

# Remote Management and Control Unit

Highlights:

* Cost effective remote monitoring of remote sites including 33kv substations
* Monitors environment, security, switch state
* Constantly measures power output and provides real-time summaries of generation.
* Immediate alerts to any number of people by SMS on any fault or threshold.
* Request the current status at any time, active alarms, configuration settings, current generation power…
* Configuration by simple text file, no programming, no special expertise needed.
* Configuration can be changed remotely using SMS.
* Monitors:
  + Up to 8 zero-volt relay contacts
  + Up to 3 analogue signals
  + RS485/Dialogue interface to monitor power and relay condition
  + Temperature and Humidity
  + PIR intruder alert
* Highly secure, multiple security roles and security protection layers.

The DNOC Remote Management and Control (RMAC) unit is designed as a cost effective solution for remote monitoring of all significant characteristics of a 33Kv substation switching installation, and to allow remote control in a secure environment.

It achieves a cost effective approach by using off the shelf components emerging from the IoT (Internet of Things) market, components designed to allow the management of all everyday items, from fridges to office HVAC. These components are designed to be efficient, compact and reliable but are also being built in the volumes that bring down the cost closer to that of consumer electronics.

The RMAC communicates using SMS as this low tech channel is ubiquitous and operates at low signal levels that would make GPRS or 4G Data unreliable. It is cheap and simple, and also allows the RMAC to send alerts (and receive commands) directly to engineers’ mobile phones. Two factor security is employed as the RMAC will only accept input from known, defined mobile numbers, and a two-level PIN code system ensures all access is authorises. Thus access requires ‘Something you own’, the mobile, and ‘something you know’, the PIN. A low level PIN allows alarms to be queried and silenced, and can be more widely distributed to all field engineers, while the high level PIN is needed to change the RMAC configuration, such as alarm settings, and should be more closely limited to senior engineers.

The RMAC is designed as a universal device with a single code base, which can be widely configured to meet customers detailed requirements, either by DNOC or by customers engineering staff.

However the RMAC is coded in the widely used C++ language through a high level IDE[[1]](#footnote-1), so it is very practical to create custom programs to meet highly specialised customer requirements, such as automatic actions on alarm detection, custom interlocks, or interfacing to customers existing SCADA systems.

The RMAC delivers 8 no-volt switch detectors (i.e. for connection to a relay contact, microswitch etc), 3 Analogue detectors for voltage level, an RS485 interface to read from common relay control units, temperature and humidity measurement and a passive PIR motion sensor, to detect intrusion or other movement, and 4 relays to control local equipment.

# Detailed Specification

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Power Supply | Input 85 → 264 V ac,  85 → 370 V dc,  210mA max | Can be run from domestic mains supply or 110V batteries.  Available to order for 12, 24 or 48V. |
| No-volt switch inputs | Qty 8. Energised by 5V 330Ω impedance, 15mA. Supply is isolated from the main unit supply. | Alarm can be raised if the switch is open or closed |
| Analogue inputs | Qty 3. Inputs are supplied to measure 0-5V or 0-12V, others can be supplied to order by changing resistor values. | Accuracy: 10 bit ADC giving 0.1% resolution, 1% resistor chain, 2% of max voltage end to end accuracy. |
| Temperature and Humidity | Temperature range: 0-50 ℃  Humidity range: 20-90% RH | Accuracy:  Temperature ±2 °C  Humidity ±5% RH |
| RS485 | Standard Modbus over RS485. | See below |
| PIR | ‘Passive InfraRed’ detector. Detecting range 7M,  Detecting angle 100° | This is a standard PIR unit capable of detecting any person intruding in the range of view. |
| Power Supply | An internal battery provides limited continuity, sufficient to send an alert on the failure of the external power supply. |  |
| Relays | 4 relays are provided . Capacity 7A at 250VAC or 30VDC. | These can be configured to permanently switch or to close for a defined time, on receiving an SMS command from an authorised mobile phone. |
| Authorised Mobile Phones | Up to 32 authorised mobile phone numbers can be stored. | Only authorised phones can interact with the RMAC, either to receive alarms or to send commands. In addition a PIN number (unique to each RMAC) is needed to issue commands. |

## Monitoring Scheme

The microcontroller operates in a continuous loop and is configured so that every alarm sensor is checked every second at a minimum. Alarms are raised if the condition persists for three successive cycles. Alarms can be configured to retransmit at a defined period (eg every hour), or not at all, and an alarm clear message is sent when the detector returns to normal. A command can be sent to silence an alarm from authorised phones. (For instance it is a good idea to silence the intruder alarm before an engineer enters the cabin).

Commands can be sent to query the current status, to query all active alarms, all alarms over a given period, and the configuration of the alarms. Commands can be sent, with the high security PIN, to re-configure alarms, for instance to change the alarm temperature, to enable a new alarm as additional equipment is bought online and so on.

Finally commands can be set to open or close each of the four control relays.

## RS485 interaction

In a standard DNOC Switch Unit, the RS485 channel is used to communicate with a Micom P341 Interconnection Protection relay to retrieve the instantaneous MW power being transmitted. This is retrieved every 10 seconds, and the RMAC internally records the minimum, maximum and average figures. This can then be send to one or more mobile phones at a configurable period from 1 minute to 24 hours. Later developments will provide a web site where graphic displays of current and trending power output will be available, expected late 2015.

## Alarms and Commands

The RMAC communicates using bidirectional SMS messages. It is also possible to plug a PC into the RMAC external USB connector and send and receive the same messages using the IDE Serial Monitor.

The command syntax is simple and similar to the long standing 'AT' command set for controlling modems. The command looks like:

PPPPP CCC <parameters>

where PPPPP is the 5 digit security PIN.

CCC is the three letter command

<parameters> are the specific parameters for the command

The first letter of the command indicates what type of command it is:

R – Request, ask the unit to send some data by return

C – Set the configuration of the device

S – Security commands

D – Disable alarms

The following table shows a subset of the commands:

(in the examples, 01012 is the low level security PIN, 98989 is the high level security pin)

Commands:

| Command | Meaning | Parameters | Security Level | Example |
| --- | --- | --- | --- | --- |
| RAL [hours] | Request Alarm | Unit sends all active alarms. If a number is specified for [hours], all alarms raised in the past number of hours are sent, even if now cleared. | Low | 01012 RAL |
| Rnn [ABC] | Request Details of channel nn | NN is the monitored channel, 01 upwards. Optionally add A for alarms only, C for configuration only, B for Both. Default is A. | Low | 01012 R02 A |
| Dnn | Disable alarms on channel NN | MMM Minutes – how long the alarm is disabled for, 000 is forever. | Medium | 01012 D02 30 |
|  |  |  |  |  |
| SLU | Security – add low security telephone number | Number in the format 004412345123456 | High | 98989 SLU 00447770333444 |
| SHU | Security – add High security phone number | Number in the format 004412345123456 | High | 98989 SHU 004412345654321 |
| S?? | List all authorised phone numbers |  | HIGH | 98989 S?? |
|  |  |  |  |  |
| CST | Configure Site | ID <5 digit ID number> | High | 98989 CST ID 12345 |
|  |  | NAME <site name> | High | 98989 CST NAME East Lothian A |
|  |  |  |  |  |
| CSA | Configure switch alarm | <Alarm Number (1..8)> <Alarm Name> | High | 98989 CSA 1 Main Relay |
|  |  | <alarm Number (1..8)> <Alarm on OPEN/CLOSED> | High | 98989 CSA 2 OPEN |
|  |  | <alarm Number (1..8)> <Alarm repeat at (minutes)> | High | 098989 CSA 1 120 |

Alarms are sent to all configured, registered phone numbers in the form:

SSSS Alarm NN AAAA hh:mm:ss <description>

Where

SSSS is the site short name

NN is the alarm number

AAAAA is the alarm short name

Hh:mm:ss is the time the alarm was detected.

<Description> describes the alarm

Examples:

SW12 Alarm 01 ProtRelay1 12:32:44 OPEN

SW01 Alarm 15 PIR 11:11:00 PIR Movement Detected

SW01 Data 22 MW 12:00:00 avg 23.5 min 11.2 max 44 05/01/15 11:00:00-12:00:00

Note that commands beginning ‘R’ request the RMAC to immediately send various status and configuration data, for example:

*Send:*

(to 07770 123654)01012 RAL

where 07770… is the number of an RMAC unit and 01012 is the low-levl PIN for that unit. The unit will then send one or more SMS messages, the first is a summary, then one SMS for each active alarm, if any.

*Receive*

NE11 Status 13:00:00 2 Alarms 01 15

NE11 Status #1 Alarm 01 ProtRelay1 12:32:44 OPEN

NE11 Status #1 Alarm 15 PIR 11:11:00 PIR Movement Detected

1. Integrated Development Environment [↑](#footnote-ref-1)