Section 3 Designing and Building a System

3.1 System Planning

Planning a VersaNet2 Radio Data System requires some knowledge of the product's capabilities and how the component parts interact. This section of the manual begins with a planning overview and continues with all the technical and practical information required to plan an efficient and reliable radio data system.

3.1.1 OVERVIEW

a. Establish Node Locations and Communication Functions

The first major step in system planning is to establish the location of each Node and decide on the method of communication, normally UHF radio. Section 3.2 describes this operation in more detail.

b. Establish I/O scheme

The entry and exit points in the system for all data, including the type etc, should be carefully planned. This enables the correct I/O modules to be selected, destinations for each message and the update period for each communication to be established. Refer to Section 3.3 for more information.

c. Establish Power Supply Requirements

Having selected the I/O modules, the overall current consumption can be calculated and the necessary power supply modules selected. Refer to Section 3.4 for power consumption of modules and power supply options.

d. Select Enclosures and Accessories

The number, type and size of enclosure space required for each Node should be calculated. Additional enclosures and fixings can be selected if required. Refer to Section 3.5 for Enclosure sizes.

e. Select Antennas and Fittings

Refer to Section 3.6 for Antennas and cable. Select the correct antenna for the application based on location and required coverage distance.

3.2 Node Location and Communication Functions.

The best approach to planning a system is to start by drawing the proposed network on paper, or better still on a map of the area. Check that distances between sites are within radio coverage range and that there are no large obstructions blocking the line of sight between Nodes. Refer to Section 3.6 for guidance on antenna selection and coverage range. Remember that raising the height of the antenna clear of all obstructions will significantly increase coverage range and improve reception.

Accurate planning will almost certainly require visits to sites. Care should also be taken on locating the equipment. This should be positioned, wherever possible, in a sheltered location with easy access for installation and ongoing maintenance.

Distances between the radio and antenna should be kept to a minimum for optimum performance.

In addition to UHF radio, VersaNet2 provides for connection using wire line modems or GSM. If any of the proposed sites are outside of the normal radio coverage area, one of these options could be considered. If GSM is an option, check with the local carrier on coverage for the proposed sites.

During the planning stage, consideration should be given to Secondary Routing. VersaNet2 can be programmed to automatically select an alternative route if the Primary Route (first choice) fails for any reason. This is a very powerful feature giving added system integrity and it can make use of wire line or GSM modems for the secondary route as an alternative to radio, or where a second radio path is not possible.

3.3 I/O Scheme

Refer to Section 2.2 for details of available I/O.
As part of the planning process, the input and output requirements for each Node must be decided. This will enable selection of the correct I/O modules and in turn, the correct power supply and housing.

It is a good idea at this stage to produce a connection list for each Node detailing the inputs and their corresponding outputs on other Nodes. This information will be required when programming the Node. In addition, from the network drawing, decide on any requirement for secondary routing and possible use of GSM or Wire Line modems. All of this information will ensure correct selection of hardware and make it easy to programme the Node prior to installation.

3.3.1. Routing

Data can be sent from any Node in the network to an output on any other Node in the network. To enable this facility, information about the route the message takes through the network must be programmed into the relevant Nodes. Refer to the network example shown in figure 1, section 2.1.1.

Each Node in the network can communicate with an adjacent Node directly without repeaters and therefore requires no entry in the routing table for these straight point to point connections. In the example Node 7 can communicate directly with Nodes 6, 8, 9, 10 and 11.

To send a message from Node 2 to Node 7 however requires Nodes 4, 5 and 6 to be used as repeaters. These Nodes must be programmed with routing information. Node 2 must be told to go via Node 4. Node 4 must be told to go via Node 5 and likewise Node 5 is told to go via Node 6. Note that Node 6 needs no routing since Node 7 is adjacent.

NOTE: There is no need to programme reverse paths for acknowledgements. These are learnt from the outward message.

3.3.4. Secondary Routing

A Secondary route may be programmed, which will be automatically selected if for any reason the Primary route fails or is unavailable. In figure 1 assume Node 1 is programmed to send to Node 3 via Node 2. Node 1 would have the routing information programmed as in 3.3.1 above. A Secondary route could be programmed to go via Node 4 in the event of a problem with the Primary route.

Node 1 may be programmed to send a digital input D0.1 to a digital output 3D0.1. It is programmed for 3 retries. If after 3 retries the communication is unsuccessful, there has been no response from Node 2, it will automatically default to the secondary route and make the connection via Node 4. At the next transmission it will revert to the Primary route again and repeat the process if the problem still persists. Note that the 'comms-fail' alarm will be activated by the failure of the Primary route. There is no alarm on the secondary route.

3.4 Power Supply Requirements

There are a number of options for powering a VersaNet2 Node. It may be powered directly from a DC supply or from an optional mains supply. There is also the possibility to configure the mains supply for battery back-up. The total power requirement for the Node must be calculated (see table 5 below – use Max values) and the correct power supply selected.

A further option is to construct a Low Power Node. This is particularly useful for remote locations with no mains power availability. The Node can be powered by batteries running from Solar Cells or Wind Generators. There are 4 cards especially designed for this purpose, the IRDN302, IRDN307, IRDN311 and IRDN212.
NOTE: On the 300 series modules, a link selects low power mode.

Current consumption of cards

Card type	Description	Typ current	Max current
IRDN334	Communications Controller (with radio)	380mA - RX	650mA - TX
IRDN301	8ch Digital Output	130mA	250mA
IRDN302	8ch Digital or Pulse Input	*50mA	70mA
IRDN307	8ch Analogue Input	*50mA	100mA
IRDN308	4ch Analogue Output	50mA	120mA
IRDN310	Combination – 4 Digital + 2 Analogue Output	50mA	120mA
IRDN311	Low Power Input, 4 Digital + 4 Analogue	*50mA	100mA
IRDN314	8ch Alarm Output	130mA	250mA
IRDN207	8ch Analogue Input	50mA	100mA
IRDN209	8ch Pulse Output	50mA	70mA
IRDN212	8ch Low Power Pulse Input	*50mA	70mA
WMOD2B	GSM Modem (Wavecom)	130mA	700mA - TX
TD-32	Wire Line Modem (Westermo)	200mA	

Table 5 Module Current Consumption

* Only 300µA in sleep mode (see section 3.4.8)

3.4.1 DC Power Supply

A 12v DC power supply can be connected to the Communications Controller Card through connector JP13. This supply is then distributed via the T2-BUS to all the other cards in the Node. Use the table above to calculate the maximum current required for the particular Node configuration. Note that the maximum input current at JP13 is 3 Amps. A second supply can be added if required using a DC Adaptor card IRDN206.

3.4.2 Mains Power Supplies

An integral mains power supply can be fitted in the Node, with the DC output connected to JP13 of the controller card for distribution to other cards, as above. Calculate the total current consumption of the Node from the above table, then select the appropriate power supply as follows:-

PSU 1531	90 - 264vAC - 12v output @ **1.0 A**	Nominal Size 90L x 50W x 30H
PSU 2092	90 - 264vAC - 12v output @ **3.0 A**	Nominal Size 156L x 95W x 40H

NOTE: Two or more power supplies may be fitted for larger Nodes, where required.

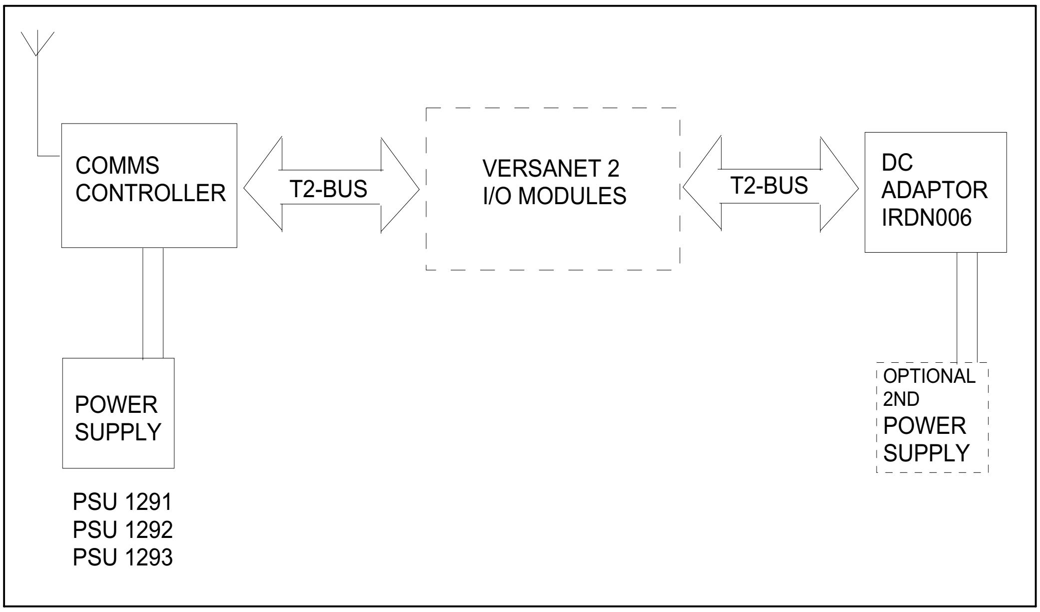


Figure 2 Module Arrangement for Mains Powered Option

3.4.3 Battery Back-up

There are a number of factors to be considered when using battery back-up. For this type of application, where the battery will be continuously trickle charged, it is recommended to use a sealed lead acid battery.
If the battery becomes discharged, during a power failure for example, it will initially draw a high current from the power supply, when the mains supply returns. This means the power supply must be capable of handling the current requirement for the Node, plus this initial (inrush) demand from the battery. To select a Power Supply with the correct rating therefore, you need to calculate the current for the Node and add the battery inrush current.

First, you must calculate the capacity of the battery required.
From Table 5 above add up the total power requirement for the Node using the **typical** figure. (This assumes a reasonable duty cycle where the Node will not be taking full power most of the time. If the Node is exceptionally busy and has a high duty cycle, use the 'max' current figures)
Decide on the length of back-up required.
The length of back-up in hours, multiplied by the total current (in Amps) for the Node will give the size of battery in Ah.
Example:
Total current (typ) for Node = 560mA = 0.56A

Back up time 4 hours
4 hours x 0.56A = 2.2 Ah minimum.
or
Total current (max) for Node = 1,000mA = 1.00A
Back up time 4 hours
4 hours x 1.00A = 4Ah

It is not recommended to discharge the battery below about 50%, therefore for the above example a battery of about 4 Ah and 8Ah respectively, should be used.

Now calculate the capacity of the Power Supply/Charger.
This is the total of the Node requirement using the **max** figures from Table 5 plus the inrush current for a 4 Ah or 8Ah battery.
Battery specifications vary for different makes but as a guide the following apply:-
4 Ah battery Inrush current 1A
8 Ah battery Inrush current 2A
16 Ah battery Inrush current 4A

Node max current 1A plus inrush current 1A requires a 2Amp Power Supply
Node max current 1A plus inrush current 2A requires a 3Amp Power Supply

In both the above cases the battery will take approximately 6 to 8 hours to recharge when flattened about 50%.
From completely flat it will take 20 to 24 hours but it is strongly advised not to let batteries discharge below the 50% level.

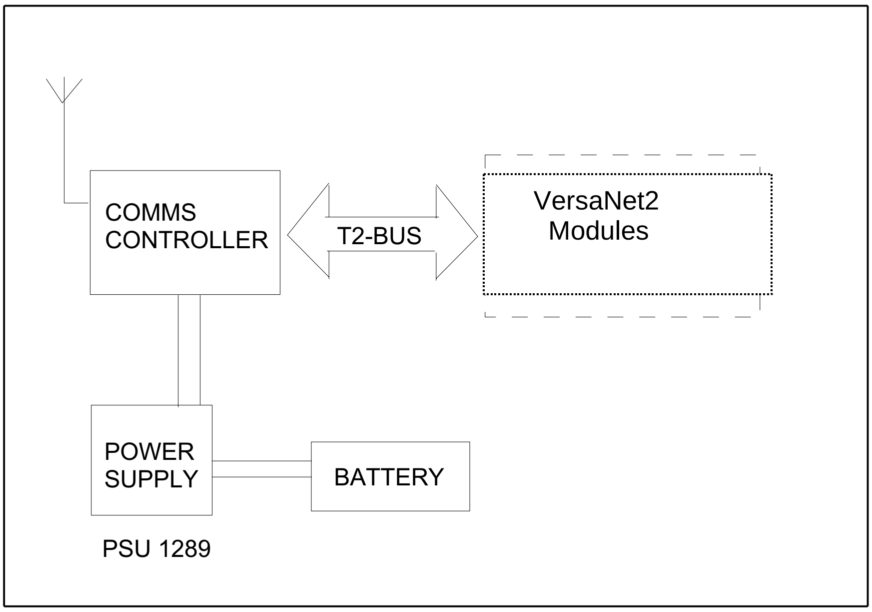


Figure 3 Module Arrangement for Battery Back-up

The following Power Supply/Battery Charger is recommended for the above applications:

PSU 2092 90 to 264vAC 12vDC output @ 3 Amp Size 156L x 95W x 40H-

3.4.4 ENC 005 Battery Mounting Kit

The Battery Mounting Kit, ENC0005, is used in conjunction with the Basic Enclosure, ENC0001, to facilitate connection of a battery to a VersaNet2 Node. The kit comprises a cable to go from the VersaNet2 module to the battery and a metal base plate incorporating battery retainers for standard 3 A/hr lead acid batteries.

3.4.5 Section deleted

3.4.6 IRDN 311 Low Power Input Module

This module can be used with a Communications Controller (IRDN300) operating in Low Power mode. Such a Node is configured to enter a sleep mode during which period the current consumption is less than 400 µA. The possible Low Power modes of operation are explained in more detail in section 3.4.8
Alternatively, this module may be used in a standard permanently powered system as a cost effective means of combining 4 x Digital & 4 x Analogue Inputs.

3.4.7 IRDN 212 Low Power Pulse Input Module

This module can be used with a Communications Controller (IRDN300) operating in Low Power mode. Such a Node is configured to enter a sleep mode during which period the current consumption is 5mA. Whilst in sleep mode, the Node continually counts pulses, transmitting the totalised count each time the Node wakes up. The possible Low Power modes of operation are explained in more detail in section 3.4.8
Up to sixteen of these modules may also be used in a standard permanently powered system.

3.4.8 Low Power Modes of Operation

For applications where Nodes are located at sites without suitable external power supply, a Node may be configured to operate from a DC supply such as a battery, with the Node switching into a low current sleep mode in between operations, to conserve battery life. It is possible to connect a DC system comprising a battery and solar panel / wind generator to replace current consumed over time, thus eliminating the need to visit remote sites to replace discharged batteries.

The Communications Controller module (IRDN300) can be programmed to operate as a Low Power Node making use of its on board I/O. If additional I/O is required then only the Low Power Input modules (IRDN311, IRDN302 & IRDN212) may be used. Attempting to use any other VersaNet2 module in this mode may cause damage to the module and invalidate the warranty.

Normally a Low Power Node would be at the remote end of a link, used to gather information and transmit back to a central Node. Additional inputs can be added with the 302, 311 and 212 modules. If however the Low Power Node is used at the receiving end, only the single inputs on the Controller Card are available.

A Low Power Node can be used as a repeater to extend coverage distance. In this case it must be programmed as a Low Power Receiver so that it will wake up and receive the signal for onward transmission.

The following section shows examples of Low Power Node configurations:

a. Low Power Transmitter (Send & Sleep Mode)

In this mode, the Node switches on at the end of the sleep period or when the Digital Input (D0.1) on the Communications Controller changes state. The function of the Alarm relay is changed so that it is activated when the Node switches on and can be used as a means of switching power to an external device.

If the 'Pre Transmit On-Time' is programmed then the Alarm Relay will activate earlier, to allow time for the external device to become fully operational and a reliable reading to be taken prior to transmission.
NOTE: The maximum power available for the external device is 12V @ 250mA.

Once powered, the Node then rapidly scans all inputs, switches to transmit mode and sends the data to the configured destination. It then switches back to receive mode to accept the acknowledgement before de-activating the Alarm relay and returning to the sleep condition for a further programmable sleep period.

The transmit and receive periods, will vary in accordance with network activity, but should be approximately 100mS each. During the sleep periods the Node only draws 300uA. It draws the normal current during the transmit and receive periods. During the pre transmit on-time the Node will draw the same as in the receive state.

NOTE: In this mode of operation the alarm relay is used to switch an external device and is therefore not available for normal alarm operation.

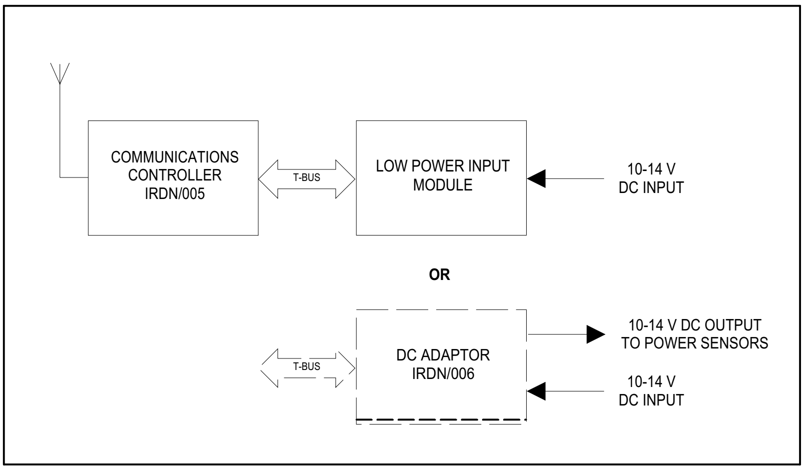


Figure 4 Low Power Node with Power to External Device

b. Low Power Receiver (Sniff Mode)

In this mode, the Node is powered down for 1.9 seconds out of every 2 seconds. During the remaining 100mS, the Node powers up, initialises the receiver and looks for a carrier on the channel. If a carrier is detected (on the channel but not necessarily for that Node) the Node powers up and receives the message.
If the message is not for this Node, it powers down. If it is for this Node, the Node will act upon the message and power down when the action is completed.

The transmitting Node will send out a long preamble (2.5 - 3 seconds) to get the attention of the Low Power receiver. It is recommended that the Transmitter is programmed for at least 2 re-tries.

The Node draws only 300uA during the sleep period but draws the normal current during transmit and receive periods.

Any transmitter always assumes it is talking to a Low Power receiver when it first communicates. Once a successful communication has taken place, the Transmitting Node remembers which Nodes are Low Power and from then on sends the long preamble to those Nodes.

c. Low Power Transmit and Receive

It is possible to programme a VersaNet2 Node to operate in both Low Power

Transmit and Low Power Receive mode simultaneously. The Node will operate exactly as described in section 'a' above, except that during the normal sleep period, the receiver will be 'sniffing' every 2 seconds, looking for carrier.

d. External Wake-up of Low Power Node

A Node configured as a Low Power Node may be woken up by changing the state of the digital input (D0.1) on the Communications Controller. Once awake, the Node will operate as specified under sections 'a', 'b' and 'c' above, as configured by the user. Each time the Node is woken up, it sends the status of all its inputs to their programmed destinations.

3.5 Enclosure Selection

In order to actually select the size of enclosure required and hence procure the correct parts, more information is required. By now, you will have drawn up a list of the modules required at each Node. Using the table below, calculate the total height of all modules in each Node:

Module Number and Name	Height/mm
IRDN334 Communications Controller	32
IRDN301 Digital Output	22
IRDN302 Digital/Pulse Input	32
IRDN307/207 Analogue Input	22
IRDN308 Analogue Output	22
IRDN310 Combination Output	32
IRDN311 Low Power Input	32
IRDN314 Alarm Output	32
IRDN209 Pulse Output	22
IRDN212 Low Power Pulse Input	22
PSU1531 1.0 Amp Power Supply	30
PSU2092 3.0 Amp Power Supply/Battery Charger	40

Table 6 Module Heights

Depending upon the number of Depth Extensions fitted, the available height of the enclosure is:

Enclosure Construction	Available Height
Basic Enclosure only	108mm
Basic Enclosure + 1 Depth Extension	158mm
Basic Enclosure + 2 Depth Extensions	208mm

Table 7 Enclosure Heights

Where the height of the modules exceeds 208mm or available height is restricted, side extensions (ENC0002) may be used to link enclosures. Where space permits, side extensions may also be used to improve access to terminations.
See Section 8.1 for details.

3.6 Antennas

Any antenna with a 50 ohm impedance designed for use at the relevant operating frequency band may be used, with the selected type dependent upon the application. The radio range achieved will be dictated by the land topography between the Nodes. In general, at UHF, good communications will be achieved up to 20km with 500 mW of power if there is line-of-sight. For applications where clear line-of-sight is not possible, the link integrity may be tested using the Received Signal Strength Indicator (RSSI) of VersaNet2. In many situations, raising the height of an antenna can dramatically improve performance.

With VersaNet2, additional Nodes can always be inserted as 'Relays' to increase the overall system range. A particular feature of VersaNet2 is that every Node can act as a repeater, therefore every Node is a potential relay point.

Antennas can be connected to VersaNet2 in two ways. The first is for enclosure-top antennas, such as the RDT part ANT0006, which is connected via the Antenna Mounting Kit (ENC0003), fitted to the top of the enclosure. Alternatively, different types of antennas may be connected via a suitable RF feeder cable to the N-type female socket provided by the Antenna Bulkhead Cable kit (ENC0007). This is fitted to the gland plate in place of a cable gland.

Three different types of antennas cover the majority of applications, as shown in the table. These details are only a guide and the precise antenna performance may vary in different applications and between different manufacturers.

Antenna Type	Range	Coverage	Gain	Mounting	Applications
½ Wave Whip	Up to 1 Km	Omnidirectional	-3dB	Enclosure top	Short range, general
End-fed Dipole	Up to 10 Km	Omnidirectional	0dB	Pole Mounted	Medium range, general
8 Element Yagi	Up to 20 Km	Directional (40º)	10dB	Pole Mounted	Long range, directional

Table 8 Antenna Types

3.6.1 Feeder Cables

Many different types of RF feeder cables are available, designed for different applications. For most VersaNet2 applications the following types are suggested:

Cable type	Ohms	Loss dB/10m	Max suggested length
URM67 or RG213/U	50	2	25m
Heliax LDF-250	50	0.8	75m

Table 9 RF Feeder Types

3.7 Configuring a Node

Introduction

The following steps must be carried out to ensure your VersaNet2 system is correctly constructed, configured and installed.

1. Plan your system, noting all Node locations, I/O connections and signal routes.
2. Connect power to each Node.
3. Configure each Node to meet the requirements of the plan, using VNMGR
4. Securely install each Node, its associated antenna system and connect Input/Output (I/O) terminations as required.
5. Run Commissioning and Test routines on each Node.
6. Check all terminations and then secure enclosure lid (if used).

NOTE: The Node may be configured on site, after installation, if preferred. It is however generally easier to programme the Nodes in advance working in an office environment. An alternative is to prepare the configuration files in the office and save them ready for simple download on site.

The following sections 3.7.1 to 3.7.3 give a brief overview of the Node configuration procedure. Refer to Section 4 for a complete guide to the features and facilities available through the VNMGR software.

3.7.1 Module Hardware Configuration

Configuration of the I/O modules consists of setting the DIL switches marked SW1 & SW2 on each of the expansion modules (see diagram).

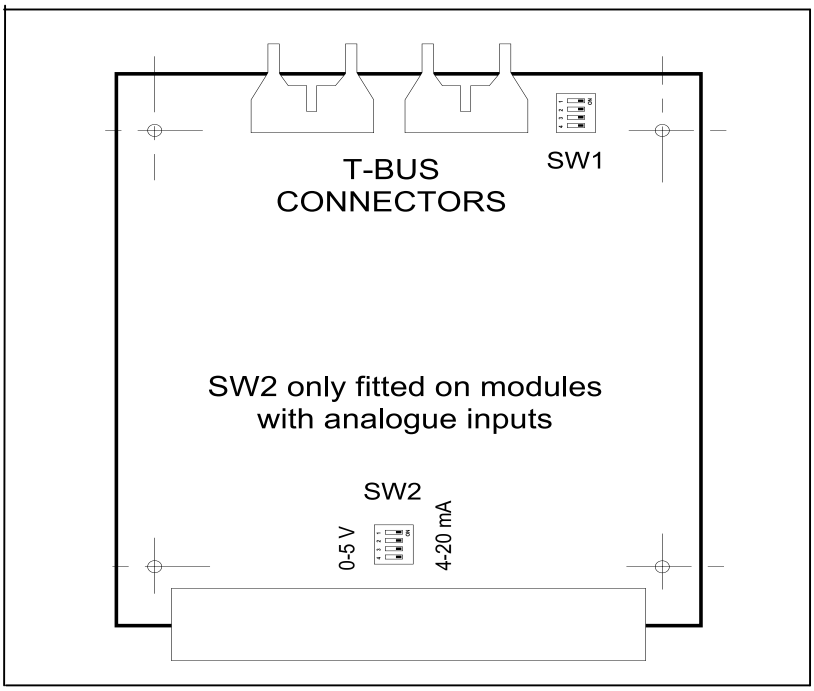


Figure 5 Location of DIL Switches on Modules

DIL switch setting should be performed without power connected. Each I/O module should be set to a unique address for that module type in a Node. For example, up to sixteen Digital Output modules may be used in a single Node, with the DIL switches on the modules set from one to sixteen. The actual switch positions required are shown in Table 6.

SW1 SETTING 1	2	3	4	ADDRESS
On	On	On	On	1
Off	On	On	On	2
On	Off	On	On	3
Off	Off	On	On	4
On	On	Off	On	5
Off	On	Off	On	6
On	Off	Off	On	7
Off	Off	Off	On	8
On	On	On	Off	9
Off	On	On	Off	10
On	Off	On	Off	11
Off	Off	On	Off	12
On	On	Off	Off	13
Off	On	Off	Off	14
On	Off	Off	Off	15
Off	Off	Off	Off	16

Table 6 DIL Switch Settings

The Digital/Pulse Input module is configured in software to accept Digital or Pulse inputs for each of the eight input channels.

In addition to this configuration, the Analogue Input Module, Combination Input Module and Low Power Input Module may also be configured to accept either analogue voltage or current inputs. This is done by switching the DIL switch, SW2, shown in Fig 5, between “Volts” and “mA” for each channel.

Communications Controller

The Communications Controller Card has a number of Switches, Links and Connectors with the following functions.

Switch 1 (SW1). 4 way DIL switch.

SW1/1	OFF Normal operation	ON Factory test only
SW1/2	OFF Normal operation	ON Factory test only
SW1/3	OFF Normal operation	ON Factory test only
SW1/4	ON Normal operation	OFF Turns off LED’s

SW1/4 may be used to switch off LED’s, on a low power Node, to reduce current.

Link 1	RUN Normal operation or PGM programming mode (see Sect 2.3)
Link 2	Sets Analogue input to V (1-5volts) or mA (4-20 mA)
Link 3 & 4	Sets Digital input to LP (low power mode) or ISOL (normal mode)
Link 5 & 6	Sets Pulse input to LP (low power mode) or ISOL (normal mode)

JP 1 & JP 2	10 way IDC connectors for the T-BUS
JP 3	Not fitted
JP 4	Set jumper to position 5 for mains operation and position 3 for battery operation. In position 5 the unit will stop working if the DC falls below 10v indicating a mains failure. In position 3 a battery low alarm will be given at 10v although the unit will continue working below 10v (at reduced power).
JP 5	16 pin connector for Radio Module
JP 6	Factory test only
JP 7	9 Way ‘D’ plug for configuration port
JP 8	5 Way plug for Digital I/O
JP 9	3 Way plug for Alarm output
JP 10	4 Way plug for Analogue I/O

JP 11	4 Way plug for Pulse I/o
JP 12	9 Way 'D' plug for Data Highway port
JP 13	2 Way plug for DC input.

See Section 7 Technical Specification for pin connections and current ratings.

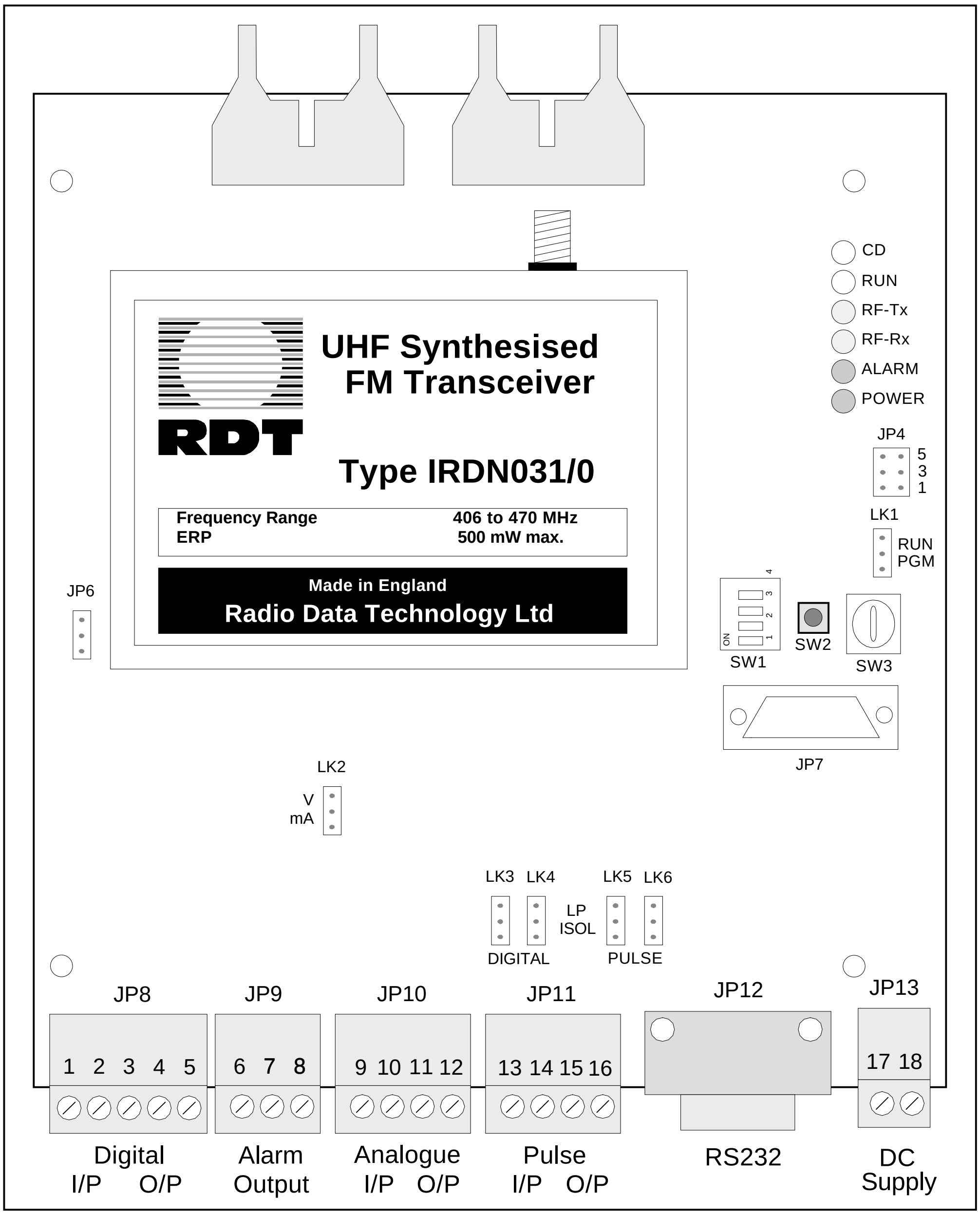


Figure 6 Communications Controller Module

3.7.2 Node Software Configuration

Before a Node can operate, it must be configured with information concerning its role in the system and any data it has to handle. It is the Communications Controller module in each Node that is configured with this information, stored in non-volatile memory. In addition, where applicable, each I/O module must be configured to its address within a Node using DIL switches.
NOTE: The controller module is normally supplied with NODE software installed. If for any reason you need to install software or upgrade to a new version, see Section 2.3 for details.

3.7.3 Using VNMGR

Connect the configuration cable supplied to the correct port of the PC and connect the other end to JP7, the RS232 Port, on the controller. Power the Node and wait until the Node has initialized. This is indicated by the following LED's, Red power 'on', amber RX 'on' and green run 'on' in steady state, not flashing. This takes a few seconds.

Open VNMGR on the PC. Watch the Icon in the top right corner. Blue dots will travel from the Node Icon to the PC Icon. This is the PC uploading data from the Node.

Select the Node Configuration pull down menu, and select 'New' or 'Receive from Node'. The latter will upload the current settings, which can be overwritten.

Fill in the boxes on the Network screen.
NOTE: If a GSM modem only is to be used on the Node, tick the GSM only box.
The radio parameter fields are then greyed out because they are not relevant.

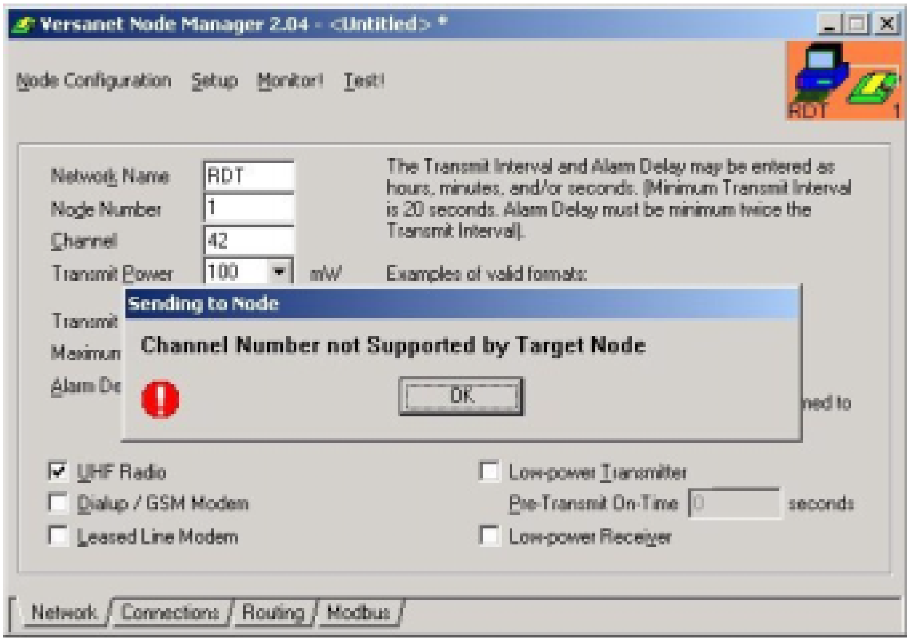
Use the tabs at the bottom of the screen to move to the other screens.

Complete the Connections screen with all the I/O information for the Node.
NOTE: all the module cards that are connected will be displayed on the left of the screen. Each can be opened out to show the I/O available.

Complete the Routing screen, if required. This information is needed for networks with multiple Nodes so that each repeater stage has details of the route to the final destination.

Complete the Highway screen only if GSM, wire line modems or Modbus are being connected to this Node.

Complete the SMS and Dial-up screens only if a GSM or external wire line modem are being connected.
NOTE: If any of the boxes are completed incorrectly, warning messages will appear asking you to make a correction.



Screenshot 1 Warning Message

Once all the information is complete, select the Node Configuration pull down menu and select 'Send to Node'. Watch the icon in the top right corner and red dots will travel from the PC icon to the Node icon, indicating downloading.

There is also information under the icon on the download status. This process may take a few minutes depending on the speed of the PC and the file size (number of connections etc.).

Screenshot 2 Download Icon

As soon as the download is completed, power the Node down, wait a few seconds and power up again. This ensures that the Node will reset to all the new parameters and connections. The Node is now operational.