will take place. With WO set to zero, the hourly checks will take place at the beginning of every hour. A value of 30 would cause the hourly check to be performed at 'half past the hour'.	0

Notes:

1) If the Micro is in low power mode, then it will wake up once each hour. The wake time will be determined by the WO setting, and so will typically be 'on the hour'.

6.2.8 Clock Settings

The Micro has its own clock which it uses to control when it wakes up and to allow time and date to be included in its SMS messages.

Setting	*Description*	*Default*
`AutoClock`	Automatic Clock Mode: If this setting has a value of '1' then the Micro will automatically correct its clock using the GSM network. If the setting is '0' then it will expect to be corrected periodically either by a `Clock` SMS message or by a server using Mobile Data.	1
`Clock`	Clock: This setting is used to manually set the Micro's Clock. This setting should only be used if `AutoClock` is set to '0'. The Clock setting can include Time and Date values as required. Dates should be in the format "yyyy/dd/mm". Times should be entered as either "hh:mm:ss" or "hh:mm". Example: `Clock=12:34 2010/07/21;`	0

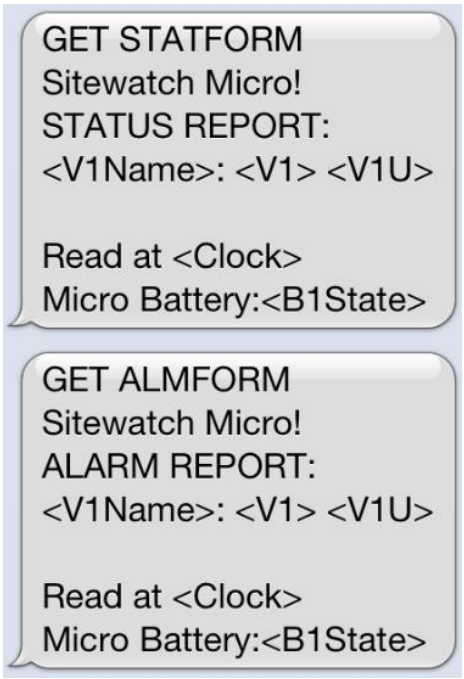
Notes:

1) Because the GSM network cannot guarantee immediate delivery of SMS messages, it may not be sensible to include the seconds when setting the Micro clock.

6.2.9 SMS Report Format Settings

In accordance with the User Settings, the Micro may send out Status and Alarm SMS reports to its SMS contacts. The contents of these two types of reports can be customised in template messages using the two User Settings detailed below.

Setting	*Description*	*Default*
`StatForm`	This setting contains a template for all the Micro's STATUS SMS reports.	See below
`AlmForm`	This setting contains a template for all the Micro's ALARM SMS reports.	See below

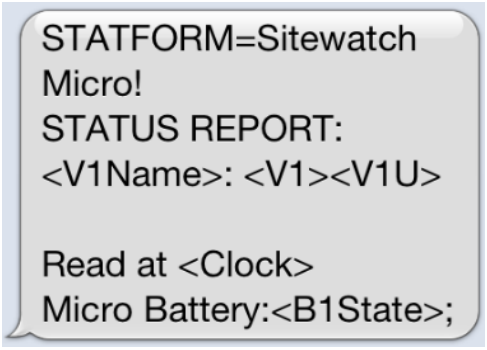


The customised reports can include free text as well as any User Settings or Values from the Micro database, for example:

- Analogue Input Value
- Time
- Date
- Ambient Temperature
- Battery Level
- Charging Voltage

To allow this, the templates must contain special place-holders (called tags) that show what values are to be included. A tag can be recognised in the template because it starts with a '<' character and ends with a '>' (such as '`<V1>`').

A typical Status template report is shown below:



This template would produce a Status SMS such as the one shown below:

Notes:

1) Any of the Micro's User Settings discussed in this section can be included in the template reports.
2) Any of the Micro's Status Tags can also be included in the template reports; these are detailed in Section 6.2.10
3) One standard SMS message is limited to 160 characters. This limit applies to any message sent TO the Micro, and any status message sent FROM the Micro.
4) Each automatic alarm SMS report will contain the configured AlmForm text, followed by an indication of the channel(s) that triggered the new alarm.

6.2.10 Status Tags

Status Tag	*Description*
V1	Value of the Analogue Input. It is scaled between V1Z and V1F. The Number of Decimal Places depends on V1DP. This can only be used if V1En is set to '1'
V1State	Indicates whether V1 is in the Normal range or is an Alarm. The value will be selected from V1NormLab, V1Hi1Lab, V1Hi2Lab, V1Lo1Lab, V1Lo2Lab.
C1	Value of the Charger Input. It is scaled between C1Z and C1F. The Number of Decimal Places depends on C1DP. This can only be used if C1En is set to '1'.
C1State	Indicates whether C1 is in the Normal range or is an Alarm. The value will be selected from C1NormLab, C1Hi1Lab, C1Hi2Lab, C1Lo1Lab, C1Lo2Lab.
T1	Value of the Micro Temperature. It is scaled between T1Z and T1F. The Number of Decimal Places depends on T1DP. This can only be used if T1En is set to '1'.
T1State	Indicates whether T1 is in the Normal range or is an Alarm. The value will be selected from T1NormLab, T1Hi1Lab, T1Hi2Lab, T1Lo1Lab, T1Lo2Lab.
B1	Health of the Micro Battery as a percentage.
B1State	Health of the Micro Battery (selected from 'Normal', 'Low' and 'Very Low').
Time	Gives the Micro's Time in format: 'hh:mm'.
Date	Gives the Micro's Date in format: 'yyyy/mm/dd'.
Clock	Gives the Micro's Date and Time in format: 'yyyy/mm/dd hh:mm'
NRT	Gives the Micro's Next Report Time in format: 'yyyy/mm/dd hh:mm'
Sig	Gives the current GSM signal strength: *To have a reliable Mobile Data connection a minimum value of 12 is recommended.*

6.2.11 Mobile Data Settings

As well as reporting using SMS (text messaging), the Micro can also send Status Reports to a server using 'Mobile Data'. To enable this, the settings in the table below must be provided.

In the same way as Status SMS reports, the Mobile Data Status updates are sent based on the Reporting Interval (`RI`), Reporting Deadband (`V1RDB`, `C1RDB`, `T1RDB`), and if new alarms are detected.

The settings below are used to setup the Mobile Data Connection:

Setting	*Description*	*Default*
`APN`	Set this to the APN details supplied by your SIM provider	Mobile.02.co.uk
`APNUser`	Set this to be the APN Username supplied by your SIM provider	vertigo
`APNPass`	Set this to be the APN Password supplied by your SIM provider	password
`ServerIP`	Set this to the IP address of your Server (typically the Lee-Dickens' Sitewatch Data-Centre, or your own Telemetry Server). *The Mobile Data feature is disabled if this field is blank.*	*Blank*
`ServerPort`	Set this to the Port number of your Server (supplied by Lee-Dickens or your Telemetry Server administrator). *The Mobile Data feature is disabled if this field is blank.*	8000

Details of the Mobile Data reporting can be found in Section 8.2.

7 MONITORING

7.1 Measured Analogue Values

The Micro can monitor up to three analogue values:

- The User Analogue Input (4-20mA current-loop) [referred to as V1]
- The Supplementary Charger Input (0 to 16.56V) [referred to as C1]
- The Ambient Temperature signal (-30 to +70 DegC) [referred to as T1]

By default, only monitoring of V1 is enabled; C1 and T1 are disabled (see section 6.2.5).

User-Settings allow the user to supply zero-scale and full-scale engineering values for measured values, as well as suitable units. When the measured value is reported it will be scaled accordingly.

Options for monitoring an expansion signal are also available – please contact Lee-Dickens technical sales team for details.

7.2 Status Reporting

The Micro can send 'Status Reports' to SMS contacts and via 'Mobile Data' to a Server such as the Lee-Dickens' Sitewatch Data-Centre. All that is required is for the relevant User Settings to be provided with valid details:

- SSMS1
- SSMS2
- Mobile Data (see section 6.2.10)

'Status Reports'can be sent at a 'Reporting Interval' that is defined by a User Setting. When the Micro is awake, a new report will be sent if the last report is older than Reporting Interval.

The 'Reporting Deadband' User Setting provides an alternative method for deciding when status reports should be sent. When the Micro is awake, a new report will be sent if the measured value has changed by more than the Reporting Deadband amount since the last status report. This 'Reporting Deadband' means that the number of status updates could be reduced; if the measured signal does not change, no reports are sent and so the network costs are reduced.

7.3 Alarm Monitoring and Reporting

The Micro can send 'Alarm Reports' to SMS contacts. All that is required is for the relevant User Settings to be provided with valid SMS numbers:

- ASMS1
- ASMS2

The Micro checks each of the measured values against the Alarm Limit User Settings whenever it is awake. The measured value is compared against the last reported value to check for a new alarm:

- High High Alarm
- High Alarm
- Low Alarm

- Low Low Alarm

Every hour, each enabled channel is monitored and its value compared with the value recorded an hour earlier; alarms are generated based on:

- Maximum Hourly Increase
- Maximum Hourly Decrease

If either of these is detected then the Micro will send Alarm SMS Reports to the Alarm contacts. The Alarm SMS messaReport format and the Alarm contacts are defined by User-Settings.

7.4 Expansion Options

Please contact Lee-Dickens' Technical Sales team for further information on the following expansion options:

7.4.1 Expanded Monitoring

The Micro includes expansion connectors that with additional hardware modules allow:

- Monitoring of Digital Inputs
- Pulse Counting
- Monitoring of an additional Analogue value
- Relay control outputs
- Serial interfaces (Modbus etc)

7.4.2 Display Module

In order to allow the monitored value to be viewed at site, Lee-Dickens offers a range of display options to accompany the Micro.

8 REPORTING

8.1 SMS

The Micro can be configured with the mobile telephone numbers of two SMS contacts for status reports and two further contacts for Alarm reports. Any contact can be left blank if it is not required.

The unit will send a **Status** SMS report to its Status contact(s):

- At a user configurable Reporting Interval
- At a user configurable Reporting Deadband

The unit will send an **Alarm** SMS report to its Alarm contact(s):

- Whenever any Alarm Level or Hourly Change Alarm is detected

The unit will send a User-Settings SMS in reply to any change of User-Settings. Note that the Micro will only respond to messages when it is awake.

The Micro includes two user configurable SMS template reports that allow Status and Alarm reports to be fully customised. Reports can include any User-Settings or Values from the Micro database, for example:

- Measured value (scaled using User configured Zero-scale and Full-scale parameters)
- Time
- Date
- Temperature
- Battery Level
- Charging Voltage

Note that one standard SMS message is limited to 160 characters.

8.2 'MOBILE DATA'

The Micro can use a 'Mobile Data' connection to communicate with a Server such as the Lee-Dickens' Sitewatch Data-Centre.

The information is sent over 'Mobile Data' at a user configurable Reporting Interval or Reporting Deadband using a fixed format of data-packet, including:

- Time
- Date
- Measured Value
- Temperature
- Battery Level
- Charging Voltage

9 POWER

The Micro is supplied with an internal reservoir battery that supports normal operation of the unit. In order to keep the battery suitably charged, the Micro offers a number of power options:

1. **Loop Powered** (standard) – if the Analogue Input is a 4-20mA current-loop, then the Micro is able to be 'loop powered' and for most applications will be able to continuously charge its battery.
2. **DC Power** – the Micro comes with terminals allowing an external supplementary DC supply (5V to 16.5V) to be used. This is typically supplied by one of the following options:
    a. 12V supply[17]
    b. External Lead-Acid Battery
    c. Stack of 'D-Cell' batteries
    d. Solar Panels
    e. Wind Turbine
3. **USB Power** – Lee-Dickens can supply an optional USB to Serial 'debug' cable that allows a user to communicate with the Micro via a standard PC or Notebook and to perform a 'quick charge'.

9.1 Battery Life

The loop-powered Micro will typically operate unattended for many years before the internal battery is in need of replacement. It will typically have sufficient power to allow the Micro to communicate every two hours. The Micro's internal battery is designed to support the unit for several days of normal operation even without any external supplementary charger[18].

If an application requires the Micro to wake and communicate more regularly, the Loop-Power may not be sufficient to keep the internal battery charged. Where this is the case an external DC power supply can also be used.

The Battery Level is continuously measured by the Micro and can be included in its regular reports in order that its health can be monitored.

If the Battery Level is considered to be getting 'Low', then the Micro will automatically change its wake-up interval from 15 minutes to one hour until the Battery Level is restored to normal. If the Battery Level is 'Very Low' then the wake-up interval is set to one day.

9.1.1 Optimising the Battery Life

When the Micro is asleep it consumes very small amounts of current and so the internal battery will be charging. When the unit wakes up it is normally awake for around 30 seconds and will slightly drain the battery. When communications via SMS or 'Mobile Data' take place then much more current is consumed.

In order to achieve optimal battery use, the Micro should be configured to reduce the number of communications via SMS/' Mobile Data'.

Since the battery level can be monitored it is easily possible to adjust the User-Settings to provide good monitoring and optimal battery life.

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[17] Alternative Charger Voltages and Charging currents can be specified when the Micro is ordered

[18] Note that the battery use depends on several factors including the wake interval, the GSM signal strength and especially the frequency of SMS/'Mobile Data' communications.

10 FAULT FINDING

The Micro should provide many years of unattended service, but the following fault-finding tips could be helpful.

1) **Wake Up.** Remove the Lid from the Micro. Check that SE1 is installed. Press the 'Wake Up' button for 3 seconds. Wait for 30 seconds for the Micro to wake up:

    a. Does the Green ('Awake') LED illuminate? If not, then check the health of the Battery.

    b. Does the Yellow ('Sig') LED illuminate? If not the check the SIM and antenna

2) **Check the Battery.** Measure the Battery volts (C03.9 is positive, C03.10 is negative). A fully charged battery should be above 4.10V.

    - If the battery is 'Low', the Micro will automatically change its wake-up interval from 15 minutes to one hour.
    - If the battery is 'Very Low', the Micro will automatically change its wake-up interval to one day.
    - If the battery drops below 3.30V then the Micro is likely to fail.

    To quickly recharge low batteries there are several options:

    a. Check that the current-loop has at least 4mA signal. Below this level very little charging can take place.

    b. Reduce the reporting interval in order to preserve the existing charge.

    c. Wire in an external power source to C01 (between C+ and 0V) which will provide a faster charge

    d. Connect a USB serial lead (plugged into a computer) into C02 (available from Lee-Dickens)

    e. Replace the Battery (3x AAA 1000mAh NiMH)

3) **Check the SIM.** Remove the SIM and test it in a mobile phone. Send an SMS from the test phone to another recipient phone; the recipient phone should display the contact number of the Micro. Reply to the text message and verify that it is successfully received. If this is not successful then contact your SIM provider for further assistance. (Remember to replace the SIM into the Micro.)

    Make sure that the SIM PIN code protection is turned off.

4) **Check the Antenna.** Use a mobile phone to send a 'Get Values' SMS to the Micro. Does the Micro illuminate its Red ('SMS RX') LED and then send a reply SMS? If not:

    a. is the Network signal strength sufficient?

    b. is the Yellow ('Sig') LED illuminated?

    c. Leave the Micro in live mode for an extended period – sometimes the GSM/Cellular providers take a few hours to resend messages that were initially sent when the Micro was asleep or off.

5) **Check Network Signal Strength.** Use the 'Get Values' command SMS to determine the GSM signal strength. To have a reliable Mobile Data connection a minimum Signal Strength value of 20 is recommended. To improve the signal strength, it might be necessary to replace the supplied antenna:

    a. Locating the Micro outside and on a high mounting pole can improve signal strength

    b. Using a directional antenna (yagi) angled towards the nearest GSM base station can also improve signal strength

6) **Check Current Loop.** Check that the Current-Loop is correctly powered and providing a calibrated signal.

7) **Reset the Micro Power.** Remove SE1 for 5 seconds. Replace SE1 and then repeat step 1 (Wake Up).

11 HARDWARE

- **Cellular Modem Interface Circuit Board** offering**:**
  - 'Wake Up' Push button (SW1)
  - Battery Isolation Link (SE1)
  - Three Indication LEDs
    - 'Awake' (Green) - indicates the Micro is Awake
    - 'SMS RX' (Red) - indicates an SMS has just been Received
    - 'Sig' (Yellow) - indicates a valid GSM Network Registration
  - Cellular Modem module
  - SIM card holder (C05)
  - Field Wiring Terminal Connector (CO1):
    1. L+ (Current Loop in)
    2. L- (Current Loop out)
    3. C+ (Extra Charging Supply)
    4. 0V (Ground of charging supply)
  - Serial Interface Connector (C02):
    1. Ground
    2. CTS
    3. VCC (USB Charging input)
    4. RX
    5. TX
    6. RTS
  - Expansion Connector (C03):
    1. VREF
    2. D1
    3. D2
    4. D3
    5. SIM enabled
    6. No connection
    7. ADC
    8. GND
    9. VCC
    10. GND
- **Power Supply Circuit Board**
- **Internal battery** comprising
  - Three AAA rechargeable NiMH 1000mAH cells.
- **External Antenna**

12 EXPANSION OPTIONS

As well as the standard signals described above, the Micro RTU also offers some expansion options for monitoring further signals.

The Expansion Inputs are connected via C03. In order to make use of these inputs, suitable interface arrangements must be used – please contact Lee-Dickens technical sales team for further information.

Parameter	Terminations	Ratings	Notes
D1	C03.2	V_{max} = 3.0V V_{Hi} = 2.0 to 2.755V V_{Lo} = 0.0 to 0.4V	D1, D2, D3 are internally pulled up, so are by default High. Users should typically us volt-free contacts to GND to send the input to the Low state
D2	C03.3		
D3	C03.4		
V2 [19]	C03.7	Vmax = 2.75V	+2.30V is V2 full scale

12.1 Digital Input Expansion

Three expansion digital inputs are available and are typically used for monitoring 'dry contacts'.

12.1.1 D1 Settings

The `D1` settings relate to the 1st Expansion Digital Input monitoring.

`D1En`	Set to either 1 or 0 to enable or disable the channel. (Default is 0)
`D1Name`	This allows you to enter a name for your Analogue Input, such as "Compressor Status", "Intruder Status" etc.
`D1OffLab`	Set the text to be displayed when the channel is off.
`D1OnLab`	Set the text to be displayed when the channel is on.
`D1`	Value of the Expansion Digital Input. This is only available if the channel is enabled (`D1En` set to '1').
`D1State`	Indicates whether the channel is on or off. The returned value will be selected from the `D1OffLab` and `D1OnLab` labels assigned by the user.

12.1.2 D2 Settings

The `D2` settings relate to the 2nd Expansion Digital Input monitoring. The Settings for `D2` are

[19] The V1 and V2 circuits are NOT internally isolated, so the field signals MUST be properly isolated to avoid damage to the Micro. Lee-Dickens Ltd are able to provide advice and supply a suitable Isolator as required.

identical to the D1 settings above, substituting D2for D1 in all cases.

12.1.3 D3 Settings

The D3 settings relate to the 3rd Expansion Digital Input monitoring. The Settings for D3 are identical to the D1 settings above, substituting D3for D1 in all cases.

12.2 Analogue Input Expansion

12.2.1 V2 Settings.

The V2 settings relate to the Expansion Analogue Input monitoring. The Settings for V2 are identical to the V1 settings in Section 6.2.2, substituting V2 for V1 in all cases. Note that some defaults will vary.

Appendix 1 – Use Instructions

User Operation

Do not operate your unit when a person is within eight inches (20 centimetres) of the antenna. A person or object within eight inches (20 centimetres) of the antenna could impair call quality and may cause the unit to operate at a higher power level than necessary, as well as expose that person to RF energy in excess of that established by the FCC RF Exposure Guidelines.

Important: The unit must be installed in a manner that provides a minimum separation distance of eight inches (20 centimetres) or more between the antenna and persons and must not be co-located or operate in conjunction with any other antenna or transmitter in order to satisfy FCC RF exposure requirements for mobile transmitting devices.

Important: To comply with the FCC RF exposure limits and to satisfy the categorical exclusion requirements for mobile transmitters, the requirements described in the following section, "Antenna Installation", must be met.

Antenna Installation

• A minimum separation distance of eight inches (20 centimetres) must be maintained between the antenna and all persons.

• If the Micro's box antenna is replaced, the combined cable loss and antenna gain must not exceed +7.5 dBi (850 band). The combined cable loss and antenna gain must not exceed +2.5 dBi and total system output must not exceed 2.0W EIRP in the PCS (1900) band.

Do not operate in an explosive atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

Do not service or adjust alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid is present.

Do not substitute parts or modify equipment

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of equipment. Contact Lee-Dickens for service and repair to ensure that safety features are maintained.

Appendix 2 - Caring for the Environment

The following information is provided to enable regulatory compliance with the European Union (EU) Directive 2002/96/EC Waste Electrical and Electronic Equipment (WEEE) when using Lee-Dickens equipment in EU countries.

Disposal in EU countries

Please do not dispose of electrical equipment in landfill sites. In the EU, Lee-Dickens in conjunction with a recycling partner will ensure that equipment is collected and recycled according to the requirements of EU environmental law.

Disposal in non-EU countries

In non-EU countries, dispose of electrical equipment in accordance with national and regional regulations.

Appendix 3 - Limitation of Liability

The Products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body; in other applications intended to support or sustain life; for the planning, construction, maintenance, operation or use of any nuclear facility; for the flight, navigation, communication of aircraft or ground support equipment; or in any other application in which the failure of the Product could create a situation where personal injury or death may occur.

If CUSTOMER should use any Product or provide any Product to a third party for any such use, CUSTOMER hereby agrees that Lee-Dickens is not liable, in whole or in part, for any claims or Warranty Notification damages arising from such use, and further agrees to indemnify and hold LEE-DICKENS harmless from any claim, loss, cost or damage arising from such use.

EXCEPT AS SPECIFICALLY STATED ABOVE, THE PRODUCTS ARE PROVIDED "AS IS" AND LEE-DICKENS MAKES NO OTHER WARRANTIES EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE REGARDING THE PRODUCTS. LEE-DICKENS SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR ARISING FROM A COURSE OF DEALING OR USAGE OF TRADE.

Under no circumstances shall LEE-DICKENS be liable to CUSTOMER or any other party for any costs, lost revenue or profits or for any other special, incidental or consequential damages, even if LEE-DICKENS has been informed of such potential loss or damage. And in no event shall LEE-DICKENS' liability to CUSTOMER for damages of any nature exceed the total purchase price CUSTOMER paid for the Product at issue in the dispute, except direct damages resulting from patent and/or copyright infringement, which shall be governed by the "INDEMNITY" Section of this Agreement.

The preceding states LEE-DICKENS' entire liability for LEE-DICKENS' breach or failure to perform under any provision of this Agreement.

Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. LEE-DICKENS assumes no liability for customer failure to comply with these precautions.

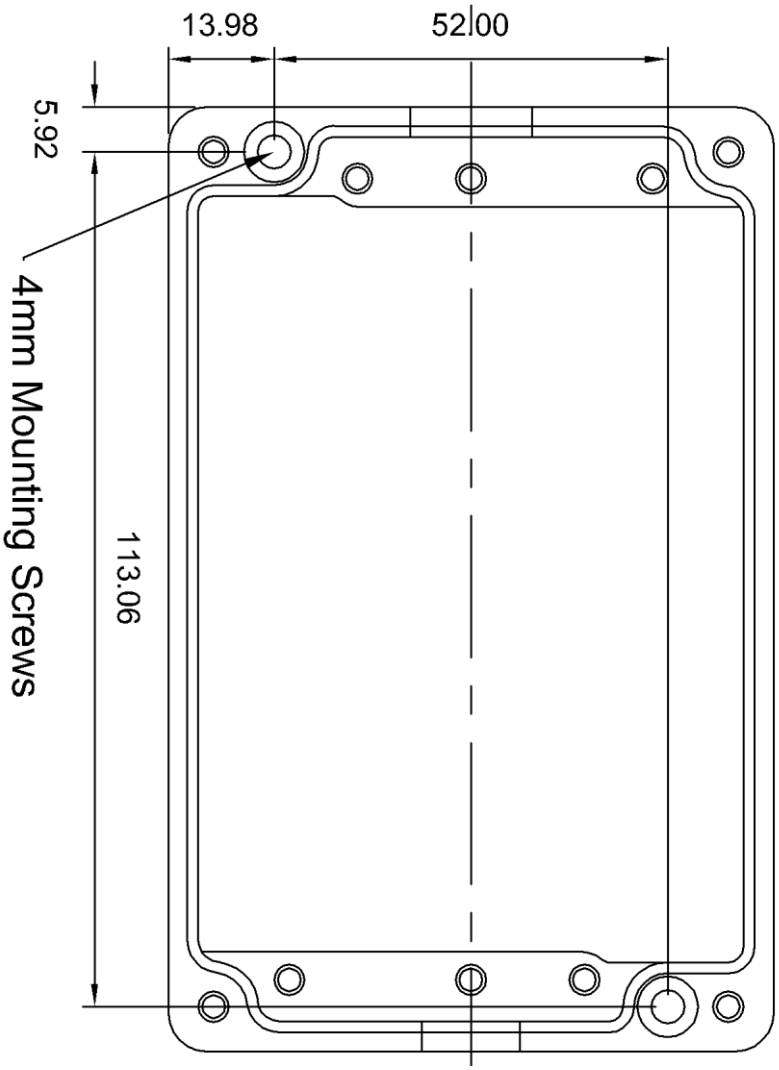
• The Micro must be operated at the voltages described in the technical documentation

• The Micro must not be mechanically nor electrically changed. Use of connectors should follow the guidance of the technical documentation

• The Micro is designed to meet the EMC and radio requirements of Directive 1995/5/EC

• When integrating the Micro into a system, LEE-DICKENS recommends to include, as a minimum, EN301489 part 1 and 7 and radiated spurious emissions requirements of EN310511 in the compliance test plan

Appendix 4 – Drilling Detail



Appendix 5 – Cheat Sheet – Micro Tag List

The table below contains all the tags that the standard Micro recognises and is provided for quick reference. For more details please refer to section 6.

Current Loop	Supplementary Charger Voltage	Ambient Temperature	General	Reports
V1	C1	T1	B1	Get Status
V1State	C1State	T1State	B1State	Get Alarms
V1En	C1En	T1En	Time	Get Values
V1Name	C1Name	T1Name	Date	Report
V1Z	C1Z	T1Z	Clock	StatForm
V1F	C1F	T1F	NRT	AlmForm
V1U	C1U	T1U	Sig	ValForm
V1Hi2	C1Hi2	T1Hi2	Ver	
V1Hi1	C1Hi1	T1Hi1	Admin	
V1Lo1	C1Lo1	T1Lo1	SSMS1	
V1Lo2	C1Lo2	T1Lo2	SSMS2	
V1DB	C1DB	T1DB	ASMS2	
V1Hi2Lab	C1Hi2Lab	T1Hi2Lab	ASMS2	
V1Hi1Lab	C1Hi1Lab	T1Hi1Lab	RI	
V1NormLab	C1NormLab	T1NormLab	WO	
V1Lo1Lab	C1Lo1Lab	T1Lo1Lab	AutoClock	
V1Lo2Lab	C1Lo2Lab	T1Lo2Lab	APN	
V1DP	C1DP	T1DP	APNUser	
V1+	C1+	T1+	APNPass	
V1-	C1-	T1-	ServerIP	
V1RDB	C1RDB	T1RDB	ServerPort	

Key:

Status Tag

User Setting Tag

User Report Template (Setting)