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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) contains the current wiring schematics for IMPROVE sampling and controller modules. IMPROVE samplers are constructed at the University of California at Davis by Air Quality Group personnel. There are several type of modules in use.

- **Satellite Sampling Module**: These modules require a separate signal from a controller to start and stop sampling. There are two variations of the satellite module: PM$_{2.5}$ and PM$_{10}$. These are identical except the PM$_{2.5}$ module has a fine inlet and a cyclone, while the PM$_{10}$ module has either a Sierra or Wedding PM$_{10}$ inlet.

- **Independent Controller Module (IC)**: These non-sampling modules control multiple satellite sampling modules. There are several versions with minor variations. One major variation is the addition of a lock-out circuit to prevent a second sample collected without an intervening sample change.

- **Single Independent Module (SIM)**: This sampling module includes the clock controller in the sampling module. It cannot control satellite sampling modules.

- **SIM-Controller (SC)**: This sampling module includes the clock controller in the sampling module, plus the relays to control satellite sampling modules. This module is now used in place of the independent controller module.

The various configurations of the controller modules are listed in Table 1.

### Table 1 Controller Module Configurations.

<table>
<thead>
<tr>
<th>Code</th>
<th>Voltage</th>
<th>Pump Relay Location</th>
<th>Pump Outlet Location</th>
<th>Thermostat and Position</th>
<th>Lock-out Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1</td>
<td>24V</td>
<td>external</td>
<td>box in pump house</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>IC1L</td>
<td>24V</td>
<td>external</td>
<td>box in pump house</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>IC2</td>
<td>110V</td>
<td>internal</td>
<td>box on module</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>IC2L</td>
<td>110V</td>
<td>internal</td>
<td>box on module</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>IC3</td>
<td>24V</td>
<td>internal</td>
<td>box on module</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>IC3L</td>
<td>24V</td>
<td>internal</td>
<td>box on module</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIM1</td>
<td>24V</td>
<td>none</td>
<td>1 on module</td>
<td>under</td>
<td>no</td>
</tr>
<tr>
<td>SIM2</td>
<td>24V</td>
<td>none</td>
<td>1 on module</td>
<td>on</td>
<td>no</td>
</tr>
<tr>
<td>SIM2L</td>
<td>24V</td>
<td>none</td>
<td>1 on module</td>
<td>on</td>
<td>yes</td>
</tr>
<tr>
<td>SC1</td>
<td>24V</td>
<td>external</td>
<td>box on module</td>
<td>on</td>
<td>no</td>
</tr>
<tr>
<td>SC1L</td>
<td>24V</td>
<td>external</td>
<td>box on module</td>
<td>on</td>
<td>yes</td>
</tr>
</tbody>
</table>

**IC** Independent Controller non-sampling, controls satellite sampling modules  
**SIM** Single Independent Module sampling, self-controlling only  
**SC** SIM-Controller sampling, controls self and satellite sampling modules  

thermostat and position:  
under: under the heater panel with relays  
on: on the heater panel
2.0 RESPONSIBILITIES

2.1 Field Specialist
The field specialist shall:
• Maintain accurate wiring schematics for existing aerosol samplers.
• Maintain records of which wiring schematic is in use at each sampling site.

2.2 Technician
The technician shall:
• Review wiring schematics prior to maintenance or troubleshooting procedures

3.0 REQUIRED EQUIPMENT AND MATERIALS
None
4.0 METHODS

The wiring schematics for each of the configurations in the IMPROVE network are listed in the following sections.

4.1 Satellite Sampling Module Wiring Schematic
4.2 Single Independent Module (SIM) Wiring Schematics
4.3 Single Independent Module (SIM) Wiring Schematics
4.4 Independent Controller Module Wiring Schematics

4.1 Satellite Sampling Module Wiring Schematic

All Satellite Sampling Modules, whether PM$_{2.5}$ or PM$_{10}$, follow the wiring schematic of Figure 1. The procedures for attaching additional satellite Sampling modules follows.

1. Install the additional Satellite Sampling module on the sampler support structure next to a functioning Satellite Sampling module.
2. Cut a length of insulated six wire cable sufficient to reach from terminal strip position 6 of the functioning Satellite Sampling module to terminal position six of the newly installed Satellite Sampling Module.
3. Turn off the power to the sampler. For an IMPROVE controller, remove the fuse in the lower right hand side of the module.
4. Disconnect the gray six wire cable from the controller module at the terminal strip in the functioning Satellite Sampling Module.
5. Remove the panduit connectors, and strip the ends of the six wires in the gray cable from the functioning Satellite Sampling Module if necessary.
6. Strip the ends of the six wires in the new section of cable.
7. Connect wires having the same color from the two cables by inserting them into a single female panduit and crimping them in position. This connection is termed a “double panduit”. Check to ensure neither wire is loose.
8. Install the double panduit connections on the terminal strip, following the color code listed in Figure 1.
9. Install female panduit on the six wires at the free end of the new cable, crimping the panduit in place firmly and checking to verify the wire will not pull out of the panduit.
10. Install the panduit on the free end of the six wire cable on the terminal strip of the new Satellite Sampling Module, following the color code listed in Figure 1.
**Figure 1** Satellite Sampling Module Wiring Schematics

**WIRE IDENTIFICATION:**

- **R** = RED - filter 1 signal (24 VAC)
- **O** = ORANGE - filter 2 signal (24 VAC)
- **G** = GREEN - filter 3 signal (not used)
- **B** = BLUE - filter 4 signal (not used)
- **Bk** = BLACK - 24 VAC hot
- **W** = WHITE - 24 VAC common
- **Y** = YELLOW - 24 VAC common
- **Gy** = GREY - elapsed timers (24 VAC)

**TERMINAL STRIP GUIDE:**

<table>
<thead>
<tr>
<th>pos</th>
<th>WIRES ON LEFT</th>
<th>WIRES ON RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R from switch</td>
<td>R from cable</td>
</tr>
<tr>
<td>2</td>
<td>R from switch</td>
<td>R from cable</td>
</tr>
<tr>
<td>3</td>
<td>O from switch</td>
<td>O from cable</td>
</tr>
<tr>
<td>4</td>
<td>none</td>
<td>G from cable</td>
</tr>
<tr>
<td>5</td>
<td>none</td>
<td>B from cable</td>
</tr>
<tr>
<td>6</td>
<td>none</td>
<td>Bk from cable</td>
</tr>
<tr>
<td>7</td>
<td>Y from switch</td>
<td>W from cable</td>
</tr>
<tr>
<td>8</td>
<td>Gy from timer 1</td>
<td>R from solenoid 1</td>
</tr>
<tr>
<td>9</td>
<td>Gy from timer 2</td>
<td>R from solenoid 2</td>
</tr>
<tr>
<td>10</td>
<td>R from switch</td>
<td>R from solenoid 1</td>
</tr>
<tr>
<td>11</td>
<td>Gy from timer 1</td>
<td>O from switch</td>
</tr>
<tr>
<td>12</td>
<td>Gy from timer 2</td>
<td>R from solenoid 2</td>
</tr>
<tr>
<td></td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
4.2 SIM wiring schematics

The schematics for the three versions of the SIM sampler are shown in Figures 2-4.

Figure 2  SIM1 SIM Version 1 Wiring Schematic
Figure 3  SIM1L SIM Version 1 with Lock-Out Relay Wiring Schematic
Figure 4  SIM2 SIM Version 2 Wiring Schematic
4.3 SIM-Controller wiring schematics

The schematics for the two versions of the SIM-Controller sampler are shown in Figures 5-6. The wiring schematic for the pump relay box is shown in Figure 7.

Figure 5 SC1 SIM Controller Module Version 1 Wiring
Figure 6 SC1L SIM Controller Module Version 1 with Lock-Out Relay Wiring Schematic
Figure 7  Pump Delay Relay for SIM-Controller Wiring Schematic

- RELAY D: 24 second delay on
- RELAY C: 16 second delay on
- RELAY B: 8 second delay on

Wiring Schematic:

- Red (A)
- Blue (D)
- Green (C)
- Yellow (B)
- White (common)
- 16 gauge black (always hot)
- 18 gauge black
- 16 gauge black (always hot)
- Ground

Table:

- Air Quality - Improve
- Pump Delay Relay Box Circuit
- CROCKER NUCLEAR LABORATORY
- UNIVERSITY OF CALIFORNIA - DAVIS
- 16 gauge black (always hot)
- 18 gauge black
- White (common)
- 16 gauge black (always hot)
- Ground

Technical Information Document TI 101C: Sampler Wiring Diagrams
4.4 Independent Controller Module Wiring Schematics

The six variations on the Independent Controller Module are visually similar, following the style shown in Figure 8. Electrical schematics for the two version 1 modules are shown in Figures 9-10. Wiring schematics for the various different Independent Controller Module versions follow in Figures 11 through 14. Note that for all Independent Controller Modules, positions 2A through 2F are identical to positions 1A through 1F respectively. 1A is connected to 2A, 1B is connected to 2B, etc.

Figure 8  Independent Controller Module Diagram
Figure 9  IC1 Independent Controller Version 1 Electrical Schematic

110 V POWER

GRASSLIN digi 128
7 DAY TIME CLOCK

THERMAL
SWITCH (85° F)

THERMAL
SWITCH (20° F)

110V

24V

30 MIN BYPASS TIMER

TC-1

TC-2

TC-3

TC-4

CR-1

CR-2

CR-3

CR-4

CR-8

CR-9

CR-10

CR-11

CR-12

CR-13

TO FILTER MODULES

TO RELAYS IN PUMP HOUSE

FILTERS 1 & 2 OF
MODULES A, B, C, & D

110 V POWER

GRASSLIN digi 128
7 DAY TIME CLOCK

THERMAL
SWITCH (85° F)

THERMAL
SWITCH (20° F)

110V

24V

30 MIN BYPASS TIMER

TC-1

TC-2

TC-3

TC-4

CR-1

CR-2

CR-3

CR-4

CR-8

CR-9

CR-10

CR-11

CR-12

CR-13

TO FILTER MODULES

TO RELAYS IN PUMP HOUSE

FILTERS 1 & 2 OF
MODULES A, B, C, & D

110 V POWER

GRASSLIN digi 128
7 DAY TIME CLOCK

THERMAL
SWITCH (85° F)

THERMAL
SWITCH (20° F)

110V

24V

30 MIN BYPASS TIMER

TC-1

TC-2

TC-3

TC-4

CR-1

CR-2

CR-3

CR-4

CR-8

CR-9

CR-10

CR-11

CR-12

CR-13

TO FILTER MODULES

TO RELAYS IN PUMP HOUSE

FILTERS 1 & 2 OF
MODULES A, B, C, & D

AIR QUALITY GROUP - IMPROVE

CROCKER NUCLEAR LABORATORY
UNIVERSITY OF CALIFORNIA-DAVIS

DRAWN

CHECKED

DRAWN

 CHECKED

02/23/96

C76-NPS-2362
Figure 10  IC1L  Independent Controller Version 1 with Lock-Out Relay Electrical Schematic
Figure 11  IC1  Independent Controller Version 1 Wiring Schematic

[Diagram of wiring schematic with labels and connections for GRAY SIX WIRE CABLE TO SLAVE MODULES and TO CONTACTOR BOX RELAYS IN PUMP HOUSE]
Figure 12 IC1L Independent Controller Version 1 with Lock-Out Relay Wiring Schematic
Figure 13  IC2 Independent Controller Version 2 Wiring Schematic

SWITCHED POWER FOR PUMPS

GRAY SIX WIRE CABLE TO SLAVE MODULES

Technical Information Document TI 101C: Sampler Wiring Diagrams
Figure 14  IC3 Independent Controller Version 3 Wiring Schematic

[Diagram of wiring schematic with various components and labels such as Clock Controller, Transformer, Time Delay, 24 V Relay, 24 V Relay, Gray Six Wire Cable, Switched Power For Pumps, and Ground.]