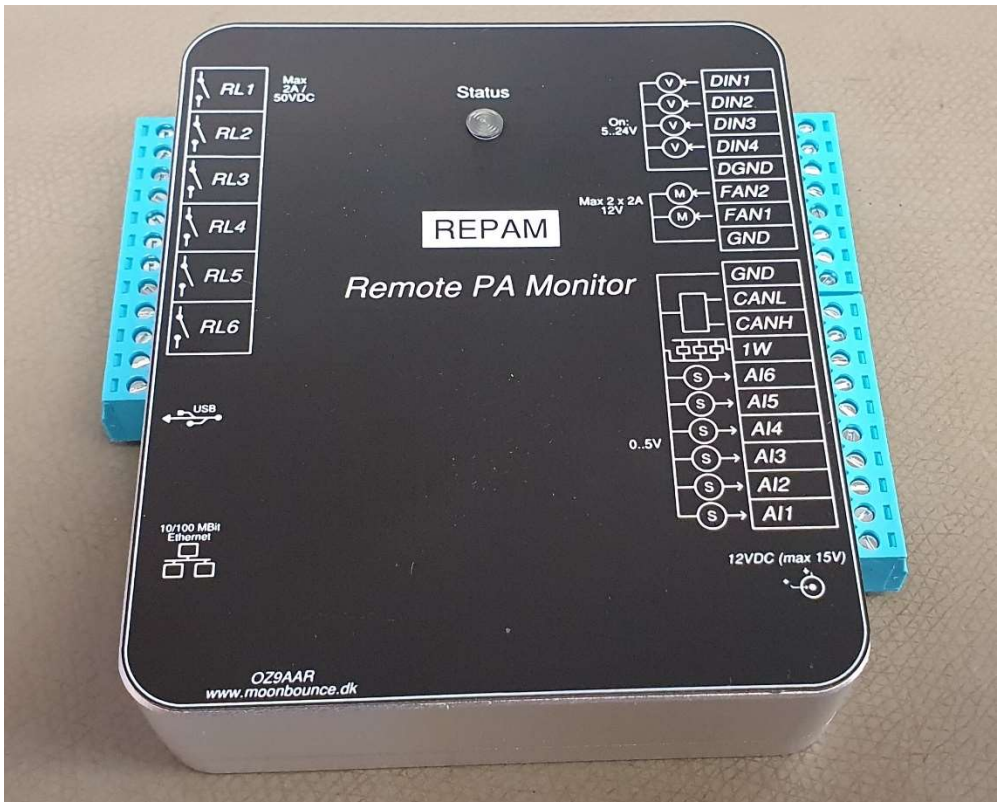
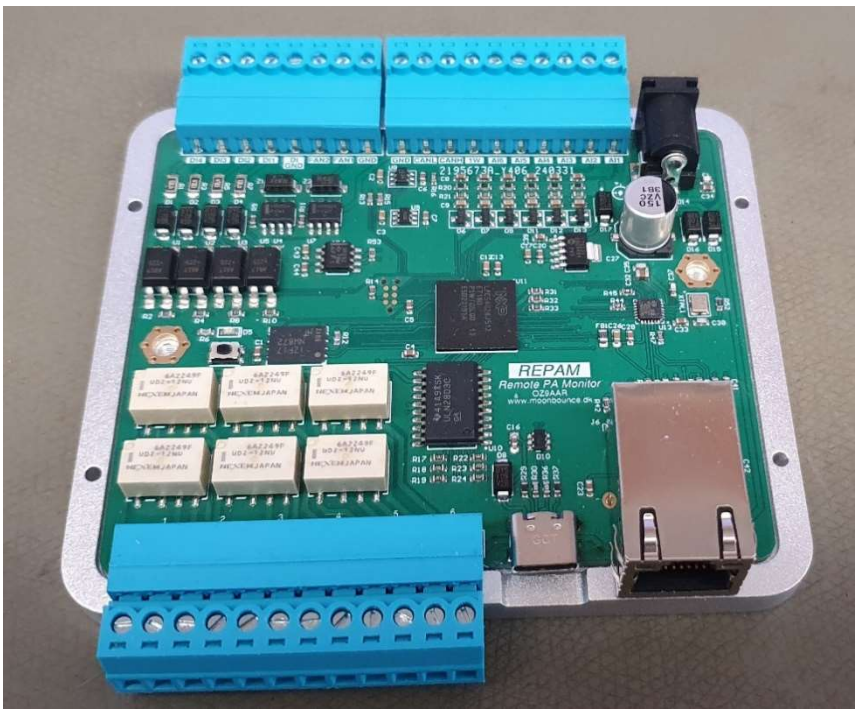
REPAM – Remote PA Monitor





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Command "IONAME":["AI1name","AI2name","AI3name","AI4name","AI5name","AI6name","DI1name","DI2name","DI3name","DI4name","DO1name","DO2name","DO3name","DO4name","DO5name","DO6name","FAN1name","FAN2name","T1name","T2name","T3name","T4name","T5name","T6name","T7name","T8name"]} | Query {" IONAME ":[]} 25
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Introduction

Often there is a need for some kind of remote I/O for various tasks in a Ham Radio Station. Some of the more important things to monitor and control, are remote located Power Amplifiers (PA) modules. The REPAM device lets you control and monitor (among other things) PA modules (or any other device).

The REPAM device is basically just a bunch of I/O signals that can be monitored/controlled via Ethernet. In addition to that, REPAM has some "standalone" features, dual fan controllers, calculation of forward power, reflected power and SWR (if used together with the "Dual RF Head" from OZ9AAR) as well as monitor the current dew point (based on relative humidity and temperature) and control optional heaters.

REPAM can also react (using "triggers") to values on analog inputs etc. and control relay outputs based on configured thresholds, all this without any connection (Ethernet) to the outside world.

The REPAM has a number of digital outputs (six relay outputs), digital inputs (four optically isolated), analog inputs (six channels 0 to 5V), temperature sensors (up to 8 DS18B20 type sensors/1Wire), humidity sensor, a CAN bus and two PWM controlled fan drivers.

While it is possible to control and configure the box using your own written software, the REPAM has currently two PC Windows applications you can use:

1) "REPAMMonitor", this application is used to monitor the REPAM device and to configure all settings of the device.
2) "PAMonitor", this is a simplified "dashboard" for a typical PA module. The C# (Visual Studio 2022) source code for this is freely available and may serve as an example of how to communicate with the device.

These two applications are described in more detail later in this document.

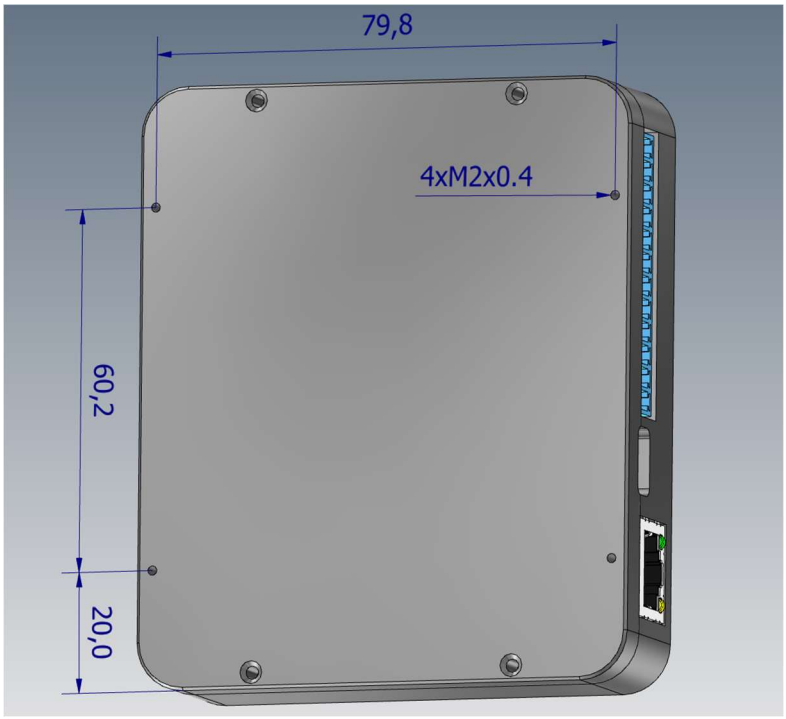
The REPAM device has no knowledge on what its inputs and outputs are used for, the only exception is the autonomous functions (which are configured using the "REPAMMonitor" application), these will have one or more inputs (temperature sensors, analog inputs, calculated values from Dual RF Head etc.) and control outputs such as the fans or the relays. There is nothing in the REPAM device that tells it that "AI1 measure the power supply voltage" etc., in the device itself, these are just referred to as "AI1" etc.

When using the PAMonitor PC application (se later in this document), each of the inputs are assigned to a certain function (power supply voltage, current measurement etc.)

Technical data

	Minimum	Maximum
Power supply[1]	11 VDC	14 VDC
Power consumption	160 mA[2]	225 mA[3]
Analog inputs, samples/sec	570[4]	
Analog inputs level	0 VDC	5 VDC[5]
Digital inputs, low	0 VDC	3 VDC
Digital inputs, high	5 VDC	24 VDC
1 Wire bus, output voltage	5 VDC[6]	
Relay outputs, voltage	50 VDC	
Relay outputs, current	2.0 ADC	
Fan outputs, current	0 mA	2.0 A[7]
Fan outputs, PWM freq.	24 KHz[8]	
CAN Bus speed[9]	10 KBit/sec	1 MBit/sec
Weight	260 gram	
Size W x H x D	85 x 100 x 25 mm (excluding pluggable terminals)	

[1] Center pin in DC connector is positive voltage. If REPAM is only connected via USB it will still run, however relays and fan outputs will not be functioning.
[2] No relays activated
[3] All relays activated
[4] Analog input sample rate.
[5] Analog inputs calibrated at 4000 mV
[6] The 1Wire bus supplies 5V to connected devices (on DS18B20 devices, connect VDD and GND to ground terminal, DQ to “1wire” terminal).
[7] Each fan output maximum 2A, maximum combined current for both outputs is 2.5A
[8] This is the repetition frequency of the PWM outputs (0..100%)
[9] The CAN Bus has a built-in 120 Ohm terminating resistor


79,8
4xM2x0.4
60,2
20,0

Built-in functions

While REPAM can be used to control things remotely (by connecting to it via network), it can also execute some simple "standalone tasks" by itself. This makes it possible to have simple (and very important!) autonomous functions running even without a network connection to a controlling computer. For power amplifiers, these are typically controlling the fan(s) (using measured temperature as input), switching the power supply off if excessive SWR, Idd current, forward power etc. are discovered in an installation.

Currently the available "autonomous" features are (may change):

1. Control the two fan outputs depending on one or two temperature sensors (if sensor(s) gets disconnected, fails etc., fan(s) will run with maximum configured speed).
2. Activate/deactivate/pulse on one of the six relay outputs if some measured value exceeds a set threshold value and/or report ALARM.
3. Monitor a "OZ9AAR Dual RF Head" sensor for FWD, REF and/or SWR, the results can trigger actions on one of the six relay outputs and/or report ALARM.
4. Monitor the (up to) eight temperature sensors and trigger actions on one of the relay outputs (high temperature etc.) and/or report ALARM.
5. Monitor the current dew point temperature, control relays based on this and report warnings to PAMonitor.

Besides these autonomous functions, you can control and monitor all I/O of the box via the network interface using simple TCP/IP socket communication (more on this later in this document).

The autonomous functions described here are all configured using the "REPAMMonitor" application.

Triggers

The "Trigger" functionality can be used to monitor the analog inputs, temperature sensors and the calculated values from a Dual RF Head (forward power, reflected power and SWR). Because of the nature of the implementation ("software in the loop") there is a certain reaction time in the REPAM device before a trigger "fire" and reacts to a threshold being crossed.

If a trigger monitors the SWR value (or forward power or reflected power) calculated from a Dual RF Head, the total time is around 2.3 milliseconds. This is the time it takes to detect that the SWR threshold (or power threshold) has been crossed plus the time it takes for one of the six relays to close its contacts. The relay is approximately taking 2 milliseconds to close its contacts and the sample and monitor time are around 0.3 millisecond giving the total delay of 2.3 milliseconds.

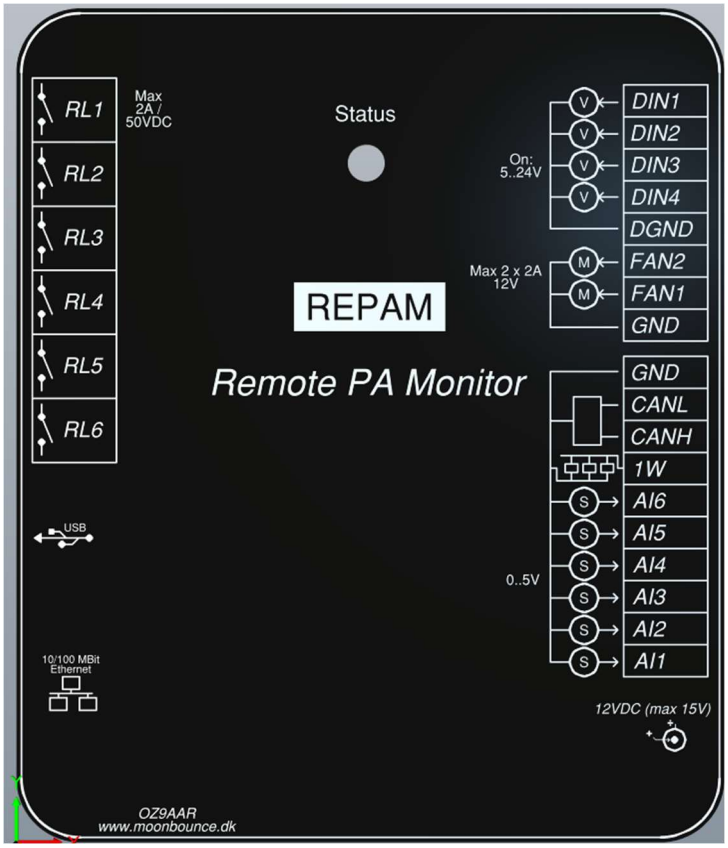
If a trigger monitors one of the analog inputs, the total delay is around 3.5 milliseconds. This includes also the time it takes one of the relays to close its contacts.

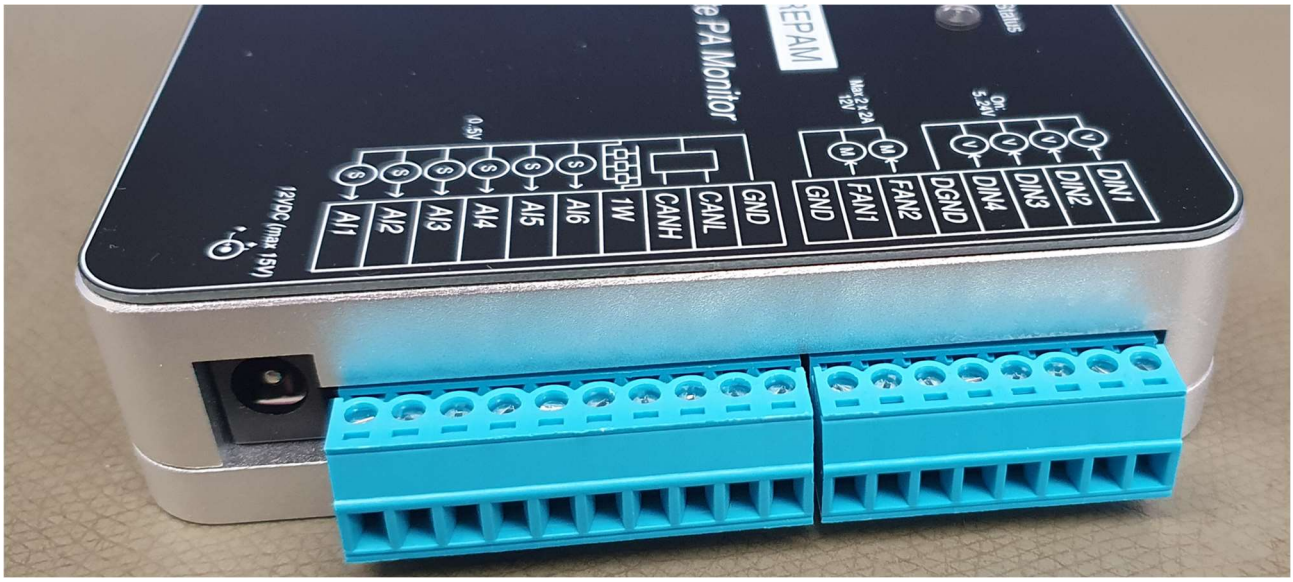
Interfaces to the outside world

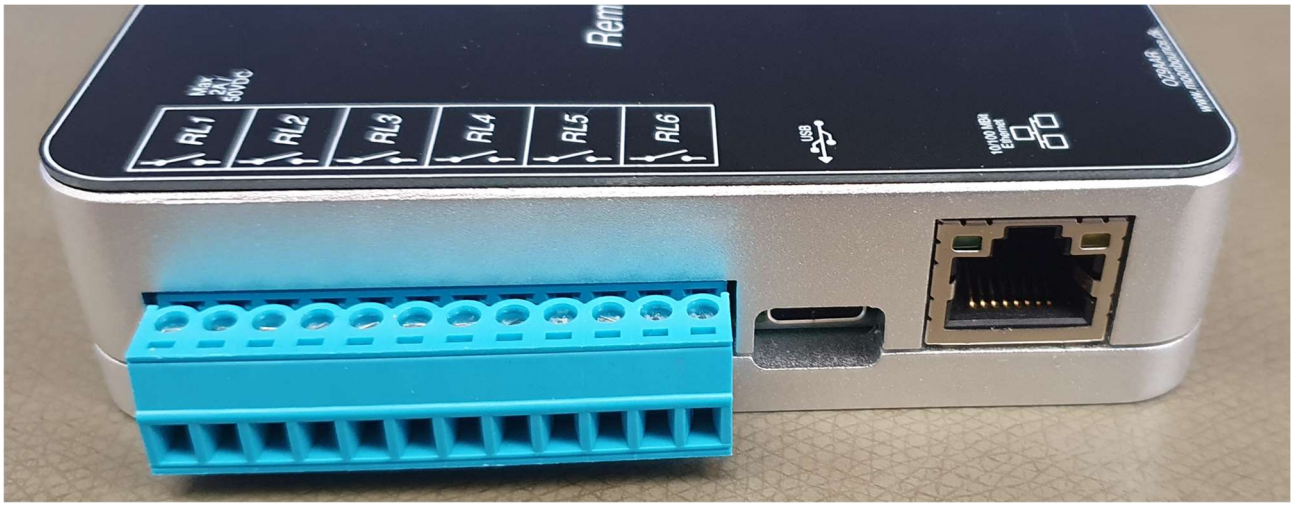
REPAM has several I/O signals available. Below is a list of the various interfaces.

1. 6 relay outputs (50VDC/2A). Each output acts as a “contact”.
2. 4 digital optically isolated inputs with a separate isolated ground. Input > 8V means active.
3. 6 analog inputs, 0 to 5VDC. Resolution is 12 bit (calibrated at factory).
4. 2 PWM outputs for driving 12V fans (0..100%). Each output can drive up to 2A (max 2A total when both in use).
5. 1Wire interface (5V drive). This allows you to attach up to 8 temperature sensors (DS18B20 type) and a humidity sensor.
6. CAN Bus (with internal 120 Ohm terminating resistor). This enables monitoring/control of for example ELTEK FlatPack2 PSU or other devices, I/O expansion etc. (not yet enabled in software)
7. 10/100 Mbit/s Ethernet (RJ45) connection for remote control (using TCP/IP Socket communications/JSON).
8. DC input plug (2.1mm standard) for 12VDC (consumption 200 mA plus any fans). (Internal power supply is of linear type to minimize radiated noise). Center pin is positive.
9. USB-C connector for diagnostics (can also power the REPAM except relays and fans are not functioning).
10. A blue status LED on the front (slow flash when idle, double flash when REPAMMonitor/PAMonitor or another device is connected via network).

Overview of the various signals/interfaces:




REPAM
AI1
AI2
AI3
AI4
AI5
AI6
1W
CANH
CANL
GND
GND
FAN1
FAN2
DGND
DIN4
DIN3
DIN2
DIN1

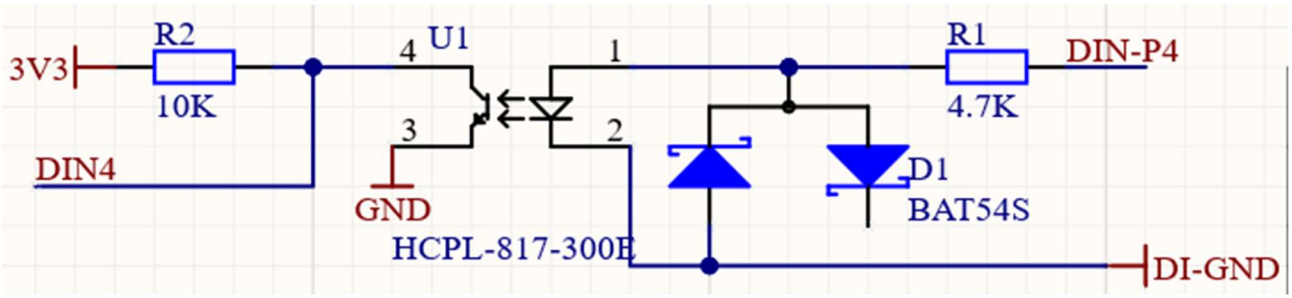

RL1
RL2
RL3
RL4
RL5
RL6

I/O circuitry

Below you will find simplified schematics of the I/O signals of the REPAM, this will help you understand how to interface to the various interfaces. Please see the Technical data section.

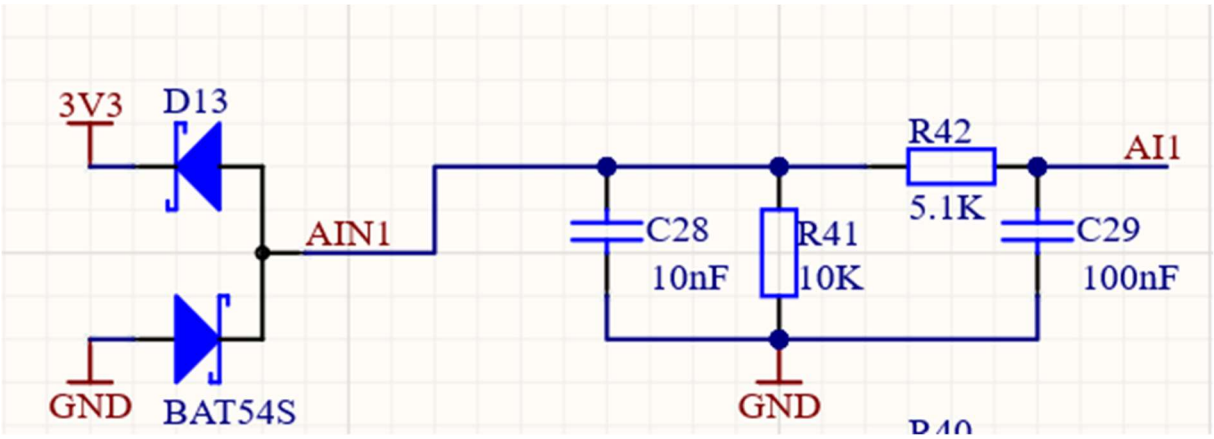
Digital inputs.

The four digital inputs are galvanic isolated from the rest of the system. They share one common ground connection (DI-GND). They will signal on when approx. 5V are applied to the inputs.



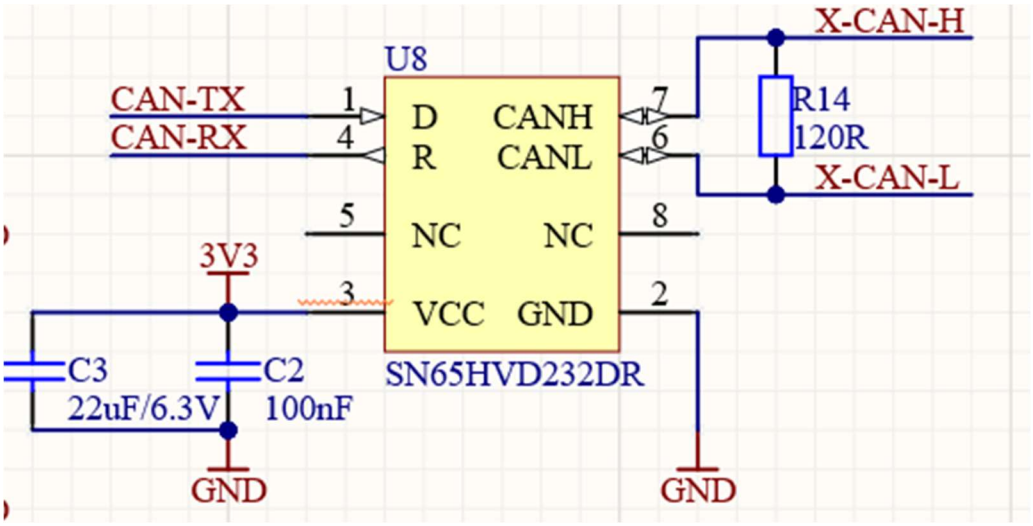
Analog inputs

The six analog inputs will each handle from 0 to 5VDC. The inputs are calibrated from factory (calibration point at 4000 mV). All analog inputs are sampled 570 times per second. The “AI” value in the JSON status message is the average of the last 64 samples of the analog channels. The “AIPEAK” value is the max value detected within the last approx. 2 seconds.



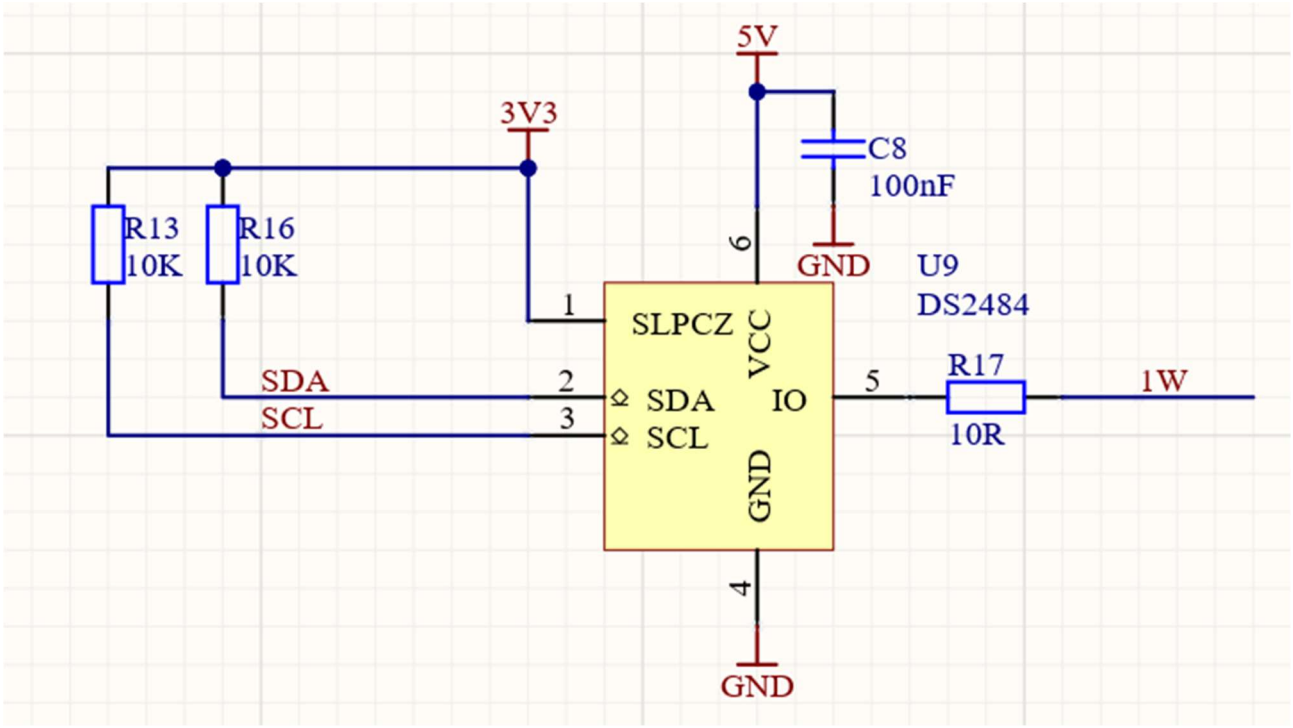
CAN Bus

The CAN bus is not currently implemented in software. Features may be implemented for this at a later time.



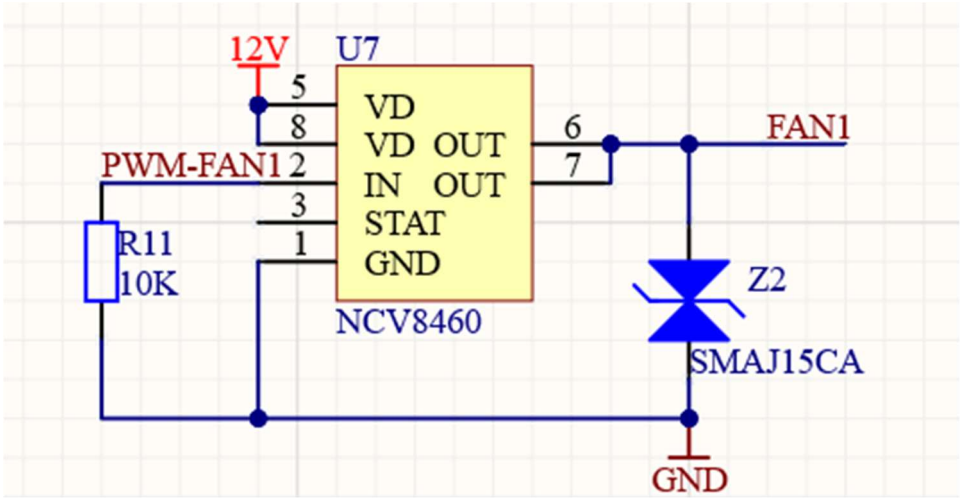
1Wire

Up to eight 1wire temperature sensors and a single humidity sensor are supported. The temperature sensors must be DS18B20 based, the humidity sensor is a special sensor developed by (and available from) OZ9AAR. Connect the sensors using the DATA and GND pins on the sensors. All sensors in parallel. They will be scanned and discovered when REPAM is powered on. The bus voltage for the 1Wire is 5.0 VDC.



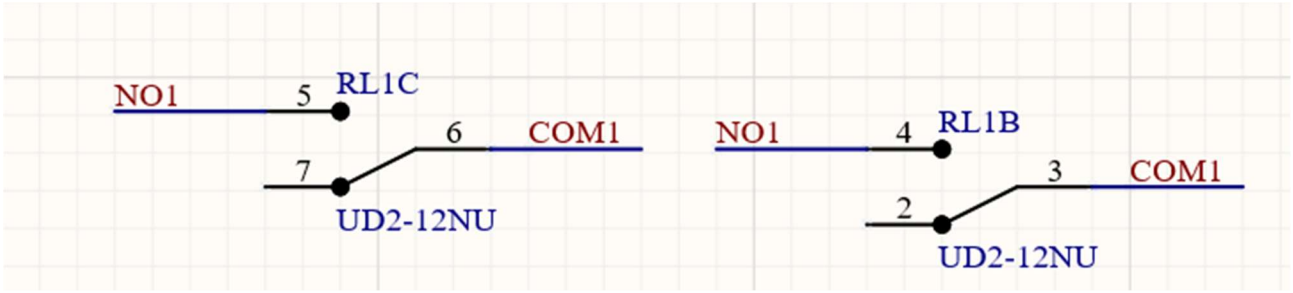
Fan outputs

The two fan outputs can drive 12V fans at up to 2 Amp each, however the total combined current for both fan outputs must not exceed 2 Amp in total.



Relay outputs

The relay outputs have both contact sets of the relays in parallel. The used relays are “Kemet UD2-12NU”
Datasheet: https://www.mouser.dk/datasheet/2/447/KEM_R7005_UC2_UD2-3316905.pdf

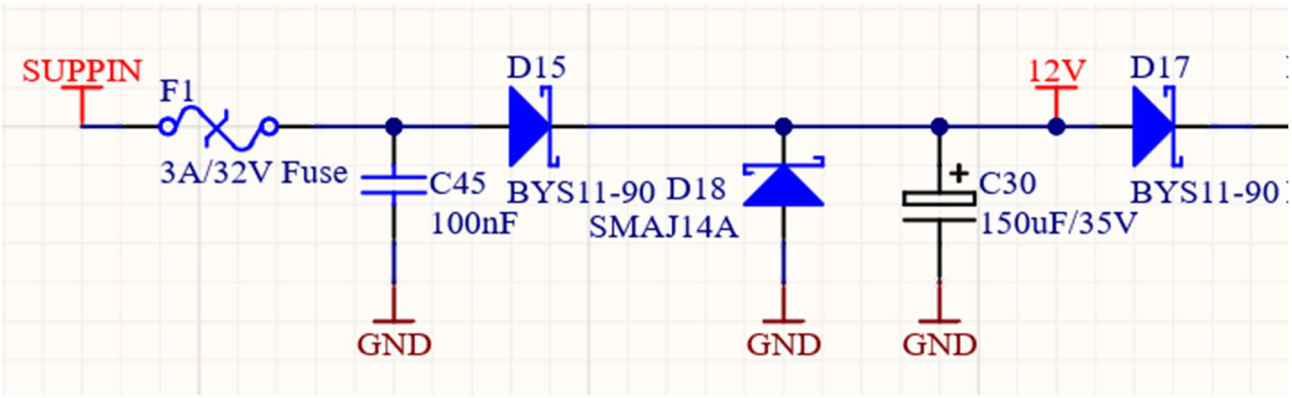


Contact Specifications

Item		UC2/UD2
Contact Form		2 Form C
Contact Material		Silver alloy with gold alloy overlay
Contact Ratings	Maximum Switching Power	30 W, 37.5 VA
	Maximum Switching Voltage	220 VDC, 250 VAC
	Maximum Switching Current	1 A
	Maximum Carrying Current	1 A
Minimum Contact Ratings		10 mVDC, 10 μA*1
Initial Contact Resistance		100 mΩ maximum (initial)
Operating Time (excluding bounce)		Approximately 2 milliseconds
Release Time (excluding bounce)		Approximately 1 milliseconds
Insulation Resistance		1,000 MΩ at 500 VDC
Withstand Voltage	Between Open Contacts	1,000 VAC (for one minute), 1,500 V surge (10 x 160 μs)*2
	Between Adjacent Contacts	1,000 VAC (for one minute), 1,500 V surge (10 x 160 μs)*2
	Between Coil and Contacts	1,500 VAC (for one minute), 2,500 V surge (2 x 10 μs)*3
Shock Resistance		735 m/s² (75 G) – misoperation 980 m/s² (100 G) – destructive failure
Vibration Resistance		10 to 55 Hz, double amplitude 3 mm (20 G) – misoperation 10 to 55 Hz, double amplitude 5 mm (30 G) – destructive failure
Ambient Temperature		-40 to +85°C
		-40 to +70°C (Low power consumption type)
Coil Temperature Rise		18°C at nominal coil voltage (140 mW)
Running Specifications	Non-load	5 x 10^7 operations (Non-latch type)*4 1 x 10^7 operations (Latch type)
	Load	30 VDC 1 A (resistive), 1 x 10^5 operations at 20°C, 1 Hz 125 VAC 0.3 A (resistive), 1 x 10^5 operations at 20°C, 1 Hz
Weight		Approximately 0.8 g

*1 *This value is a reference value in the resistance load. Minimum capacity changes depending on the switching frequency, environment temperature, and load.*
*2 *Rise time: 10 μs; decay time to half crest: 160 μs.*
*3 *Rise time: 2 μs; decay time to half crest: 10 μs.*
*4 *This shows the number of operations with fatal defects. Stable characteristics are maintained for 1 x 10^7 operations.*

Power supply input



Do NOT exceed 14VDC on the input!

Center pin on the DC 2.1 mm connector is positive.

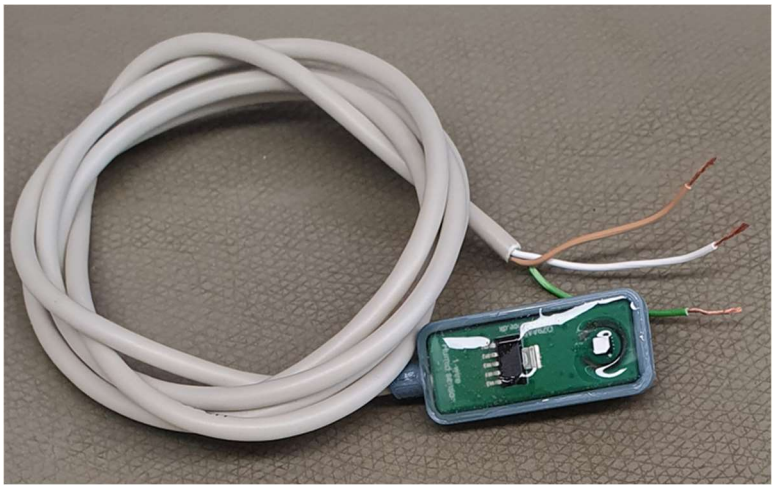
Humidity monitoring and control

Depending on the climate you mount your equipment (PA) in, you can experience problems with dew forming. The dew point temperature is the temperature at which the water vapor in the air condenses into liquid water (much more information can be found on the internet).

To calculate the current dew point, you need to measure the temperature and the relative humidity (RH) of the air. The REPAM device can use a combined temperature and RH sensor to calculate the dew point. This sensor is available from the same place as you got your REPAM device from. The sensor is connected in parallel with the 1-wire temperature sensors in your system.

The RH sensor has 3 wires coming out:

- GND (brown)
- 1-wire signal (green)
- Power supply 12VDC (white).



The temperature/RH sensor is cast in transparent epoxy. Only the actual sensor element (with the white square) is exposed to the air.

The REPAM device has built in “Humidity warning and control” feature. Using this, it is possible for the REPAM device to control one or more relay outputs and the two fans if one or more of the connected temperature sensors comes “too close” to the calculated dew point. A typical setup would have some sort of heating element controlled by one of the relay outputs. Whenever the dew point is reached, the heater would turn on, at the same time one of the two fan outputs could also be commanded to turn on. This would help preventing the forming of dew in the system. The PAMonitor application (and other) will also get an alarm notification for each of the temperature sensors that are close to the dew point temperature.

The setup of the humidity warning and control feature is done in the REPAM Monitor application (see page 35).

Network communication

Communication with the REPAM is done using socket communication (default port number 30200). Data are formatted as JSON records. The REPAM device returns data when a command is sent to it. A command can be a request for a specific part of configuration. If you send "POLL" to the device, it will effectively function as a "NOP" command, REPAM will reply with the status of all inputs etc.
A command can f.ex. be configuration of one of the two fan controllers. It can also be configuration of one of the twelve triggers that can be set etc. A list of parameters/commands that can be sent are shown below.

UDP simple command interface (netcat).

The REPAM device is listening for simple commands on (fixed) UDP Port 30100. The interface is a very simple command/response type of interface. You can use "netcat" to interact with the device using the UDP port. Below is an example of how to upgrade the firmware from a remote FTP server (as an example). (You could also just have used the UPDATE command):

```
D:\PRJ\RePam - Remote PA Monitor>nc64 -u 192.168.0.57 30100
<== Press enter
I'm sorry Dave, I'm afraid I can't do that (use HELP for help)
>>GET moonbounce.selfhost.eu username password Public/repam.sfw firmware.sfw
Getting file..please wait..
>>dir
  Listing files in filesystem...please wait..
.       <DIR>
..      <DIR>
boot_count      4
firmware.sfw    244784
>>reset
<== Press enter
I'm sorry Dave, I'm afraid I can't do that (use HELP for help)
>>dir
  Listing files in filesystem...please wait..
.       <DIR>
..      <DIR>
boot_count      4
>> <== Press enter
I'm sorry Dave, I'm afraid I can't do that (use HELP for help)
>>help
-----------------------------------------------
Commands: (use strict syntax!)
"HELP" - This list of commands
"RESET" - Resets device
"FACTORY" - Resets all settings to factory default!!
"UPDATE" – Get new firmware for REPAM
"GET 10.11.12.13 userid password remotefilename localfilename"  - FTP GET file from FTP server
"DIR" - List contents of filesystem
"DELete filename" - Delete a file in the filesystem
"IPConfig" - Show current IP configuration
The following commands needs RESET command to be effective
  "SET DHCP [NO | YES]" - Disable/Enable DHCP
  "SET IP 10.11.12.13" - Set my IP address (if DHCP=NO)
  "SET GW 10.11.12.13" - Set Gateway IP address (if DHCP=NO)
  "SET MASK 255.255.255.0" - Set netmask (if DHCP=NO)
-----------------------------------------------
>> <== Pressing CTRL+C exits the netcat program
```

Above you can see that after the FTP GET and the reset command, the firmware.sfw file is no longer present in the filesystem of the REPAM. This means the firmware has been applied to the REPAM (you can also see the VERSION info has changed in JSON data etc)

JSON format and command/responses

A command and the reply are both formatted as JSON records. REPAM understands a number of commands (for configuration). If you send REPAM a command it does not understand, it will just reply with current status (as for the "POLL" command shown below).

Command: {"POLL"}

Response from REPAM:

{"TICK":1467,"UPTIME":47,"CPULOAD":31.1,"VERSION":0.13,"DI":[0,0,0,0],"DO":[0,0,0,0,0,0],"AI":[1.625000,1.187500,30.675469,27.000000,21.250000,0.953125],"AIPEAK":[6.000000,6.000000,147.770000,112.000000,48.000000,2.000000],"AIRAW":[2.000000,2.000000,21.110000,32.000000,16.000000,1.000000],"FAN":[0,0],"ALARM":[0,0,0,0,0,0,0,0,0,0,0,0],"POWER":[0.0,0.0,-60.00,2,0.0,0.0,-99.00,2,1.0],"HUMID":[23.42,58.89,14.92,0,17,0],"T1":[22.9,0,17],"T2":[22.9,0,17],"T3":[23.1,0,17],"T4":[-99.9,0,0],"T5":[-99.9,0,0],"T6":[-99.9,0,0],"T7":[-99.9,0,0],"T8":[-99.9,0,0]}

TICK: Incrementing number
UPTIME: number of seconds since REPAM was last powered on
CPULOAD: The current CPU load in the REPAM device (in %)
VERSION: Firmware version of REPAM
DI: Status for the four digital inputs
DO: Status for the six relay outputs
AI: Analog value in mV for the six analog inputs (averaged over 64 samples). These are the values shown in the REPAMMonitor and on the PA Monitor (details view)
AIPEAK: Peak values for the six analog inputs (reset after a couple of seconds)
AIRAW: Instantaneous values for the six analog inputs (result from last conversion of AD converter)
FAN: Speed (0..100%) for each of the two fan outputs
ALARM: Status for the twelve possible alarms (each of the twelve triggers can potentially activate an alarm (0=no alarm, 1=alarm active, 2=alarm not active but has been, can be cleared with "ALARMACK")
POWER: If a Dual RF Head sensor are defined, this is data from that. The order of data is:

1) Forward power in watt
2) Peak forward power in watt
3) Forward power in dBm
4) Voltage measured at forward analog input
5) reflected power in watt
6) Peak reflected power in watt
7) reflected power in dBm
8) Voltage measured at reflected analog input
9) Calculated SWR

HUMID: Data from a connected humidity sensor

1. Temperature (deg C)
2. Relative humidity (0..100%)
3. Calculated dewpoint (deg C)
4. Number of conversions errors from sensor (could be because of RF interference)
5. Number of successful conversions from sensor
6. Status. Which of the T1-T8 sensors have dew point warning (Bit 0=T1, Bit 7=T8), Bit 8=Heater status

T1..T8: This is data for the (up to) eight connected 1wire temperature sensors. The order of data is:

1) Current temperature (-99.9 if no sensor connected)
2) Number of conversion errors (could be because of RF interference)
3) Number of successful conversions done

Command {“ALARMACK”:1}

This will clear alarm 1 if it is currently in state 2 (not active but has been). Using this command you can clear any of the 12 possible alarms.

Response from REPAM same as for a {“POLL”} command.

Command {“FAN”:[50,70]}

This will set the minimum speed of fan1 and fan2 output (0..100). Please note that if a fan is controlled by its “fan controller” in the REPAM device, the fan might be commanded by the fan controller to run faster. It can however NOT run slower than set with this command! If the speed is set to 0 for a fan, the fan controller is fully in command of the specific fan.

Response from REPAM same as for a {“POLL”} command.

Command {“FAN1”:50}

This will set the minimum speed of fan1 output (0..100). Please note that if a fan is controlled by its “fan controller” in the REPAM device, the fan might be commanded by the fan controller to run faster. It can however NOT run slower than set with this command! If the speed is set to 0 for a fan, the fan controller is fully in command of the specific fan.

Response from REPAM same as for a {“POLL”} command.

Command {“FAN2”:50}

This will set the minimum speed of fan1 output (0..100). Please note that if a fan is controlled by its “fan controller” in the REPAM device, the fan might be commanded by the fan controller to run faster. It can however NOT run slower than set with this command! If the speed is set to 0 for a fan, the fan controller is fully in command of the specific fan.

Response from REPAM same as for a {“POLL”} command.

Command {“DO”:[0,0,0,0,1,1]}

Set the state of the six relay outputs. Please note that a trigger on REPAM can override these settings whenever a trigger fires (if configured).

Response from REPAM same as for a {“POLL”} command.

Command {“DHCP”:true/false}

Set DHCP to true or false. If set to true, REPAM will try to get a valid IP address when it is powered on/connected to network. Reset device after changing this

Response from REPAM same as for a {“POLL”} command.

Command {"IP":"192.168.0.57"] }

Set IP address of REPAM (if not using DHCP)

Response from REPAM same as for a {"POLL"} command.

Command {"GW":"192.168.0.1"] }

Set gateway address for REPAM to use (if not using DHCP)

Response from REPAM same as for a {"POLL"} command.

Command {"MASK":"255.255.255.0"] }

Set IP mask of REPAM (if not using DHCP)

Response from REPAM same as for a {"POLL"} command.

Command {"PORT":30200] }

Set port number to use when talking to REPAM (default 30200)

Response from REPAM same as for a {"POLL"} command.

Command {"TCON":[1,1,21.5,50.0,40.0,100]} | Query {"TCON":1/2}

Configure one of the two fan controllers. Using this command, you can set the temperature sensor to use (0=disable, 1..8=T1..T8), and the low and high temperature/speeds. The fan will start spinning with the "low fan speed" when temperature reaches the "low temperature", speed will increase up to "high fan speed" when "High temperature" has been reached.

The order of data is:

1) Index, which temperature controller to configure, can be 1 or 2.
2) Which temperature sensor to use (1..8), if set to 0, this temperature controller is disabled
3) Low temperature in degrees Celsius
4) Low fan speed when temperature reaches "Low temperature"
5) High temperature in degrees Celsius
6) High fan speed when temperature reaches "High temperature"

The query command will return the configuration for the indicated index (1/2).

Response from REPAM same as for a {"POLL"} command.

Command {"TRIG":[1,1,1500,0,5,1]} | Query {"TRIG":1..12}

This command is used to configure one of the twelve triggers. A trigger can trigger on a number of inputs/calculated values. Triggers can set relay outputs on/off or pulse for a number of mS, they can also set an alarm bit or both at the same time. Triggers can trigger when a value is either above or below a threshold. The order of data is:

1) Index, which one of the twelve triggers we are configuring (1..12)
2) Which input to use for the trigger:
    a. 0, this trigger is inactive
    b. 1..6, this is AI1..AI6 analog inputs (value taken after "scaling", see later)
    c. 7..14, this is T1..T8 temperature sensor
    d. 15, forward power (Watt) from a Dual RF Head
    e. 16, reflected power (Watt) from a Dual RF Head
    f. 17, calculated SWR from a Dual RF Head
3) Threshold value, this is the value the input is compared to
4) Trigger type, 0=above threshold, 1=below threshold
5) Output control, this is the output the trigger will control, 0..5=Relay 1..relay 6, 6=ALARM bit. If bit 8 is set, the trigger will in addition to the relay it controls, also set the ALARM (f.ex the value 0x100 means trigger will control Relay 1 as well as setting the ALARM status). Setting value to only 6 means it will only trigger an ALARM. ALARM status can be read in the normal REPAM status message in the "ALARM" field).
6) What action to use if output control is one of the relays, 0=turn off, 1=turn on, 10..1000 pulse the relay for this number of milliseconds.

The query command will return the configuration for the indicated index (1..12).

Response from REPAM same as for a {"POLL"} command.

Command {"DUALRF":[1,2,-41.2,-31.5,-40,1500,0,700,-40,1500,0,700]} | Query {"DUALRF":[]}

This is used to configure a "Dual RF Head" type of sensor. REPAM supports one Dual RF Head sensor. When defining this, you specify which analog inputs the forward and reflected voltages are input on. You also define the low and high power calibration points. The order of data is:

1) Which AI input to use for forward power (0=Dual RF Head not used, 1..6=AI1..AI6)
2) Which AI input to use for reflected power (0=Dual RF Head not used, 1..6=AI1..AI6)
3) Coupling factor for forward port in dB. This can be set to 0 if Dual RF Head are calibrated in the final system (value is simply added to the calculated power)
4) Coupling factor for reflected port in dB. This can be set to 0 if Dual RF Head are calibrated in the final system (value is simply added to the calculated power)
5) Minimum forward power in dBm. This is the lowest power for calibration
6) Forward port voltage in mV when minimum power is applied
7) Maximum forward power in dBm. This is the highest power for calibration
8) Forward port voltage in mV when maximum power is applied to forward port
9) Minimum reflected power in dBm. This is the lowest power for calibration on forward port
10) reflected port voltage in mV when minimum power is applied to reflected port
11) Maximum reflected power in dBm. This is the highest power for calibration on reflected port
12) reflected port voltage in mV when maximum power is applied to reflected port

The query command will return the configuration for the Dual RF Head.

Response from REPAM same as for a {"POLL"} command.

Command {“AIMUL”:[1.0,1.0,1.0,1.0,1.0,1.0]} | Query {“AIMUL”:[]}

The six analog inputs can each be scaled by a number. This is beneficial in systems where the value (voltage) you measure is not “1:1” with the process value. An example, you measure current thru a resistor, each Ampere gives you 50 millivolts on the analog input. In that case, it would be nice to multiply the actual voltage measured by 20, doing so would result in 1000 for each Ampere measured.

The parameters to the command are simply the multiplication factors for each of the six analog inputs. If these are all set to 1.0, all values from the AI inputs will be one to one the number of millivolts that are measured.

The query command will return the scaling values.

Response from REPAM same as for a {“POLL”} command.

Command {“HUMIDMON”:[33,2.5,-1.5,1,0,0,0,0,0,0,0]} | Query {“HUMIDMON”:[]}

This command sets the parameters for the humidity warning system. You specify which of the (up to) eight temperature sensors you want to monitor, what threshold to use, what (if any) relay output to activate and which fan to activate (and its speed) for each of the eight temperature sensors, should one of them reach the current dew point temperature (closer to the dew point than the threshold). The data are:

1. Bit mask for which temperature sensor to monitor, bit 0 = T1..Bit 7=T8. If value is 0, humidity warning is disabled
2. Threshold in degrees. If one of the (in bit mask) selected temperature sensors comes closer to the dewpoint than this number of degrees, a warning will be issues/relay activated.
3. Temperature offset for the temperature sensor in the RH sensor. Typically needs around -1.50 (because of self-heating of the sensor).
4. Fan, speed and output relay number for T1. See below.
5. Fan, speed and output relay number for T2. See below.
6. Fan, speed and output relay number for T3. See below.
7. Fan, speed and output relay number for T4. See below.
8. Fan, speed and output relay number for T5. See below.
9. Fan, speed and output relay number for T6. See below.
10. Fan, speed and output relay number for T7. See below.
11. Fan, speed and output relay number for T8. See below.

The fan, speed and output relay number are specified like this:

1. Bit 2 .. 0 is the relay output number to activate (1 to 6). Set to 0 if no output should activate.
2. Bit 8 .. 14 is the speed for the fan selected. Speed = 0 means no fan used.
3. Bit 15 is low if fan 1 should be controlled, bit 15 is high if fan 2 should be used.

The query command will return the current configuration.

Response from REPAM same as for a {“POLL”} command.

Command {"IPCONFIG":[“true”,”192.168.0.57”,”192.168.0.1”,”255.255.255.0”,30200]} | Query {"IPCONFIG":[]}

Remember to put quotes (“ “) around the first 4 parameters !

This command sets the IP configuration of the REPAM device. The order of the data is:

1) DHCP in use (true/false) (default true)
2) If DHCP not in use, this is the IP address the REPAM should use (default 192.168.0.200)
3) If DHCP not in use, this is the IP address of the gateway (default 192.168.0.1)
4) If DHCP not in use, this is the netmask that REPAM will use (default 255.255.255.0)
5) The port number to use for socket communication (default 30200)

The query command will return the current IP configuration.

Response from REPAM same as for a {“POLL”} command.

Command "IONAME":["AI1name","AI2name","AI3name","AI4name","AI5name","AI6name","DI1name","DI2name","DI3name","DI4name","DO1name","DO2name","DO3name","DO4name","DO5name","DO6name","FAN1name","FAN2name","T1name","T2name","T3name","T4name","T5name","T6name","T7name","T8name"]} | Query {" IONAME ":[]}

Each name can maximum be 8 characters long!

Remember to put quotes (“ “) around all the parameters !

This command sets the names of the I/O signals on the REPAM device. This is not as such used by the device itself, but the REPAM Monitor application uses the information to make the settings window more readable. Using these names, it is possible to make “easy to remember names” for the different I/O signals.

1) Names for analog inputs 1 to 6
2) Names for digital inputs 1 to 4
3) Names for digital (relay) outputs 1 to 6
4) Names for Fan 1 and 2
5) Names for temperature sensors 1 to 8

The query command will return the current configuration of the names.

Response from REPAM same as for a {“POLL”} command.

REPAMMonitor application

The “REPAMMonitor” PC application is a Windows (10/11) application for configuring and exercising the REPAM module. Using that, you can see the status of the various inputs, control the relay outputs and configure the fan controllers, analog input scaling, Dual RF Head configuration etc. The REPAMMonitor application uses the JSON commands/responses shown elsewhere in this document.

As REPAMMonitor needs a configuration file to be specified, you can start REPAMMonitor a bit different than a “normal” Windows application if you need to. When starting the application, you can specify the name of a configuration file (if it does not exist, it will be created).

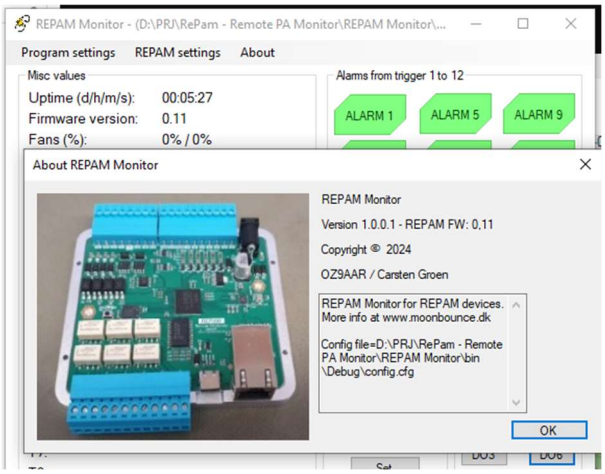
D:\REPAMMonitor\REPAMMonitor.exe config.cfg

This will start the REPAMMonitor and use the 70cm.cfg file in the D:\REPAMMonitor folder (you can also make a shortcut on the Windows desktop).

If you only have a single REPAM device and you don’t have a need for multiple configurations you can change between, you can just start the application by double clicking on it, in that case it will create a default configuration file with the name of “REPAMMonitor.cfg” and place it in the same folder as the application itself resides.

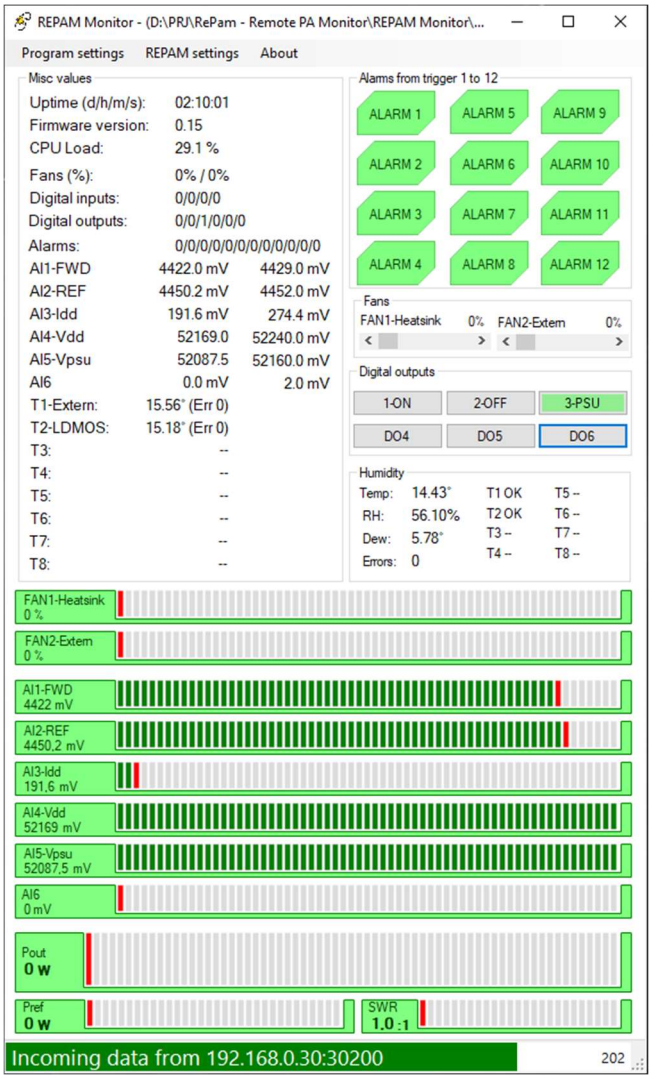
About

The “about dialog” shows the version number (here it is 1.0.0.1) of the REPAMMonitor program, the firmware version of the currently connected REPAM device (if any), here it is 0.11. The configuration file used by the REPAMMonitor is also shown in this window (the configuration file that was specified when program was started).



Main window

Below is a screenshot of the main window of the application.



This is the main window. It shows the analog input values (after scaling), digital inputs, the connected temperature sensors, the current fan speeds, relay output status, alarm bits and (if connected) the forward and reflected power as well as SWR if a Dual RF Head sensor is connected and configured in the connected REPAM device.

You can adjust the two sliders for the fans and the fans will spin with that speed you have set (0..100%).

You can toggle each of the six relay outputs on and off.

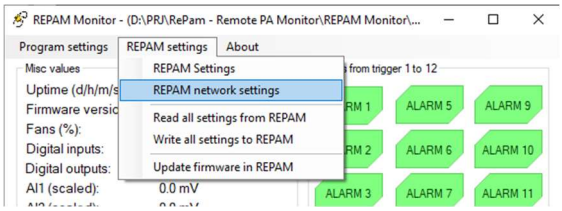
Status of the 12 ALARM bits (from the Triggers) is shown. If an alarm occurs, the indicator will be red, once the alarm is gone again it will turn yellow (to show the alarm was detected). You can click on the indicator to reset it from yellow to green (acknowledge). The alarm acknowledge etc. are handled in the REPAMMonitor application, the REPAM device itself only reports if an alarm is currently active or not.

Status for an (optionally) connected humidity sensor are also shown.

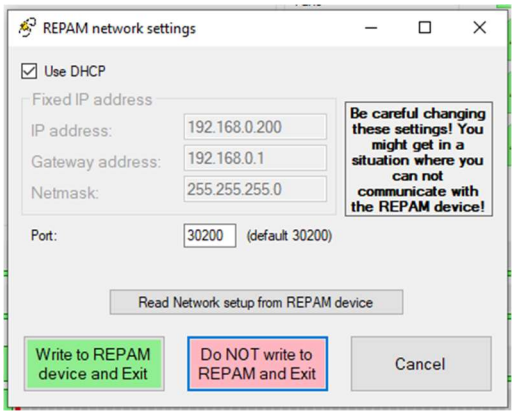
The status bar at the bottom will show if REPAMMonitor is currently receiving data from the connected REPAM device.

Change network settings in REPAM

Using the menu item “REPAM network settings” you can change the network settings of the connected REPAM device. Be VERY careful when you change these parameters as you can end up in a situation where you lose the connection to the REPAM device over the network! The new settings will NOT be active before the REPAM device is powered down and up again. When changing these settings, you might need to go into the “Connection Settings” menu below, this menu contains the settings the PA Monitor application uses to communicate with the REPAM device, the IP address and port number there must match the settings you do in this menu!



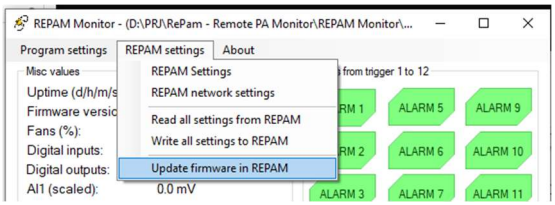
Using this menu, you can change the network connection parameters the REPAM device uses to connect to the Ethernet. Default the device uses DHCP where it will get an IP address (typically) assigned by your router in your network. It is also possible to assign a static IP address to the REPAM device, in that case you need to set the gateway address (typically the IP address of your router) and the netmask to use (typically 255.255.255.0). BE CAREFUL CHANGING THESE! You can end up in a situation where you can no longer communicate with the REPAM device, and will need to do a factory reset!



Update firmware in REPAM

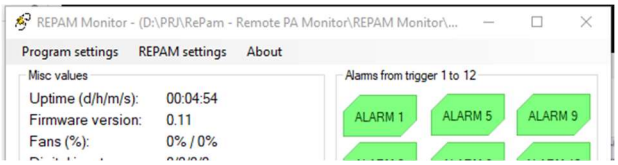
DO NOT update the firmware in the REPAM device while operating the connected device (PA etc)!

It is possible to update the firmware in the connected REPAM device. By activating this menu item, REPAM will on its own look on a remote server for a new version of the firmware running. It will fetch the firmware, reset itself and do an update. You will be asked to confirm that you really want to upgrade the firmware before REPAM does so.

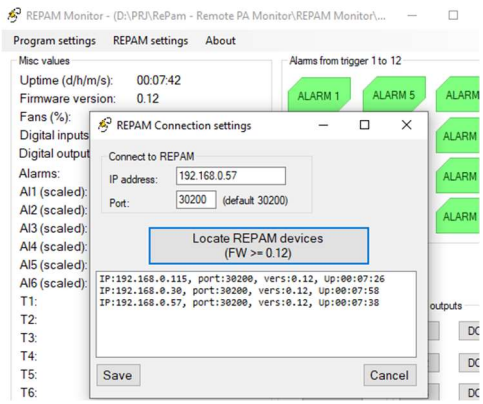


After the update has completed, you can see the new firmware version on the main screen:

In the example below, the version currently running on the REPAM is version 0.11:



Connection Settings



The Connection Settings window is used to configure the IP address and port number used to communicate with the REPAM device. The IP address can either be set by DHCP in the network, or it can be a fixed address (see JSON commands).

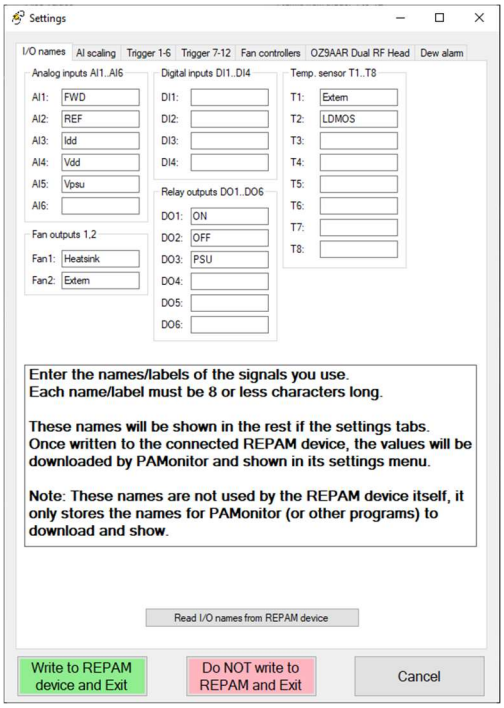
From REPAM firmware version 0.12 and forward, the REPAM present in the network can be located and found by REPAMMonitor by pressing the “Locate REPAM devices” button. REPAMMonitor will send out a message to the network and the connected REPAM devices (with firmware 0.12 or later) will respond back with their IP address, port number, firmware version and time since poweron/reset.

If you double-click on one of the lines in the list of discovered REPAM devices, the IP address and port number will be copied to the entry fields at the top of the window.

The IP address and port number must be correct for the REPAMMonitor application to communicate with the REPAM device.

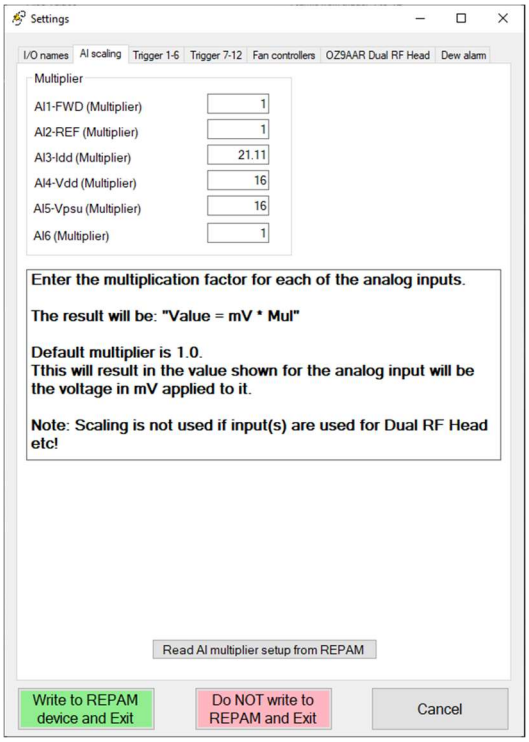
REPAM settings

Selecting the REPAM Settings submenu item brings up the settings window for the connected REPAM device. This window consists of many tabs where the different settings in the REPAM device can be set.



The first page is where you (optionally) can set "human readable" labels/names for the different I/O signals and temperature sensors. These names will be shown on the other settings tabs, this makes it easier to configure the various items. These names are stored in the connected REPAM device when "Write to REPAM device and Exit" button is pressed. The REPAM device itself, does not use these labels/names itself, it is only used as "storage" for the names, PAMonitor application (and possibly other applications) can then download these names and use them.

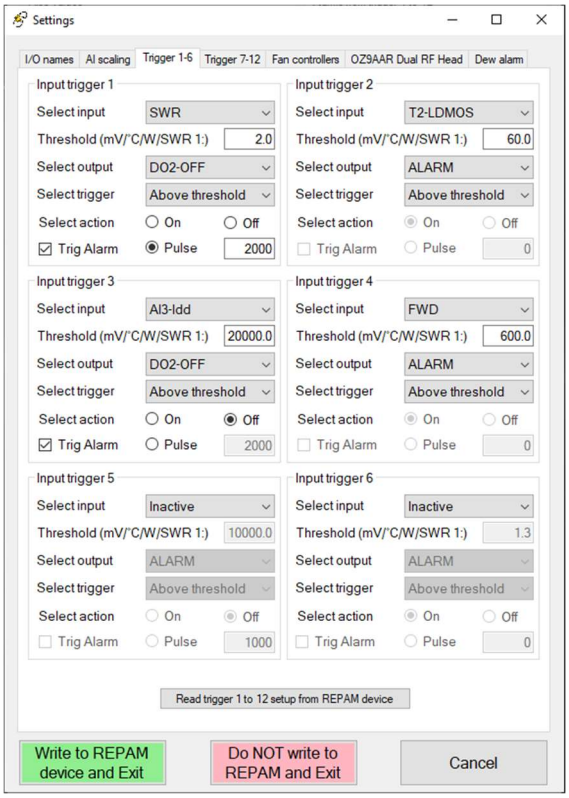
If you press the "Read I/O names from REPAM", the current values in the connected REPAM will be read and shown in this window.

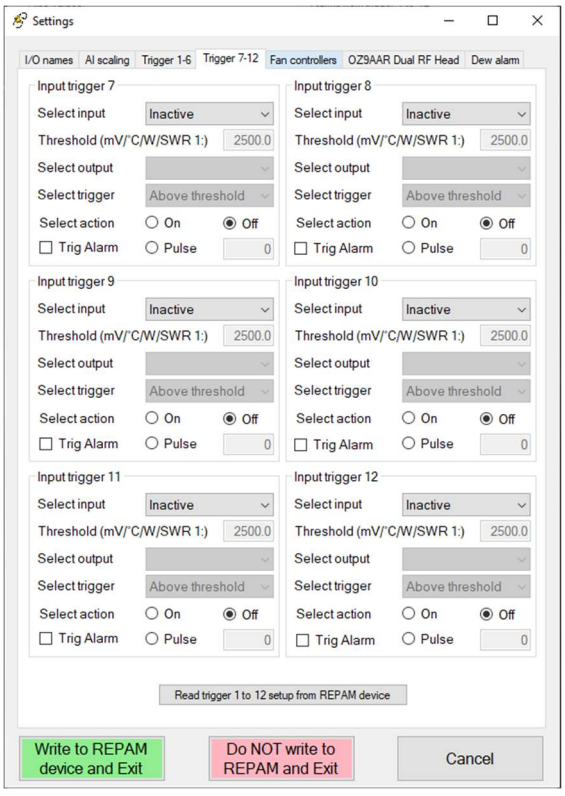


The second page is the scaling factors for the analog inputs. These scaling factors are applied to the value that is being read on the analog inputs. If f.ex you apply 1.0V (1000 mV) to an input, and you set the scaling factor for the input to 10.0, the value reported by the REPAM device (and the value that will be used as input to triggers) will be 10.0V (10000 mV). Likewise, if you set the scaling factor to 0.1 only 100 mV will be reported.

Using the scaling value it is easy to scale inputs to their "natural" values, f.ex measuring the current thru a shunt resistor, you can use the scaling to get the value in f.ex mA (this is the case in the window to the left, AI3 is multiplied with 21.11 which will result in AI3 showing the current flowing as mA.

If you press the "Read AI multiplier setup from REPAM", the current values in the connected REPAM will be read and shown in this window.





The next two pages is the settings for the twelve triggers that can be defined. Triggers can basically do an action whenever some value goes above or below a threshold.

Each trigger uses an input, this can be an analog value, temperature, calculated values such as forward power etc. For each trigger, you define which output should be activated, the threshold to compare to, if the trigger should happen if the input is above or below the threshold.

If the output is selected as ALARM (no relay controlled), the status will be shown in the ALARM field of the JSON data sent from the device (when you do a “POLL” command etc).

If a relay output is selected as the “output” for the trigger, you can choose if the relay should go on, off or if it should pulse for a number of milliseconds. You can also enable ALARM on the same trigger that control a relay. Handling of ALARM is the same way as if the “select output” was set to ALARM.

The first four of the twelve triggers are defined in the screenshots to the left.

Trigger 1 will set an alarm if the SWR (calculated from values from Dual RF Head exceeds 1:2.0) and it will also make a 2 second pulse on DO2 (relay 2) which will switch the PA off.

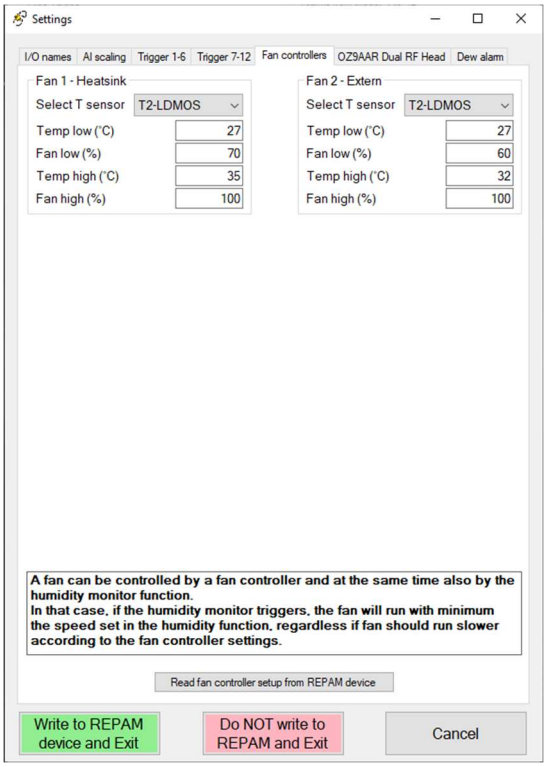
Trigger 2 will set an alarm if the temperature measured on T2 (in this case, mounted close to the LDMOS in a PA) gets above 60 °C.

Trigger 3 will set an alarm if AI3 exceeds a value of 20000 mV. The value on AI3 is scaled by 21.11 in the scaling window, so the “20000 mV” is actually only 947 mV in the physical input. AI3 measures the current going to the LDMOS, levels are approximately 50 mV/Amp, so the scaling makes the value act like it was in mA. In this case, 20000 is the equivalent of 20 Amp. It will also make a 2 second pulse on DO2 (relay 2) which will switch the PA off.

Trigger 4 will set an alarm if the forward power from the Dual RF Head exceeds 550 Watt.

In a real world scenario, one or more of the triggers would probably activate/deactivate one of the relay outputs, f.ex Trigger 3 would probably switch off the power supply if the current exceeds 20 Amp etc.

Press the “Read trigger setup from REPAM”, to read current values from the REPAM. Will then be shown in this window.

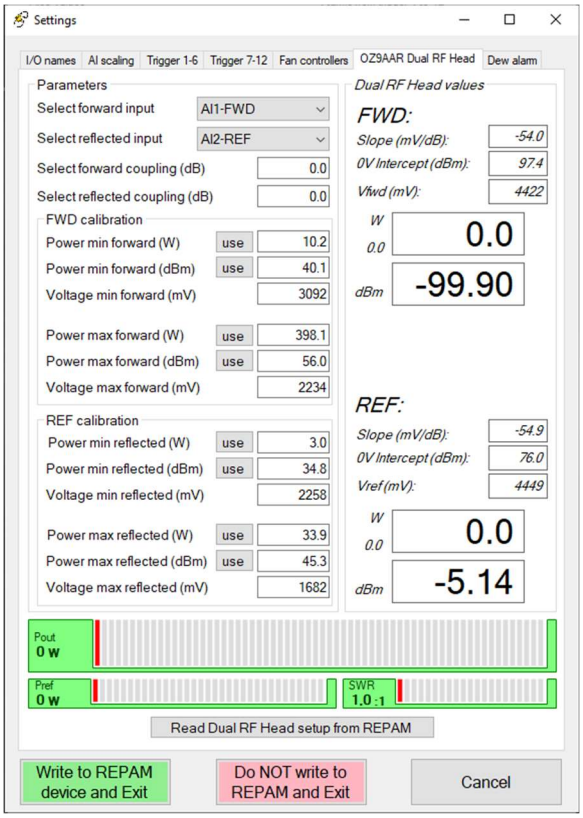


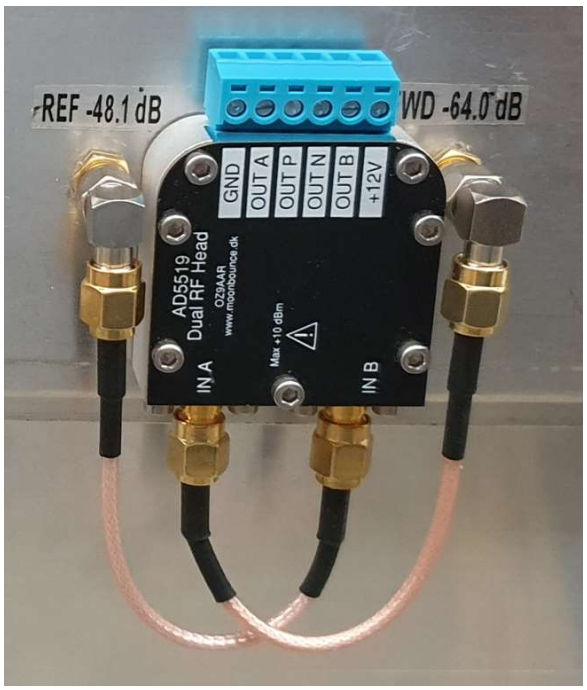
The REPAM device has two autonomous fan controllers. The two controllers control the FAN1 and FAN2 outputs. These are 12V (max 2 Amp) PWM controlled outputs. The controller can set the outputs to a value between 0 and 100%.

For each of the two controllers, you can select which temperature sensor is used as input (T1 to T8). You also set the low temperature, when temperature reaches this, the fan will start running with the speed in the “Fan low (%)” field. The speed will increase linearly until it reaches the “Fan high (%)” value, this will be reached when the temperature reaches (or exceeds) the “Temp high (°C).

Please note that most fans don’t like to run below 50%, please make appropriate tests!

If you press the “Read fan controller setup from REPAM”, the current values in the connected REPAM will be read and shown in this window.





The picture above is of a Dual RF Head, this one is mounted outside the cabinet of a 70 cm 500W PA. It gets its (RF) input from a dual directional coupler inside the PA.

The last page of the settings window is the configuration of a “Dual RF Head” sensor (available from OZ9AAR). The Dual RF Head is a dual logarithmic power sensor with a dynamic range of 50 dB and a frequency response to 8 GHz (useable up to 10 GHz).

The Dual RF Head has two analog outputs, “OUTA” and “OUTB”. Normally OUTA is the forward power and “OUTB” is the reflected power. Using the settings shown, you can configure low and high power levels. In the right part of the window, the values calculated from the calibration factors are shown. When you change values, you need to do a “Save to device and Exit” for the values to take effect in the REPAM device!

The forward and reflected coupling values are just values that will be added to the calculated forward and reflected powers. If you install and calibrate the Dual RF Head in a final system, these are usually set to 0.

The minimum and maximum power and voltages are measured for “the lowest power” and the “highest power” you will be using. Please take VERY much care when measuring these values as they directly impact how precise the power and SWR readings will be!

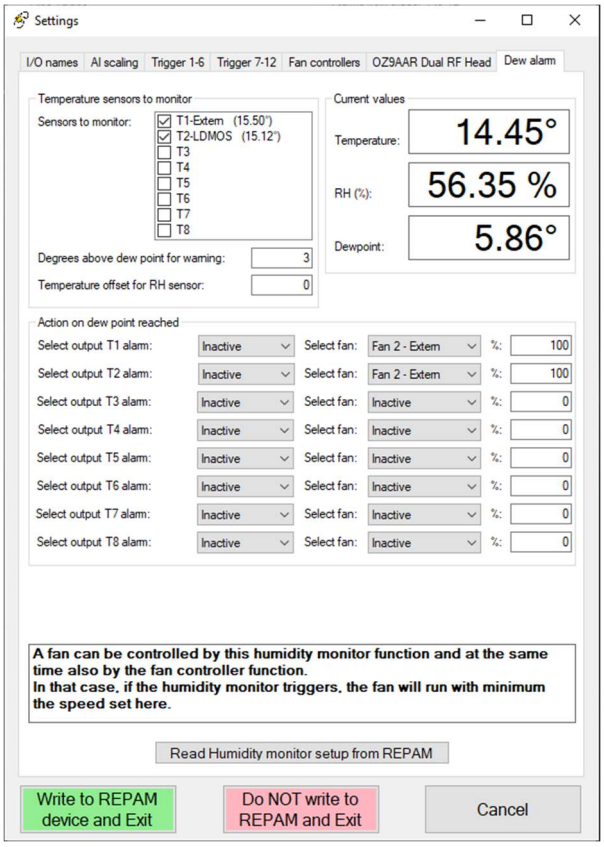
Please notice, if you enter either the “Watt” value or the “dBm” value and press the “use” button next to the entry field you used (Watt or dBm), the value will be converted and copied to “the other field” also. While doing so, the current voltage level for the channel will be copied to the “Voltage min” or “Voltage max” entry fields!

To calibrate:

1. Apply low(est) power to forward port.
2. Enter the power (Watt) in the “Watt entryfield”
3. Press the “use” button to the left of entryfield
4. Apply high(est) power to forward port.
5. Enter the power (Watt) in the “Watt entryfield”
6. Press the “use” button to the left of entryfield

Do the same for the reflected port.
When done, press “Save to device and Exit”.

If you press the “Read Dual RF Head setup from REPAM”, the current values in the connected REPAM will be read and shown in this window.



It is possible to connect a combined humidity/temperature sensor to the REPAM device using the 1-wire interface. This allows the REPAM device to monitor the current dew point temperature and warn/control a relay output for each of the possible eight temperature sensors that can be connected via the 1-wire bus. You specify which sensor should be monitored, which relay to control if a specific sensor comes “too close” to the dew point. “Too close” is specified by the “Degrees above dew point for warning”. This parameter is the number of degrees above the dew point you want to trigger alarm/output. The threshold is the same for all sensors monitored.

The humidity sensor is specially designed and is available from OZ9AAR.

If you press the “Read humidity monitor setup from REPAM”, the current values in the connected REPAM will be read and shown in this window.

PAMonitor application

The PAMonitor application is a small C# project (source code/project is available for download) that shows the normal operating parameters of the REPAM device. The PAMonitor can be the basis for your own application that fits your exact needs. The PAMonitor has been developed around quite a lot of parameters so you can adapt the indicators, warning/error level, texts in alarm indicators etc. to suit your own project. If this does not cover all you need, there is a possibility to modify the code so it will work with your specific installation. As PAMonitor needs a configuration file to be specified, you need to start PAMonitor a bit differently than a "normal" Windows application. When starting the application, you must specify the name of a configuration file (if it does not exist, it will be created), if you don't specify the name of a configuration file, it will create a default one and use that.

PAMonitor has been developed with the assumption that a Dual RF Head is also connected to the REPAM device, measuring forward and reflected power. If this is not the case in your setup, you can modify the PAMonitor accordingly.

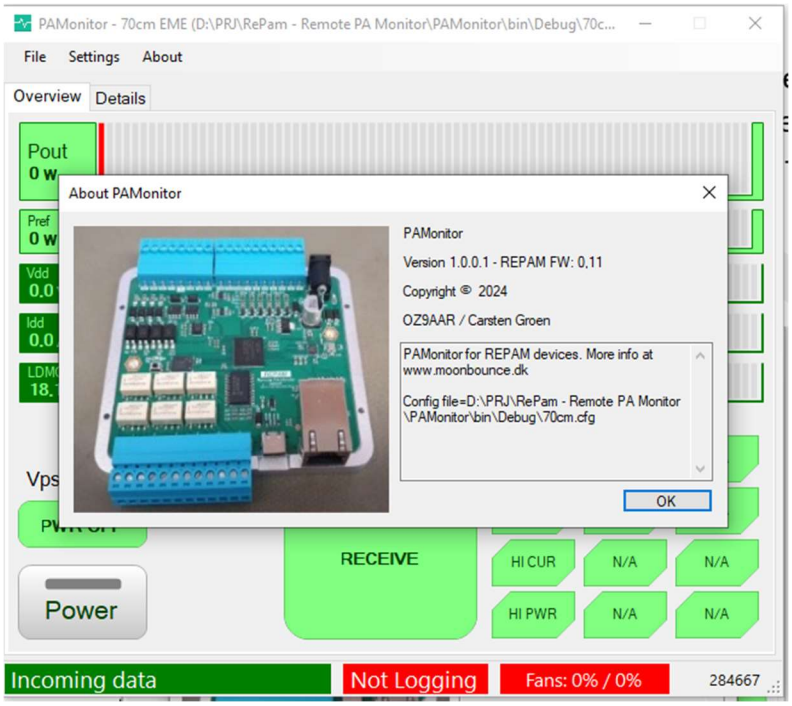
D:\PAMonitor\PAMonitor.exe 70cm.cfg

This will start the PAMonitor and use the 70cm.cfg file in the D:\PAMonitor folder (you can also make a shortcut on the Windows desktop).

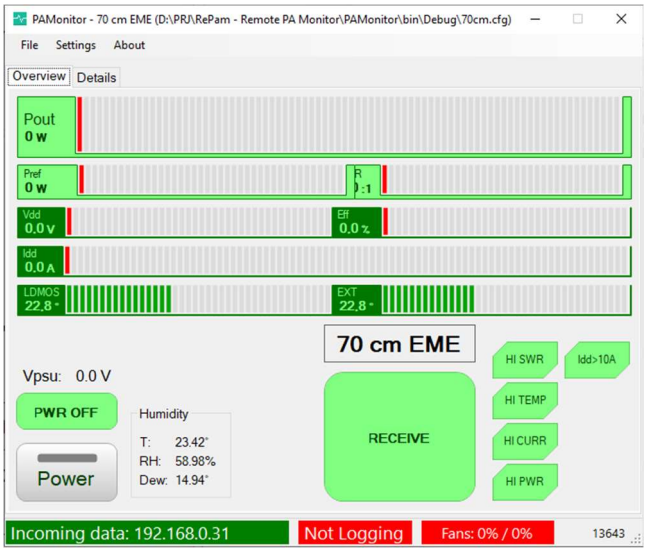
If you just double-click on the exe file, the application will start and create its own default configuration file.

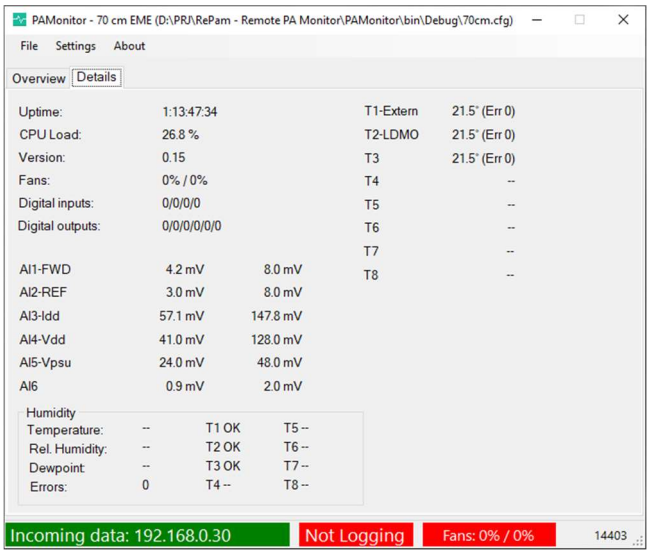
About

The "about dialog" shows the version number (here it is 1.0.0.1) of the PAMonitor program, the firmware version of the currently connected REPAM device (if any), here it is 0.11. The configuration file used by the PAMonitor is also shown in this window (the configuration file that was specified when program was started).



Main screen





The PAMonitor has two main screens, the “Overview” and the “Details” view. The “Overview” page is the default page shown after starting the application. The “Details” view shows the raw values of the different inputs and output of the REPAM device.

The PAMonitor assumes that the “PA overcurrent monitor” module from OZ9AAR controls the power on/off to the PA (it also has built-in overcurrent protection, on/off control etc. Please see www.moonbounce.dk for further information).

The ”Overview” page shows the power measured by the Dual RF Head, it can control the power to the amplifier (using two relay outputs, one for turning on and one for turning off).

The values and texts that are shown as well as which inputs and outputs are being used to control the PA module connected to the REPAM, is configured thru several settings.

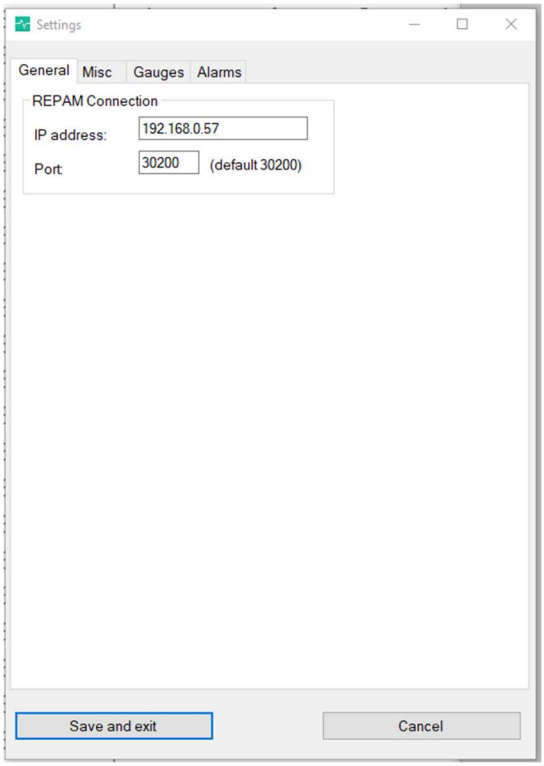
Program settings

There is a rather large number of settings for the PAMonitor. It is important to remember that these settings are local to the program, none of these are written to the connected REPAM device. All configuration of the physical REPAM device is done using the REPAMMonitor application.

The way settings work for the PAMonitor application can be a bit different than “normal” Windows applications. Normally the settings are handled by the Windows operating system, the placement of the configuration file etc.
This is handled differently by PAMonitor. When you start the application, you can specify the name of a configuration file as a parameter to the application (if the configuration file does not already exist, it will be created). This allows you to have multiple REPAM devices, each with their own configuration file when starting PAMonitor. You can even have multiple PAMonitor instances running, each with their own configuration file! The various settings are shown below.

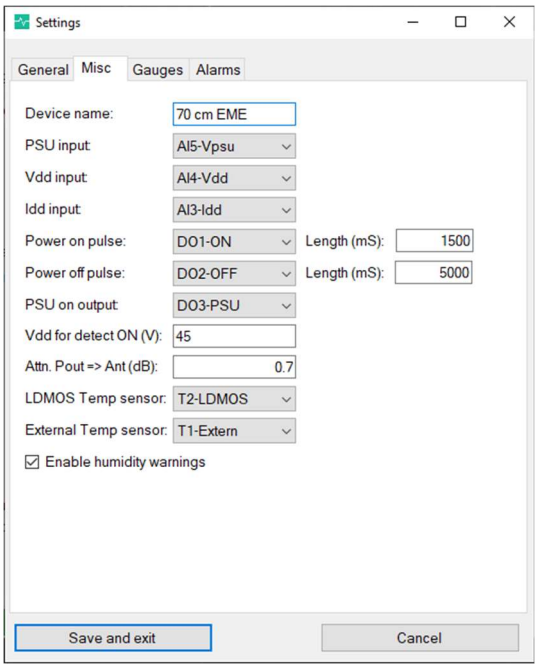
If you only have a single REPAM device and you don't have a need for multiple configurations you can change between, you can just start the application by double clicking on it, in that case it will create a default configuration file with the name of "PAMonitor.cfg" and place it in the same folder as the application itself resides.

General settings



These are the settings used for setting up the communication with the REPAM device. You need to specify the IP and the port number to use when communicating with a REPAM device.

Misc settings

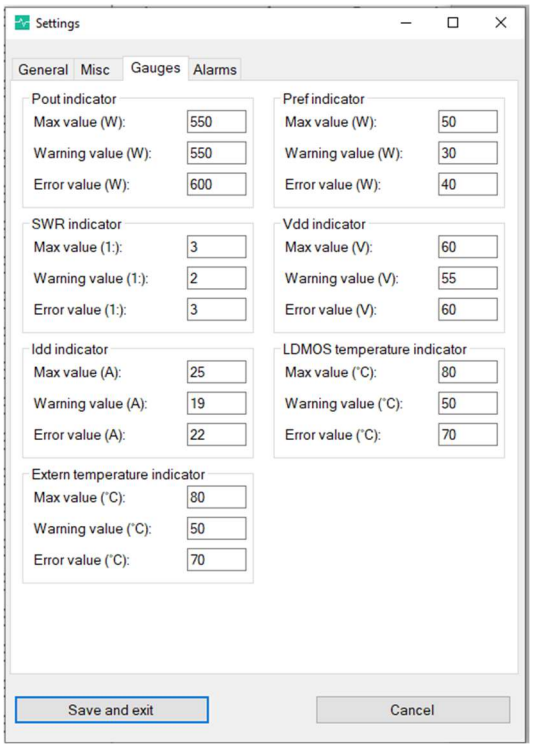


Device name is the name shown on the main window ("70 cm EME" in the example). The PSU, Vdd and Idd input selectors selects which AI input to use for each of these values. Power on and off pulse is the relay outputs to use for switching the amplifier on and off (this assumes you use the "OZ9AAR PA overcurrent protection board, see www.moonbounce.dk). You can also set the pulse lengths on the two relay outputs for "on" and "off", 1500 mS is a good starting point (Resolution is only 250 mS). "PSU on output" can control a relay for the main HV (LDMOS) power supply. This will switch it on/off following the "Power on" button on the main window.

"Vdd for detect ON" is the voltage the Vdd must be at minimum for PAMonitor to consider the PA as "powered on".

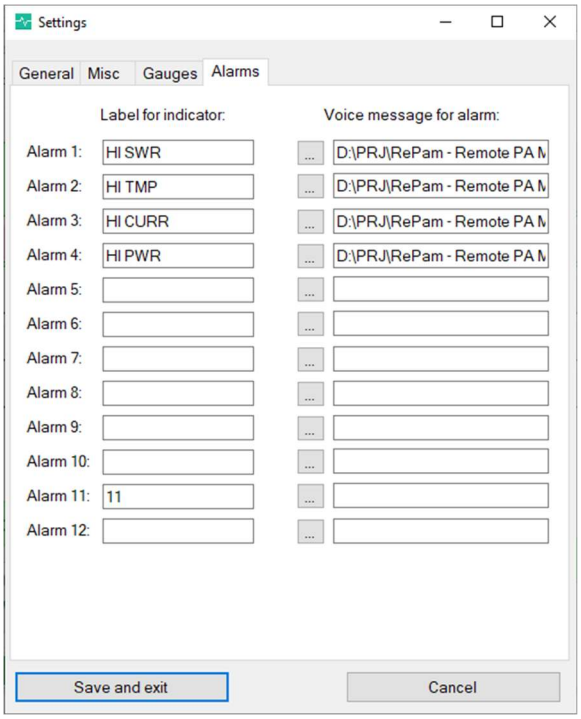
The "Attn Pout=>Ant" is an (optional) attenuation value from the PA output to the feed-point of the antenna. If different than 0, you can click on the Pout indicator on the main page to switch between Pout and Pant. Finally, you define which temperature sensor is monitoring the LDMOS and the external temperature. It is also possible to enable the info from an optional Humidity sensor.

Gauge settings



In this window, you define the maximum value of each indicator on the main window, their warning value (when they turn orange) and their error value (when they turn red).

Alarms



This holds the labels and optional voice message file for the twelve possible alarms. Alarm 1 is the indicator for trigger 1 (if ALARM is selected as “output” or enabled for the trigger), alarm 12 is the output for trigger 12 if ALARM is selected as “output” or enabled and so on.

The ”voice message” is an optional WAV file that will be played if the alarm is triggered. Only standard WAV files are supported.

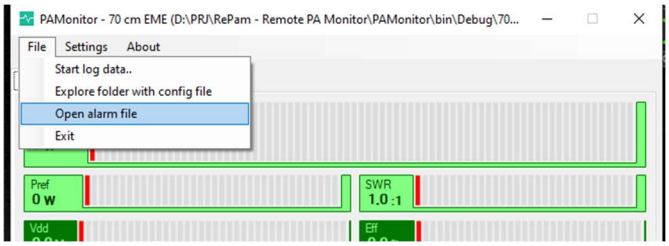
Alarm log

The PAMonitor application will make a log in your “xxx/Documents/REPAM” folder, filename is “alarms.txt”. This is a textfile that will contain a line for each alarm that has occurred. When you acknowledge an alarm, this is also logged in the file

Below is an example, the trigger/alarm was defined for forward power>100W, notice that the values dumped are not when the forward power>100, this is due to the fact that the alarm handling is done directly in the REPAM device, and the different values have not yet been sent to the PAMonitor application, hence the values are a few 10th of seconds “old”.

```
07-07-24 16:16:09.977::Alarm from REPAM device 70 cm EME. Message=HI SWR. Vers=0,11, Vpsu=52.1V, Vdd=52.1V, Idd=1.0A, Eff=0.0%, Fwd=0.0W, Ref=0.0W, SWR=1:1.0, Temp LDMOS=24.2°, Temp Extern=23.9°, Fan 1=0%, Fan 2=0%, State=Transmit
07-07-24 16:17:37.171::Alarm from REPAM device 70 cm EME. Message=HI PWR. Vers=0,11, Vpsu=52.1V, Vdd=52.1V, Idd=6.7A, Eff=25.7%, Fwd=90.2W, Ref=0.4W, SWR=1:1.1, Temp LDMOS=24.2°, Temp Extern=23.8°, Fan 1=0%, Fan 2=0%, State=Transmit
07-07-24 16:31:33.251::Alarm acknowledged for REPAM device 70 cm EME. Alarm was=HI PWR
07-07-24 16:36:22.332::Alarm from REPAM device [70 cm EME]. Message=HI PWR. Vers=0,11, Vpsu=52.1V, Vdd=52.1V, Idd=6.7A, Eff=25.8%, Fwd=90.2W, Ref=0.4W, SWR=1:1.1, Temp LDMOS=24.4°, Temp Extern=23.9°, Fan 1=0%, Fan 2=0%, State=Transmit
07-07-24 16:36:50.709::Alarm from REPAM device [70 cm EME]. Message=HI PWR. Vers=0,11, Vpsu=52.1V, Vdd=52.1V, Idd=6.7A, Eff=25.2%, Fwd=87.6W, Ref=0.4W, SWR=1:1.1, Temp LDMOS=28.4°, Temp Extern=24.0°, Fan 1=70%, Fan 2=70%, State=Transmit
```

Using the menu item “File -> Open alarm file”, the text file with all alarms will be shown in notepad.

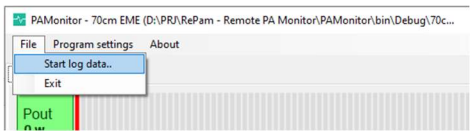


Contents of settings file

Below is an example of the contents of a configuration file.

```
ï»¿<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <userSettings>
    <Roaming>
      <PAMonitor.Properties.Settings>
        <BarWarningLDMOS>50</BarWarningLDMOS>
        <BarErrorLDMOS>70</BarErrorLDMOS>
        <BarMaxVdd>60</BarMaxVdd>
        <Alarm3>HI CUR</Alarm3>
        <VddInput>4</VddInput>
        <IddInput>3</IddInput>
        <BarWarningPref>30</BarWarningPref>
        <PowerOnDO>1</PowerOnDO>
        <BarErrorVdd>60</BarErrorVdd>
        <BarWarningIdd>19</BarWarningIdd>
        <BarWarningPout>550</BarWarningPout>
        <Alarm7>N/A</Alarm7>
        <TempExternInput>1</TempExternInput>
        <PowerOffDO>2</PowerOffDO>
        <Alarm4>HI PWR</Alarm4>
        <TempLDMOSInput>2</TempLDMOSInput>
        <MainLocation>689, 34</MainLocation>
        <BarWarningVdd>55</BarWarningVdd>
        <BarWarningEXT>50</BarWarningEXT>
        <BarMaxLDMOS>80</BarMaxLDMOS>
        <BarErrorEXT>70</BarErrorEXT>
        <BarMaxPout>550</BarMaxPout>
        <Alarm5>N/A</Alarm5>
        <Alarm1>HI SWR</Alarm1>
        <DeviceName>70cm EME</DeviceName>
        <BarMaxSWR>3</BarMaxSWR>
        <MainSize>661, 580</MainSize>
        <BarErrorPout>600</BarErrorPout>
        <Alarm2>HI TMP</Alarm2>
        <BarErrorPref>40</BarErrorPref>
        <Alarm8>N/A</Alarm8>
        <BarWarningSWR>2</BarWarningSWR>
        <Maximized>False</Maximized>
        <BarMaxPref>50</BarMaxPref>
        <Count>123</Count>
        <Minimized>False</Minimized>
        <BarErrorSWR>3</BarErrorSWR>
        <BarMaxEXT>80</BarMaxEXT>
        <BarErrorIdd>22</BarErrorIdd>
        <Alarm6>N/A</Alarm6>
        <Alarm9>N/A</Alarm9>
        <Alarm10>N/A</Alarm10>
        <Alarm11>N/A</Alarm11>
        <Alarm12>N/A</Alarm12>
        <BarMaxIdd>25</BarMaxIdd>
        <AttnPoutPant>1000</AttnPoutPant>
        <REPAMIPPort>30200</REPAMIPPort>
        <REPAMIPAddr>192.168.0.57</REPAMIPAddr>
        <VpsuInput>5</VpsuInput>
      </PAMonitor.Properties.Settings>
    </Roaming>
  </userSettings>
</configuration>
```

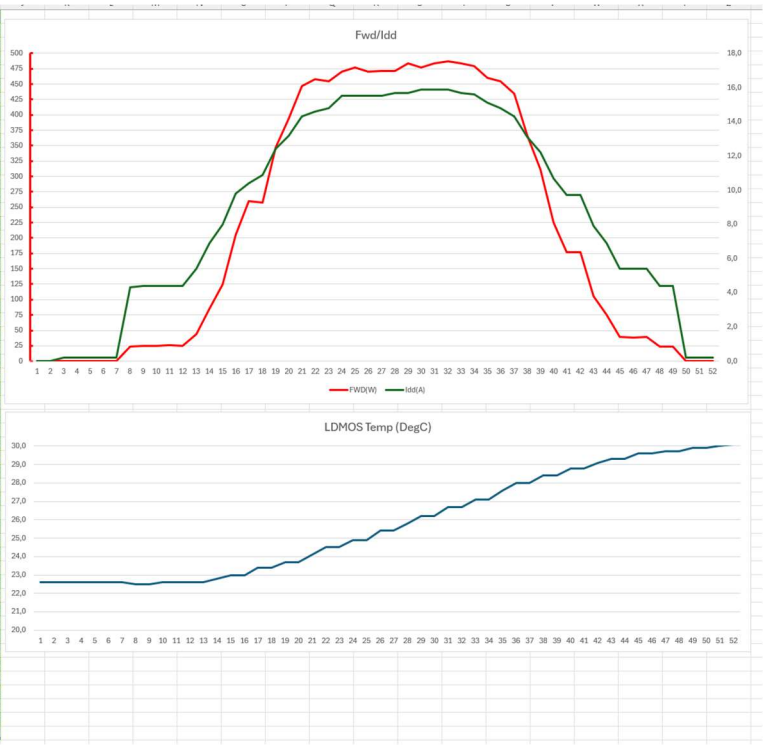
Logging of live data



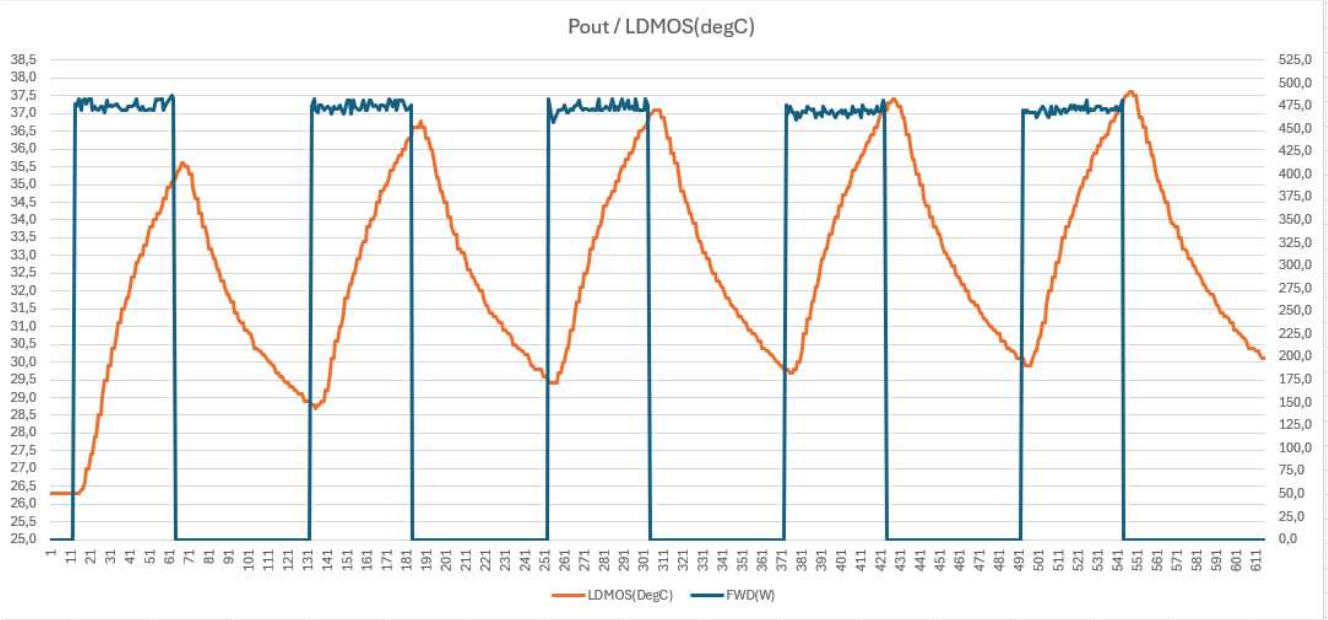
PAMonitor can also log all values from the connected PA module to a CSV file. This allows you to examine all the various parameters, do calculations etc. Some of the possible uses are shown below (CSV file imported into Microsoft Excel).

First example is from a short run of a PA. The top graph shows the forward power (measured by Dual RF Head) and the Idd (LDMOS current). The lower graph shows the LDMOS temperature.

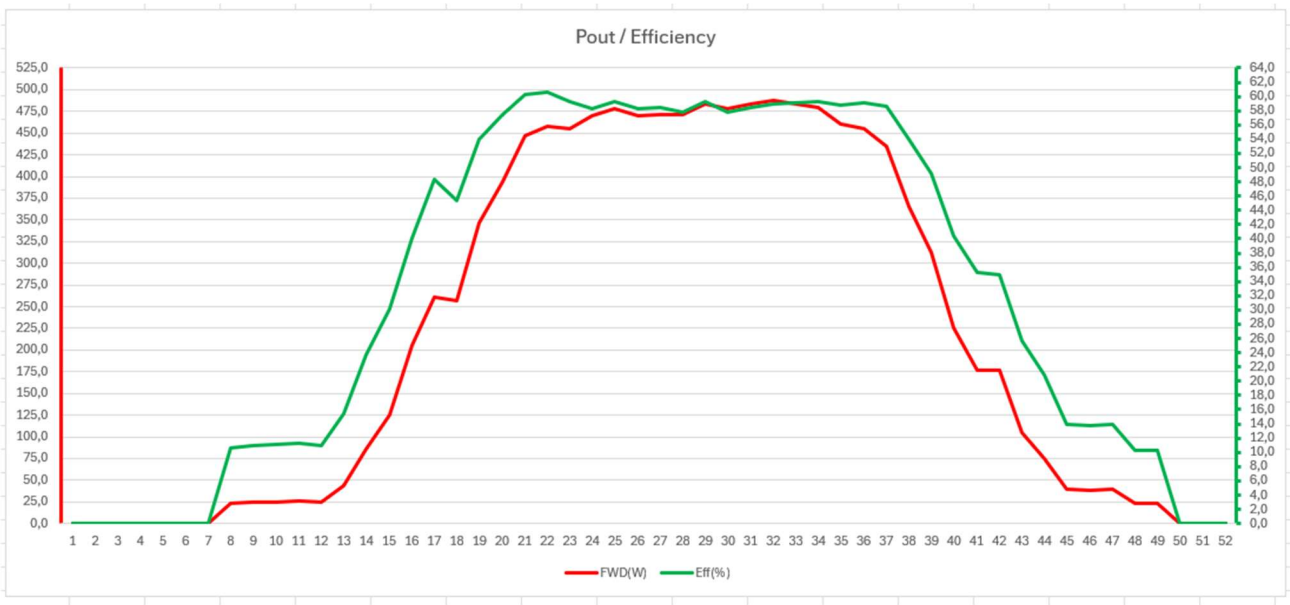
Time	FWD(W)	REF(W)	SWR(1:)	Idd(A)	Vdd(V)	Eff(%)	LDMOS(DegC)	EXT(DegC)
2024-06-23 12.31.57	0,0	0,0	1,0	0,0	0,0	0,0	22,6	22,6
2024-06-23 12.31.58	0,0	0,0	1,0	0,0	0,0	0,0	22,6	22,6
2024-06-23 12.31.59	0,0	0,0	1,0	0,2	52,1	0,0	22,6	22,6
2024-06-23 12.32.00	0,0	0,0	1,0	0,2	52,1	0,0	22,6	22,6
2024-06-23 12.32.01	0,0	0,0	1,0	0,2	52,2	0,0	22,6	22,6
2024-06-23 12.32.02	0,0	0,0	1,0	0,2	52,2	0,0	22,6	22,6
2024-06-23 12.32.03	0,0	0,0	1,0	0,2	52,1	0,0	22,6	22,6
2024-06-23 12.32.04	23,9	0,9	1,5	4,3	52,1	10,7	22,5	22,6
2024-06-23 12.32.05	24,8	0,9	1,5	4,4	52,1	10,9	22,5	22,6
2024-06-23 12.32.06	25,3	0,9	1,5	4,4	52,1	11,1	22,6	22,6
2024-06-23 12.32.07	25,6	0,9	1,5	4,4	52,1	11,2	22,6	22,6
2024-06-23 12.32.08	25,3	0,9	1,5	4,4	52,1	11,0	22,6	22,6
2024-06-23 12.32.09	43,3	1,4	1,4	5,4	52,1	15,4	22,6	22,6
2024-06-23 12.32.10	85,4	2,3	1,4	6,9	52,1	23,7	22,8	22,6
2024-06-23 12.32.11	124,6	3,0	1,4	8,0	52,1	30,1	23,0	22,6
2024-06-23 12.32.12	205,3	4,6	1,4	9,8	52,0	40,1	23,0	22,6
2024-06-23 12.32.13	260,4	5,5	1,3	10,4	52,0	48,3	23,4	22,6
2024-06-23 12.32.14	257,2	5,5	1,3	10,9	52,0	45,3	23,4	22,6
2024-06-23 12.32.15	346,9	6,8	1,3	12,4	52,0	54,0	23,7	22,6
2024-06-23 12.32.16	393,9	7,5	1,3	13,2	52,0	57,5	23,7	22,6
2024-06-23 12.32.17	447,2	8,5	1,3	14,3	52,0	60,3	24,1	22,6
2024-06-23 12.32.18	458,4	8,7	1,3	14,6	52,0	60,6	24,5	22,6
2024-06-23 12.32.19	454,6	8,5	1,3	14,8	52,0	59,3	24,5	22,6
2024-06-23 12.32.20	469,8	9,0	1,3	15,5	51,9	58,3	24,9	22,6
2024-06-23 12.32.21	477,5	8,7	1,3	15,5	51,9	59,3	24,9	22,6
2024-06-23 12.32.22	469,8	8,9	1,3	15,5	51,9	58,3	25,4	22,6
2024-06-23 12.32.23	471,7	8,9	1,3	15,5	52,0	58,5	25,4	22,6
2024-06-23 12.32.24	471,7	8,7	1,3	15,7	51,9	57,8	25,8	22,6
2024-06-23 12.32.25	483,5	8,9	1,3	15,7	51,9	59,2	26,2	22,6
2024-06-23 12.32.26	477,5	8,8	1,3	15,9	51,9	57,8	26,2	22,6
2024-06-23 12.32.27	483,5	8,9	1,3	15,9	51,9	58,5	26,7	22,6
2024-06-23 12.32.28	487,4	8,8	1,3	15,9	51,9	59,0	26,7	22,6
2024-06-23 12.32.29	483,5	8,7	1,3	15,7	51,9	59,1	27,1	22,6
2024-06-23 12.32.30	479,5	8,7	1,3	15,6	51,9	59,3	27,1	22,6
2024-06-23 12.32.31	460,3	8,2	1,3	15,1	52,0	58,8	27,6	22,6
2024-06-23 12.32.32	454,6	8,4	1,3	14,8	52,0	59,1	28,0	22,6
2024-06-23 12.32.33	434,6	7,7	1,3	14,3	52,0	58,6	28,0	22,7
2024-06-23 12.32.34	365,9	6,9	1,3	13,1	52,0	53,9	28,4	22,7
2024-06-23 12.32.35	311,9	6,1	1,3	12,2	52,0	49,1	28,4	22,7
2024-06-23 12.32.36	225,6	4,8	1,3	10,7	52,0	40,4	28,8	22,7
2024-06-23 12.32.37	177,2	3,9	1,3	9,7	52,0	35,2	28,8	22,7
2024-06-23 12.32.38	176,5	3,9	1,4	9,7	52,0	35,0	29,1	22,7
2024-06-23 12.32.39	105,3	2,6	1,4	7,9	52,1	25,6	29,3	22,8
2024-06-23 12.32.40	74,9	2,0	1,4	6,9	52,1	20,9	29,3	22,8
2024-06-23 12.32.41	39,1	1,2	1,4	5,4	52,1	13,9	29,6	22,8
2024-06-23 12.32.42	38,6	1,2	1,4	5,4	52,1	13,7	29,6	22,8
2024-06-23 12.32.43	39,1	1,2	1,4	5,4	52,1	13,9	29,7	22,8
2024-06-23 12.32.44	23,9	0,8	1,5	4,4	52,1	10,3	29,7	22,8
2024-06-23 12.32.45	23,8	0,8	1,5	4,4	52,1	10,3	29,9	22,8
2024-06-23 12.32.46	0,0	0,0	1,0	0,2	52,2	0,0	29,9	22,8
2024-06-23 12.32.47	0,0	0,0	1,0	0,2	52,2	0,0	30,0	22,8
2024-06-23 12.32.48	0,0	0,0	1,0	0,2	52,2	0,0	30,1	22,8



The next graph is a longer run of the PA, this time it was running Q65-60 (1 minute TX, 1 minute RX) as is being used on 70 cm EME. This test was to show the cooling of the system. In the beginning of the test, you see that the rise in temperature is more steep than at the end of the test. This shows that temperature is about to stabilize. Had the test been running for a longer time, one could see if the implemented cooling of the PA was sufficient or not.



Last graph shows the forward power and the efficiency. At full output, around 480 Watt, the efficiency tops around 58 to 59%.



There are of course many other possibilities with the logged data.