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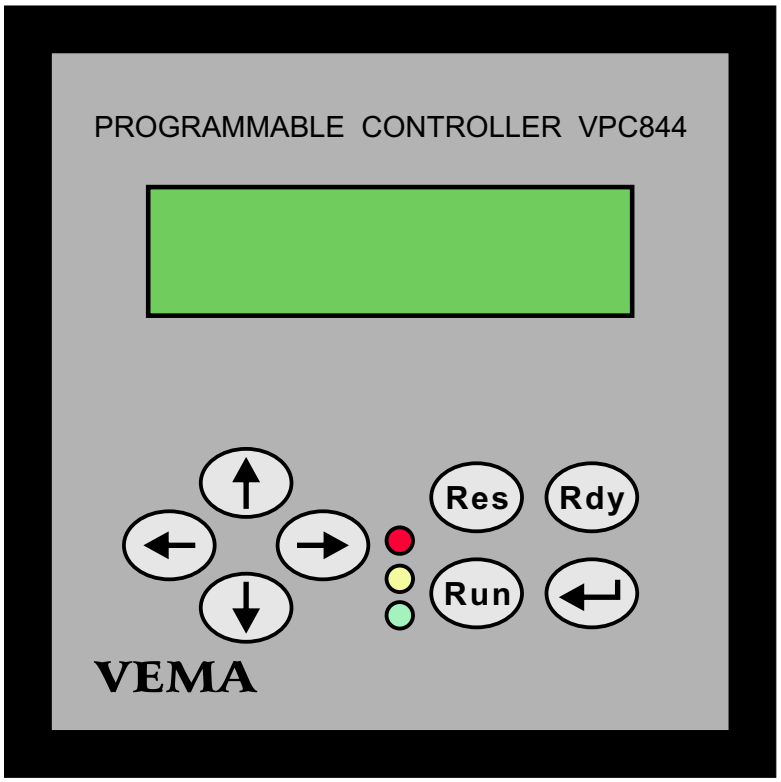
Programmable controller **VPC844** for fire detector test tunnels



USER'S MANUAL

1. Introduction

The microprocessor programmable controllers ***VPC844*** offer optimal comfort of service and visualization of parameters and processes in fire detect test tunnel.

They are designed to control the level of smoke thickness in a fire detect test tunnel in both static and dynamic mode. The smoke level is measured by one frequency and two voltage sensors, and controlled by one of the discrete outputs. ***VPC844*** controller has analog input for measuring the temperature in the tunnel via thermistor *Pt100*.

Output signal for smoke level control is transistor open collector. There are three more output of the same type: "airing" (optoisolated), "blinding" and "alarm"(optoisolated).

Technological data of the fire detect test tunnel are displayed on four screens in Monitoring mode, including the level of smoke thickness, temperature, responses from fire detectors, as long as some of the inner parameters of the controller in PARAMETERS mode.

The parameters of ***VPC844*** can be accessed and changed by the inbuilt keyboard. Pressing (↵) will invoke the PARAMETERS mode of the controller, and using the arrow keys any parameter can be chosen by the display cursor. Pressing (↵) again will put the cursor in the position of changing the value of the selected parameter by the means of the arrow keys.

The controller has a RS232 unit to provide connection to a PC and allow for a more sophisticated proceeding of the fire test tunnel data. There is a special communication protocol which specifies the way the controller constantly sends out the values of the parameters of the smoke tunnel. Thus computer systems and applications can be developed for collecting all this data, and proceed with archiving and displaying it.

2. Technical specifications

2.1. Inputs:	
- 00-07 discrete	0-24 V/20 mA
- AI0, AI1, AI2 analog with variable	0-5 V
amplification coefficient	Ko=1 to 6
AI0, AI1 only	programmable offset
- AI3 analog for Pt100 thermistor	-15 to 250 °C
- HFC counting input	0-5 V / 55000 Hz
2.2. Outputs:	
- O1 "alarm" opto-isolator open collector	0-30V / 20 mA
- O2 "airing" opto-isolator open collector	0-30V / 20 mA
- Ra "blinding" open collector	0-30V / 20 mA
- Rb "control" open collector	0-30V / 20 mA
2.3. Indication:	
- inner and technological parameters	2x16 LCD
- "smoke", "alarm" and "ramping"	light diodes
2.4. Parameters:	
- technological	10 items
- feedback	4 items
- bias	10 items
- inner	10 items
2.5.Communication interface to PC	RS 232C
2.6. Keyboard-	8 keys, membrane
2.7. Power supply	187- 242 V/48-62 Hz
2.8. Size	96x96x135 mm
2.9. Ambient temperature	0 to 50 °C.

3. Keyboard and Indication

VPC844 controller is equipped with two-line LCD indication for displaying the values and mnemonics of the parameters and data of the fire detect test tunnel and the controller itself.

Three light diodes indicate the following processes:
"smoke" - red diode,
"alarm" - yellow diode,
"dynamic mode"(ramping) - green diode.

Controller's keyboard has eight keys: four arrows and the buttons: (↵), (Res), (Rdy) and (Run) . The user can navigate through four screens in Monitoring mode using the arrow keys. In PARAMETERS mode all parameters can be accessed and changed using the (↵) button. (Res) button restarts the controller and sets it in Monitoring mode. (Rdy) button serves for picking clear reference levels in Screen 1 in Monitoring mode. (Run) button starts a new control procedure of the controller, according to the current parameters.

4. Controller modes and basic parameters

VPC844 controller can work in two modes: Monitoring and PARAMETERS. Monitoring mode serves for checking the value of the fire detect test tunnel parameters in four screens. User must choose which input signal pair - <HFC, AI1> or <AI0, AI1> - will define the data on the screens, using the parameter Mf (see. PARAMETERS of the Controller). Thus the following parameters will be defined:

- frequency f, measured by the HFC input;
- voltage ú, measured by analog input AI0;
- voltage ü, measured by analog input AI1;
- Xu=U1/ú,
- Y=U2/ü,
- Xf=F/f,
- m=(10/d)log(Xf) or m=(10/d)log(Xu) , depending on which input is chosen for the control (HFC or AI0),

where U1, U2, F, d are parameters of the controller defining respectively clear reference level for ú, clear reference level for ü, clear reference level for f and distance between the sender and receiver of the optical system.

Monitoring mode will be set anytime the controller is restarted by powerup or by (Res) button. Switching to Monitoring mode from PARAMETERS mode is also possible by pressing and holding the (↵) button.

The PARAMETERS mode gives access to all parameters of the controller needed to set up the profile, control and view of measured data. Pressing (↵) will enter the Monitoring mode and the display will read:

Parameters:
Sy=1.000 My= off

(↵) button ----->

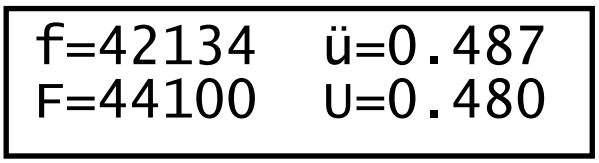
Sy=1.000 My= off
Sm=0.300 Mm= dyn

All 36 parameters are placed on 18 lines, by two per line. The blinking cursor can be used to navigate to the mnemonics of the desired parameter. Pressing (↵) again will move the cursor onto the value of the selected parameter and it can be modified by the arrow keys. The arrow keys are multi-speed and, when held down, the value can be changed more rapidly. The new value of the parameter will be saved and set by pressing the (↵) button once more, and the cursor will move back to the mnemonics.

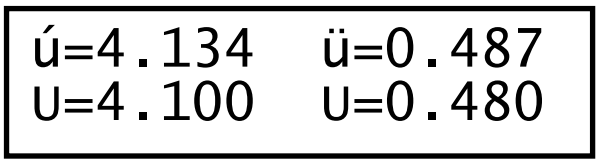
5. Display screens of the controller in Monitoring mode

In Monitoring mode, the controller constantly reads the status of the fire detector test tunnel and displays the data over four different screens. On initial startup, the first screen is viewed. Navigation to the other three and vice versa is performed by using the corresponding arrow buttons:

5.1.Screen 1. "Preliminary readings in clear environment to get reference levels"



when HFC and AI1 are selected, [parameter Mf=on]

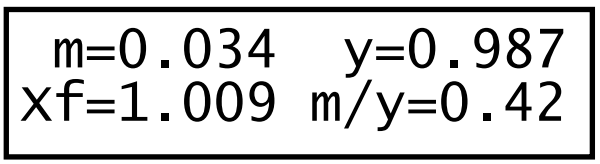


when AI0 and AI1 are selected, [parameter Mf=off]

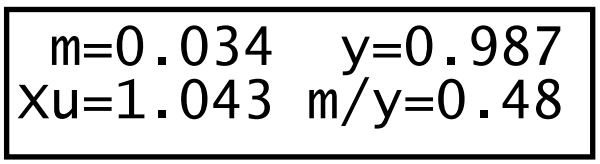
This is the first screen of the controller on powerup. First line will indicate the current values of the selected pair of control inputs - counting HFC (f in Hz) or voltage input AI0 (ú in Volts), and the second voltage input AI1 (ü in Volts). The second line will show the corresponding reference levels for the inputs (parameters U1, U2 and F). This screen can be used by the user to select new reference levels. Pressing the (Rdy) button will copy the current measured values of the inputs to the reference levels U1, U2 (or F, U2). These parameters can be modified further in PARAMETERS mode, if needed.

This screen will be view when the controller is reset by pressing the (Res) button.

5.2.Screen 2. 'Current readings of *m*, *y*, and *Xf* (*Xu*)"



when HFC and AI1 are selected, [parameter Mf=on]

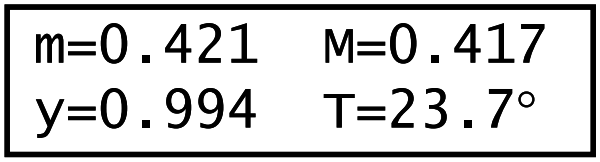


when AI0 and AI1 are selected, [parameter Mf=off]

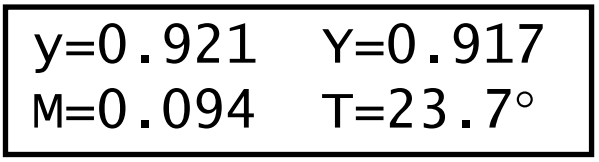
This screen serves to display the current values of the variables m, y, Xu, Xf, defined according to the following formulas:

Xu=U1/ú, y=U2/ü, Xf=F/f, where f, ú and ü are the values of the inputs HFC, AI0, AI1, and m=(10/d)log(Xf) or m=(10/d)log(Xu) depending on the control input (HFC or AI0). The parameter d denotes the distance between the sender and the receiver of the optical system.

5.3.Screen 3. "Monitoring control values"



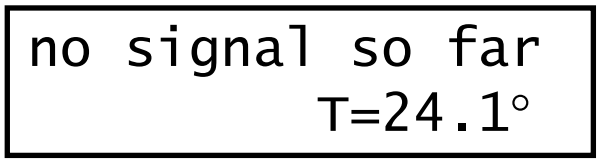
when control on HFC/A I0, [Mm=sta/dyn]



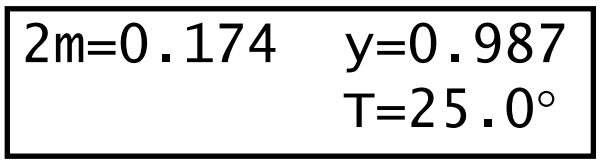
when control on A I1, [My=sta/dyn]

The first line of this screen indicates the current measured value and the set value of the controlled variable (*m* or *y* according to the Mm and My parameters). The set value will be indicated only during the control procedure, e.g. after pressing the (Run) button and the initial preliminary time passed. Outside the actual control procedure and during the preliminary state, the set value will be indicated as "-.---'. The second line will display the current value of the non-controlled variable and the current temperature in the tunnel. When no thermistor is connected to AI3, the display will read "T (off)".

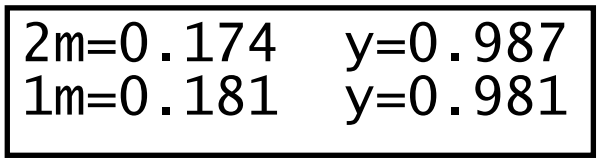
5.4.Screen 4. 'Captured readings of *m* and *y* on response by the digital inputs"



, no response from the detectors so far since the last reset of the controller by (Res) button



only one detector has responded (on input 2). The controller jumps automatically to this screen to display the captured readings of m and y



more than one detector responded (second and first in this case) and the last two captured readings of m and y are displayed

This screen indicates the values of *m* and *y* on each response from the inputs, i.e. each time a tested detector in the tunnel has responded. The number of the responded line will be indicated as a first digit on the display line. The controller will jump to this screen on each response (if it is in Monitoring mode). The captured readings are displayed in successive order, but only the last two (at most) will be viewed on the screen. After the No -th response the controller will wait To seconds, then stop the control routine and set the "airing"output to take the smoke out of the tunnel.

6. Parameters of the controller and their range

Sy - set value (or ramp endpoint) of *y* *(0.000 -5.000)*

My - type of control on *y*:
{off} the control is not on *y* variable;
{sta} static control on *y* (set value will be Sy),
{dyn} ramping on *y* (from the current value to Sy for dy per minute).

Sm - set value (or ramp endpoint) of *m* *(0.000 -5.000)*

Mm - type of control on *m*:
{off} the control is not on *m* variable;
{sta} static control on *m* (set value will be Sm),
{dyn} ramping on *m* (from the current value to Sm for dm per minute).

dy - acceleration rate per minute for ramping on *y* *(0.000 -5.000)*

Mf - defines which pair of control inputs will be used for the control variables:
{off} AI0 and AI1;
{on} HFC and AI1.

dm - acceleration rate per minute for ramping on *m* *(0.000 -5.000)*

MD - defines the type of "blinding":
{off} no "blinding (same on reset ot startup of the controller);
{bli} blinking mode of "blinding" according to Pu and Pd;
{on} "blinding" constantly on until MD change .

Pu - time in seconds for "blinding" on (only if MD=bli) *(00.0 -99.9)*

Pd - time in seconds for "blinding" off (only if MD=bli) *(00.0 -99.9)*

U1 - reference level for analog input AI0 *(0.000 -5.000)*

Nd - time in seconds to integrate the control variables *(2 -10)*

U2 - reference level for analog input AI1 *(0.000 -5.000)*

No - number of responses by the tested detector before "waiting before airing" and the actual airing *(2 -10)*

F - reference level for counting input HFC *(0-55000)*

RC - type of remote control on RS232C:
{off} no remote control, only data is sent out on RS232C by the controller;
{on} full remote control on RS232C.

Kp - proportional PID feedback coefficient *(00.0-99.9)*

Td - differential PID feedback constant in seconds *(00.0-99.9)*

Ti - integral PID feedback constant in seconds *(000-999)*

rt - preliminary time before control starts (in seconds) *(00.0-99.9)*
after pressing (Run) the controller will output only the bias value ri for rt seconds. After that the green diode will light up to indicate start of the actual control

ri - initial value of output bias in percent *(00.0-99.9)*

rd - acceleration rate of output bias in percent per minute *(00.0-99.9)*

Tc - cycle time for PWM in seconds (Hw=0) *(00.1-25.0)*
The control of output "smoke" is defined by parameter Hw. If it is 00.0, then the way of control will be PWM with period Tc. When Hw>0, then the way of control is FM with impulse of ON-length Hw and period according to the output value of the control unit. In this case, the minimal period (maximal smoke thickness) will be Hq and maximal period (hysteresis of smoke) will be Hs.

Hw - width of the ON state of the impulse in seconds (when FM) *(00.0-99.9)*

Hq - minimal period for FM (Hw>0) *(00.0-99.9)*

Hs - maximal period for FM (Hw>0) *(00.0-99.9)*

d - distance between the sender and the receiver of the optical system *(0.00-2.50)*

Al - alarm band, if controlled variable deviates more than Al from the set value the yellow diode will light up *(0-999)*

V1 - programmable reference voltage subtracted from the signal before ADC reading on analog input AI0 *(0.000 -5.000)*

Dv - ADC linear correction value in thousandths *(0 -250),* default *100*

V2 - programmable reference voltage subtracted from the signal before ADC reading on analog input AI1 *(0.000 -5.000)*

To - time to wait in seconds before "airing" after the No-th response on digital inputs *(00.0 -99.9)*

fc - frequency correction of the quartz resonator *(0 -5000),* default *4320*
the resonator frequency must be (18.000.000+100xfc) Hz

Mp - direction of control:
{nor} normal, smoke rises with increasing of the control impulse length;
{rev} reverse, smoke rises with decreasing of the control impulse length.

7. RS232C data protocol

VPC844 controller constantly sends out on the RS232 interface port data for the main variables of the fire detector test tunnel. Data is sent 9600 bps, 8 bits, 1 stop-bit, no parity check. Each 100 ms a packet of 4 bytes is sent out, where the fourth byte always is the checksum (XOR) of the previous three, in order to guarantee the data integrity:

packet=<Byte1, Byte2, Byte3, Byte4>, Byte4:=Byte1⊕Byte2⊕Byte3

There are 12 different data packets with number of each data packet (Byte3-127). After the 12 packets, the controller sends out two control packets with Byte3=117, so the total of 14 packets is sent in cyclic order:

```
<(m*1000) mod 256, (m*1000) div 256, 128, Control Byte>
<(y*1000) mod 256, (y*1000) div 256, 129, Control Byte>
<(SP*1000) mod 256, (SP*1000) div 256, 130, Control Byte>
<(t*10+150) mod 256, (t*10+150) div 256, 131, Control Byte>
<f mod 256, f div 256, 132, Control Byte>
<F mod 256, F div 256, 133, Control Byte>
<(AI0*1000) mod 256, (AI0*1000) div 256, 134, Control Byte>
<(AI1*1000) mod 256, (AI1*1000) div 256, 135, Control Byte>
<(U1*1000) mod 256, (U1*1000) div 256, 136, Control Byte>
<(U2*1000) mod 256, (U2*1000) div 256, 137, Control Byte>
<[x,x,x,dyn,prg,pid,ramp,wait], X, 138, Control Byte>
<[in8,in7,in6,in5,in4,in3,in2,in1], X, 139, Control Byte>

<23, 176, 117, Control Byte=210>
<23, 176, 117, Control Byte=210>
```

with following explanation of the symbols:

`mod` and `div` denote the arithmetic operations modulo and division;
`SP` is the set value;
`t` is the temperature in the tunnel, rounded to tenths of degree;
`X/x` denote arbitrary byte/bit;
`dyn` indicates if the controller is in ramping mode (1 - ramping, 0 -static);
`prg` indicates if the controller is in PARAMETERS mode;
`pid` indicates that `(Run)` is pressed and a new control routine is requested;
`ramp` indicates that `(Run)` is pressed and the set value is ramped, but the endpoint is not reached yet;
`wait` indicates that the controller still waits to start the actual control routine and the preliminary time `rt` has not passed yet.

A normal smoke control operation should send the flags in the following order:
`dyn=1, pid=0, ramp=0, wait=1` - initial startup or manual reset
`pid=1, ramp=1, wait=1` - `(Run)` is pressed and preliminary time `rt` running
`pid=1, ramp=1, wait=0` - actual control on ramp started
`pid=1, ramp=0, wait=0` - end of ramping and waiting for reset.

8. Mechanical connection and mounting

The controller is assigned for mounting on facet panels of electrical units. The slot for mounting should have a square shape of (92+0.6)x(92+0.6) mm. To secure the controller on the panel, use the attaching screws.

The connector pin attachment of the controller is pictured on its rear panel. The connecting wires must be isolated and of minimal cross section of 0.35 to 0.75 mm^2. The following figure explains the proper way of connecting: