AHVPS714-40-MV-PCB
14kV/40mA High Voltage Power Supply for Electrostatic Air Cleaner
Specifications and Operating Manual

1. Overview

The 14kVDC/40mA HV power supply is an OEM product and comes without AC power ON/OFF controls and safety interlocks. It is system integrator responsibility to assure that all national, state and local electrical safety codes are followed.

1.1 Principle of operation

The block diagram of HV Power Supply is shown in Fig. 1

The HV Power supply has built in universal input, power factor corrected AC/DC power converter, which produces 450VDC for the resonant DC/DC HV power converter. The Resonant Power Converter drives the HV step up transformer, which delivers up to 1.5kV RMS to the HV multiplier. The 4 stage HV multiplier produces up to 14kVDC at the output (Ionizer) and 7kVDC at the output of second stage (collector).

This PS has capabilities to deliver up to 40mA DC current at 10KVDC or 33mA at 12KVDC (400W) to12 X 24" Linear cells.

The resonant power converter is over voltage, over current, overpower protected including continuous output short circuit condition.

Operating HV and output current limit are set manually however Intelligent Controller has the capability to perform the following functions:

1. Monitors internal ambient temperature and turns HV converter off if temperature is outside operating limits.
2. Monitors HV and output current
3. Maintain the best performance and minimize load cell arcing
4. Reports HV converter status using LED Lamps and optional serial messages on RS-485 port or Modbus.
   Operating HV, Current, Temperature, number of hours of operation, error codes can be monitored on optional RS-485 output or Modus output terminals.

Additional HV and current can be monitored on scaled down analog output.

I Monitor – 100mV per 1mA

V monitor – 100mV per 1KV

5. Keeps track of operating hours
6. Connect to Remote LED diagnostic PCB.

Status LED functionality and simplified flowchart are shown in Appendix A.

2.0 The HVPS has 3 distinct modes of operation:

Voltage Source Mode
Current Source Mode
Burn-in Mode

The HV and Current adjust potentiometers are located on the PCB.
The Burn-in mode is invoked by the pushbutton momentary switch located on PCB or 2 terminals for remote.

2.1 Voltage source Mode

In Voltage Source Mode the HVPS maintains the preset voltage while current is determined by the load. As long as current does not exceed the max limit of 40mA the HVPS will maintain the preset HV.
Voltage mode example settings: The HV was set to 12kV and current limit was set to the maximum value of 33mA. After connecting the clean load cell, the HVPS was operating at 12kV with current floating around 33mA. With the same settings and dirty load cell connected, the HVPS was still operating at 12kV, but the load current dropped to 30mA.

2.2 Current Source Mode

In Current Source Mode the HVPS maintains the preset current while voltage is determined by the load. If output voltage does not exceed the max limit of 14kV the HVPS will maintain the preset current.

Current Mode example settings. The current limit was set to 33mA and HV to 14kV. After connecting the clean load cell, the HVPS was operating at 33mA current and HV floating around 12kV. With the same settings and dirty load cell connected, the HVPS was operating with 33mA current, but HV increased to 12.5kV to maintain 33mA current.

2.3 Burns-In Mode.

In normal operation the HVPS is exposed to occasional overload conditions caused by arcing in the load cells. The HVPS monitors the rate and duration of overload conditions and shut down if overload condition persists.

New load cells may be contaminated with remnants of machining process and may cause excessively high rate of arcing for first few hours of operation which may cause the HVPS to shut down prematurely. To prevent this unnecessary shutdown the Burn In mode was introduced.

When Burn In mode is activated (by pressing the Burn In ON/OFF switch), the HVPS will not shut down in response to persistent overload condition for 3 hours period.
In Burn-In mode the protection algorithm, which monitors rate and duration of overloads and shuts down the HVPS if overload persists is suspended for 3 hours.
The Burn In mode can be terminated before 3-hour timer expires by pressing the Burn In ON/OFF switch.
During Burn In cycle the display alternates between standard Voltage and Current readings and Burn In cycle message.

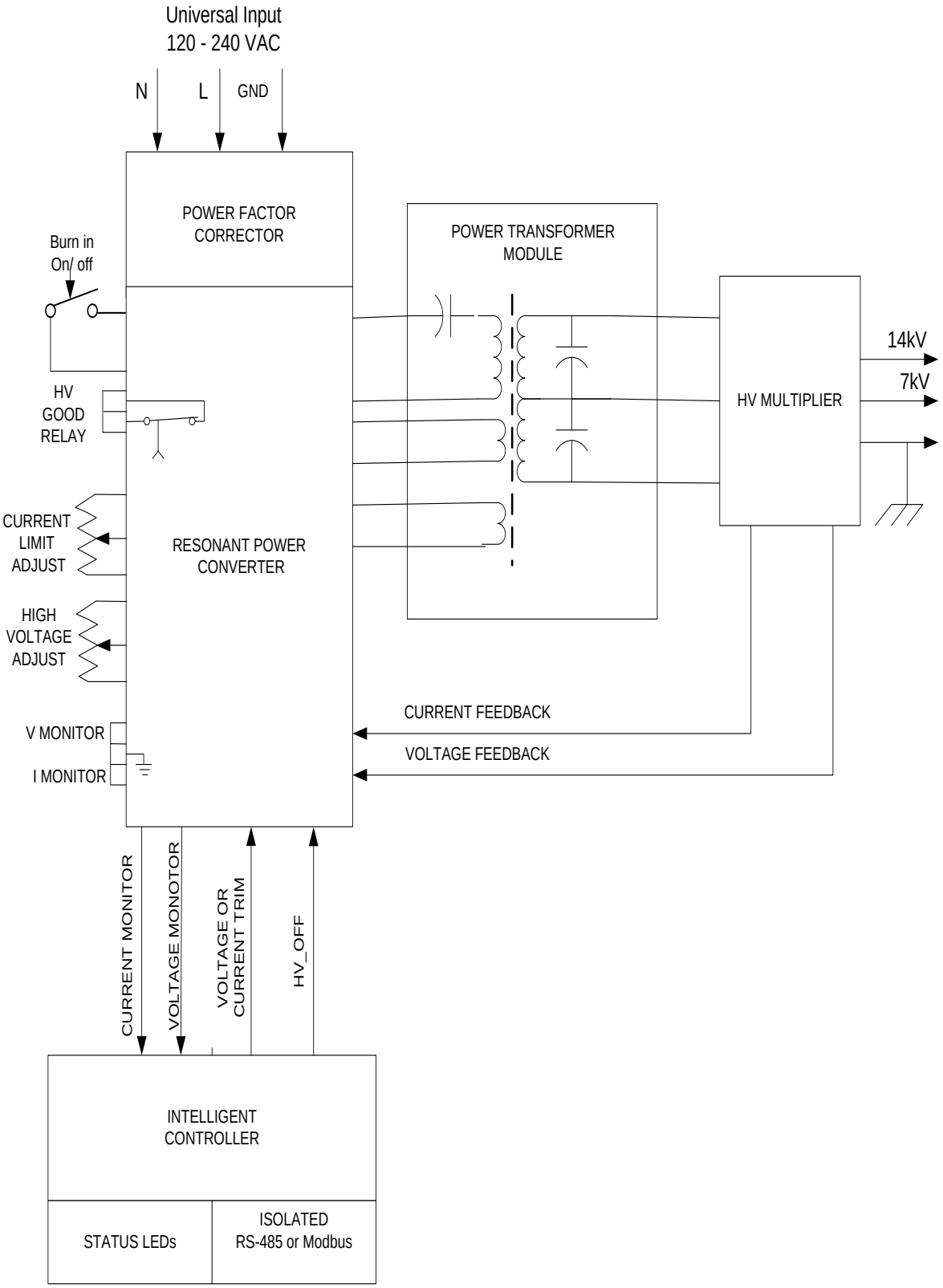

Fig.1 HV Power Supply Block Diagram

3.0 Installation and safety

The HV Power Supply must be mounted indoors, protected from weather Elements, in a location easily accessible by operating service personnel.

The HV Power Supply is equipped with universal input; power factor corrected (PFC) AC/DC power supply and can operate from 120VAC or 240VAC power lines.
The maximum current draw is 4 Amp from 120 VAC line and 2.0 Amp from 240VAC line. Use these numbers to select proper wire gage as per applicable standards.

The connection diagram of HV Power Supply is shown in Fig.2 All connections are made to terminals on the Main Board.

The HV Multiplier has two outputs:

Ionizing Voltage – Labeled as 14kVDC
Collector Voltage – Labeled as 7kVDC

The HV and current adjustment trim pots and status LEDs are located at the edge of the Main Board as well as AC power input, HV Good Relay and RS-485 serial port.

4.0 Field wiring connections

These instructions are for qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than contained in the instructions unless you are qualified to do so. All wiring must be installed according to national, state and local codes.

The HV Power Supply requires the following field connections:

1. AC line connection including safety GND (J10, highlighted in green)
2. HV Connection (7kV and 14kV terminal studs, highlighted in red)
3. HV Good Relay contacts (J1, highlighted in green)
4. RS-485 / Modbus communication port (J12, highlighted in green)
5. HV GND and AC GND (corner mounting screws to carrier plate)

5. Start - up

WARNING!!! HIGH VOLTAGE - RISK OF ELECTRIC SHOCK

Check load cells specifications and number of cells connected before adjusting the HV and current limits. Instructions below are to operate the HV Power supply in Voltage Source Mode. Consult factory if Current Source Mode is preferred.

1. Turn the HV Adjust trim pot to the minimum (fully CCW position) and Current Limit trim pot to the maximum (Fully CW position)
2. Turn AC power on.

   WARNING HV comes on as soon as AC power is applied.

   Power On LED (Green) and HV On LED (Yellow) should turn On.
   Fault LED (red) should stay Off. If Fault LED, comes on follow instruction in Service/troubleshooting manual.
3. Adjust slowly HV by turning the trim pot clockwise until HV Good LED (Blue) turns On and output current reaches required value.

Output current adjustment is based on the type and number of load cells connected to the HV supply. Typical settings are 1mA per cubic foot of load cell.

To facilitate installation and initial adjustment The HV and load current can be monitored on PC running any ASCII data terminal or Lab View application.

This concludes powering up/adjusting the HV power supply.

Air cleaner 14 kV HV power supply
Connections, indicators and controls

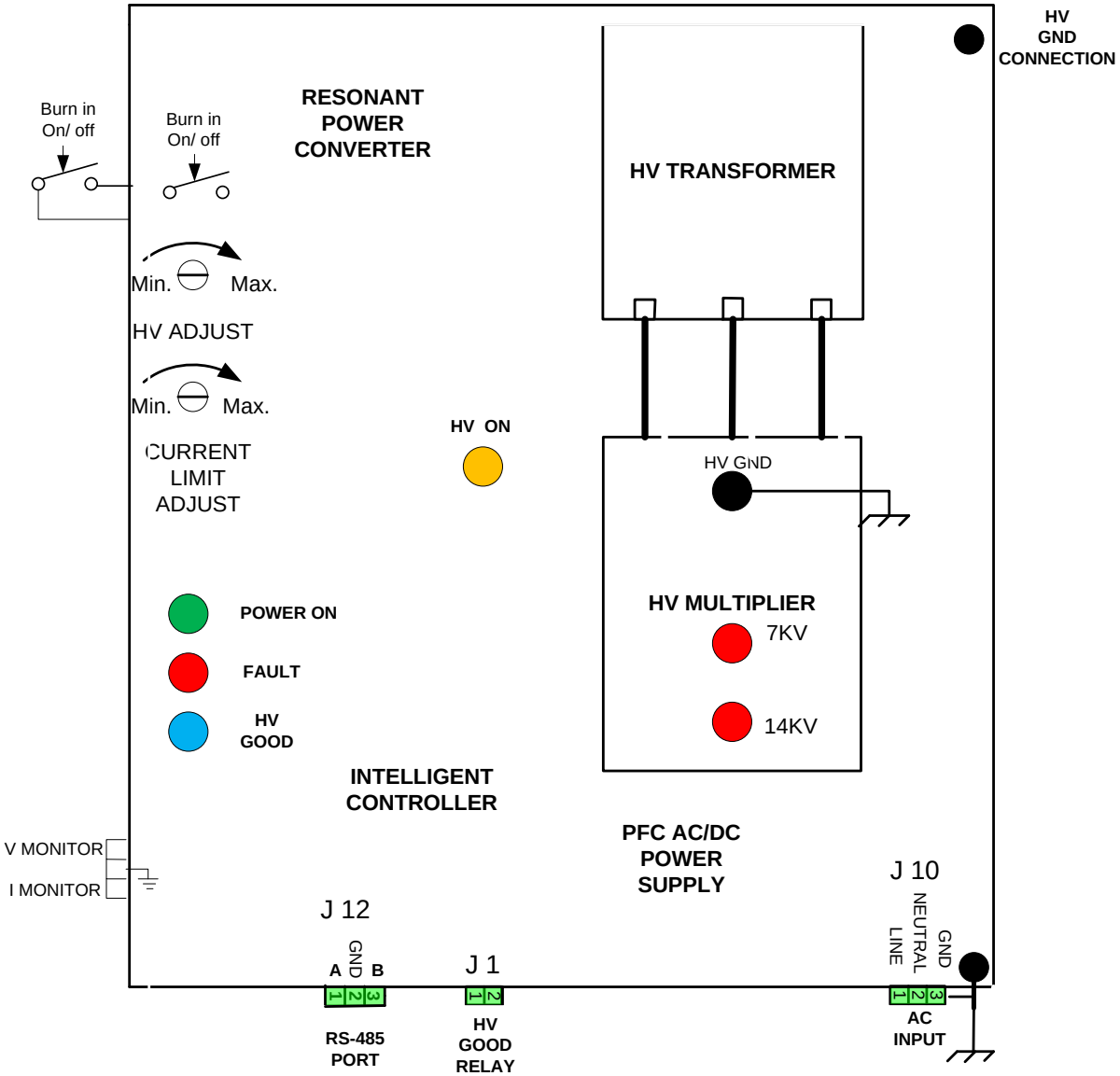

Fig.2 Connections, Indicators and Controls

6. Specifications

1. **Power Input:**

   a. Voltage: Universal voltage input 120 – 240VAC

   b. Current: 4A @ 120VAC, 2 Amp at 240VAC

   c. Frequency: 50/60HZ

   d. Power: < 500W

   e. Power Factor : > 0.90

   f. Operating efficiency: 82% typical

2. **HV Output:**

   a. Voltage: IONIZER adjustable 7.0 to 14.0 kV DC
   COLLECTOR adjustable 3.5 to 7.0kV DC

   b. Current: 40mA max at 10kV or 33mA at max 12KVDC
   Current limit adjustable 1mA to 40mA

3. **Temperature:**

   Operating: 0 to 50 deg C

   Storage: -40 to +80 deg C

4. **Overload/Fault protection**

   a. Automatic shut down when load current exceeds 33mA load at 12KVDC.

   Automatic and soft restart when overload condition is removed.

   b. Fast control loop (Fast Clamp) keeps the output below 15kV when HV load is disconnected and when main regulation loop fails.

   c. Voltage and Current Faults

   d. The recovery from fault condition caused by voltage or current outside the operating window is monitored and timed by two fault counters - Fault Counter 1 and Fault Counter 2. Refer to protection flow chart.

   e. When voltage or current fault happens, unit restarts automatically after 2 sec delay and displays error message. The internal Fault Counter 1 is incremented. After 10

restarts, HV shuts down for 1 min, Fault Counter # 2 is incremented, and Fault Counter # 1 is cleared.

This process may repeat 3 times (until Fault Counter 2 content exceeds 3) and then the HV is turned off permanently.

So, the unit allows 5 x 10 = 30 faults with 2 sec recovery time after each fault and additional 1 min recovery after every 10 faults.

With persisting voltage and/or current type faults it will take ~ 4min before unit shuts down permanently.

To restart the unit from the permanent shutdown condition input AC power must be recycled.

Temperature Fault

Recovery process from over temperature condition is not using Fault Timers. When internal temperature exceeds +60C unit turns HV Off waits until temperature drops below +60C and restarts. Unit will not start if internal temperature is above +60C

7.0 Intelligent Controller

Microcontroller based, comprising status LED and optional communication port

- Monitors output current, HV and temperature.
- Monitors internal ambient temperature and shuts down the HV when temperature is outside operating limits
- Counts hours of operation
- Optional Isolated RS-485 or Modbus port outputs Voltage, Current, Temperature, Hours of operation, Faults alerts.
- Custom protocol using Lab View Application or standard ASCII characters output to be used with Hyper Terminal or similar serial terminal software.

The simplified flowchart, Status LEDs functionality and serial protocol details are shown in the Appendix A.

Safety features

- HV ON warning LED
- Dry contacts to signal HV GOOD (contacts closed when HV within operating window)

8.0 Connectivity

a. Inputs:

120V to 240VAC, Live and Neutral on terminal strip, Earth Ground, #6 Lug on chassis

b. OUTPUTS:

- Ionizer Voltage, Collector Voltage - # 10 Lugs on # 10 studs.
- High Voltage Return - #6 Lug on chassis
- 250VAC/10Amp dry contacts to indicate HV GOOD condition
- Isolated RS-485 or Modbus port

c. INDICATORS: On Controller PCB and remote PCB

LED Blue Indicator: HV Good (for remote LED terminal)

LED Green Indicator: Input Power On

LED Yellow Indicator: HV ON

LED RED Indicator: FAULTS

The complete functionality of LED indicators and Relay output logic is shown in Appendix A, Table 1

9.0 Mechanical Specifications

All PCB electrical & components must be mounted in custom metal enclosure with fan on one side and ventilation levers on other side to create air circulations inside the box.

The PS PCB must be mounted in the enclosure with min of 2” distance from metal surface on all sides.

Proposed enclosure dimensions 12” W x 15” L x 6” H

Proposed PCB’s will be mounted on Aluminum plate dimensions

11.30” W x 13” L x 0.125” thickness

10.0 Agency Approvals

rUL, or ETL, optional

11.0 Manufacturer's Marking:

P/N, Date code, serial #

Appendix A

#	System Status	BLUE LED - HV Good,	GREEN LED - AC Supply is ON	RED LED FAULT	YELLOW LED HV ON	Relay - Dry Contact NO
1	System Good	ON	ON	OFF	ON	ON - dry contact closed
2	Temp fault	OFF	ON	ON	OFF	OFF - dry contact open
3	Overload fault	OFF	ON	2 Flashes & pause	ON	OFF - dry contact open
4	Over voltage fault	OFF	ON	3 Flashes & pause	OFF	OFF - dry contact open
5	System shutdown for 10min due to Continues arcing below 10KV.	OFF	ON	Flashes continuously	OFF	OFF - dry contact open

Table1. LED Indicators and Relay output logic

RS-485 Serial port protocol or Modbus protocol

RS-485 / Modbus is available on J12 terminal block

J12-1 RS-485 NON_INV (A)

J12-2 GND

J12-3 RS-485 INV (B)

Data Format.

Voltage [kVx10]	Current [mAx10]	Temp [C]	Hrs. of operation	Fault
142	**66**	**32**	**300**	**0**

Fault codes:

0	**No Fault**
1	**Over voltage**
2	**Over current**
3	**Overload (arcing)**
4	**Temperature too high**
5	**HV ON/OFF fault**