

KAESER

INSTRUCTION MANUAL

KAD SERIES

MODELS	RATED FLOW	MODEL REFERENCE
KAD 40	40 SCFM	40
KAD 60	60 SCFM	60
KAD 90	90 SCFM	90
KAD 115	115 SCFM	115
KAD 165	165 SCFM	165
KAD 260	260 SCFM	260
KAD 370	370 SCFM	370
KAD 450	450 SCFM	450
KAD 590	590 SCFM	590
KAD 750	750 SCFM	750
KAD 930	930 SCFM	930
KAD 1130	1130 SCFM	1130
KAD 1350	1350 SCFM	1350
KAD 1550	1550 SCFM	1550
KAD 2100	2100 SCFM	2100
KAD 3000	3000 SCFM	3000
KAD 4100	4100 SCFM	4100
KAD 5400	5400 SCFM	5400



PRESSURE-SWING

DESICCANT TYPE

COMPRESSED

AIR DRYERS

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1. GENERAL SAFETY INFORMATION

1.1 Pressurized Devices

- This equipment is a pressure-containing device.
- Do not exceed maximum operating pressure as shown on the equipment serial number tag.
- Verify that equipment is fully de-pressurized before performing service or maintenance functions.

1.2 Electrical:

- This equipment requires electricity to operate.
- Install equipment in compliance with national and local electrical codes.
- Standard equipment is supplied with NEMA 4,4X electrical enclosures and is not intended for installation in hazardous environments.
- Disconnect power supply to equipment when performing any electrical service work.

1.3 Breathing Air:

- Air treated by this equipment may not be suitable for breathing without further purification.
- Refer to OSHA standard 1910.134 for the requirements for breathing quality air.

1.4 Noise:

CAUTION: Do not operate dryer without mufflers installed.

1.5 High Velocity Air:

CAUTION: Do not stand near mufflers during tower depressurization.

2. RECEIVING, MOVING, UNPACKING

2.1 Receiving:

- This shipment has been thoroughly checked, packed and inspected before leaving our plant.
- It was received in good condition by the carrier and was so acknowledged.
- Check for visible loss or damage. If this shipment shows evidence of loss or damage at time of delivery to you, insist that the carrier's agent make a notation of this loss or damage on the delivery receipt.

2.2 Moving:

CAUTION: Use lifting lugs or forklift. Do not lift equipment by piping.

2.3 Unpacking:

- Check for concealed loss or damage. When a shipment has been delivered to you in apparent good order, but concealed damage is found upon unpacking, notify the carrier immediately and insist that his agent inspects the shipment.
- Fifteen days from receipt of shipment is the maximum time limit for requesting such inspection.
- Concealed damage claims are not our responsibility as our terms are F.O.B. point of shipment.

3. DESCRIPTION

3.1 Dryer Function

- Dual tower regenerative desiccant dryers are an economical and reliable way to dry compressed air to dew points below the freezing point of water (dew points as low as -100°F (-73.3°C) [0.2 ppmV @ 100 psig, 6.9 barg] are possible) or reduce the moisture content of compressed air when used in critical process applications.
- These dryers continuously dry compressed air by using two identical towers, each containing a desiccant bed. While one tower is on-stream drying, the other tower is off-stream being regenerated (reactivated, i.e., dried out). The towers are alternated on- and off-stream so that dry desiccant is always in contact with the wet compressed air. In this way a continuous supply of dry air downstream of the dryer is possible.
- Desiccant dryers lower the dew point of compressed air by adsorbing the water vapor present in the compressed air onto the surface of the desiccant. Desiccant is a highly porous solid containing extensive surface area.
- Adsorption occurs until the partial pressure of the water vapor in the air and that on the surface of the desiccant come into equilibrium. As adsorption occurs, heat is released (referred to as the heat of adsorption) and is stored in the bed for use during regeneration.
- Desiccant is regenerated by driving off (desorbing) the water collected on its surface. Pressure-swing (also called heatless or heater-less because no outside heat is added) dryers regenerate by expanding a portion (approximately 14 -15% at 100 psig, 6.9 barg) of the dried air to atmospheric pressure. This "swing in pressure" causes the expanded air to become very dry (have a very low vapor pressure). This very dry air (called purge air) plus the stored heat of adsorption allows the moisture to desorb from the desiccant. The purge air then carries the desorbed water out of the dryer.

3.2 Automatic Purge Saving System

Featured with the Level 2 Controller, the Automatic Purge Saving System is designed to save energy (purge air) when pressure-swing dryers are operated at reduced loads.

The Purge Saving System operates by monitoring the changes in temperature within the desiccant beds. These changes in temperature are the result of heat (thermal energy) that is released when a bed is on-line drying (heat of adsorption), and the heat that is used when a bed is off-line being regenerated (heat of desorption). The magnitude of these changes in temperature is an indirect measure of the water vapor content in the air being dried. This information is used to determine the time a tower stays on line during the drying cycle.

3.3 Description of Operation – Dryer

3.3.1 Models 40 to 3000 w/ Shuttle Valve

(Refer to Fig. 3-1a.) Compressed air flows through inlet shuttle valve (3) to tower (4A) where the air is dried. After the air is dried it flows through outlet shuttle valve (5) and then to the dryer outlet. A portion of the dry air, the purge stream, branches off from the main air stream prior to the outlet. The purge stream flow rate is controlled by the adjustable purge rate valve (6) and the two purge orifices (7).

The purge flow, which has been throttled to near atmospheric pressure, is directed to tower (4B). As the purge flow passes over the desiccant in tower (4B), it removes the water vapor, which was deposited there while the tower was on-line drying. The purge air then passes through purge and repressurization valve (9B) (normally closed) and purge muffler (10B) to the atmosphere.

After regeneration, purge and repressurization valve (9B) (normally closed) closes allowing tower (4B) to repressurize slowly. Adequate repressurization time is allowed so that tower (4B) is fully repressurized before tower switchover. After a controlled time period, purge and repressurization valve (9A) (normally closed) then opens. This causes the inlet and outlet shuttle valves to shift, directing the air flow through tower (4B).

(Refer to Fig. 3-1b.) Tower (4B) is now drying the main air stream while tower (4A) is being regenerated by the purge air stream. The operation of the purge and repressurization (normally closed) valves is sequenced by the control system located in the electrical enclosure.

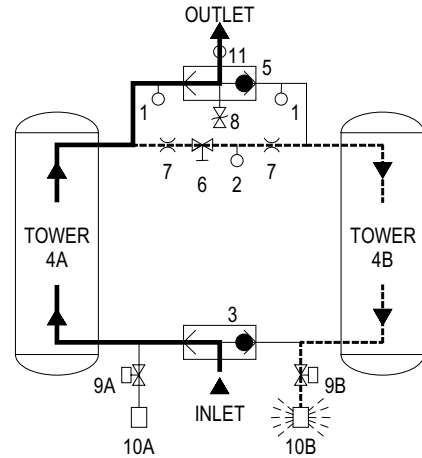


FIGURE 3-1a
TOWER 4A DRYING
TOWER 4B REGENERATING

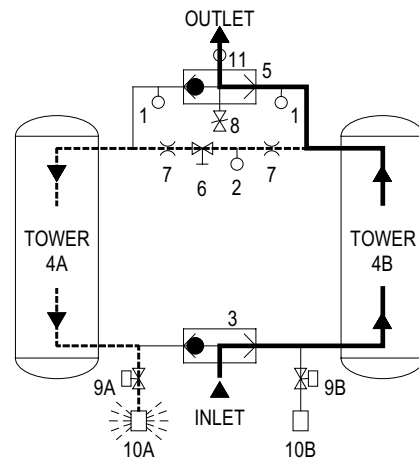


FIGURE 3-1b
TOWER 4A REGENERATING
TOWER 4B DRYING

- | | |
|--------------------------------|--------------------------------------|
| 1. Tower Pressure Gauges | 8. Safety Valve |
| 2. Purge Pressure Gauge | 9. Purge and Repressurization Valves |
| 3. Inlet Shuttle Valve | 10. Purge Mufflers |
| 4. Desiccant Drying Towers | 11. Moisture Indicator |
| 5. Outlet Shuttle Valve | A Left Tower Suffix |
| 6. Adjustable Purge Rate Valve | B Right Tower Suffix |
| 7. Purge Orifices | |

Process Stream —————
Purge Stream - - - - -

3.3.2 Models 4100 to 5400 w/ Check Valves

(Refer to Fig. 3-2a.) Compressed air flows through inlet switching valve (3A) (normally open) to tower (4A) where the air is dried. After the air is dried it flows through outlet check valve (5A) and then to the dryer outlet. A portion of the dry air, the purge stream, branches off from the main air stream prior to the outlet. The purge stream flow rate is controlled by the adjustable purge rate valve (6) and the single purge orifice (7).

The purge flow, which has been throttled to near atmospheric pressure, is directed through purge check valve (5D) to tower (4B). As the purge flow passes over the desiccant in tower (4B), it removes the water vapor which was deposited while the tower was on-line drying. The purge air then passes through purge and repressurization valve (9B) (normally closed) and purge muffler (10B) to the atmosphere.

After regeneration, purge and repressurization valve (9B) (normally closed) closes allowing tower (4B) to re-pressurize slowly. Adequate repressurization time is allowed so that tower (4B) is fully re-pressurized before switchover. After a controlled time period, air inlet switching valve (3B) (normally open) opens and inlet-switching valve (3A) (normally open) closes, purge and repressurization valve (9A) (normally closed) then opens.

(Refer to Fig. 3-2b.) Tower (4B) is now drying the main air stream while tower (4A) is being regenerated by the purge air stream. The operation of the inlet switching (normally open) and purge and repressurization (normally closed) valves is sequenced by the control system located in the electrical enclosure.

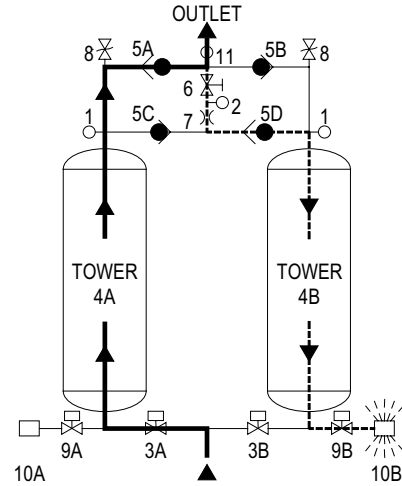


FIGURE 3-2a
TOWER 4A DRYING
TOWER 4B REGENERATING

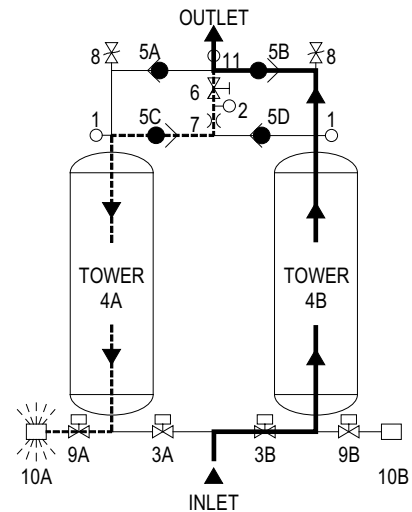


FIGURE 3-2b
TOWER 4A REGENERATING
TOWER 4B DRYING

- | | |
|--------------------------------|--------------------------------------|
| 1. Tower Pressure Gauges | 8. Safety Valves |
| 2. Purge Pressure Gauge | 9. Purge and Repressurization Valves |
| 3. Inlet Switching Valves | 10. Purge Mufflers |
| 4. Desiccant Drying Towers | 11. Moisture Indicator |
| 5. Check Valves | A & C Left Tower Suffixes |
| 6. Adjustable Purge Rate Valve | B & D Right Tower Suffixes |
| 7. Purge Orifice | |

Process Stream —————
Purge Stream - - - - -

3.3.3 Models 40 to 450 (High Pressure Option)

(Refer to Fig. 3-3a.) Compressed air flows through inlet switching valve (3A) (normally open) to tower (4A) where the air is dried. After the air is dried it flows through shuttle valve (5) and then to the dryer outlet. A portion of the dry air, the purge stream, branches off from the main air stream prior to the outlet. The purge stream flow rate is controlled by the adjustable purge rate valve (6) and the two purge orifices (7).

The purge flow, which has been throttled to near atmospheric pressure, is directed to tower (4B). As the purge flow passes over the desiccant in tower (4B), it removes the water vapor which was deposited while the tower was on-line drying. The purge air then passes through purge and repressurization valve (9B) (normally closed) and purge muffler (10B) to the atmosphere.

After regeneration, purge and repressurization valve (9B) (normally closed) closes allowing tower (4B) to re-pressurize slowly. Adequate repressurization time is allowed so that tower (4B) is fully re-pressurized before switchover. After a controlled time period, air inlet switching valve (3B) (normally open) opens and inlet-switching valve (3A) (normally open) closes, purge and repressurization valve (9A) (normally closed) then opens.

(Refer to Fig. 3-3b.) Tower (4B) is now drying the main air stream while tower (4A) is being regenerated by the purge air stream. The operation of the inlet switching (normally open) and purge and repressurization (normally closed) valves is sequenced by the control system located in the electrical enclosure.

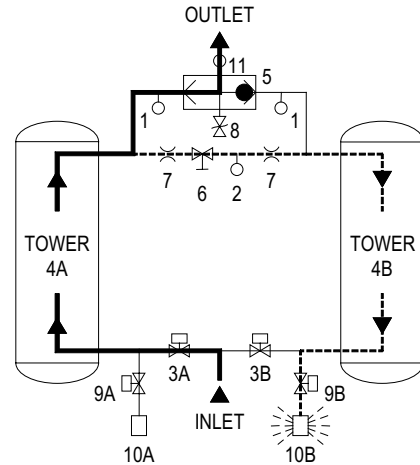


FIGURE 3-3a
TOWER 4A DRYING
TOWER 4B REGENERATING

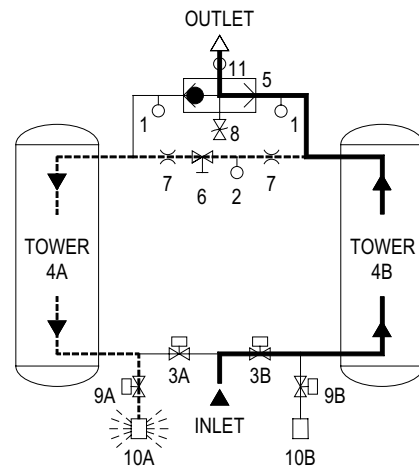


FIGURE 3-3b
TOWER 4A REGENERATING
TOWER 4B DRYING

- | | |
|--------------------------------|--------------------------------------|
| 1. Tower Pressure Gauges | 8. Safety Valve |
| 2. Purge Pressure Gauge | 9. Purge and Repressurization Valves |
| 3. Inlet Switching Valves | 10. Purge Mufflers |
| 4. Desiccant Drying Towers | 11. Moisture Indicator |
| 5. Shuttle Valve | A Left Tower Suffix |
| 6. Adjustable Purge Rate Valve | B Right Tower Suffix |
| 7. Purge Orifices | |

Process Stream —————
Purge Stream - - - - -

3.4 Automatic Purge Saving System

(Refer to Figure 3-4a for Models 40 through 3000 and Figure 3-4b for Models 4100 through 5400.)

Assume tower A is on-line drying while tower B has just gone off-line to be regenerated. At the beginning of tower B's regeneration cycle a thermistor temperature measurement is made at position B1. After the tower has been regenerated, another measurement is made at B1. The drop in temperature sensed during regeneration is an indirect measure of the water vapor content of the inlet air. The Automatic Purge Saving System's microprocessor then uses this information to calculate an allowable temperature rise in the bed during the drying cycle.

When tower B goes back on-line, a temperature probe at position B2 measures the initial bed temperature at this point and then monitors the bed until the calculated temperature rise occurs. The temperature rise occurs as heat of adsorption is released during the drying process. The time for the temperature rise to occur depends on flow rate. At 100% flow the temperature rise takes 5 minutes, at 50% flow it takes 10 minutes.

NOTE: If after 30 minutes, the bed temperature has not risen to the calculated value, the dryer will automatically switch towers.

When the calculated temperature rise is reached, the towers switch with tower A now drying and tower B being regenerated. Tower B regenerates for 3.9 minutes, re-pressurizes, and remains idle until it is called upon for the next drying cycle.

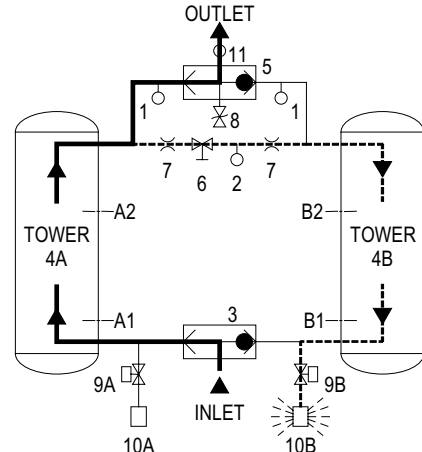


FIGURE 3-4a
Models 40 through 3000
TOWER 4A DRYING
TOWER 4B REGENERATING

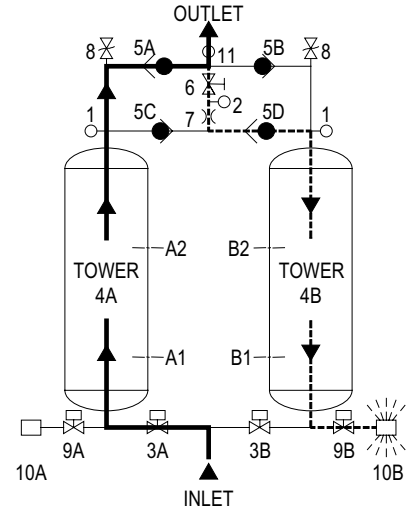


FIGURE 3-4b
Models 4100 through 5400
TOWER 4A DRYING
TOWER 4B REGENERATING

- | | |
|--------------------------------------|--------------------------------------|
| 1. Tower Pressure Gauges | 8. Safety Valve(s) |
| 2. Purge Pressure Gauge | 9. Purge and Repressurization Valves |
| 3. Inlet Shuttle or Switching Valves | 10. Purge Mufflers |
| 4. Desiccant Drying Towers | 11. Moisture Indicator |
| 5. Shuttle or Check Valve(s) | A & C Left Tower Suffix(es) |
| 6. Adjustable Purge Rate Valve | B & D Right Tower Suffix(es) |
| 7. Purge Orifice(s) | |

Process Stream —————
Purge Stream - - - - -

4. INSTALLATION

4.1 Location in the compressed air system

NOTE: The air compressor should be adequately sized to handle air system demands as well as purge loss. Failure to take this into account could result in overloading air compressors and/or insufficient air supply downstream. It is desirable to install the dryer where the compressed air is at the lowest possible temperature (downstream of aftercoolers) and the highest possible pressure (upstream of pressure reducing valves) without exceeding the maximum operating pressure of the equipment. (Refer to Figure 4-1)

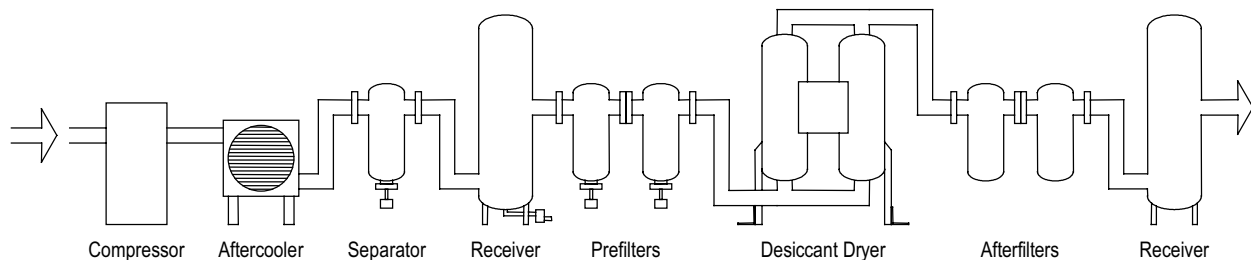


Figure 4-1

4.1.1 Aftercooler/Separator –

Compressed air entering dryer must be cooled to a temperature of 140°F (60°C) or lower. Use of an aftercooler and condensate separator may be necessary to reduce inlet air temperature to an acceptable level.

NOTE: Installation of a refrigerated dryer ahead of a pressure-swing desiccant dryer does not increase desiccant dryer capacity or reduce purge flow requirements.

4.1.2 Receiver(s) –

Air receivers dampen pulsations from the compressor discharge line and can eliminate some of the condensed moisture that is carried over from the aftercooler and separator. They also provide a reservoir of stored air for response to system demands in excess of compressor capacity. Size and location of receivers in the compressed air system need to be considered carefully. Flows must not exceed the adjusted maximum inlet capacity of the desiccant air dryer.

4.1.3 Prefilter(s) –

Adequate filtration is required upstream of the dryer in order to protect the desiccant bed from contamination. The following filtration, equipped with automatic condensate drains, is recommended:

- First Prefilter - Particulate/Gross Liquid Removal - On heavily contaminated systems, a gross contaminant filter to remove solids and high inlet liquid concentrations should be used.
- Second Prefilter - Oil Aerosol Removal - On systems with lubricated compressors, an oil removal filter to remove oil aerosols and protect the desiccant beds from oil contamination is required.

4.1.4 Heatless Pressure-Swing Desiccant Air Dryer

4.1.5 Afterfilter(s) –

To ensure downstream air purity (prevent desiccant dust from traveling downstream) adequate filtration downstream of the dryer is required.

- First Afterfilter - Particulate Removal - Typically 1-micron filtration is specified although finer filtration is available.
- Second Afterfilter - Oil Vapor Adsorption - This filter is used to remove oil vapor and its subsequent taste and odor and to protect downstream components from solid particles 0.01 micron and larger.

NOTE: By-pass lines and isolation valves are recommended so that maintenance work can be performed without shutting off the air supply.

4.2 Physical Location

The dryer must be installed with suitable overhead protection as well as clearance to change desiccant. Sufficient clearance around the periphery of the dryer should be provided to allow maintenance personnel access to all areas for routine inspections and adjustments.

4.3 Minimum & Maximum Operating Conditions

The compressed air supply to the dryer inlet should be checked periodically to ensure that dryer design specifications are not exceeded. Normally the compressor installation includes intercoolers, aftercoolers, separators, receivers, or similar equipment, which adequately pretreat the compressed air supply in order to avoid excessively high air temperatures and liquid slugging of downstream equipment.

4.4 Maximum Operating Pressure (MOP):

- 150 psig (10.3 barg) is standard.
- 250 psig (17.2 barg) is optional.

Refer to Dryer Serial Number Tag.

WARNING - Do not operate the dryer at pressures above the maximum operating pressure shown on the serial number tag.

NOTE: Consult factory for applications requiring higher maximum operating pressures.

4.5 Minimum Operating Pressures:

4.5.1 For 150 psig (10.3 barg) MOP models -

- 60 psig (4.1 barg) is the minimum operating pressure for dryers operated on ISO classes 1, 2, 3, and 4.

4.5.2 For 250 psig (17.2 barg) MOP models -

- 120 psig (8.3 barg) is the minimum operating pressure for dryers operated on ISO classes 1, 2, 3, and 4.

Refer to Dryer Serial Number Tag.

WARNING - Do not operate the dryer at pressures below the minimum operating pressure shown on the serial number tag.

NOTE: Consult factory for applications requiring lower minimum operating pressures.

4.6 Maximum Compressed Air Temperature at Dryer Inlet:

- 140°F (60°C) for all models.

4.7 Ambient Temperatures:

4.7.1 Minimum Ambient Temperature

- Standard units: 35°F (2°C)
- Units with optional low ambient package: -20°F (-29°C)

4.7.2 Maximum Ambient Temperature

- 120°F (49°C)

NOTE: If dryer is installed in ambients below 35°F (2°C), low ambient protection requiring heat tracing and insulation of the prefilter bowls, auto drains and/or sumps, and lower piping with inlet switching and purge/repressurization valves is necessary to prevent condensate from freezing. If installing heat tracing, observe electrical class code requirements for type of duty specified. Purge mufflers and their relief mechanisms must be kept clear from snow and ice buildup that could prevent proper discharge of compressed air.

4.8 Mounting

Install dryer on a level pad. Holes are provided in the dryer base members for floor anchors.

NOTE: Floor anchors must be used if area is subject to vibration.

4.9 Piping

Inlet and Outlet connections

Observe locations of inlet and outlet connections as shown in Figures 4-2, 4-3 or 4-4 and connect inlet and outlet piping as indicated.

NOTE: All piping must be supported so as not to bear on the dryers or filters.

4.10 Isolation Valves

If isolation or bypass valves are installed, care must be used to ensure that equipment is pressurized slowly. This is particularly true if isolation valves are placed before and after pre and afterfilters where rapid pressurization could cause excessive pressure drop across filter elements.

NOTE: When quarter-turn valves (e.g. ball or butterfly valves) are used for isolation of pressure components, care should be taken to open or close valves slowly.

4.11 Electrical Connections

Refer to the appropriate controller sections for detailed information on connections, ratings, and operation of the Level 1 or Level 2 Controller.

NOTE: Refer to the dryer serial number tag for allowable voltages, frequency and power rating.

4.12 Provisions for Purge Exhaust

- Purge exhaust must be routed through the factory supplied mufflers or piped to a remote location.
- Purge mufflers - If shipped separately, install purge exhaust mufflers in the locations shown in Figures 4-2, 4-3 or 4-4.
- If purge exhaust is piped to a muffler located in a remote location, choose a combination of diameters, lengths, and turns that limits the additional pressure drop to 1 psid or less.

WARNING - Do not operate dryer without installed mufflers. Exhausting compressed air directly to atmosphere will result in noise levels above OSHA permissible levels and rapidly expanding gas could potentially cause harm to persons or property.

4.13 Initial Desiccant Charge

The dryer is shipped complete with desiccant and is ready to operate after piping and electrical connections are made and controller settings are established.

4.14 Icon Identification



Left Tower Pressure Gauge



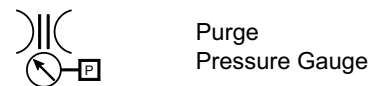
Right Tower Pressure Gauge



Air Outlet



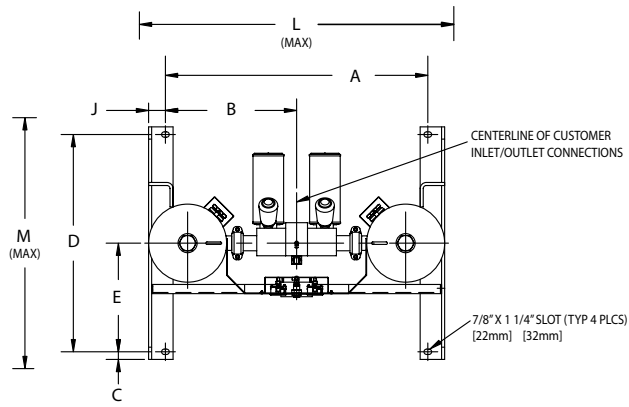
Air Inlet



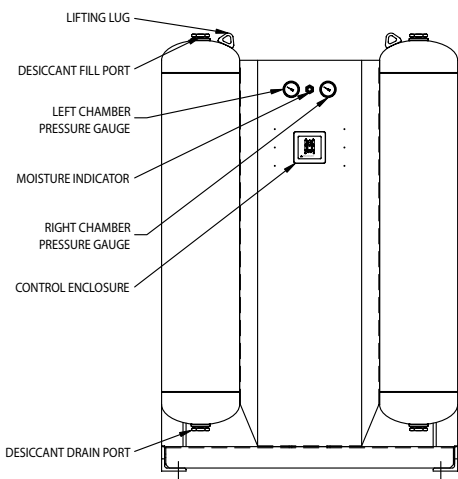
Purge Pressure Gauge



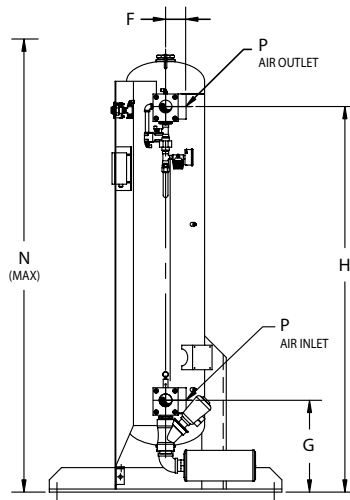
Electrical Inlet



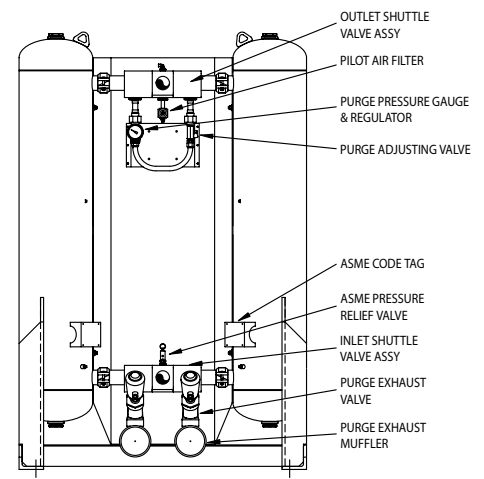
TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW
RIGHT CHAMBER REMOVED FOR CLARITY



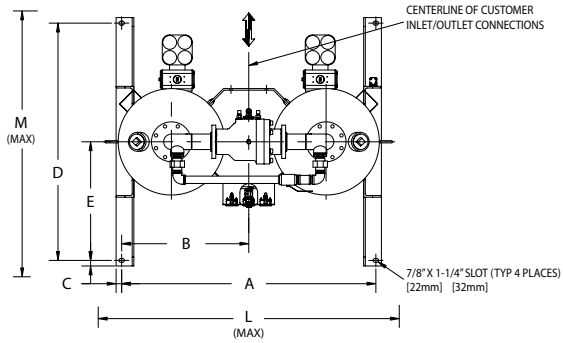
REAR VIEW

Figure 4-2
40-450 SCFM General Arrangement
(continued on next page)

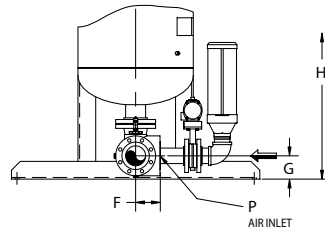
DIMENSIONS IN INCHES								
MODEL	40	60	90	115	165	260	370	450
A	27.5/8	27.5/8	27.5/8	38.3/8	38.3/8	41.3/8	49.3/8	49.3/8
B	13.13/16	13.13/16	13.13/16	19.13/16	19.13/16	20.11/16	24.11/16	24.11/16
C	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4
D	29.1/2	29.1/2	29.1/2	35.1/2	35.1/2	35.1/2	35.1/2	35.1/2
E	14.3/4	14.3/4	14.3/4	17.3/4	17.3/4	17.3/4	17.3/4	17.3/4
F	2.13/16	2.13/16	2.13/16	2.13/16	2.13/16	3.1/4	3.1/4	3.1/4
G	14	14	14	15	15	15	16	16
H	39	54	71	45	45	63	53	61
J	1.3/4	1.3/4	1.3/4	1.3/4	1.3/4	2.3/4	2.3/4	2.3/4
L	35	35	37	50	50	51	58	58
M	35	35	35	41	41	41	42	42
N	49	64	81	57	57	75	65	73
P	1 NPT	1 NPT	1 NPT	1 NPT	1 NPT	2 NPT	2 NPT	2 NPT
WT/LBS	365	445	575	685	685	1010	1215	1350
DIMENSIONS IN MILLIMETERS								
MODEL	40	60	90	115	165	260	370	450
A	702	702	702	975	975	1051	1254	1254
B	351	351	351	487	487	525	627	627
C	32	32	32	32	32	32	32	32
D	749	749	749	902	902	902	902	902
E	375	375	375	451	451	451	451	451
F	71	71	71	71	71	83	83	83
G	356	356	356	381	381	381	406	406
H	991	1372	1803	1143	1143	1600	1346	1549
J	44	44	44	44	44	70	70	70
L	889	889	948	1264	1264	1305	1470	1470
M	889	889	889	1041	1041	1041	1062	1062
N	1235	1616	2047	1437	1437	1894	1658	1861
P	1 NPT	1 NPT	1 NPT	1 NPT	1 NPT	2 NPT	2 NPT	2 NPT
WT/KGS	166	202	261	311	311	458	551	612

NOTE: Dimensions and weights are for reference only. Request certified drawings for construction purposes.

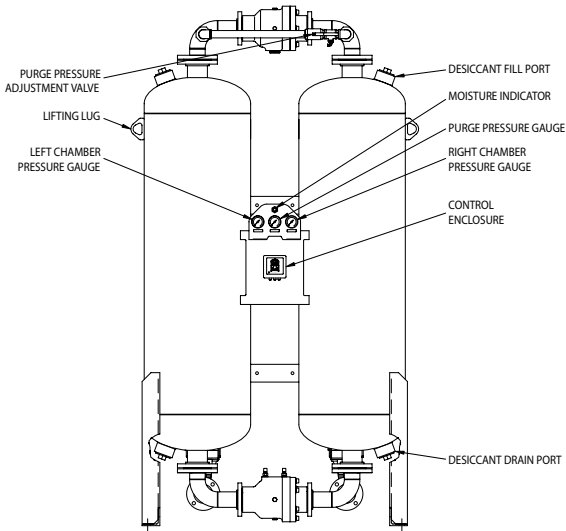
Figure 4-2
40-450 SCFM General Arrangement
(continued from previous page)



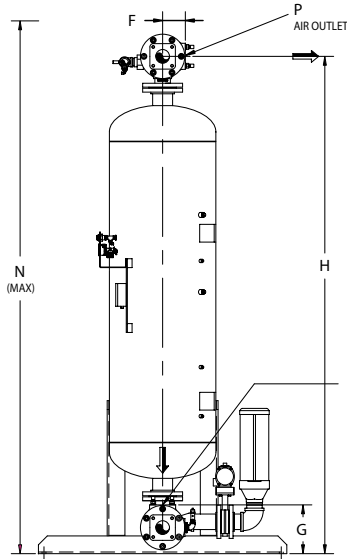
TOP VIEW



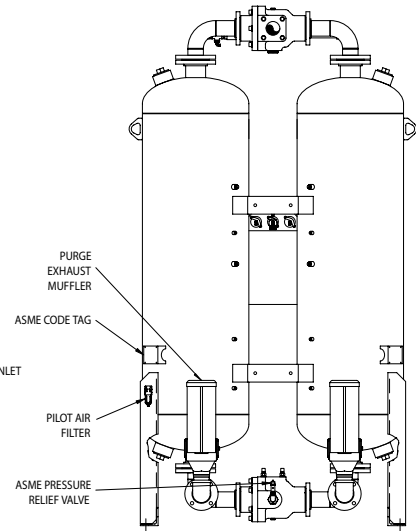
BOTTOM RIGHT SIDE VIEW
(Models 1550, 2100 and 3000)
RIGHT CHAMBER REMOVED FOR CLARITY



FRONT VIEW



RIGHT SIDE VIEW
(Models 590 through 1350)
RIGHT CHAMBER REMOVED FOR CLARITY



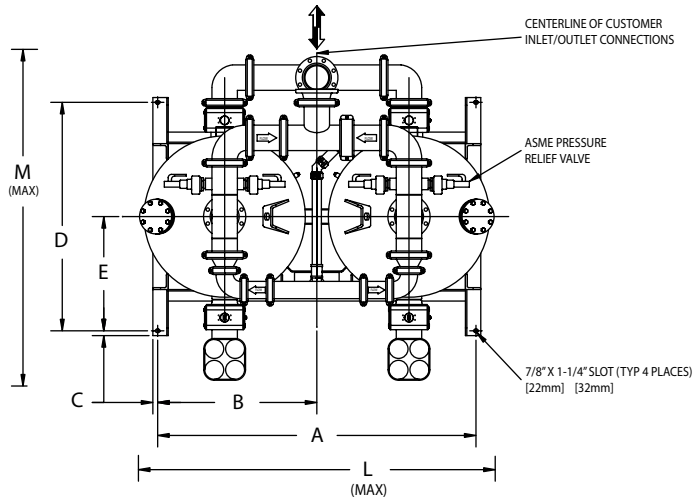
REAR VIEW

Figure 4-3
590-3000 SCFM General Arrangement
(continued on next page)

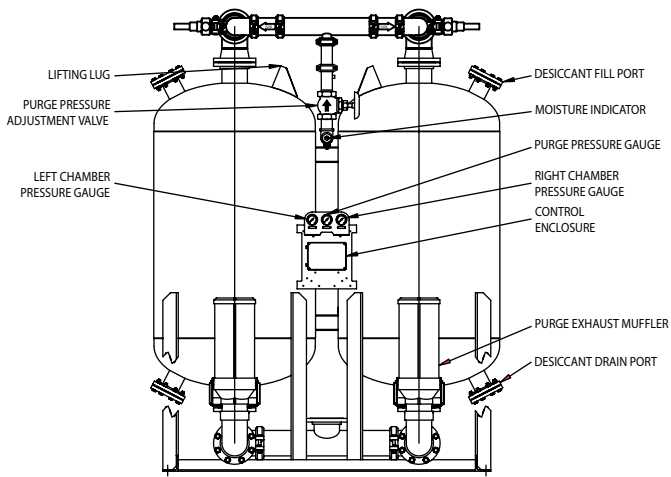
DIMENSIONS IN INCHES								
MODEL	590	750	930	1130	1350	1550	2100	3000
A	46.3/4	47.9/16	52.11/16	56.7/16	57.5/16	63.1/8	69.13/16	73.3/8
B	23.3/8	23.13/16	26.5/16	28.1/4	28.11/16	31.9/16	34.7/8	36.11/16
C	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4	1.1/4
D	45.1/2	45.1/2	53.1/2	53.1/2	53.1/2	53.1/2	53.1/2	59.1/2
E	22.3/4	22.3/4	26.3/4	26.3/4	26.3/4	26.3/4	26.3/4	29.3/4
F	3.1/4	3.1/4	3.1/4	5.1/8	5.1/8	5.9/16	5.9/16	5.9/16
G	9.3/16	9.11/16	11.7/16	11	11	5.1/4	6.3/16	8.1/2
H	97.5/16	100.13/16	105.9/16	107.1/8	112.1/8	109.1/2	111.5/16	117.3/8
L	55	57	63	66	68	74	82	86
M	51	51	59	59	59	59	59	67
N	104	107	112	115	120	117	119	125
P	2 NPT	2 NPT	2 NPT	3 FLANGE	3 FLANGE	4 FLANGE	4 FLANGE	4 FLANGE
WT/LBS	1473	2134	2414	2875	3722	4167	4417	9010
DIMENSIONS IN MILLIMETERS								
MODEL	590	750	930	1130	1350	1550	2100	3000
A	1187	1208	1338	1434	1456	1604	1773	1864
B	594	604	669	717	728	802	886	932
C	32	32	32	32	32	32	32	32
D	1156	1156	1359	1359	1359	1359	1359	1511
E	578	578	679	679	679	679	679	756
F	83	83	83	130	130	141	141	141
G	234	247	291	279	279	133	157	216
H	2472	2561	2681	2721	2848	2781	2827	2981
L	1387	1438	1603	1673	1724	1876	2080	2172
M	1295	1295	1499	1499	1499	1499	1499	1693
N	2631	2720	2841	2924	3051	2980	3026	3180
P	2 NPT	2 NPT	2 NPT	3 FLANGE	3 FLANGE	4 FLANGE	4 FLANGE	4 FLANGE
WT/KGS	668	968	1095	1304	1688	1890	2004	4087

NOTE: Dimensions and weights are for reference only. Request certified drawings for construction purposes.

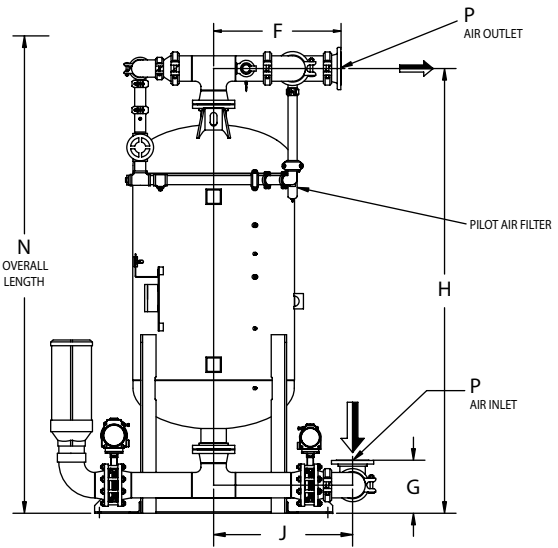
Figure 4-3
590-3000 SCFM General Arrangement
(continued from previous page)



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW
RIGHT CHAMBER REMOVED FOR CLARITY

Figure 4-4
4100-5400 SCFM General Arrangement
(continued on next page)

DIMENSIONS IN INCHES		
MODEL	4100	5400
A	82.7/8	93.3/8
B	41.7/16	46.11/16
C	1.1/4	1.1/4
D	59.1/2	63.1/2
E	29.3/4	31.3/4
F	33.3/16	35.7/8
G	13.13/16	19.7/16
H	115.13/16	116.3/16
J	36.3/16	38.7/8
L	100	105
M	88	89
N	124	124
P	6 FLANGE	6 FLANGE
WT/LBS	9900	12000
DIMENSIONS IN MILLIMETERS		
MODEL	4100	5400
A	2106	2372
B	1053	1186
C	32	32
D	1511	1613
E	756	806
F	843	911
G	351	494
H	2942	2951
J	919	988
L	2537	2667
M	2227	2253
N	3158	3158
P	6 FLANGE	6 FLANGE
WT/KGS	4500	5445

NOTE: Dimensions and weights are for reference only. Request certified drawings for construction purposes.

Figure 4-4
4100-5400 SCFM General Arrangement
(continued from previous page)

5. CONTROLLERS – GENERAL

5.1 Overview

The solid-state dryer controller is located in a polycarbonate, NEMA Class 4/4X, IP66 rated electrical enclosure mounted to a center panel located between the two desiccant towers. Controls are available in three functional levels. The Timer Controller offers a fixed-time cycle that provides a dew point corresponding to ISO compressed air quality class 2. Both the Level 1 and Level 2 controls offer four fixed-time cycles that provide dew points corresponding to ISO compressed air quality classes 1 through 4. A key difference between the Level 1 and Level 2 controls is the way in which they address energy savings. When

inlet flow is less than the adjusted rated capacity of the dryer, average purge air requirements are reduced. This reduction can translate to energy savings at the air compressor.

The Level 1 Controller offers 8 selectable fixed-cycle Energy (purge) Saver modes (0% to 70% in 10% increments) to reduce purge time to match the load on the dryer.

Level 2 Controllers feature the Automatic Purge Saving System (APSS) as described in Sections 3.2 and 3.4. When Level 2 Controllers are operated in demand rather than fixed cycle modes, the APSS automatically adjusts to dryer loading and extends drying time when possible. Average purge use is thus automatically reduced.

A feature-by-feature comparison of each controller can be found in Table 5-1.

Desiccant Dryer Controllers		KADE (Timer Controller)	KAD (Level 1) (Fixed Cycle Only)	KADPS (Level 2) (Fixed Cycle and APSS)
Category	Feature			
General	AC Input Voltage: 100-240 VAC, 50-60 Hz (See Note 1)	•		
	AC Input Voltage: 85-264 VAC, 47-63 Hz (See Note 1)		•	•
	DC Input Voltage: 11.5-28 VDC (See Note 1)		•	•
	Auxiliary power terminals (See Note 2)		•	•
	Solenoid valve coil voltage	12 VDC	12 VDC	12 VDC
	NEMA 4/4X, IP 66 electrical enclosure rating	•	•	•
	Soft on/off switch with two power recovery modes (See Note 3)		•	•
	Tower status LEDs (amber=drying)	•		
	Tower status LEDs (green=drying, amber=regenerating)		•	•
	Process valve status LEDs (on=valve open, off=valve closed)		•	•
	Operating mode LEDs (see next category for number of modes)		•	
	Alarm LED (red)		•	•
	Voltage-free alarm contacts, 5A rating		•	•
	Alarm reset switch (mounted on front panel)		•	•
	Service reminder LEDs (See Note 4)		•	•
Vacuum fluorescent text display			•	
Operating Modes (See Note 5 and Note 7)	60-150 or 120-250 psig MOP (selectable via jumper on circuit board)		•	•
	ISO Class 1 (-100°F/-73°C PDP) - fixed cycle (4 minute)		•	•
	ISO Class 2 (-40°F/-40°C PDP) - fixed cycle (10 minute)	•	•	•
	ISO Class 3 (-4°F/-20°C PDP) - fixed cycle (16 minute)		•	•
	ISO Class 4 (+38°F/+3°C PDP) - fixed cycle (24 minute)		•	•
	Fixed Cycle Energy (purge) Saver (See Note 6)		•	
	Manual Cycle (test mode)		•	•
	ISO Class 2 (-40°F/-40°C PDP) - demand cycle			•
	ISO Class 3 (-4°F/-20°C PDP) - demand cycle			•
	ISO Class 4 (+38°F/+3°C PDP) - demand cycle			•
Digital I/O	Controlled shutdown and restart (upon user supplied contact closure)		•	•
	Tower pressure switches (2)		•	•
	High Humidity Alarm			Optional
	Filter monitor alarm (1 or 2 filters)			Optional
	Electric drain alarm (1 or 2 filters)			Optional
Analog I/O (12 bit accuracy)	Thermistors (4)			•
Communication	RS232 communication port		•	•

Table 5-1
Feature Comparison
(continued on next page)

Table 5-1 (continued from previous page)

Notes:

1. The Timer Controller will accept AC (Alternating Current) input power. The Level 1 and Level 2 Controllers will accept either AC (Alternating Current) or DC (Direct Current) input power.
2. (Level 1 & Level 2 Controllers) The auxiliary power terminals are in parallel with the input power terminals (i.e., there are two common terminals for each input power connection point, L, N, and PE. The auxiliary power terminals provide a connection point for another device that operates on the same voltage as the Desiccant Dryer Controller.
3. (Level 1 & Level 2 Controllers) The controller has two power recovery modes. For Level 1 the selection is made using a jumper on the circuit board. For Level 2 the selection is made using the switches on the front panel. In one mode, the controller remembers its state (on or off) prior to a power interruption and returns to that state when power is restored. In the other mode, the controller always returns to the off state when power is restored after an interruption.
4. (Level 1 & Level 2 Controllers) The service reminder LEDs indicate that it is time to perform preventive maintenance on the (a) filters and drains, (b) valves, or (c) desiccant. The user selects between Normal and Severe service intervals. For Level 1 the selection is made using a jumper on the circuit board. For Level 2 the selection is made using the switches on the front panel.
5. (Level 1 & Level 2 Controllers) For Level 1 and Level 2, the operating mode (with exception of the MOP) is selected via switches on the front panel.
6. (Level 1 Controllers) The Level 1 Energy (purge) Saver feature has eight settings, 0% to 70% in 10% increments. Energy Saver setting = $100\% - (\text{percentage of adjusted allowable inlet flow})$. (e.g. if the maximum adjusted allowable inlet flow to a dryer was 1000 SCFM, but the actual flow to the inlet was only 300 SCFM, then the Energy Saving setting would be $100\% - ((300/1000) * 100\%) = 70\%$. At 300 SCFM, only 30% of the dryer capacity is being utilized. Average purge requirements and the related energy needed to compress that purge air can be reduced by 70%.) The selection is made using a switch on the front panel.
7. PDP - Pressure Dew Point
MOP - Maximum Operating Pressure

6. CONTROLLER – TIMER BASED

This section provides connection, adjustment and operational information for the Timer Based – Fixed Cycle Controller. Similar information for the Level 1 – Fixed Cycle Controller and Level 2 Controller featuring the APSS, Automatic Purge Saving System, can be found in Sections 7 and 8 respectively.

6.1 Reference Figures – Timer Based Controller

- Figure 6-1, Front Panel Overlay – Timer Controller
- Figure 6-2, Point-to-Point Diagram – Timer Controller

6.2 Connections – Timer Based Controller

See Figure 6-2, Point-to-Point Diagram for the location and function of the various cable and cord connectors that are provided on the bottom of the Timer Based enclosure.

6.2.1 Connections - Input Power

6.2.1.1 VAC Input Power Connections

Single-phase, alternating current (AC) input power connection of 100-240 VAC / 1 ph / 50-60 Hz. can be made at terminals mounted within the control enclosure. See reference figures for proper polarity.

Program Step	1	2	3	4	5	6	7	8
Left tower status	drying	drying	drying	drying	regen	regen	regen	regen
Right tower status	regen	regen	regen	regen	drying	drying	drying	drying
Left purge solenoid	off	off	off	off	off	off	on	off
Right purge solenoid	off	off	on	off	off	off	off	off
Left purge valve	closed	closed	closed	closed	closed	closed	open	closed
Right purge valve	closed	closed	open	closed	closed	closed	closed	closed

Table 6-1
Cycle Sequence Steps –Timer Based Controller

Dryer MOP	60- 150 psig (4.1 - 10.3 barg)	120-250 psig (8.3- 17.2 barg)
ISO Class	2	2
Dew Point	-40°C	-40°C
	-40°F	-40°F
Cycle Time (minutes)	10	10
Time	Time from start of cycle (minutes:seconds)	Time from start of cycle (minutes:seconds)
t0	00:00	00:00
t1	00:02	00:02
t2	00:06	00:06
t3	04:12	04:12
t4	05:00	05:00
t5	05:02	05:02
t6	05:06	05:06
t7	09:12	09:12
t8	10:00	10:00
Reference Data		
Purge time (min:sec)	04:12	04:12
Repress. time (min:sec)	00:48	00:48

Table 6-2
Fixed Cycle Timing –Timer Based Controller

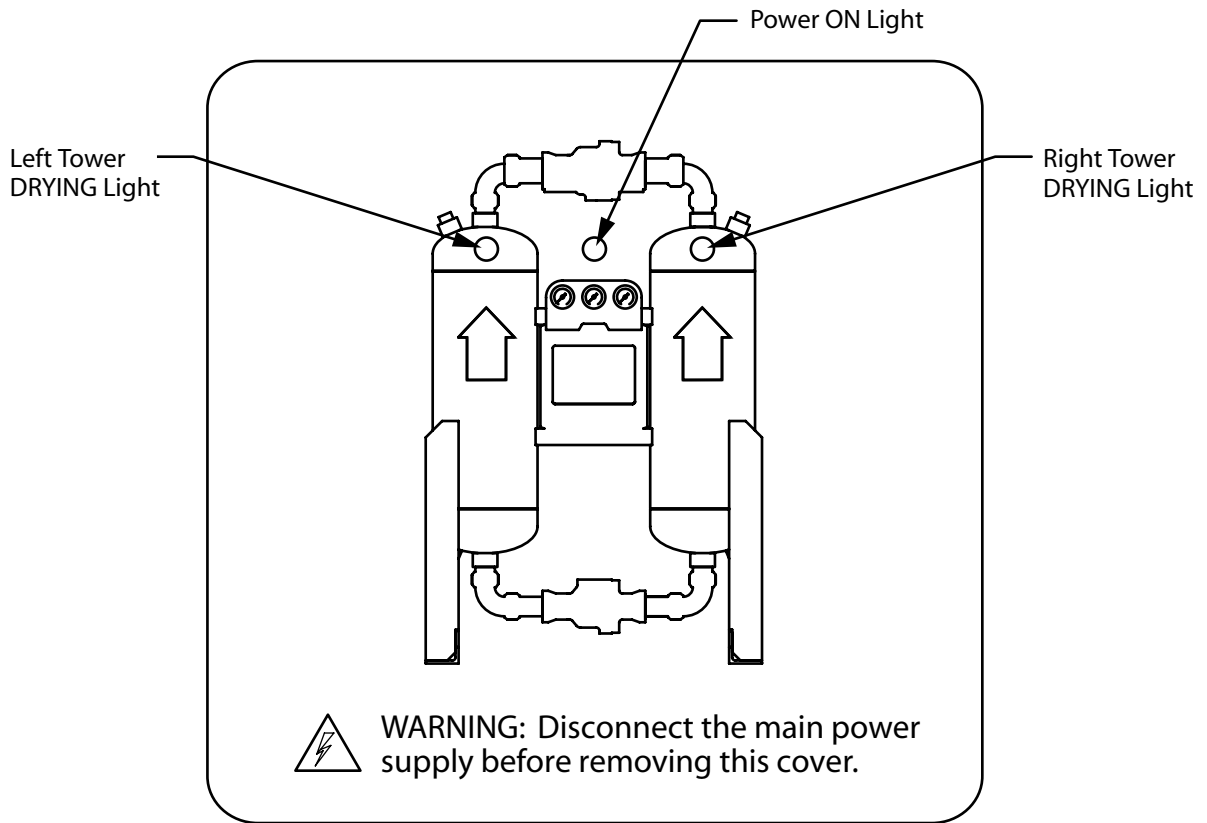


Figure 6-1
Front Panel Overlay –Timer Based Controller
(Note: Figure is representative of Models KADE 40 through 3000.)

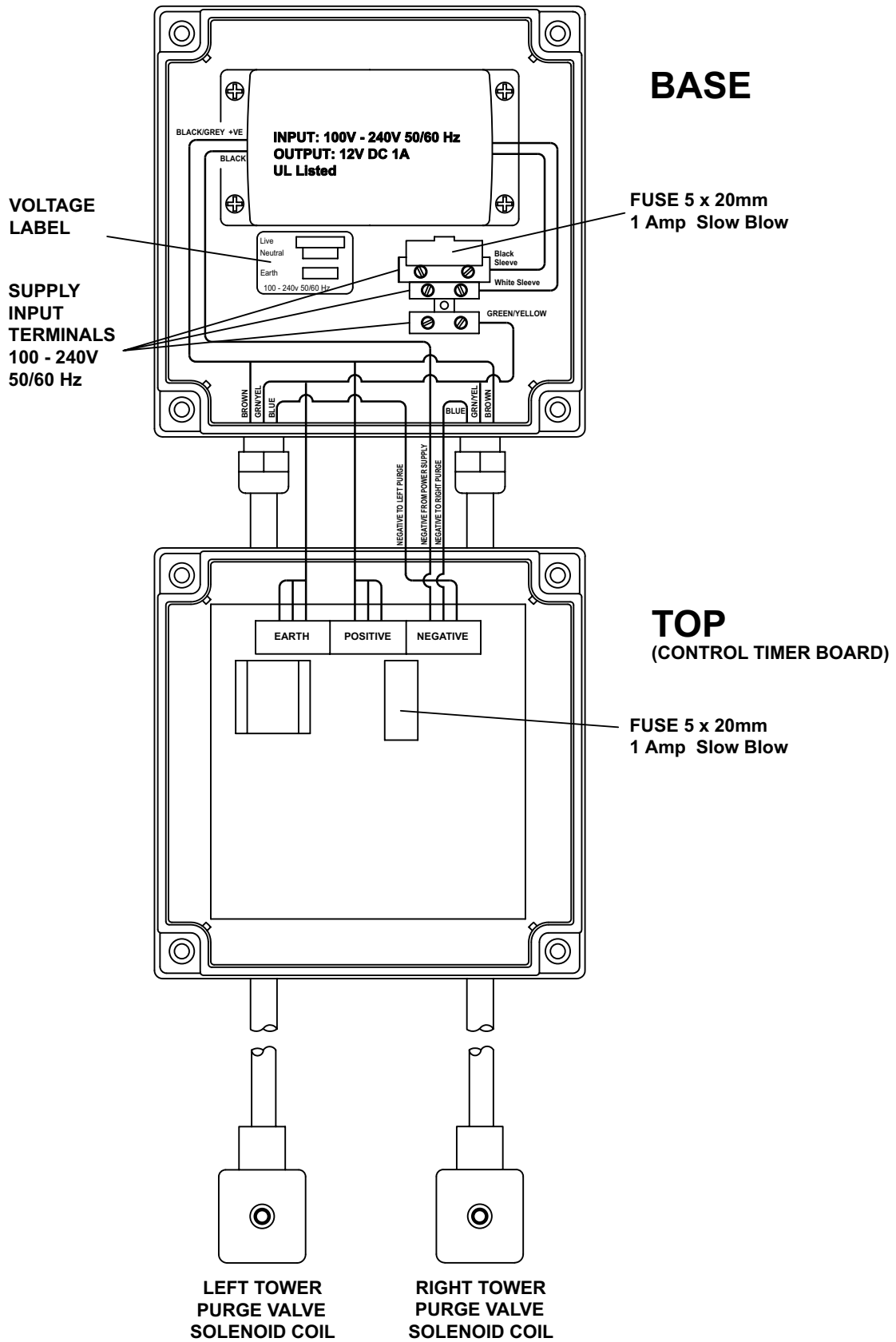


Figure 6-2
 Point-to-Point Connection Diagram –Timer Based Controller

7. CONTROLLER – LEVEL 1

This section provides connection, adjustment and operational information for the Level 1 – Fixed Cycle Controller. Similar information for the Level 2 Controller featuring the APSS, Automatic Purge Saving System, can be found in Section 8.

7.1 Reference Figures – Level 1 Controller

- Figure 7-1, Front Panel Overlay – Level 1 Controller
- Figure 7-2, Electrical Schematic – Level 1 Controller
- Figure 7-3, Point-to-Point Diagram – Level 1 Controller
- Figure 7-4, Panel Layouts – Level 1 Controller
- Figure 7-5, Enclosure Penetrations – Level 1 Controller

7.2 Connections – Level 1 Controller

See Figure 7-5, Enclosure Penetrations for the location, size and function of the various cable and cord connectors that are provided on the bottom of the Level 1 enclosure.

7.2.1 Connections - Input Power

7.2.1.1 VAC Input Power Connections

Single-phase, alternating current (AC) input power connections ranging from 85-264 VAC and 47 to 63 Hz. can be made at terminals TB5-20, -22, and -24. See reference figures for proper polarity. These terminals are connected to accessory output terminals TB5-21, -23, and -25 respectively. Accessory output terminals can be used to direct power at the same voltage and frequency to external devices.

CAUTION: Accessory output terminals are NOT controlled by the power on/off switch and are always energized when power is provided to terminals TB-20, -22, and -24.

7.2.1.2 VDC Power Connections

- The control and display boards operate on low-voltage direct current. The controller is provided pre-wired with an AC to 12 VDC power supply board. For users with AC power as described in Section 7.2.1.1, their AC input is directed to the power supply board where it is conditioned and returned to the control board as 12 VDC at terminals TB4-18 and -19.
- For users with direct current (DC) input power ranging from 11.5 to 28 VDC, use of the AC to DC power supply board is not needed and their connections can be made at terminals TB4-18 and -19 by first removing the black and red leads coming from the power supply board. See reference figures for proper polarity.

7.2.2 Connections – Common Alarm Contacts

Connections to voltage-free common alarm contacts with a maximum 5-amp rating can be made at terminals TB2-7 through -9.

- Terminal TB2-9 is the common contact connection.
- Terminal TB2-7 is the N.O. (normally open) contact connection.
- Terminal TB2-8 is the N.C. (normally closed) contact connection.
- The alarm relay coil is energized when power is supplied to the controller input terminals and there are no alarms.
- The coil is de-energized when power is removed or when an alarm condition exists.

- The common alarm is designed to activate on: a) either a dryer fault condition or a service reminder, or b) a dryer fault condition only. This is user selectable.
- For the common alarm to activate on either a dryer fault condition or a service reminder, the jumper at J2 is removed. This is the default configuration.
- To have the common alarm activate on a dryer fault condition only, the jumper at J2 is installed.
- Additional information on the common alarm relay logic appears in Table 7-1.

Power To Controller	Controller On or Off?	Alarm or Service Reminder	Alarm Relay Coil	Alarm N.O. Contact (TB2-7)	Alarm N.C. Contact (TB2-8)
No	N/A	N/A	De-Energized	Open	Closed
Yes	Off	N/A	Energized	Closed	Open
Yes	On	No	Energized	Closed	Open
Yes	On	Yes	De-Energized	Open	Closed

Table 7-1
Common Alarm Relay Logic –Level 1 Controller

7.2.3 Connections – Remote Start / Stop

Terminals TB1-1 and -2 are used to provide a 5 VDC output to a remote switch or volt free contacts that when closed will stop the dryer at the end of the current half cycle. The dryer will resume running at the beginning of the new half cycle when the remote switch or contacts are reopened. When dryer operation is in the remote stop state, all four tower drying (green) and regenerating (amber) LEDs flash simultaneously.

NOTE: Remote start / stop is disabled when the dryer is in the Manual cycle operation mode. When the dryer is in the remote stop state, the only front panel and remote selector switches (see Section 7.2.4) that remain enabled are the power on/off switches.

7.2.4 Connections – Remote Switches

The controller door is equipped with four momentary-contact, push button switches. Pressing the appropriate icon printed on the display overlay actuates these switches. The display board containing the switches, display LEDs and the J2 terminal strip is mounted on the inside of the enclosure door. The terminal strip provides connection points for remotely mounted, NO (normally open), momentary-contact push buttons that provide the same function as the board mounted switches. The terminal – switch combinations are:

- Terminals J2-1 and -2 (remote switch to select ISO dew point class or manual cycle / test mode)
- Terminals J2-3 and -4 (remote switch to select % energy savings mode)
- Terminals J2-5 and -6 (remote power on / off switch)

NOTE: Care must be exercised in using this remote switch to stop a dryer. Closing this switch will affect the same response as a loss of power. Both purge-repressurization valves will close. On standard pressure models 4100 & 5400 and high pressure models 40 through 450, both inlet-switching valves will open. A

tower that is actively purging when the power on/off button is actuated will be subjected to a rapid repressurization that can lead to fluidization and subsequent abrasion of the desiccant bed. Ideally, dryers should only be powered off during those portions of the drying cycle when both desiccant towers are at full operating pressure. Use of the remote start/stop connections as described in Section 7.2.3 would be preferable in most cases.

- Terminals J2-7 and -8 (remote alarm reset and manual cycle increment switch)

7.2.5 Connections – RS232

Refer to Figure 7-4, Panel Layouts – Level 1 Controller. RS232 connections can be made at the 3-pin connector labeled J5 and located at the upper left-hand corner of the control board. A cable for this connection can be purchased through your distributor.

7.3 Control Board Jumpers – Level 1

Refer to Figure 7-3, Point to Point Connection Diagram – Level 1 Controller. In the upper left hand corner of the control board there are four two-pin jumpers labeled J1 through J4. The jumper is a removable bridge that is used to make or break continuity between the two pins that form a pair. When installed in the ON position, the jumper is placed on both pins of the pair and continuity between the pins is established. When installed in the OFF position, the jumper is removed or stored on a single pin and continuity is broken. Jumper functions are as follows:

7.3.1 Jumper J1 – Maximum Operating Pressure

Jumper J1 is used to select the maximum operating pressure. Installed in the OFF position when operating at inlet pressures of 60 to 150 psig (4.1 to 10.3 barg). Installed in the ON position when operating at inlet pressures of 120 to 250 psig (8.3 to 17.2 barg). This setting will affect tower purge and repressurization times. (Refer to serial number tag.)

7.3.2 Jumper J2 – Common Alarm.

Jumper J2 is installed in the OFF position to enable both dryer fault alarms and service alarms to activate the common alarm. This is the default configuration. Install jumper J2 in the ON position if the common alarm is to be activated by a dryer fault alarm only.

7.3.3 Jumper J3 – Service Reminder Interval

Jumper J3 is used to select the service reminder interval. Installed in the OFF position when the Normal service reminder interval is desired. Installed in the ON position when the Severe service reminder interval is desired. Service items, check points and time intervals appear in Table 7-2.

7.3.3.1 Filter Service

When the service interval for filters has expired the following LEDs will blink:

- Service LED (amber)
- Three filter LEDs (amber)

7.3.3.2 Desiccant Service

When the service interval for desiccant has expired, the following LEDs will blink:

- Service LED (amber)
- Both tower regenerating LEDs (amber). The service function overrides the normal display of the tower regenerating LEDs.

7.3.3.3 Valve Service

When the service interval for valves has expired, the following LEDs will blink:

- Service LED (amber)
- Valve LEDs (green) The service function overrides the normal display of the valve LEDs.

To extinguish the blinking LEDs and restart the timer for a new service interval, press the alarm reset button.

NOTE: Time continues to accumulate as long as power is supplied to the controller, whether the controller is switched on or off.

Use the following sequence to manually reset the accumulated service interval time for all timers.

- Pause for about 1 second at each instruction. If the sequence is executed too quickly it will not work.
- With the controller already on, press and hold the alarm reset button.
- Press and hold the on/off button.
- Release the on/off button.
- Release the alarm reset button. The service interval time is now reset; the maintenance LED flashes three times to acknowledge the action.

Service Item (Customer check points are listed for each item)	Normal Service Interval (J3 OFF)	Severe Service Interval (J3 ON)
Filters 1. Check prefilter Delta-P 2. Ensure prefilter drain is discharging 3. Check afterfilter Delta-P	4,000 Hours	2,000 Hours
Desiccant 1. Check moisture indicator 2. Check dryer outlet dew point 3. Inspect mufflers for excessive dusting	8,000 Hours	4,000 Hours
Valves 1. Ensure valves are cycling properly 2. Check for switching failure alarms 3. Inspect valves for leaks - adjust purge valve as needed	4,000 Hours	2,000 Hours

Table 7-2
Jumper J3 – Service Reminder Intervals

7.3.4 Jumper J4 – Power Recovery Mode

Jumper J4 is used to select the power recovery mode. When power to the controller is interrupted, the position of this jumper controls the recovery mode of the dryer when power is restored. Installed in the OFF position when automatic power recovery is not desired. Installed in the ON position when automatic power recovery is desired.

- Jumper J4 installed in the OFF position – Automatic power recovery is turned off. The controller returns to the off state when interrupted power to the controller is restored.
- Jumper J4 installed in the ON position – Automatic power recovery is turned on. The controller remembers its state (on or off) prior to a power interruption and returns to that state (at the beginning of the prior ISO operating cycle) when power is restored. If power is interrupted while the controller is in the Manual cycle mode, the controller will return to the prior ISO operating cycle and not the Manual cycle when power is restored.

7.4 Front Panel Overlay – Level 1 Controller

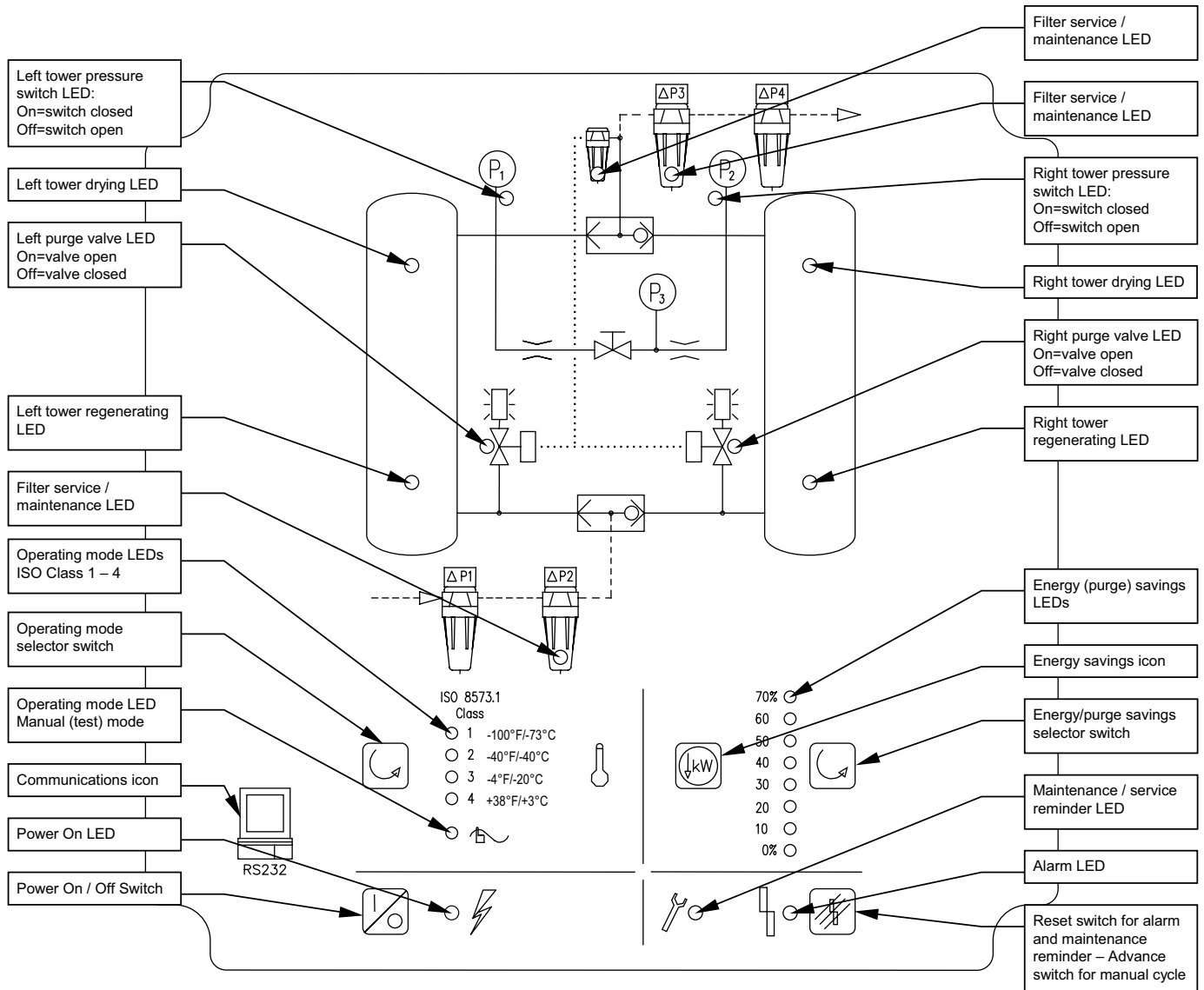


Figure 7-1
 Front Panel Overlay – Level 1 Controller
 (Note: Figure is representative of Standard Pressure Models KAD 40 through 3000.)
 (Note: Overlay for Standard Pressure Models KAD 4100 & 5400 depicts a different inlet valve and outlet/purge circuit. Overlay for High Pressure Models KAD 40 through 450 depicts a different inlet valve circuit.)

7.4.1 Front Panel LEDs

- Power on - green
- Alarm – red
- Service / maintenance reminder – amber
- Filters (pre, after, and pilot) service / maintenance reminders - amber
- Operating mode (ISO class / manual (test) mode) – green
- Energy (purge) savings % – green
- Purge / repressurization valve status (On = valve open; Off = valve closed) – green
- Left and right tower status (regenerating) - amber
- Left and right tower status (drying) - green
- Left and right tower pressure switch status (On = switch closed; Off = switch open) - green

7.4.2 Front Panel Switches

The front panel contains four momentary-contact push button switches. Refer to Figure 7-1, Front panel Overlay – Level 1 Controller for the appropriate icon associated with each switch. Pushing on the overlay icon actuates the switch. Switching can be affected remotely by wiring external push-buttons to the J2 terminals located on the rear of the display board. Refer to Section 7.2.4.

7.4.2.1 Dryer On / Off Switch

This switch is used to turn the dryer on (run) or off (stop).

CAUTION: In the event of a loss of power, either intentional or unintentional, both purge-repressurization valves will close. On standard pressure models 4100 & 5400 and high pressure models 40 through 450, both inlet-switching valves will open. A tower that is actively purging when the power off button is actuated will be subjected to a rapid repressurization that can lead to fluidization and subsequent abrasion of the desiccant bed. Ideally, dryers should be powered off at the end of any half cycle when both desiccant towers are at full operating pressure.

Power recovery after an external loss of power is affected by the position of control board jumper J4 (power recovery mode). Refer to Section 7.3.4 for additional information.

7.4.2.2 Operating Mode Selector Switch

- Four fixed-time cycles provide varying degrees of dryness corresponding to ISO Classes 1, 2, 3, and 4.
- Manual cycle (test mode) is used for troubleshooting and startup.
- The operating mode can be changed at any time. Press the switch repeatedly until the desired mode's LED is blinking. The LED for the current mode remains illuminated until the end of the current half-cycle, at which time the new selection becomes active. At this time, the LED for the new selection switches from blinking to illuminated, and the LED for the previous selection is extinguished.
- To select Manual (test) cycle, press and hold the switch for approximately 2 seconds. The current ISO Class LED will remain illuminated and the Manual cycle mode LED will illuminate. When in the Manual cycle mode, the dryer can be advanced one step at a time using the reset/manual advance switch. Refer to section 7.4.2.4.
- NOTE: Button function is disabled when the remote start / stop feature has placed the dryer in the cycle interrupted (stop) mode. Refer to section 7.2.3.

7.4.2.3 Percent Energy / Purge Savings Selector Switch

- If dryer is operated at less than maximum flow capacity a reduction in purge air usage may be possible. Eight settings (0% to 70% in 10% increments) reduce the purge time to match the load on the dryer. Refer to the Operation Section to determine maximum inlet flow capacity at operating pressure. The Energy savings selection can be changed at any time. Press the switch repeatedly until the desired selection's LED is blinking. The LED for the current selection remains illuminated until the end of the current half-cycle, at which time the new selection becomes active. At this time, the LED for the new selection switches from blinking to illuminated, and the LED for the previous selection is extinguished.
- Example: If the maximum adjusted allowable inlet flow to a dryer was 1000 SCFM, but the actual flow to the inlet was only 300 SCFM, then the Energy Saving setting would be $100\% - ((300/1000) * 100\%) = 70\%$. At 300 SCFM, only 30% of the dryer capacity is being utilized. Average purge requirements and the related energy needed to compress that purge air can be reduced by 70%.
- NOTE: Button function is disabled when the remote start / stop feature has placed the dryer in the cycle interrupted (stop) mode. Refer to section 7.2.3.

7.4.2.4 Reset / Manual Advance Switch

- This switch is normally used to reset an alarm or service reminder. When the Manual cycle (test) mode is selected, this switch is used to advance through the operating cycle one step at a time.
NOTE: Allow towers to fully repressurize before advancing to tower switchover.

7.4.3 Switching Failure Alarms

- When a tower does not de-pressurize, the Alarm LED, Pressure Switch LED, and Tower Regenerating LED will blink.
- When a tower does not re-pressurize, the Alarm LED, Pressure Switch LED, and Tower Drying LED will blink.
- To extinguish the blinking LEDs, correct the fault condition and press the alarm-reset button.
- Refer to Table 7-4.

7.5 Fixed Cycle Timing

Refer to Table 7-3 for the fixed cycle timing for the Level 1 Controller.

7.6 Event Sequence and Component Status

Refer to Table 7-4 for the event sequence and component status for the Level 1 Controller.

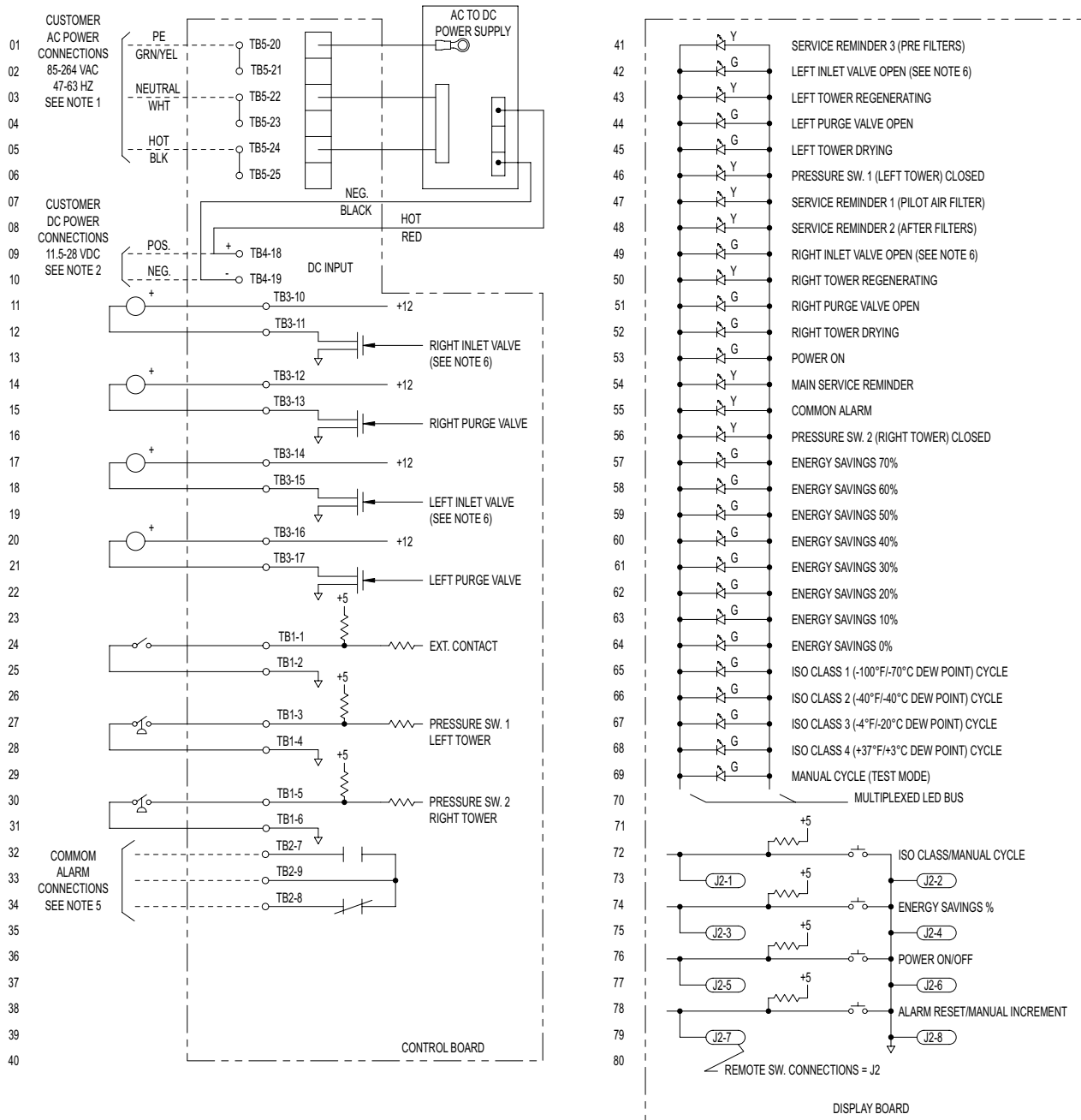
Dryer MOP		60 - 150 psig (4.1 - 10.3 barg)				120 - 250 psig (8.3 - 17.2 barg)			
ISO Class		1	2	3	4	1	2	3	4
Dew Point		-73°C	-40°C	-20°C	+3°C	-73°C	-40°C	-20°C	+3°C
		-100°F	-40°F	-4°F	+38°F	-100°F	-40°F	-4°F	+38°F
Cycle Time (minutes)		4	10	16	24	4	10	16	24
Time	Energy (Purge) Savings Settings	Time from start of cycle (minutes : seconds)				Time from start of cycle (minutes : seconds)			
t0	all	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
t1	all	00:02	00:02	00:02	00:02	00:02	00:02	00:02	00:02
t2	all	00:06	00:06	00:06	00:06	00:06	00:06	00:06	00:06
t3	70%	00:26	01:16	02:09	03:19	00:19	00:58	01:46	02:52
	60%	00:32	01:40	02:50	04:24	00:23	01:16	02:20	03:48
	50%	00:39	02:03	03:31	05:28	00:27	01:33	02:53	04:43
	40%	00:46	02:26	04:11	06:32	00:31	01:50	03:26	05:38
	30%	00:52	02:50	04:52	07:37	00:35	02:08	04:00	06:34
	20%	00:59	03:13	05:33	08:41	00:40	02:25	04:33	07:29
	10%	01:05	03:37	06:14	09:46	00:44	02:43	05:07	08:25
	0%	01:12	04:00	06:55	10:50	00:48	03:00	05:40	09:20
t4	all	02:00	05:00	08:00	12:00	02:00	05:00	08:00	12:00
t5	all	02:02	05:02	08:02	12:02	02:02	05:02	08:02	12:02
t6	all	02:06	05:06	08:06	12:06	02:06	05:06	08:06	12:06
t7	70%	02:26	06:16	10:09	15:19	02:19	05:58	09:46	14:52
	60%	02:32	06:40	10:50	16:24	02:23	06:16	10:20	15:48
	50%	02:39	07:03	11:31	17:28	02:27	06:33	10:53	16:43
	40%	02:46	07:26	12:11	18:32	02:31	06:50	11:26	17:38
	30%	02:52	07:50	12:52	19:37	02:35	07:08	12:00	18:34
	20%	02:59	08:13	13:33	20:41	02:40	07:25	12:33	19:29
	10%	03:05	08:37	14:14	21:46	02:44	07:43	13:07	20:25
	0%	03:12	09:00	14:55	22:50	02:48	08:00	13:40	21:20
t8	all	04:00	10:00	16:00	24:00	04:00	10:00	16:00	24:00
Reference Data									
Purge time (min:sec) at 0% Energy Savings settings [(t3-t2) or (t7-t6)]		01:06	03:54	06:49	10:44	00:42	02:54	05:34	09:14
Purge time (min:sec) at 0% Energy Savings settings [(t4-t3) or (t8-t7)]		00:48	01:00	01:05	01:10	01:12	02:00	02:20	02:40

Table 7-3
Fixed Cycle Timing – Level 1 Controller

Process valve name (Process valve state w/ de-energized pilot solenoid valve)	Time (refer to Table 7-3)								
	t0	t1	t2	t3	t4	t5	t6	t7	t8
	Left Tower Drying Right Tower Regenerating Half Cycle				Right Tower Drying Left Tower Regenerating Half Cycle				
Left purge valve (normally closed)							Pilot Energized (open)		
Left inlet valve (normally open) (See NOTE 1)							Pilot Energized (closed)		
Right inlet valve (normally open) (See NOTE 1)		Pilot Energized (closed)							
Right purge valve (normally closed)			Pilot Energized (open)						
Normal status of pressure switches									
Left tower pressure switch	closed	closed	closed	closed	closed	closed	closed	closed for < 5 sec. then open	open at t7, closed before t8
Right tower pressure switch	closed	closed	closed for < 5 sec. then open	open at t3, closed before t4	closed	closed	closed	closed	closed
Pressure switch status that causes an alarm									
Left tower drying Low tower pressure ^a			open ¹	open ¹					
Left tower regenerating Fail to de-pressurize ^b							closed ¹		
Left tower regenerating Fail to re-pressurize ^c									open ²
Right tower drying Low tower pressure ^d							open ¹		open ¹
Right tower regenerating Fail to de-pressurize ^e			closed ¹						
Right tower regenerating Fail to re-pressurize ^f				open ²					
Note	Stop cycle on fault	Comments							
1: Check for fault condition at 15, 25, 35,... seconds into half-cycle	no	If the fault condition is clear for 2 cycles: the alarm LED stays on (without blinking); the tower and pressure switch LEDs stop blinking (return to normal operation). Once the fault condition is clear, pressing the reset button will clear the alarm LED (and the tower and pressure switch LEDs if they are still blinking).							
2: Check for fault condition just before the end of the half-cycle	yes	If the fault condition clears: resume cycling; the alarm LED stays on (without blinking); the pressure switch LED stops blinking (returns to normal operation). Once the fault condition is clear, pressing the reset button will clear the alarm LED.							
a: Blink the following LEDs: Alarm + P1 + Left tower drying									
b: Blink the following LEDs: Alarm + P1 + Left tower regenerating									
c: Blink the following LEDs: Alarm + P1									
d: Blink the following LEDs: Alarm + P2 + Right tower drying									
e: Blink the following LEDs: Alarm + P2 + Right tower regenerating									
f: Blink the following LEDs: Alarm + P2									

NOTE 1: Standard Pressure Models 4100 & 5400 ONLY. High Pressure Models 40 through 450 ONLY

Table 7-4
Event Sequence and Component Status – Level 1 Controller



NOTES:

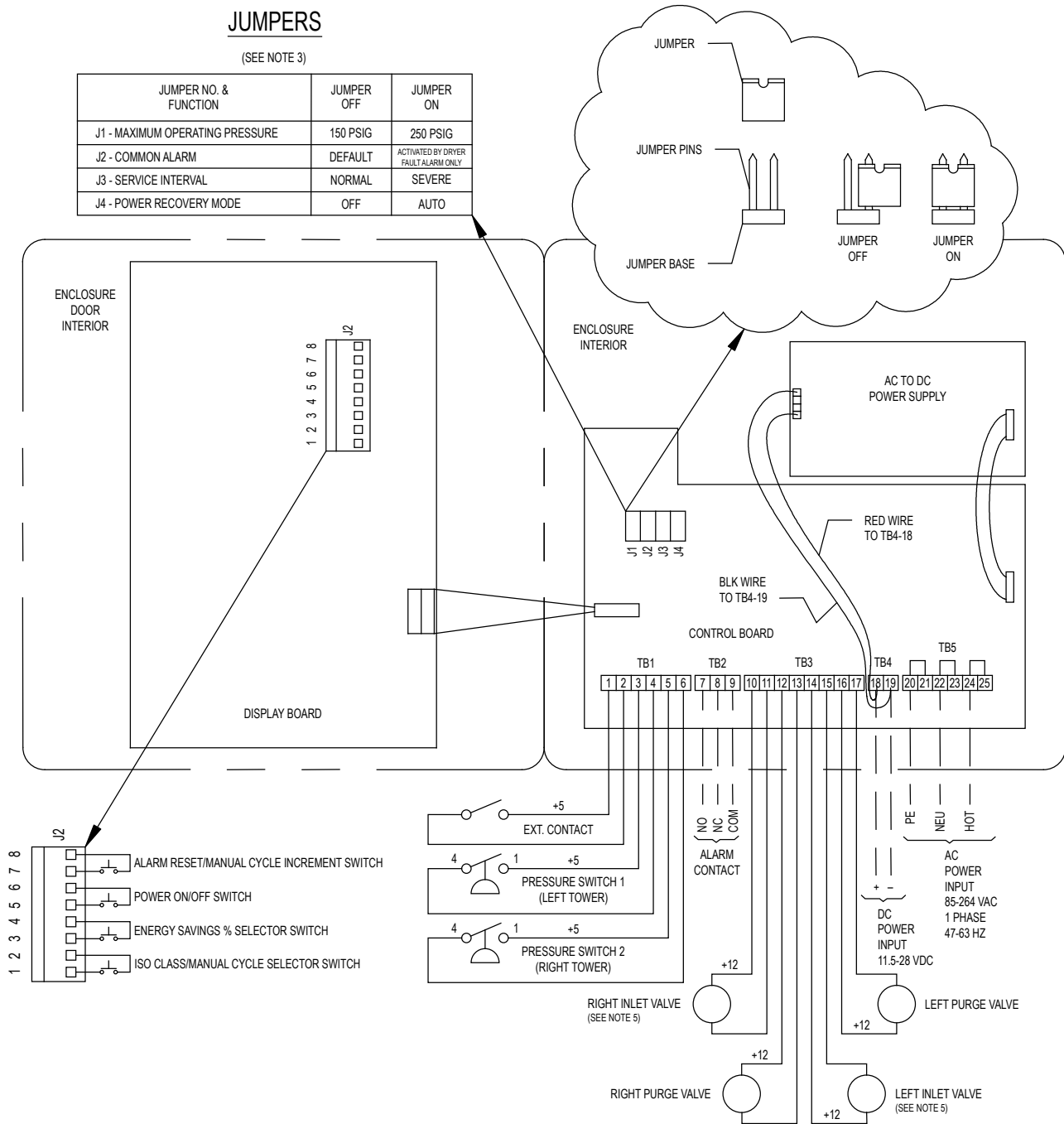
- CUSTOMER POWER CONNECTIONS WHEN SUPPLY VOLTAGE IS AC (ALTERNATING CURRENT). TERMINALS TB5-21, TB5-23 AND TB5-25 CAN BE USED TO PROVIDE ACCESSORY POWER AT THE SAME VOLTAGE AND FREQUENCY. AC POWER IS DIRECTED TO POWER SUPPLY BOARD WHERE IT IS CONVERTED TO 12 VDC AND RETURNED TO THE CONTROL BOARD.
- CUSTOMER POWER CONNECTIONS WHEN SUPPLY VOLTAGE IS DC (DIRECT CURRENT). RED AND BLACK WIRES FROM THE POWER SUPPLY BOARD SHOULD BE REMOVED AND THE CUSTOMER SHOULD MAKE THEIR POWER CONNECTIONS AT TERMINALS TB4-18 AND TB4-19.
- VOLTAGE RATING OF VALVES IS 12 VDC.
- VOLTAGE RATING OF SWITCHES IS 5 VDC.
- WITH UNIT ON AND NO ALARMS, THERE SHOULD BE CONTINUITY BETWEEN TERMINALS TB2-7 AND TB2-9.
- STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.

Figure 7-2
Electrical Schematic – Level 1 Controller

JUMPERS

(SEE NOTE 3)

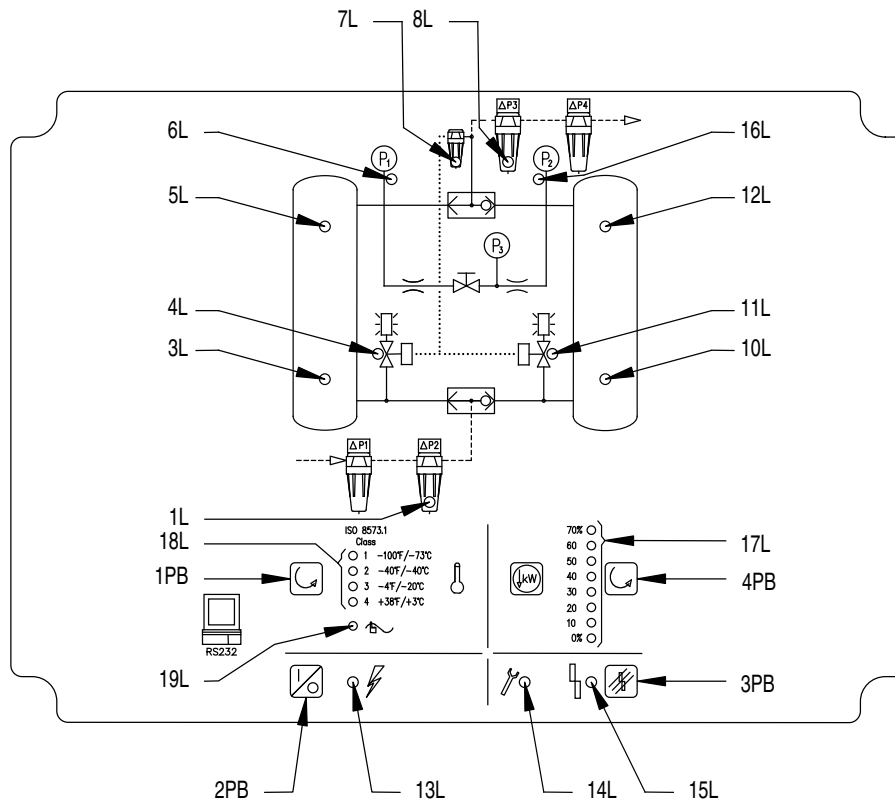
JUMPER NO. & FUNCTION	JUMPER OFF	JUMPER ON
J1 - MAXIMUM OPERATING PRESSURE	150 PSIG	250 PSIG
J2 - COMMON ALARM	DEFAULT	ACTIVATED BY DRYER FAULT/ALARM ONLY
J3 - SERVICE INTERVAL	NORMAL	SEVERE
J4 - POWER RECOVERY MODE	OFF	AUTO



NOTES:

- SEE FIGURE 7-5 FOR RECOMMENDED AWG CONDUCTOR SIZES.
- CUSTOMER SUPPLIED AC (ALTERNATING CURRENT) INPUT POWER CONNECTIONS SHOULD BE MADE AT TERMINALS TB5-21, TB5-23, AND TB5-25. FOR CUSTOMER SUPPLIED DC (DIRECT CURRENT) POWER, THE RED AND BLACK WIRES FROM THE POWER SUPPLY BOARD SHOULD BE REMOVED AND THE CUSTOMER POWER CONNECTIONS SHOULD BE MADE AT TERMINALS TB4-18 AND TB4-19.
- IN THE "JUMPER OFF" POSITION, THE JUMPER CAN BE COMPLETELY REMOVED OR STORED ON A SINGLE PIN. IN THE "JUMPER ON" POSITION, THE JUMPER IS INSTALLED ACROSS BOTH PINS TO PROVIDE CONTINUITY.
- WITH THE UNIT ON AND NO ALARMS, THERE SHOULD BE CONTINUITY BETWEEN TERMINALS TB2-7 AND TB2-9.
- STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.

Figure 7-3
Point-to-Point Connection Diagram - Level 1 Controller



ENCLOSURE DOOR EXTERIOR

LEGEND

CR	COMMON ALARM RELAY	12L	RIGHT TWR. DRYING (GREEN)	1PB	ISO CLAS/MANUAL CYCLE SELECTOR SWITCH
1L	SERVICE REMINDER 3 - PREFILTERS (AMBER)	13L	POWER ON LED (GREEN)	2PB	POWER ON/OFF SWITCH
3L	LEFT TOWER REGEN. (AMBER)	14L	MAIN SERVICE REMINDER (AMBER)	3PB	ALARM RESET/MANUAL CYCLE INCREMENT SWITCH
4L	LEFT PURGE VALVE OPEN (GREEN)	15L	COMMON ALARM (RED)	4PB	ENERGY SAVINGS % SELECTOR SWITCH
5L	LEFT TOWER DRYING (GREEN)	16L	PRESS. SWITCH 2 - R. TWR. CLOSED (GREEN)	RS232	SERIAL I/O CONNECTION
6L	PRESS. SWITCH 1 - L. TWR. CLOSED (GREEN)	17L	ENERGY SAVINGS % LEDS (GREEN)	PS	AC TO DC POWER SUPPLY
7L	SERVICE REMINDER 1 - PILOT AIR FILTER (AMBER)	18L	ISO CLASS (DEW POINT) CYCLE LEDS (GREEN)	J2	REMOTE SWITCH TERMINALS
8L	SERVICE REMINDER 2 - AFTERFILTERS (AMBER)	19L	MANUAL CYCLE (TEST MODE) LED (GREEN)	TB1	EXTERNAL CONTROL INPUT TERMINALS
10L	R. TWR REGEN. (AMBER)	CNTRLPCB	CONTROL BOARD	TB2	COMMON ALARM CONTACT TERMINALS
11L	RIGHT PURGE VALVE OPEN (GREEN)	DISPCB	DISPLAY BOARD	TB3	VALVE OUTPUT TERMINALS
		JMP	CONFIGURATION JUMPERS	TB4	DC POWER INPUT TERMINALS
				TB5	AC POWER INPUT TERMINALS

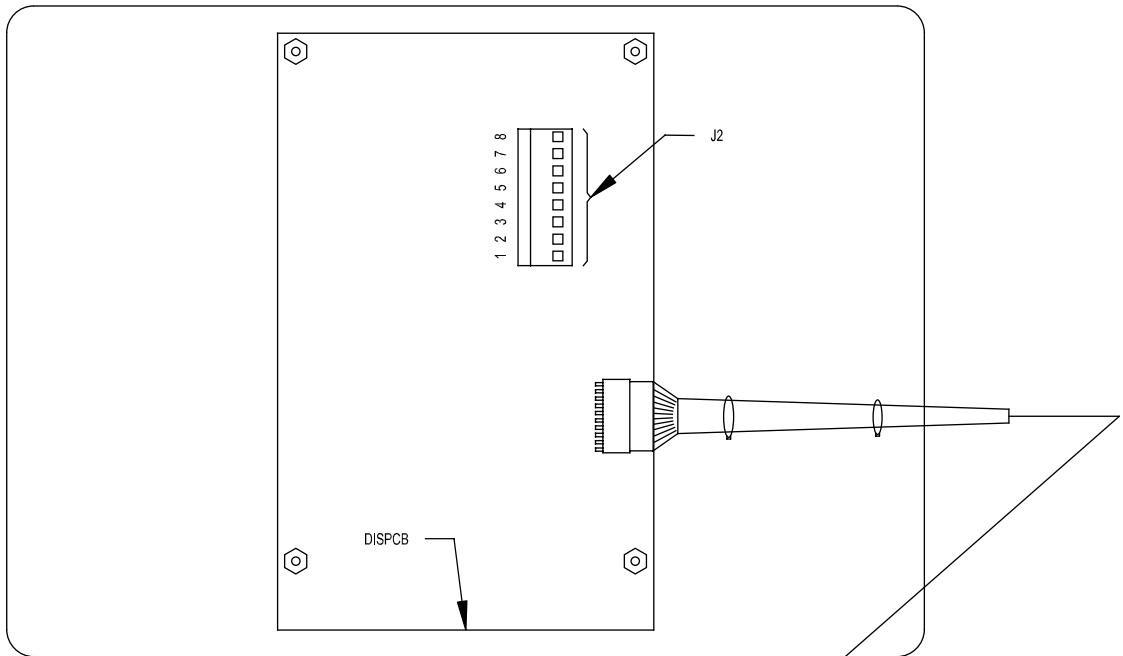
Figure 7-4

Panel Layouts - Level 1 Controller

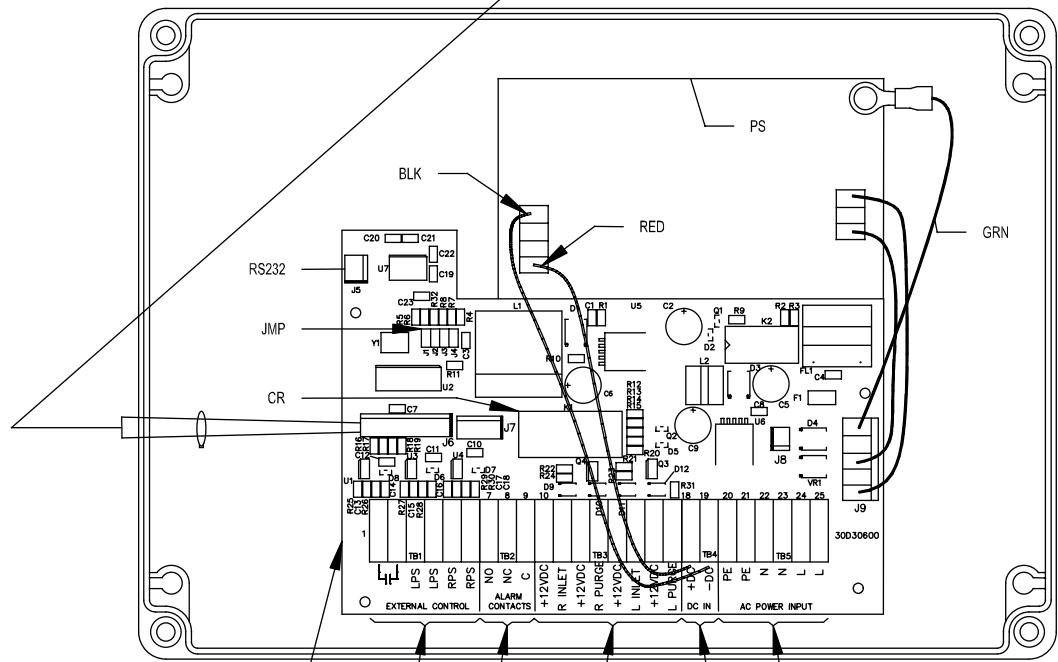
(Note: Figure is representative of Standard Pressure Models KAD 40 through 3000.)

(Note: Overlay for Standard Pressure Models KAD 4100 & 5400 depicts a different inlet valve and outlet/purge circuit. Overlay for High Pressure Models KAD 40 through 450 depicts a different inlet valve circuit.)

(continued on next page)



ENCLOSURE DOOR INTERIOR

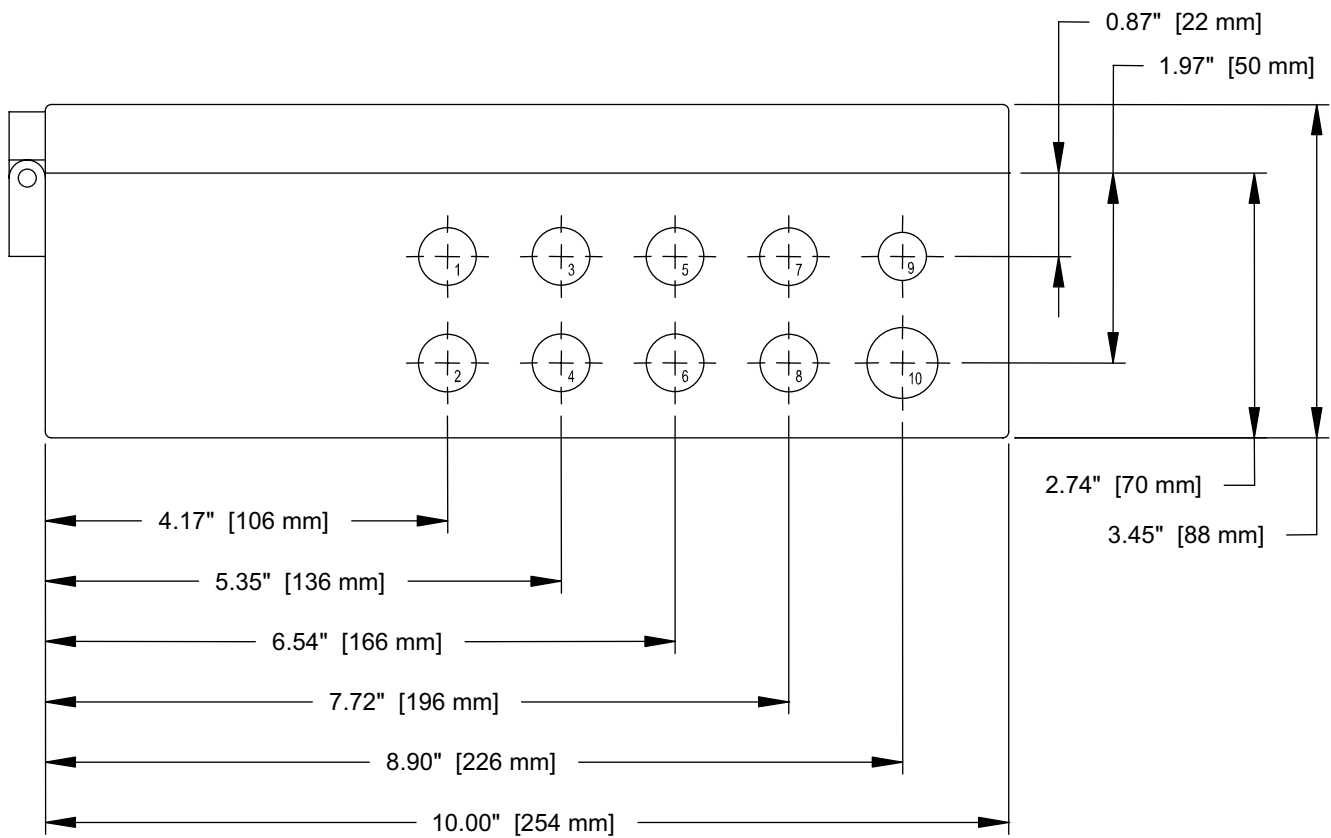


ENCLOSURE INTERIOR

Figure 7-4
Panel Layouts - Level 1 Controller
(continued from previous page)

LOCATION	FUNCTION	# OF CONDUCTORS	AWG SIZE	CABLE DIAMETER RANGE				CONNECTOR SIZE	ENCLOSURE HOLE DIA.		
				MIN. DIA.		MAX. DIA.			in.	mm	
				in.	mm	in.	mm				
1	FACTORY CONNECTIONS STANDARD DEVICES	PRESSURE SWITCH - RIGHT TOWER	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
2		PRESSURE SWITCH - LEFT TOWER	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
3		SOLENOID - LEFT PURGE VALVE	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
4		SOLENOID - LEFT INLET VALVE*	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
5		SOLENOID - RIGHT PURGE VALVE	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
6		SOLENOID - RIGHT INLET VALVE*	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
7	USER CONNECTIONS	ALARM CONTACTS	2	16	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
8		REMOTE STOP / START	2	16	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
9		RS232	3	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
10		INPUT POWER	3	14	0.230	5.8	0.395	10.0	PG-11	0.733	18.6

* STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.



BOTTOM VIEW - HINGE LEFT

Figure 7-5
Enclosure Penetrations - Level 1 Controller

8. CONTROLLER – LEVEL 2

This section provides connection, adjustment and operational information for the Level 2 Controller featuring the Automatic Purge Saving System (APSS). Similar information can be found in Section 7 for the Level 1, Fixed Cycle Controller.

8.1 Reference Figures – Level 2 Controller

- Figure 8-1, Front Panel Overlay – Level 2 Controller
- Figure 8-2, Electrical Schematic – Level 2 Controller
- Figure 8-3, Point-to-Point Diagram – Level 2 Controller
- Figure 8-4, Panel Layouts – Level 2 Controller
- Figure 8-5, Enclosure Penetrations – Level 2 Controller

8.2 Connections – Level 2 Controller

See Figure 8-5, Enclosure Penetrations for the location, size and function of the various cable and cord connectors that are provided on the bottom of the Level 2 enclosure.

8.2.1 Connections - Input Power

8.2.1.1 VAC Input Power Connections

Single-phase, alternating current (AC) input power connections ranging from 85-264 VAC and 47 to 63 Hz. can be made at terminals TB6-45, -47, and -49. See reference figures for proper polarity. These terminals are connected to accessory output terminals TB6-44, -46, and -48 respectively. Accessory output terminals can be used to direct power at the same voltage and frequency to external devices.

CAUTION: Accessory output terminals are **NOT** controlled by the power on/off switch and are always energized when power is provided to terminals TB6-45, -47, and -49.

8.2.1.2 VDC Power Connections

- The control and display boards operate on low-voltage direct current. The controller is provided pre-wired with an AC to 12 VDC power supply board. For users with AC power as described in Section 8.2.1.1, their AC input is directed to the power supply board where it is conditioned and returned to the control board as 12 VDC at terminals TB5-42 and -43.
- For users with direct current (DC) input power ranging from 11.5 to 28 VDC, use of the AC to DC power supply board is not needed and their connections can be made at terminals TB5-42 and -43 by first removing the black and red leads coming from the power supply board. See reference figures for proper polarity.

8.2.2 Connections – Common Alarm Contacts

Connections to voltage-free common alarm contacts with a maximum 5-amp rating can be made at terminals TB4-39 through -41.

- Terminal TB4-41 is the common contact connection.
- Terminal TB4-39 is the N.O. (normally open) contact connection.
- Terminal TB4-40 is the N.C. (normally closed) contact connection.
- The alarm relay coil is energized when power is supplied to the controller input terminals and there are no alarms.
- The coil is de-energized when power is removed or when an alarm condition exists.

- The common alarm is designed to activate on: a) either a dryer fault condition or a service reminder, or b) a dryer fault condition only. This is user selectable.
- For the common alarm to activate on either a dryer fault condition or a service reminder, the jumper at JP6 is removed. This is the default configuration.
- To have the common alarm activate on a dryer fault condition only, the jumper at JP6 is installed.
- Additional information on the common alarm relay logic appears in Table 8-1.

Power To Controller?	Controller On or Off?	Alarm or Service Reminder	Alarm Relay Coil	Alarm N.O. Contact (TB4-39)	Alarm N.C. Contact (TB4-40)
No	N/A	N/A	De-Energized	Open	Closed
Yes	Off	N/A	Energized	Closed	Open
Yes	On	No	Energized	Closed	Open
Yes	On	Yes	De-Energized	Open	Closed

Table 8-1
Common Alarm Relay Logic –Level 2 Controller

8.2.3 Connections – Remote Start / Stop

Terminals TB2-17 and -18 are used to provide a 5 VDC output to a remote switch or volt free contacts that when closed will stop the dryer at the end of the current half cycle. The dryer will resume running at the beginning of the new half cycle when the remote switch or contacts are reopened. When dryer operation is in the remote stop state, all four tower drying (green) and regenerating (amber) LEDs flash simultaneously.

NOTE: Remote start / stop is disabled when the dryer is in the Manual cycle operation mode. When the dryer is in the remote stop state, the only front panel and remote selector switches (see Section 8.2.4) that remain enabled are the power on/off switches.

8.2.4 Connections – Remote Switches

The controller door is equipped with four momentary-contact, push button switches. Pressing on the appropriate icon printed on the display overlay actuates these switches. The display board containing the switches, display LEDs, text display, and the RPB (J2) terminal strip is mounted on the inside of the enclosure door. The terminal strip provides connection points for remotely mounted, NO (normally open), momentary-contact push buttons that provide the same function as the board mounted switches. The terminal – switch combinations are:

- Terminals J2-1 and -2 (Remote “SELECT” switch)
- Terminals J2-3 and -4 (Remote “ENTER” switch)
- Terminals J2-5 and -6 (Remote Power On / Off Switch)

NOTE: Care must be exercised in using this remote switch to stop a dryer. Closing this switch will affect the same response as a loss of power. Both purge-repressurization valves will close. On standard pressure models 4100 & 5400 and high pressure models 40 through 450, both inlet-switching valves will open. A tower that is actively purging when the power on/off button is actuated will be subjected to a rapid repressurization that can lead to fluidization and subsequent abrasion of the desiccant bed. Ideally, dryers should only be powered off during those portions of

the drying cycle when both desiccant towers are at full operating pressure. Use of the remote start/stop connections as described in Section 8.2.3 would be preferable in most cases.

- Terminals J2-7 and - 8 (Remote Alarm Reset Switch)

8.2.5 Connections – RS232

Refer to Figure 8-4, Panel Layouts – Level 2 Controller. RS232 connections can be made at the 3-pin connector labeled J3 and located at the upper left-hand corner of the control board. A cable for this connection can be purchased through your distributor.

8.2.6 Connections – High humidity alarm

The normally closed dry contacts from a high humidity alarm device can be wired to AUX 1 terminals TB1-7 and TB1-8. A shorting jumper that connects the two terminals must be installed if an alarm device is not wired to the terminals. When continuity between the terminals is broken, the controller displays an outlet dew point alarm (refer to Section 8.9, screens 17 and 18).

8.3 Control Board Jumpers – Level 2

Refer to Figure 8-3, Point to Point Connection Diagram – Level 2 Controller. In the upper left hand corner of the control board there are eight two-pin jumpers labeled JP1 through JP8. Only three of the eight jumper pairs are utilized. Pairs JP3-JP5 and JP7-JP8 are not used.

NOTE: Do not install jumpers in the ON position on pairs JP3 through JP5 or JP7 through JP8.

The jumper is a removable bridge that is used to make or break continuity between the two pins that form a pair. When installed in the ON position, the jumper is placed on both pins of the pair and continuity between the pins is established. When installed in the OFF position, the jumper is removed or stored on a single pin and continuity is broken. Jumper functions are as follows:

8.3.1 Jumper JP1 – Maximum Operating Pressure

- Jumper JP1 is used to select the maximum operating pressure. Installed in the OFF position when operating at inlet pressures of 60 to 150 psig (4.1 to 10.3 barg). Installed in the ON position when operating at inlet pressures of 120 to 250 psig (8.3 to 17.2 barg).
- This setting will affect tower purge and repressurization times.

8.3.2 Jumper JP2 – Electric Drains

- Jumper JP2 is installed in the ON position if one or two electric demand drains are installed. It is installed in the OFF position when no electric drains are installed.
- The drains can be manually tested through the Level 2 controller Setup Mode.
- The drains provide a digital alarm signal to the Level 2 controller, which then displays an alarm message.
- If the dryer has only 1 drain, then the alarm input terminals for Drain 2 (TB2-25 and TB2-26) must be shorted.

8.3.3 Jumpers JP3 through JP5 – Unused.

8.3.4 Jumper JP6 – Common Alarm.

Jumper JP6 is installed in the OFF position to enable both dryer fault alarms and service alarms to activate the common alarm. This is the default configuration. Install jumper JP6 in the ON position if the common alarm is to be activated by a dryer fault alarm only.

8.3.5 Jumpers JP7 through JP8 – Unused.

8.4 Front Panel Overlay – Level 2 Controller

Refer to Figure 8-1, Front Panel Overlay – Level 2 Controller for information regarding the location and function of the LEDs, switches, and text display.

8.4.1 Front Panel LEDs

- Power on – green (constant when controller is switched on; flashing when controller is energized but switched off.)
- Alarm – red
- Service/maintenance reminder – amber
- Filters (pre, after, and pilot) service/maintenance reminders - amber
- Purge / repressurization valve status (On = valve open; Off = valve closed) – green
- Left and right tower status (regenerating) - amber
- Left and right tower status (drying) - green
- Left and right tower pressure switch status (On = switch closed; Off = switch open) – green

8.4.2 Front Panel Switches

The front panel contains four momentary-contact push button switches. Refer to Figure 8-1, Front Panel Overlay – Level 2 Controller for the appropriate icon associated with each switch. Pushing on the overlay icon actuates the switch. Switching can be affected remotely by wiring external push-buttons to the RPB (J2) terminals located on the rear of the display board. Refer to Section 8.2.4.

8.4.2.1 Dryer On / Off Switch

This switch is used to turn the dryer on (run) or off (stop).

CAUTION: In the event of a loss of power, either intentional or unintentional, both purge-repressurization valves will close. On standard pressure models 4100 & 5400 and high pressure models 40 through 450, both inlet-switching valves will open. A tower that is actively purging when the power off button is actuated will be subjected to a rapid repressurization that can lead to fluidization and subsequent abrasion of the desiccant bed. Ideally, dryers should be powered off at the end of any half cycle when both desiccant towers are at full operating pressure.

Power recovery after an external loss of power is affected by the programming of the auto restart mode (Program Mode – Screen 2). Refer to Section 8.7 for additional information.

8.4.2.2 SELECT Switch

This button is located to the left of the text display window. Refer to Section 8.6 for additional information.

8.4.2.3 ENTER Switch

This button is located to the right of the text display window. Refer to Section 8.6 for additional information.

8.4.2.4 Alarm Reset Switch

This switch is normally used to reset an alarm or service reminder. Refer to Section 8.9 for additional information.

8.5 Event Sequence and Component Status

Refer to Tables 8-2, 8-3, and 8-4 for the event sequence, timing and component status for the Level 2 Controller.

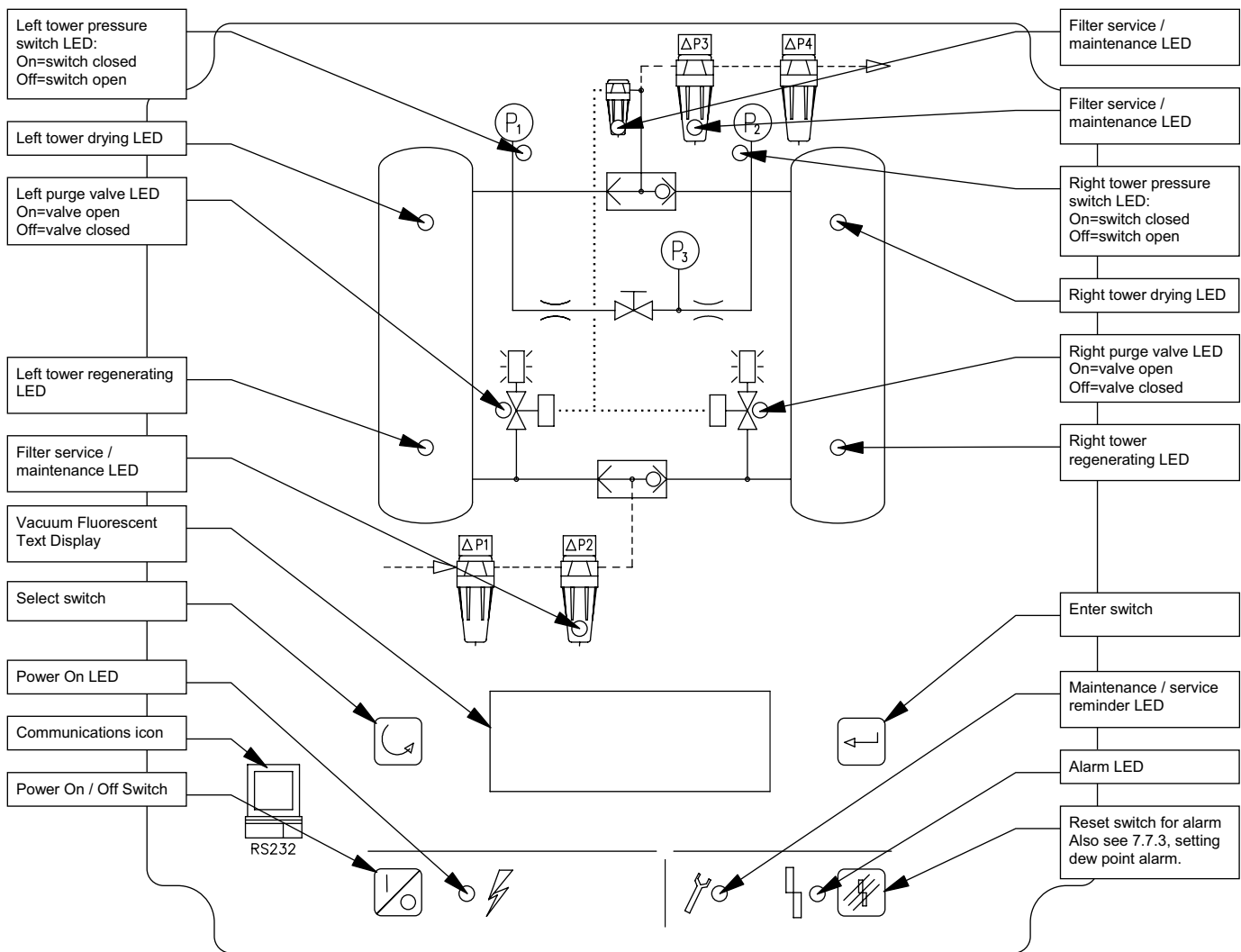






Figure 8-1
 Front Panel Overlay – Level 2 Controller
 (Note: Figure is representative of Standard Pressure Models KADPS 40 through 3000.)
 (Note: Overlay for Standard Pressure Models KADPS 4100 & 5400 depicts a different inlet valve and outlet/purge circuit. Overlay for High Pressure Models KADPS 40 through 450 depicts a different inlet valve circuit.)

8.6 Front Panel Operation



1. There are five operating modes for the Level 2 Desiccant Dryer Controller.
 - a. Program Mode
 - b. Setup Mode
 - c. Alarm & Service Mode
 - d. Display Mode
 - e. Test Mode
2. Each mode is described in the following pages.

8.7 Program Mode

1. Press and hold  and  simultaneously for 3 seconds to enter Program Mode.
2. Program Mode is comprised of the screens that are described below.
3. There are three ways to exit Program Mode.
 - a. Press  after making the selection in the final screen.
 - b. At any screen, press and hold  for 3 seconds.
 - c. The controller automatically exits Program Mode if no button is pressed within 60 seconds.
4. Upon exiting Program Mode the controller will switch to Display Mode.



8.7.1 Program Mode Screen 1 – Select the language.

ENGLISH

- Press  to scroll through the available language choices: ENGLISH, DEUTSCH, FRANCAIS, ESPANOL, and ITALIANO.
- When finished, press  to save the selection and move to Screen 2.


8.7.2 Program Mode Screen 2 – Select the auto restart mode.


AUTO RESTART
DISABLED

- Press  to toggle between DISABLED and ENABLED.
- When finished, press  to save the selection and move to Screen 3.

8.7.3 Program Mode Screen 3 – Select the service level.



SERVICE LEVEL
NORMAL

- Press  to toggle between NORMAL and SEVERE.
 - a. NORMAL service intervals are:
 - i. 4000 hours for filters
 - ii. 8000 hours for desiccant
 - iii. 4000 hours for valves
 - b. SEVERE service intervals are:
 - i. 2000 hours for filters
 - ii. 4000 hours for desiccant
 - iii. 2000 hours for valves

- NOTE: Time continues to accumulate as long as power is supplied to the controller, whether the controller is switched on or off.
- When finished Press  to save the selection and move to Screen 4 (if no filter monitors are detected) or Screen 5 (if 1 or 2 filter monitors are detected).



8.7.4 Program Mode Screen 4 – Reset the timer for filter service.

FILTER SERVICE
RESET? NO

- Press  to toggle between NO and YES.
- When finished, press  to acknowledge the selection and move to Screen 5.



8.7.5 Program Mode Screen 5 – Reset the timer for desiccant service.

DESICCANT SERVICE
RESET? NO

- Press  to toggle between NO and YES.
- When finished, press  to acknowledge the selection and move to Screen 6.



8.7.6 Program Mode Screen 6 – Reset the timer for valve service.

VALVE SERVICE
RESET? NO




- Press  to toggle between NO and YES.
- When finished, press  to acknowledge the selection and move to Screen 7.

8.7.7 Program Mode Screen 7 – Reset the valve cycle counter.

CYCLE COUNTER
RESET? NO

- Press  to toggle between NO and YES.
- When finished, press  to acknowledge the selection and exit Program Mode.



8.8 Setup Mode

- Press and hold  for 3 seconds to enter Setup Mode.
- Setup Mode is comprised of the screens that are described on the following page.
- There are three ways to exit Setup Mode.
 1. Press  after making the selection in Screen 2 (if the dryer does not have electric drains) or Screen 3 (if the dryer has electric drains).
 2. At any screen, press and hold  for 3 seconds.
 3. The controller automatically exits Setup Mode if no button is pressed within 60 seconds.

- One of two things will happen upon exiting Setup Mode.
 1. The controller will switch to Display Mode if DEMAND CYCLE or FIXED CYCLE was selected.
 2. The controller will switch to Test Mode if MANUAL CYCLE was selected.



8.8.1 Setup Mode Screen 1 – Select the dew point class.

ISO 8573 DEW PT
2: -40°C/-40°F

- Press  to scroll through the choices:
 - 1: -73°C/-100°F
 - 2: -40°C/-40°F
 - 3: -20°C/-4°F
 - 4: +3°C/+38°F
- When finished, press  to save the selection and move to Screen 2.



8.8.2 Setup Mode Screen 2 – Select the cycle type.

CYCLE TYPE
DEMAND CYCLE

- Press  to scroll through the choices: DEMAND CYCLE, FIXED CYCLE, and MANUAL CYCLE. Note: DEMAND CYCLE is not available if Class 1 was selected in the previous screen.
- When finished, press  to save the selection and move to Screen 3 (if the dryer has electric drains) or exit Setup Mode (if the dryer does not have electric drains).

8.8.3 Setup Mode Screen 3 – Test the drains.

TEST DRAIN ?
NO

- Press  to toggle between NO and YES.
- Press  to continue.
 - a. If NO was selected, the controller immediately exits Setup Mode.
 - b. If YES was selected, the controller energizes Drain 1 and Drain 2 for 4 seconds before exiting Setup Mode.

8.9 Alarm & Service Mode

Alarm & Service Mode is active when the controller is in Display Mode. It is not active in Program Mode, Setup Mode, or Test Mode.

NOTE: Alarm messages have priority over Service messages. Service messages have priority over Display messages. When an alarm occurs, Display Mode is disabled and only the alarm message is shown. When a service message is active, it takes the place of the corresponding service reminder in the Display Mode (e.g. "HOURS TO SERVICE FILTERS: XXXX" would be replaced by "SERVICE DRYER FILTERS").

8.9.1 Alarm messages

Alarm messages are displayed on a first-out basis with one exception. The alarm caused by an open pressure switch at the end of the regeneration cycle, takes precedence over existing alarms. See 8.9.1.1 (3).

8.9.1.1 Pressure Switch Alarms

There are three alarms for each tower that are triggered by the tower pressure switches. These alarms can occur in either the fixed or demand cycle. Following is a brief description of each alarm.

1. Left or right tower, drying, low pressure
 - Pressure switch open during drying cycle
2. Left or right tower, regenerating, high pressure
 - Pressure switch closed while purge valve is open (after an initial time delay)
3. Left or right tower, regenerating, low pressure
 - Pressure switch open at the end of the regenerating cycle

8.9.1.2 Thermistor Alarms

There are two alarms for each of the four thermistors. These alarms can only occur in the demand cycle. Following is a brief description of each alarm.

1. Left or right tower, upper or lower sensor, over-range
 - Temperature above 150°F (66°C)
 - Thermistor circuit shorted
2. Left or right tower, upper or lower sensor, under-range one cycle
 - Temperature below 40°F (4°C)
 - Thermistor circuit open

8.9.1.3 Optional Device Alarms

1. Electric Drains with Alarm Contacts
 - Each drain has alarm contacts that connect to the Level 2 Controller.
 - If the contacts open, then a drain alarm is indicated.
2. Humistat (humidity sensor) - AUX 1 input
 - The humistat has alarm contacts that connect to the Level 2 controller.
 - If the contacts open, the outlet dew point alarm is indicated.

When an alarm condition occurs, the controller operates as follows.

- The alarm LED blinks and the appropriate alarm message is shown on the text display.
- The dryer continues to cycle normally (see below for exception). NOTE: The LEDs for the valves, pressure switches, and desiccant towers are not used for alarm indication (as in the Level 1 Controller).
- If the alarm condition clears for one cycle, then the alarm LED stops blinking (LED on); the alarm message continues to be displayed.
- Exception: If the alarm is caused by the condition in Section 8.9.1.1, then the cycle stops. Once the alarm condition is corrected, the alarm LED stops blinking (LED on) and the cycle continues normally; the alarm message continues to be displayed.
- In the demand cycle, the control switches to a fixed 10 minute cycle when the alarm LED begins blinking. Control switches back to the selected demand cycle after the alarm condition clears. This applies to thermistor and outlet dew point alarms, but not to drain alarms.
- When the alarm condition is corrected, press the reset button to extinguish the alarm LED and to clear the alarm message from the text display.

The following text display is shown for each alarm. The second line of the alarm screens contains up to three messages, which are scrolled through, displaying each one for 3 seconds after the alarm condition clears.

8.9.1.4 Alarm Mode Screen 1 – Left Tower Drying – Low Pressure (Open Pressure Switch Circuit)

ALARM
LEFT TOWER DRYING LOW PRESSURE

8.9.1.5 Alarm Mode Screen 2 – Left Tower Regenerating – High Pressure (Closed Pressure Switch Circuit)

ALARM
LEFT TOWER REGENERATING HIGH PRESSURE

8.9.1.6 Alarm Mode Screen 3 – Left Tower Regenerating- Low Pressure (Open Pressure Switch Circuit)

ALARM
LEFT TOWER REGENERATING LOW PRESSURE

8.9.1.7 Alarm Mode Screen 4 – Left Tower, Upper Sensor (Thermistor) Under-Range

ALARM
LEFT TOWER UPPER SENSOR UNDER-RANGE

8.9.1.8 Alarm Mode Screen 5 – Left Tower, Upper Sensor (Thermistor) Over-Range

ALARM
LEFT TOWER UPPER SENSOR OVER-RANGE

8.9.1.9 Alarm Mode Screen 6 – Left Tower, Lower Sensor (Thermistor) Under-Range

ALARM
LEFT TOWER LOWER SENSOR UNDER-RANGE

8.9.1.10 Alarm Mode Screen 7 – Left Tower, Lower Sensor (Thermistor) Over-Range

ALARM
LEFT TOWER LOWER SENSOR OVER-RANGE

8.9.1.11 Alarm Mode Screen 8 - Right Tower Drying – Low Pressure (Open Pressure Switch Circuit)

ALARM
RIGHT TOWER DRYING LOW PRESSURE

8.9.1.12 Alarm Mode Screen 9 – Right Tower Regenerating – High Pressure (Closed Pressure Switch Circuit)

ALARM
RIGHT TOWER REGENERATING HIGH PRESSURE

8.9.1.13 Alarm Mode Screen 10 – Right Tower Regenerating- Low Pressure (Open Pressure Switch Circuit)

ALARM
RIGHT TOWER REGENERATING LOW PRESSURE

8.9.1.14 Alarm Mode Screen 11 – Right Tower, Upper Sensor (Thermistor) Under-Range

ALARM
RIGHT TOWER UPPER SENSOR UNDER-RANGE

8.9.1.15 Alarm Mode Screen 12 – Right Tower, Upper Sensor (Thermistor) Over-Range

ALARM
RIGHT TOWER UPPER SENSOR OVER-RANGE

8.9.1.16 Alarm Mode Screen 13 – Right Tower, Lower Sensor (Thermistor) Under-Range

ALARM
RIGHT TOWER LOWER SENSOR UNDER-RANGE

8.9.1.17 Alarm Mode Screen 14 – Right Tower, Lower Sensor (Thermistor) Over-Range

ALARM
RIGHT TOWER LOWER SENSOR OVER-RANGE

8.9.1.18 Alarm Mode Screen 15 – Alarm Drain 1

ALARM
DRAIN 1

8.9.1.19 Alarm Mode Screen 16 – Alarm Drain 2

ALARM
DRAIN 2

8.9.1.20 Alarm Mode Screen 17 – Alarm

ALARM
LEFT TOWER DRYING OUTLET DEW POINT

8.9.1.21 Alarm Mode Screen 18 – Alarm

ALARM
RIGHT TOWER DRYING OUTLET DEW POINT

8.9.2 Service messages

There are two service levels (normal and severe) as described in Program Mode. Each service level has preset time intervals for servicing the filters, desiccant, and valves. Time continues to accumulate as long as power is supplied to the controller, whether the controller is switched on or off.

When a service time interval expires, the controller operates as follows.

- The service LED blinks and the appropriate service message is shown on the text display. (See 8.9.1)
- When the service interval for filters has expired the three filter LEDs also blink. NOTE: If the dryer has 1 or 2 filter monitors, the timer for filter service is disabled. When the filter monitor(s) sends an alarm signal (change filter) to the Level 2 Controller, the controller displays the same LEDs and messages it would if the timer for filter service had expired.
- The dryer continues to cycle normally.
NOTE: The LEDs for the valves, pressure switches, and desiccant towers are not used for service indication (as in the Level 1 Controller).

To extinguish the service LED and clear the service message from the text display, go to Program Mode and reset the appropriate service timer. If a filter monitor is installed, reset the monitor to clear the Service LED.

The following text display is shown for each service message. Replacement or repair of the affected item may or may not be necessary. The service reminders are used to schedule routine evaluation of the operational status of key components.

8.9.2.1 Service Mode Screen 1 – Service filters

SERVICE DRYER
FILTERS

Check filter Delta-P gauges and ensure that drains are functioning properly. Inspect pilot air filter element. Check filter monitors, if equipped.

8.9.2.2 Service Mode Screen 2 – Service desiccant

SERVICE DRYER
DESICCANT


Check moisture indicator or outlet dew point and inspect mufflers for excessive dusting.

8.9.2.3 Service Mode Screen 3 – Service valves

SERVICE DRYER
VALVES

Ensure that valves are cycling properly. Check for switching failure alarms and adjust purge pressure. Check for leaks.

8.10 Display Mode

- Display Mode is active when the user exits Program Mode or Setup Mode (unless MANUAL cycle was selected in Setup Mode) and no alarms are active.
- The LEDs for the valves, pressure switches, and desiccant towers operate in the same manner as in the Level 1 Controller, except in the case of an alarm or service reminder (see 5.b and 7.b in Alarm & Service Mode).
- Display Mode is comprised of several screens (described below). The controller automatically scrolls through the screens, displaying each one for 4 seconds. The user can override the 4 second time period and force the next screen to be displayed by pressing .
- The screens are displayed in the following sequence: 1, 2, 3A, 1, 2, 3B, 1, 2, 3C, 1, 2, 3D, ... with the exceptions noted below.

8.10.1 Display Mode Screen 1 – Dew point class and cycle type.

2: -40°C/-40°F
DEMAND CYCLE

8.10.2 Display Mode Screen 2 – Energy savings. This screen is not displayed if FIXED cycle is selected.

ENERGY SAVINGS
XX%

8.10.3 Display Mode Screen 3A – Service reminder (filters). This screen is not displayed if 1 or 2 filter monitors are detected.

HOURS TO SERVICE
FILTERS: XXXX

8.10.4 Display Mode Screen 3B – Service reminder (desiccant).

HOURS TO SERVICE
DESICCANT: XXXX

8.10.5 Display Mode Screen 3C – Service reminder (valves).






HOURS TO SERVICE
VALVES: XXXX

8.10.6 Display Mode Screen 3D – Valve cycle counter.

CYCLE COUNTER
XXXXXXXX


8.11 Test Mode

- Test Mode is active when the user exits Setup Mode after selecting operation in MANUAL CYCLE.
- Test Mode is comprised of eight screens. Each screen corresponds to one of eight program steps (described in Table 8-2).

- Press  to advance from one screen (program step) to the next. Be sure to read and understand all cautions listed with the screen (program step) descriptions.
- If the temperature is below 40°F or the thermistor circuit is open, the second line of the display will read “UNDER-RANGE” instead of the temperature reading. (Refer to screens 2, 3, 4, 6, 7, and 8.)
- If the temperature is above 150°F or the thermistor circuit is shorted, the second line of the display will read “OVER-RANGE” instead of the temperature reading. (Refer to screens 2, 3, 4, 6, 7, and 8.)
- Upon entering Test Mode, the program can be at any one of the eight steps.
- To exit Test Mode:
 1. Use  to manually advance the program to step 1 or 5.
 - a) The program must be set at step 1 or 5 to exit Test Mode.
 - b) Screen 9 is displayed for 3 seconds if the user attempts to exit the program from step 2, 3, or 4.
 - c) Screen 10 is displayed for 3 seconds if the user attempts to exit the program from step 6, 7, or 8.
 2. Press and hold  for 3 seconds to exit Test Mode. The display switches to Screen 2 of Setup Mode.
 3. Use  to select DEMAND CYCLE or FIXED CYCLE.
 4. Press  to accept the selection and activate Display Mode.


8.11.1 Test Mode Screen 1 – Step 1

TEST MODE STEP 1
OK TO EXIT NOW

- No temperature display on this screen.
- Press  to advance to screen 2.


8.11.2 Test Mode Screen 2 – Step 2

TEST MODE STEP 2
XX°C XXX°F

- The left tower drying light is blinking to indicate the thermistor location (upper left) that corresponds to the temperature display.
- Press  to advance to screen 3.

8.11.3 Test Mode Screen 3 – Step 3


TEST MODE STEP 3
XX°C XXX°F

- The right tower regenerating light is blinking to indicate the thermistor location (lower right) that corresponds to the temperature display.
- Press  to advance to screen 4.

8.11.4 Test Mode Screen 4 – Step 4


TEST MODE STEP 4
XX°C XXX°F

- The left tower drying light is blinking to indicate the thermistor location (upper left) that corresponds to the temperature display.

- CAUTION: Do not advance to step 5 until the right tower has fully pressurized.
- Press  to advance to screen 5.


8.11.5 Test Mode Screen 5 – Step 5

TEST MODE STEP 5
OK TO EXIT NOW

- No temperature display on this screen.
- Press  to advance to screen 6.


8.11.6 Test Mode Screen 6 – Step 6

TEST MODE STEP 6
XX°C XXX°F

- The right tower drying light is blinking to indicate the thermistor location (upper right) that corresponds to the temperature display.
- Press  to advance to screen 7.


8.11.7 Test Mode Screen 7 – Step 7

TEST MODE STEP 7
XX°C XXX°F

- The left tower regenerating light is blinking to indicate the thermistor location (lower left) that corresponds to the temperature display.
- Press  to advance to screen 8.

8.11.8 Test Mode Screen 8 – Step 8

TEST MODE STEP 8
XX°C XXX°F

- The right tower drying light is blinking to indicate the thermistor location (upper right) that corresponds to the temperature display.
- CAUTION: Do not advance to step 1 until the left tower has fully pressurized.
- Press  to advance to screen 1.

8.11.9 Test Mode Screen 9 – Attempting to exit test mode from step 2, 3, or 4

TO EXIT TEST
GO TO STEP 5

- This screen is displayed for 5 seconds if the user attempts to exit test mode from step 2, 3, or 4.
- At the end of the 5-second time period, the display returns to the previous screen (2, 3, or 4).

8.11.10 Test Mode Screen 10 – Attempting to exit test mode from step 6, 7, or 8.

TO EXIT TEST
GO TO STEP 1

- This screen is displayed for 5 seconds if the user attempts to exit test mode from step 6, 7, or 8.
- At the end of the 5-second time period, the display returns to the previous screen (6, 7, or 8).

Program Step	1	2	3	4	5	6	7	8
Left tower status	drying	drying	drying	drying	regen.	regen.	regen.	regen.
Right tower status	regen.	regen.	regen.	regen.	drying	drying	drying	drying
Left tower pressure switch	closed	closed	closed	closed	closed	closed	closed at start, open at end	open at start, closed at end
Right tower pressure switch	closed	closed	closed at start, open at end	open at start, closed at end	closed	closed	closed	closed
Left inlet solenoid (see Note 1)	off	off	off	off	off	on	on	on
Left purge solenoid	off	off	off	off	off	off	on	off
Right inlet solenoid (see Note 1)	off	on	on	on	off	off	off	off
Right purge solenoid	off	off	on	off	off	off	off	off
Inlet shuttle valve (see Note 2)	open to left chamber				open to right chamber			
Left inlet valve (see Note 1)	open	open	open	open	open	closed	closed	closed
Left purge valve	closed	closed	closed	closed	closed	closed	open	closed
Right inlet valve (see Note 1)	open	closed	closed	closed	open	open	open	open
Right purge valve	closed	closed	open	closed	closed	closed	closed	closed
Temperature display - thermistor location	none	upper left	lower right	upper left	none	upper right	lower left	upper right

Note 1: Standard Pressure Models 4100 & 5400 ONLY. High Pressure Models 40 through 450 ONLY.

Note 2: Standard Pressure Models 40 through 3000 ONLY.

Table 8-2
Cycle Sequence Steps

Dryer MOP	60 - 150 psig (4.1 - 10.3 barg)				120 - 250 psig (8.3 - 17.2 barg)			
ISO Class	1	2	3	4	1	2	3	4
Dew Point	-73°C	-40°C	-20°C	+3°C	-73°C	-40°C	-20°C	+3°C
	-100°F	-40°F	-4°F	+38°F	-100°F	-40°F	-4°F	+38°F
Cycle Time (minutes)	4	10	16	24	4	10	16	24
Time	Time from start of cycle (minutes : seconds)				Time from start of cycle (minutes : seconds)			
t0	00:00	00:00	00:00	00:00	00:00	00:00	00:00	00:00
t1	00:02	00:02	00:02	00:02	00:02	00:02	00:02	00:02
t2	00:06	00:06	00:06	00:06	00:06	00:06	00:06	00:06
t3	01:12	04:00	06:55	10:50	00:48	03:00	05:40	09:20
t4	02:00	05:00	08:00	12:00	02:00	05:00	08:00	12:00
t5	02:02	05:02	08:02	12:02	02:02	05:02	08:02	12:02
t6	02:06	05:06	08:06	12:06	02:06	05:06	08:06	12:06
t7	03:12	09:00	14:55	22:50	02:48	08:00	13:40	21:20
t8	04:00	10:00	16:00	24:00	04:00	10:00	16:00	24:00
Reference Data								
Purge time (min:sec) [(t3-t2) or (t7-t6)]	01:06	03:54	06:49	10:44	00:42	02:54	05:34	09:14
Repress. time (min:sec) [(t4-t3) or (t8-t7)]	00:48	01:00	01:05	01:10	01:12	02:00	02:20	02:40

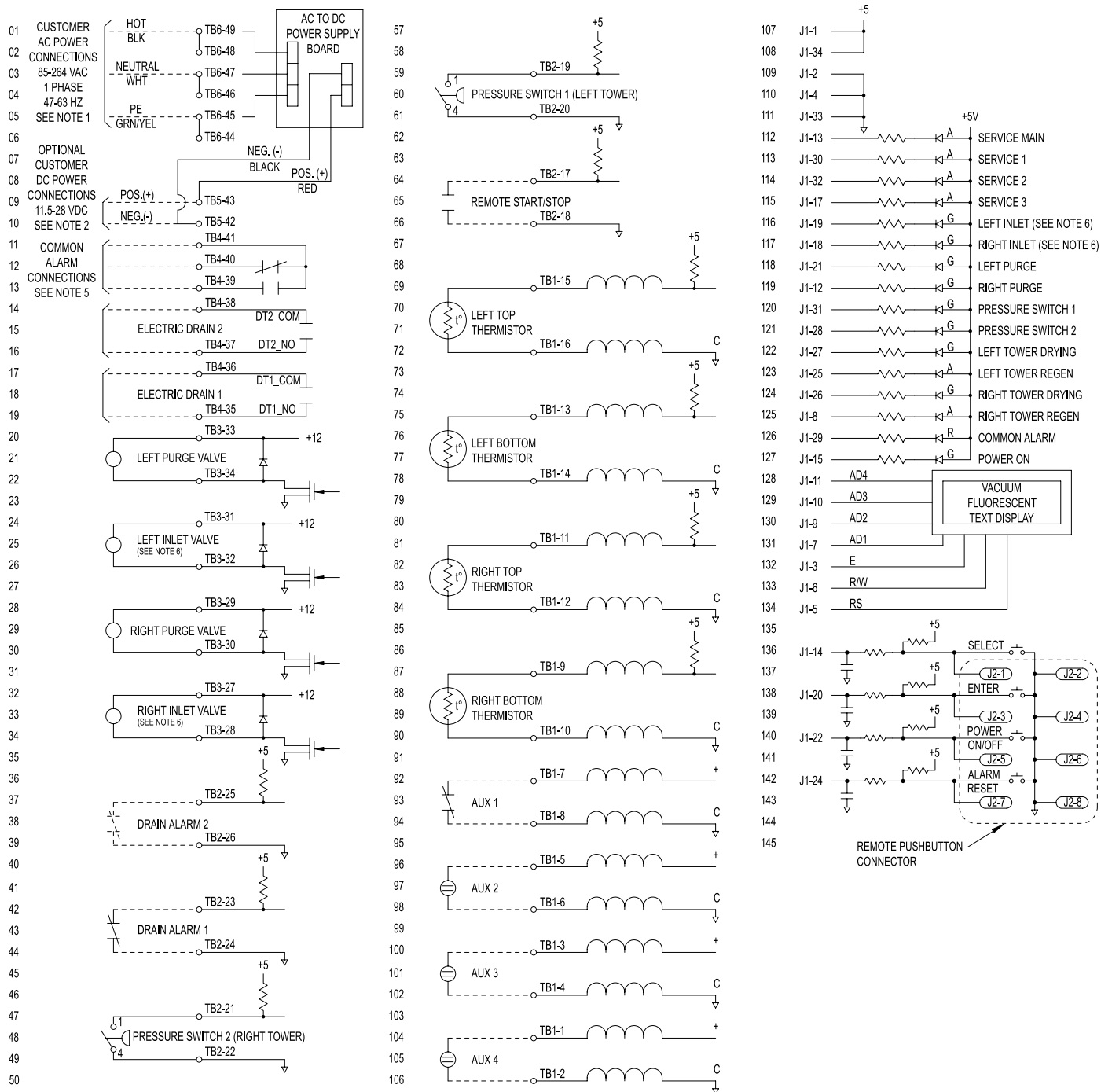
Table 8-3
Fixed Cycle Timing – Level 2 Controller

NOTE: When operated in the Demand Mode, drying times t4-t0 and t8-t4 can extend to a maximum of 30 minutes each. Purge times in the Demand Mode, regardless of the ISO Class selection, will always be equal to the purge times of the ISO Class 2 (10 min.) Fixed Cycle (3:54 for 150 psig MOP and 2:54 for 250 psig MOP).

Process valve name (Process valve state w/ de-energized pilot solenoid valve)	Time (refer to Table 8-3)								
	t0	t1	t2	t3	t4	t5	t6	t7	t8
	Left Tower Drying Right Tower Regenerating Half Cycle				Right Tower Drying Left Tower Regenerating Half Cycle				
Left purge valve (normally closed)							Pilot Energized (open)		
Left inlet valve (normally open) (See NOTE 1)							Pilot Energized (closed)		
Right inlet valve (normally open) (See NOTE 1)		Pilot Energized (closed)							
Right purge valve (normally closed)			Pilot Energized (open)						
Normal status of pressure switches									
Left tower pressure switch	closed	closed	closed	closed	closed	closed	closed	closed for < 5 sec. then open	open at t7, closed before t8
Right tower pressure switch	closed	closed	closed for < 5 sec. then open	open at t3, closed before t4	closed	closed	closed	closed	closed
Pressure switch status that causes an alarm									
Left tower drying Low tower pressure ^a			open ¹	open ¹					
Left tower regenerating Fail to de-pressurize ^b							closed ¹		
Left tower regenerating Fail to re-pressurize ^c									open ²
Right tower drying Low tower pressure ^d							open ¹		open ¹
Right tower regenerating Fail to de-pressurize ^e			closed ¹						
Right tower regenerating Fail to re-pressurize ^f				open ²					
Note	Stop cycle on fault	Comments							
1: Check for fault condition at 15, 25, 35... seconds into the half-cycle	no	If the fault condition is clear for 1 cycle: the alarm LED stays on (without blinking) and the alarm message continues to be displayed. Once the fault condition is clear, pressing the reset button will clear the alarm LED and message.							
2: Check for fault condition just before the end of the half-cycle	yes	If the fault condition clears: tower cycling resumes and the alarm LED stays on (without blinking). Once the fault condition is clear, pressing the reset button will clear the alarm LED and message.							
a: Blink the Alarm LED and display the following text message: Alarm + Left Tower Drying + Low Pressure									
b: Blink the Alarm LED and display the following text message: Alarm + Left Tower Regenerating + High Pressure									
c: Blink the Alarm LED and display the following text message: Alarm + Left Tower Regenerating + Low Pressure									
d: Blink the Alarm LED and display the following text message: Alarm + Right Tower Drying + Low Pressure									
e: Blink the Alarm LED and display the following text message: Alarm + Right Tower Regenerating + High Pressure									
f: Blink the Alarm LED and display the following text message: Alarm + Right Tower Regenerating + Low Pressure									

NOTE 1: Standard Pressure Models 4100 & 5400 ONLY. High Pressure Models 40 through 450 ONLY

Table 8-4
Event Sequence and Component Status – Level 2 Controller



NOTES:

1. CUSTOMER POWER CONNECTIONS WHEN SUPPLY VOLTAGE IS AC (ALTERNATING CURRENT), TERMINALS TB6-44, TB6-46 AND TB6-48 CAN BE USED TO PROVIDE ACCESSORY POWER AT THE SAME VOLTAGE AND FREQUENCY. AC POWER IS DIRECTED TO POWER SUPPLY BOARD WHERE IT IS CONVERTED TO 12 VDC AND RETURNED TO THE CONTROL BOARD.
2. CUSTOMER POWER CONNECTIONS WHEN SUPPLY VOLTAGE IS DC (DIRECT CURRENT), RED AND BLACK WIRES FROM THE POWER SUPPLY BOARD SHOULD BE REMOVED AND THE CUSTOMER SHOULD MAKE THEIR POWER CONNECTIONS AT TERMINALS TB5-42 AND TB5-43.
3. VOLTAGE RATING OF VALVES IS 12 VDC.
4. VOLTAGE RATING OF SWITCHES IS 5 VDC.
5. WITH UNIT ON AND NO ALARMS, THERE SHOULD BE CONTINUITY BETWEEN TERMINALS TB4-39 AND TB4-41. CONTACTS ARE RATED AT 5 AMPS.
6. STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.

Figure 8-2
Electrical Schematic – Level 2 Controller

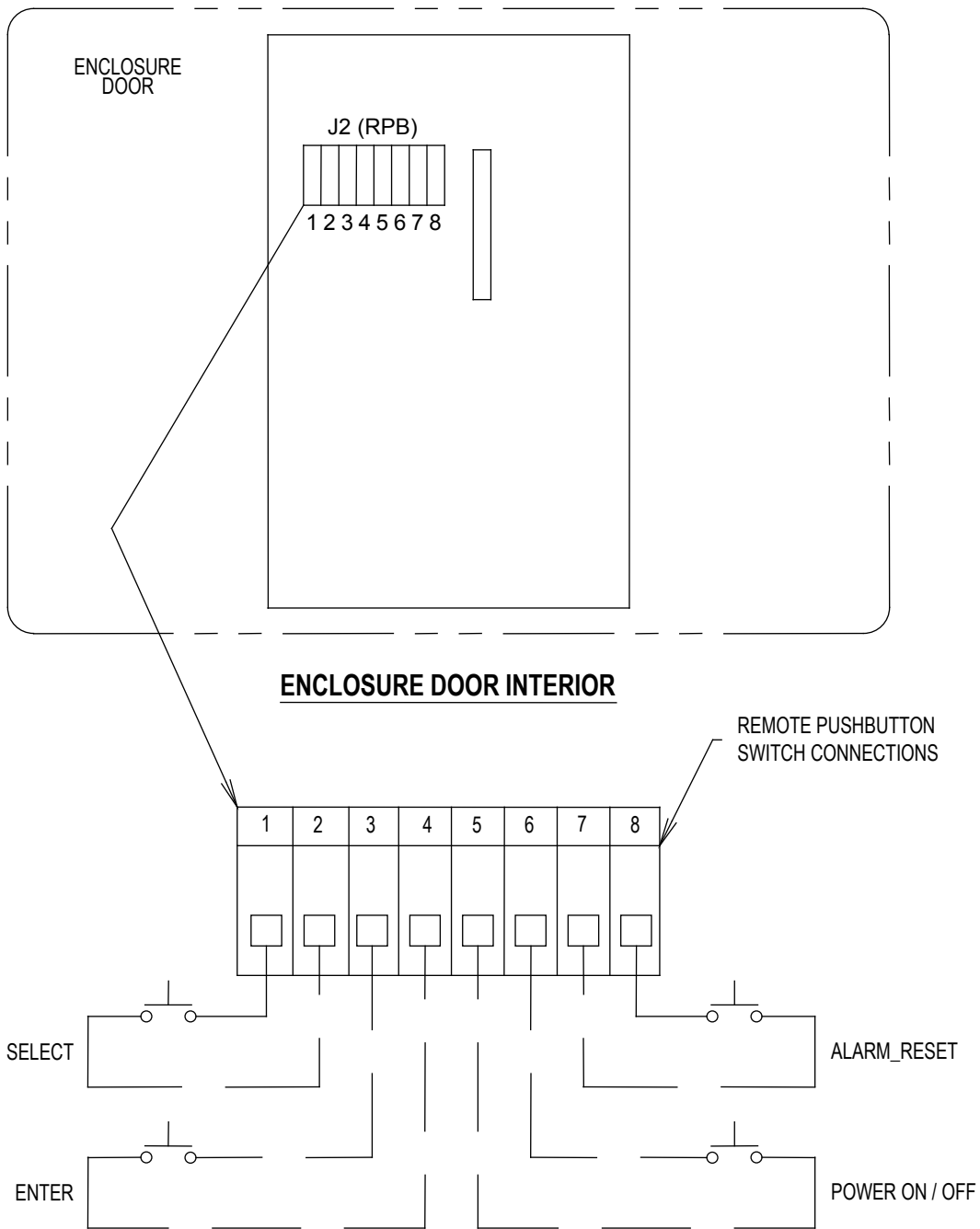
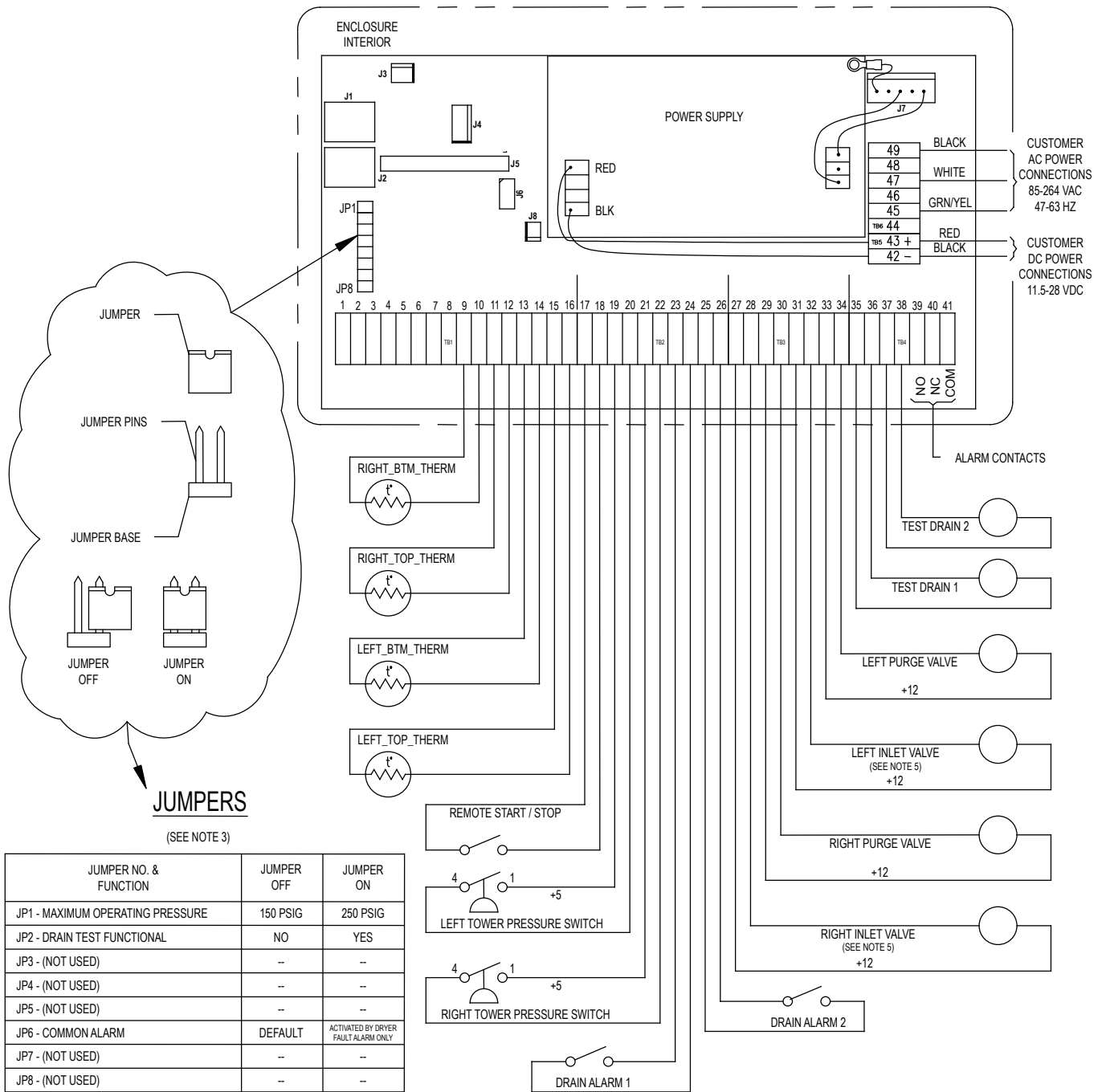


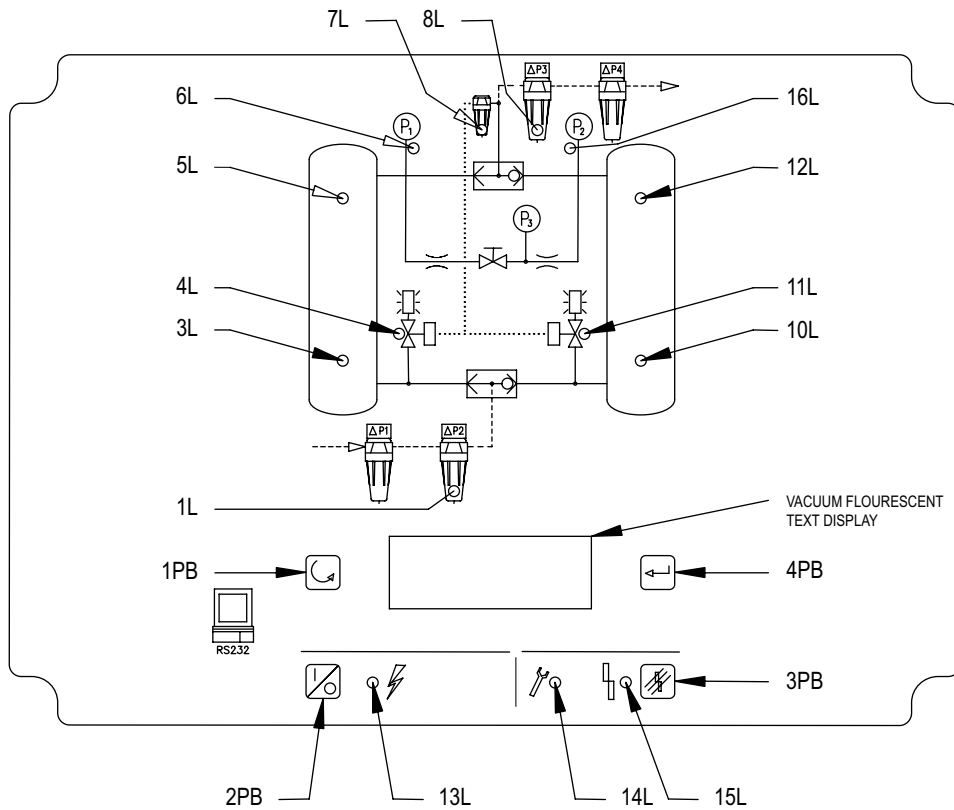
Figure 8-3
 Point-to-Point Diagram – Level 2 Controller
 (continued on next page)



NOTES:

- SEE FIGURE 8-5 FOR RECOMMENDED AWG CONDUCTOR SIZES.
- CUSTOMER SUPPLIED AC (ALTERNATING CURRENT) INPUT POWER CONNECTIONS SHOULD BE MADE AT TERMINALS TB6-44, TB6-46 AND TB6-48. FOR CUSTOMER SUPPLIED DC (DIRECT CURRENT) POWER, THE RED AND BLACK WIRES FROM THE POWER SUPPLY BOARD SHOULD BE REMOVED AND THE CUSTOMER POWER CONNECTIONS SHOULD BE MADE AT TERMINALS TB5-42 AND TB5-43.
- IN THE 'JUMPER OFF' POSITION, THE JUMPER CAN BE COMPLETELY REMOVED OR STORED ON A SINGLE PIN. IN THE 'JUMPER ON' POSITION, THE JUMPER IS INSTALLED ACROSS BOTH PINS TO PROVIDE CONTINUITY.
- WITH UNIT ON AND NO ALARMS, THERE SHOULD BE CONTINUITY BETWEEN TERMINALS TB4-39 AND TB4-41. CONTACTS ARE RATED AT 5 AMPS.
- STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.

Figure 8-3
Point-to-Point Diagram – Level 2 Controller
(continued from previous page)



ENCLOSURE DOOR EXTERIOR

LEGEND

1L	SERVICE REMINDER 3 - PRE FILTERS (AMBER)	15L	COMMON ALARM (RED)	J3	RS232 SERIAL I/O CONNECTOR
3L	LEFT TOWER REGENERATING (AMBER)	16L	PRESSURE SWITCH 2 (RIGHT TOWER) CLOSED (GREEN)	J4	PICPROG. CONNECTOR
4L	LEFT PURGE VALVE OPEN (GREEN)	1PB	SELECT SWITCH	J6	XILINX PROGRAM CONNECTOR
5L	LEFT TOWER DRYING (GREEN)	2PB	POWER ON/OFF SWITCH	J7	POWER SUPPLY INPUT CONNECTOR
6L	PRESSURE SWITCH 1 (LEFT TOWER) CLOSED (GREEN)	3PB	ALARM RESET SWITCH	PS	AC TO DC POWER SUPPLY
7L	SERVICE REMINDER 1 - PILOT AIR FILTER (AMBER)	4PB	ENTER SWITCH	RPB	REMOTE SWITCH TERMINALS
8L	SERVICE REMINDER 2 - AFTER FILTERS (AMBER)	CNTRLPCB	CONTROL BOARD	TB1	ANALOG INPUT TERMINALS
10L	RIGHT TOWER REGENERATING (AMBER)	CR	ALARM CONTROL RELAY	TB2	SWITCH INPUT TERMINALS
11L	RIGHT PURGE VALVE OPEN (GREEN)	DISPPCB	DISPLAY BOARD	TB3	VALVE OUTPUT TERMINALS
12L	RIGHT TOWER DRYING (GREEN)	JMP	CONFIGURATION JUMPERS	TB4	CONTACT OUTPUT TERMINALS
13L	POWER ON INDICATOR (GREEN)	J1	FILTER MONITOR 2 CONNECTOR	TB5	DC POWER INPUT TERMINALS
14L	MAIN SERVICE REMINDER (AMBER)	J2	FILTER MONITOR 1 CONNECTOR	TB6	AC POWER INPUT TERMINALS

Figure 8-4

Panel Layout – Level 2 Controller

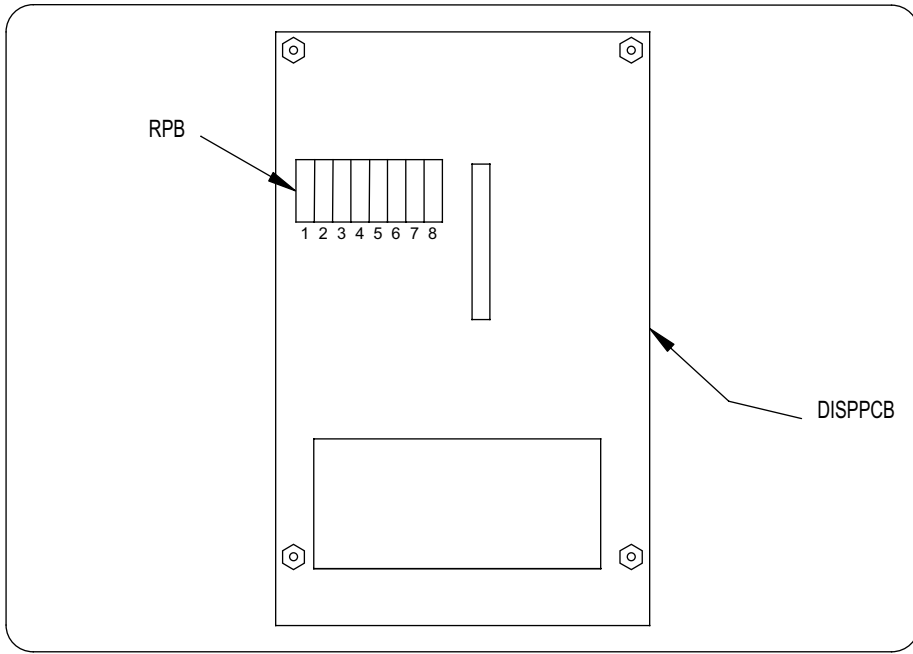
(Note: Figure is representative of Standard Pressure Models KADPS 40 through 3000.)

(Note: Overlay for Standard Pressure Models KADPS 4100 & 5400 depicts a different

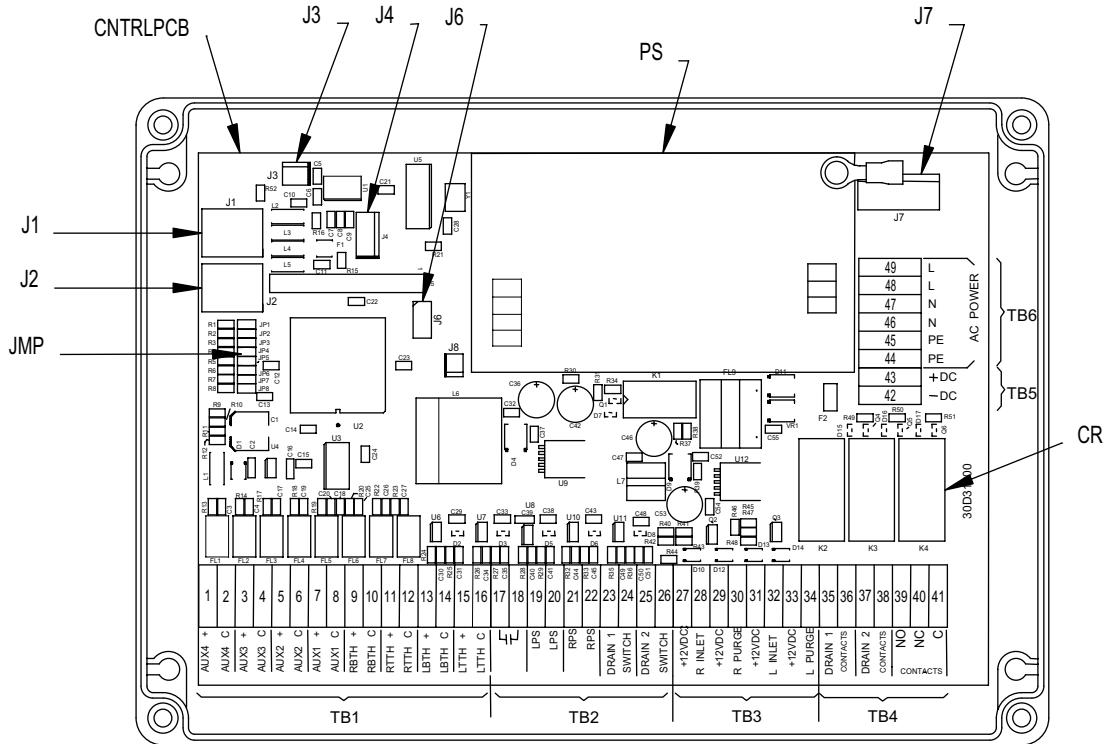
inlet valve and outlet/purge circuit. Overlay for High Pressure Models KADPS 40

through 450 depicts a different inlet valve circuit.)

(continued on next page)



ENCLOSURE DOOR INTERIOR



ENCLOSURE INTERIOR

Figure 8-4
 Panel Layout – Level 2 Controller
 (continued from previous page)

LOCATION	FUNCTION		# OF CONDUCTORS	AWG SIZE	CABLE DIAMETER RANGE				CONNECTOR SIZE	ENCLOSURE HOLE DIA.	
					MIN. DIA.		MAX. DIA.			in.	mm
					in.	mm	in.	mm			
1	FACTORY CONNECTIONS	HUMIDITY-DEW POINT SENSOR	2	22	0.230	5.8	0.395	10.0	PG-11	0.733	18.6
		DRAIN 1 (POWER & TEST)	4								
		DRAIN 1 (ALARM)	2								
		DRAIN 2 (POWER & TEST)	4								
		DRAIN 2 (ALARM)	2								
2	OPTIONAL DEVICES	FILTER MONITOR 1	TBD	22	0.230	5.8	0.395	10.0	PG-11	0.733	18.6
		FILTER MONITOR 2	TBD								
		ANALOG INPUT 1	2								
		ANALOG INPUT 2	2								
		ANALOG INPUT 3	2								
3	FACTORY CONNECTIONS	THERMISTOR 1 LEFT TOWER - UPPER	2	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
4		THERMISTOR 2 RIGHT TOWER - UPPER	2	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
5		THERMISTOR 3 LEFT TOWER - LOWER	2	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
6		THERMISTOR 4 RIGHT TOWER - LOWER	2	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
7		PRESSURE SWITCH - RIGHT TOWER	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
8		PRESSURE SWITCH - LEFT TOWER	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
9		SOLENOID - LEFT PURGE VALVE	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
10		SOLENOID - LEFT INLET VALVE*	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
11		SOLENOID - RIGHT PURGE VALVE	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
12		SOLENOID - RIGHT INLET VALVE*	2	18	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
13	USER CONNECTIONS	ALARM CONTACTS	2	16	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
14		REMOTE STOP / START	2	16	0.181	4.6	0.312	7.9	PG-9	0.599	15.2
15		RS232	3	22	0.114	2.9	0.250	6.4	PG-7	0.492	12.5
16		INPUT POWER	3	14	0.230	5.8	0.395	10.0	PG-11	0.733	18.6

* STANDARD PRESSURE MODELS 4100 & 5400 ONLY. HIGH PRESSURE MODELS 40 THROUGH 450 ONLY.

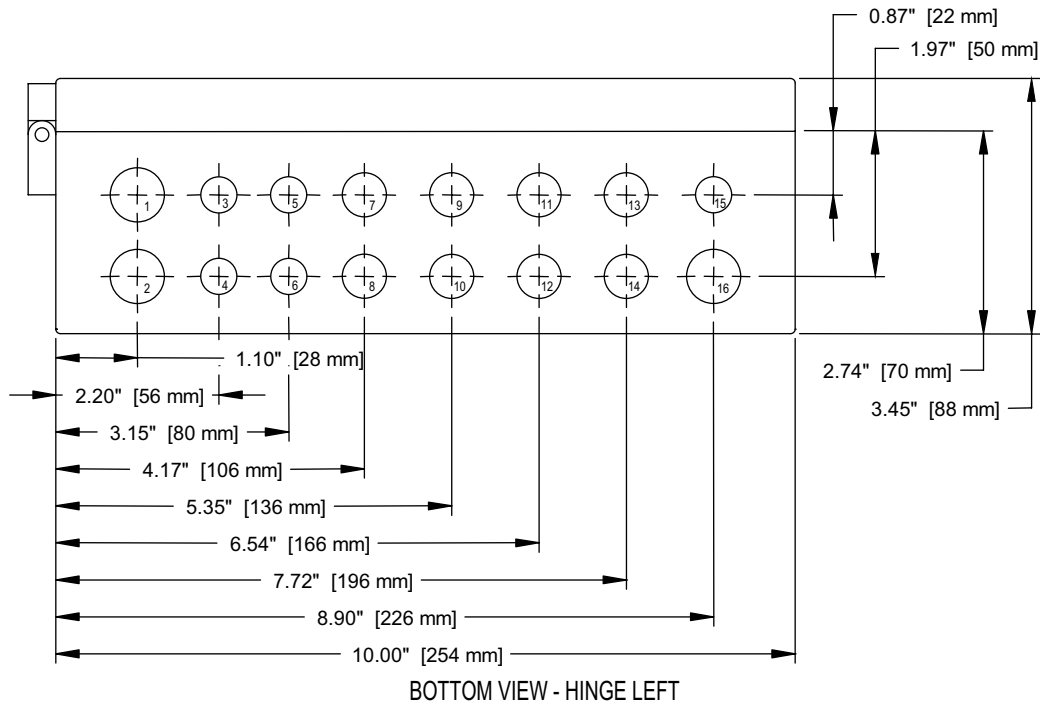


Figure 8-5
Enclosure Penetrations – Level 2 Controller

9. OPERATION

9.1 Start-up

9.1.1 Controller Settings (Level 1 or Level 2 Controller)

- Set or verify settings on the Level 1 or Level 2 Controller. General information regarding both controllers can be found in Section 5. Detailed operational points are presented in Sections 7 and 8.

WARNING - Enclosure may have live electric parts. De-energize dryer before opening enclosure.

- If a Cycle or Energy (purge) Savings % change is made while the dryer is operating, the change will occur at the end of the current half-cycle. If it is necessary to begin a new selection immediately, shut the unit off and then back on.

NOTE: A tower that is actively purging when the power on/off button is actuated will be subjected to a rapid repressurization that can lead to fluidization and subsequent abrasion of the desiccant bed. Ideally, dryers should only be powered off during those portions of the drying cycle when both desiccant towers are at full operating pressure.

- If switching to a cycle mode producing a lower dew point (e.g. 0°F to -40°F [-17.8°C to -40°C]) while the dryer is operating, one or two days of operation may be needed before the new dew point is achieved.

9.1.2 Initial Pressurization

- SLOWLY pressurize dryer to full line pressure. (If the dryer was installed with inlet and outlet isolation valves, the inlet isolation valve should be slowly opened while the outlet isolation valve remains closed.)
- During initial start-up, check the entire system for leaks. If necessary, de-pressurize the dryer and correct any leaks.

9.1.3 Energizing the Dryer

- (Timer Based Controller) Energize the dryer using the disconnect fuse located next to the customer connections in the bottom of the control box.
- (Level 1 or Level 2 Controller) Energize the dryer using the power switch located on the control panel.
- **NOTE:** The switching failure alarm may be activated if the unit is energized before it is pressurized. To deactivate alarm, allow dryer to cycle to next step and press the reset button.

9.1.4 Adjusting the Purge Rate

Determine the following:

- Maximum operating pressure (MOP) of dryer from the dryer serial number tag.
- Air pressure at inlet to dryer.
- ISO Class cycle setting (Class 1, 2, 3, or 4).

NOTE: For units with the Level 2 Controller and the Automatic Purge Saving System in the demand cycle mode use the ISO Class 2 (10 min.) purge pressure settings only.

- Energy (purge) Savings % setting. This setting is applicable to the Level 1 Controller only.

9.1.4.1 Purge Rate Pressure – Models 40 to 3000

- Refer to Table 9-4 for the proper purge rate pressure setting corresponding to the conditions listed in Section 9.1.4.

NOTE: For units with the Level 2 Controller and the Automatic Purge Saving System in the demand cycle mode use the ISO Class 2 (10 min.) purge pressure settings only.

- Adjust purge rate valve until purge pressure gauge indicates the required pressure. The purge pressure adjustment valve on Models 40 through 3000 is a quarter-turn ball valve located in the smaller bypass line of the upper piping of the dryer. Refer to Figures 4-2 or 4-3 for location. Models 40 through 3000 use a double orifice purge circuit. Equally sized orifices are located at either end of the bypass line. The purge pressure adjustment valve, and a pressure tap for the purge pressure gauge are piped between the two orifices. Looking at the front of the dryer, when the left tower is drying and the right tower is purging, purge air flows from left to right through the first orifice, then the purge pressure adjustment valve, past the pressure tap for the purge pressure gauge, through the second and final orifice and into the offline tower. The pressure in the purge circuit just before the final orifice controls the purge flow rate. Because the purge pressure tap lies between the purge pressure adjustment valve and the orifice closest to the right hand tower, the purge pressure can only be correctly read and adjusted when the purge flow is from left to right. This only occurs when the right hand tower is actively purging. **IMPORTANT:** Purge pressure adjustment must be made while the **RIGHT HAND TOWER AS SEEN FROM THE FRONT OF THE UNIT** is regenerating and the right hand tower is actively purging (the purge valve associated with the right tower is open and air is exhausting from its muffler). Due to the symmetry of the design, identical orifices at opposite ends and the bi-directional flow characteristics of the purge pressure adjustment ball valve, purge flow will be similar when towers switch and the purge flow is from the drying tower on the right towards the regenerating tower on the left. Purge pressure as indicated by the purge pressure gauge should be disregarded during this half of the operating cycle.
- The purge pressure adjustment valve should never be fully closed. Proper purge flow is required to regenerate and re-pressurize the offline tower. Should the tower fail to re-pressurize, a switching failure alarm will be initiated, and the cycle will be stopped before tower switch over.
- After the purge pressure has been correctly set, the handle of the purge pressure adjustment valve may be removed and stored to prevent tampering with the setting.

9.1.4.2 Purge Rate Pressure – Models 4100 to 5400

- Refer to Table 9-4 for the proper purge rate pressure setting corresponding to the conditions listed in Section 9.1.4.

NOTE: For units with the Level 2 Controller and the Automatic Purge Saving System in the demand cycle mode use the ISO Class 2 (10 min.) purge pressure settings only.

- Adjust purge rate valve until purge pressure gauge indicates the required pressure. The purge pressure adjustment valve on Models 4100 through 5400 is a globe valve located in the smaller by-pass line of the upper piping in the front of the dryer. Refer to Figure 4-4. **IMPORTANT:** Adjustment must be made while either tower is purging (air exhausting from muffler).

- The purge pressure adjustment valve should never be fully closed. Proper purge flow is required to regenerate and re-pressurize the offline tower. Should the tower fail to re-pressurize, a switching failure alarm will be initiated, and the cycle will be stopped before tower switch over.
- After the purge pressure has been correctly set, the handle of the purge pressure adjustment valve may be removed and stored to prevent tampering with the setting.

Insufficient purge air will eventually result in saturation of the desiccant beds and wet air downstream. Verify that maximum operating pressure mode, cycle time, energy (purge) savings percent selection, and purge pressure are correctly set.

9.1.5 Bringing the Dryer Online

Establish a normal flow through the dryer. Slowly open the outlet isolation valve if present. Close any dryer by-pass valves.

NOTE: When dew points below -40°F (-40°C) are required, the dryer must be run with an inlet flow rate of less than 50% of maximum until the desired dew point is attained. Depending on the initial dryness of the desiccant, this can take as long as 2 to 3 days. This stabilization period is required on initial startup, after the dryer has been shutdown for extended periods of time, or after dryer maintenance (desiccant change, etc.) has been performed.

9.1.6 Readjusting the Purge Rate

With the inlet pressure to the dryer at its minimum level, readjust the purge pressure per the instructions in Section 9.1.4.

NOTE: Adjustment must be made while the appropriate tower is purging (air exhausting from muffler).

9.2 Operational Check Points

9.2.1 Power to unit

Check periodically that there is power to the unit (indicating lights illuminated).

9.2.2 Moisture Indicator

Every four hours check moisture indicator. Indicator should be green. The color change moisture indicator indicates the outlet relative humidity of the desiccant dryer.

Green indicates a R.H. below 3% and yellow indicates a R.H. above 3%. Table 9-5 cross references outlet pressure dew points to moisture indicator changes from green to yellow at various inlet temperatures.

NOTE: During start-up the indicator may be yellow, however, it should begin to change to green within four hours.

9.2.3 Purge Pressure Setting

Every four hours check the purge pressure gauge for the proper setting and adjust as required. Adjustment should be made when the inlet pressure to the dryer is at its minimum level.

NOTE: Adjustment must be made while the appropriate tower is purging (air exhausting from muffler).

9.2.4 Alarms

Periodically check for flashing red alarm LED.

9.2.4.1 Alarms – Level 1 Controller

Alarm light will flash if either tower fails to pressurize or de-pressurize to the required levels at the proper time. Refer to Section 7.4.3 and Table 7.4.

NOTE: Alarm will activate if dryer is energized without being pressurized. If this occurs, allow dryer to cycle to next step and press reset button. Alarm light will continue to illuminate even if fault clears. To clear alarm, press reset button.

If the tower being regenerated fails to re-pressurize, the dryer will not switch towers. The switching failure alarm will be activated and the dryer will remain in this mode until the tower re-pressurizes.

9.2.5 Tower Status LEDs

Illuminated LEDs indicate which tower is on-line drying or off-line regenerating.

9.2.6 Tower Pressure Gauges

Periodically check tower pressure gauges to verify that the pressure gauge of the online tower reads line pressure and the pressure gauge of the offline tower reads below 2 psig (0.14 barg).

NOTE: Read the offline tower pressure gauge when the tower is purging (air exhausting from muffler).

9.2.7 Check Mufflers For Back Pressure

Excessive back pressure may result due to the accumulation of desiccant fines (dust) in the muffler cartridges. This sometimes occurs after start-up due to dusting of the desiccant during tower filling and dryer transport. If the tower pressure gauge of the off-stream tower rises above 5 psig (3.5 barg), the muffler elements should be replaced.

IMPORTANT: Replace muffler cores provided with unit after 5 complete cycles following the completion of the Start-Up Procedures.

9.2.8 Process Valves

Determine if air control valves are operating and sequencing correctly. Refer to Section 3.3 for a general description of operating sequence. Refer to Tables 7-3 and 7-4 for time sequences for Level 1 Controllers. Refer to Tables 8-3 and 8-4 for time sequences for Level 2 Controllers.

9.2.8.1 Valves – Models 40 through 3000

- Inlet/Outlet switching valves are non-lubricated shuttle valves. Pressure differences between the online and offline desiccant towers cause the shuttle valve to shift.
- High Pressure Models 40 through 450 ONLY. Inlet switching valves are normally open, pneumatically piston-actuated, Y-angle poppet valves. A yellow indicator can be seen through a clear window at the top of the actuator when the valve is in the open position.
- Purge/repressurization valves are normally closed, pneumatically piston-actuated, Y-angle poppet valves. A yellow indicator can be seen through a clear window at the top of the actuator housing when the valve is in the open position.
- 12 volt DC, normally-closed, 3-way pilot solenoid valves are wired to the controller and are used to direct pilot air to the actuators of the purge/repressurization valves.
- Purge pressure and subsequent flow is adjusted by means of a quarter-turn ball valve located in the bypass line of the upper piping.

- Models 40 through 3000 are equipped with a single safety relief valve that has been sized at a minimum to provide overpressure protection due to a fire for both desiccant towers.

9.2.8.2 Valves – Models 4100 through 5400

- Inlet switching valves are resilient seated butterfly valves with double acting pneumatic rack and pinion actuators. A yellow arrow indicator located on the top of the actuator output shaft points to valve position indicator icons. Pilot air is directed to actuator ports to open both inlet valves upon loss of power.
- Purge/repressurization valves are resilient seated butterfly valves with spring return, fail closed, pneumatic rack and pinion actuators. A yellow arrow indicator located on the top of the actuator output shaft points to valve position indicator icons. Pilot air is directed to actuator ports to close both purge/repressurization valves upon loss of power.
- 12 volt DC, single solenoid, 4-way pilot valves are wired to the controller and are used to direct pilot air to the actuators of the inlet switching and purge/repressurization valves.
- Two mainline outlet and two smaller purge line check valves are installed in the upper piping to control the flow of outlet and purge air. Check valve sticking will result in excessive air discharge through a muffler. Excessive air discharge through the muffler can be associated with a leaking outlet check valve on the same side or a purge check valve of the opposite side tower.
- Purge pressure and subsequent flow is adjusted by means of a throttling globe valve located in the bypass line of the upper piping
- Models 4100 through 5400 are equipped with multiple safety relief valves that have been sized to provide overpressure protection for capacities equal to or greater than the adjusted capacity of the dryer at its maximum operating pressure.
- The tower pressure gauge of the online tower should read line pressure. Air should not be leaking from the purge-repressurization valve of the on-line tower.
- The tower pressure gauge of the offline tower should read below 2 psig (0.14 barg) while that tower is purging. If excessive air is exhausting during the purge cycle, the inlet-switching valve on the same side may have failed to close or a check valve may be sticking.

9.3 Operating Sequence

9.3.1 Operating sequence – Timer Based Controllers

The operating sequence for dryers equipped with Timer Based Controllers appears in Tables 6.1 and 6.2.

9.3.2 Operating sequence – Level 1 Controllers

The operating sequence for dryers equipped with Level 1 Controllers appears in Tables 7.3 and 7.4.

9.3.3 Operating sequence – Level 2 Controllers

The operating sequence for dryers equipped with Level 2 Controllers appears in Tables 8-2, 8-3, and 8-4.

9.4 Dryer Shut Down

- If the dryer installation is equipped with dryer bypass and inlet and outlet isolation valves, the bypass valve should be opened and the inlet and outlet isolation valves closed.

- De-pressurize the dryer by allowing the controller to run through tower change cycles until pressure gauges on both towers read zero. Manual test mode may be used to speed up this process. NOTE: Below 60 psig (4.1 barg) purge/repressurization valves may not open. Opening the manual drain on the pilot air filter or any mounted pre or afterfilters may bleed off remaining pressure.
- Turn dryer off using on-off switch (indicating LEDs extinguished).

9.5 Loss of Power

Control valves are designed so that upon loss of power the air dryer is capable of drying air until the desiccant exposed to the airflow is saturated.

9.6 Operating Parameters

Verify that dryer is operating within the following design parameters:

9.6.1 Maximum Operating Pressure (MOP):

- 150 psig (10.3 barg) is standard.
- 250 psig (17.2 barg) is optional.

Refer to Dryer Serial Number Tag.

WARNING - Do not operate the dryer at pressures above the maximum operating pressure shown on the serial number tag.

NOTE: Consult factory for applications requiring higher maximum operating pressures.

9.6.2 Minimum Operating Pressures:

9.6.2.1 For 150 psig (10.3 barg) MOP models -

- 60 psig (4.1 barg) is the minimum operating pressure for dryers operated on a 4, 10, 16, or 24-minute cycle.

9.6.2.2 For 250 psig (17.2 barg) MOP models -

- 120 psig (8.3 barg) is the minimum operating pressure for dryers operated on a 4, 10, 16, or 24-minute cycle.

Refer to Dryer Serial Number Tag.

WARNING - Do not operate the dryer at pressures below the minimum operating pressure shown on the serial number tag.

NOTE: Consult factory for applications requiring lower minimum operating pressures.

9.6.3 Maximum Compressed Air Temperature at Dryer Inlet:

- 140°F (60°C) for all models.

9.6.4 Ambient Temperatures:

9.6.4.1 Minimum Ambient Temperature:

- Standard units: 35°F (2°C)
- Units with optional low ambient package: -20°F (-29°C)

9.6.4.2 Maximum Ambient Temperature:

- 120°F (49°C)

NOTE: If dryer is installed in ambients below 35°F (2°C), low ambient protection requiring heat tracing and insulation of the prefilter bowls, auto drains and/or sumps, and lower piping with inlet switching and purge/repressurization valves is necessary to prevent condensate

from freezing. If installing heat tracing, observe electrical class code requirements for type of duty specified. Purge mufflers and their relief mechanisms must be kept clear from snow and ice buildup that could prevent proper discharge of compressed air.

9.7 Maximum Inlet Flow Capacity

- Refer to Table 9-1 for maximum inlet flow at rated conditions of 100 psig (6.9 barg) and 100°F (38°C).
- At other conditions, multiply inlet flow from Table 9-1 by the multipliers from Tables 9-2 and 9-3 that correspond to the pressure and temperature at the inlet to the dryer.

9.8 Purge and Outlet Flows

9.8.1 Maximum Purge Flow

- Maximum Purge Flow is the amount of purge air flowing through the off-stream tower when the purge/repressurization valve is open. After the purge/repressurization valve closes, the purge flow will gradually decrease as the off-stream tower re-pressurizes to line pressure.
- For maximum purge flow multiply the Inlet Flow At Rated Conditions from Table 9-1 by Maximum Purge Flow Factor from Table 9-6 that corresponds to the dryer MOP, Cycle Time Setting, and air pressure at inlet to dryer.
NOTE: For Level 2 Controller equipped dryers supplied with the Automatic Purge Saving System operating in the Demand Cycle Mode, use ISO Class 2 (10 minutes) as the cycle time.

9.8.2 Average Purge Flow

- For dryers with Level 1 or 2 Controllers operating in the fixed cycle mode, the Average Purge Flow is the actual amount of flow used during the entire purge/repressurization cycle. It includes the maximum purge flow for a portion of the purge/repressurization time and the volume of air used for repressurization, averaged over the cycle time.
- For average purge flow multiply the Inlet Flow At Rated Conditions from Table 9-1 by Average Purge/Repressurization Flow Factor from Table 9-7 that corresponds to the dryer MOP, Cycle Time Setting, Energy (purge) Savings % setting, and air pressure at inlet to dryer.

9.8.3 Minimum Outlet Air Flow

- Determine minimum outlet flow available from dryer by subtracting Maximum Purge Flow found above from inlet flow to the dryer.

9.8.4 Average Outlet Air Flow

- For dryers with Level 1 or 2 Controllers operating in the fixed cycle mode, the average outlet flow available from dryer can be determined by subtracting the Average Maximum Purge Flow found above from the inlet flow to the dryer.

9.9 EXAMPLE

- Find the maximum inlet flow, maximum purge flow, and minimum outlet flow for a 60 SCFM unit with a MOP of 150 psig operated with 120 psig and 100°F inlet conditions on a 10 minute cycle. Dryer will operate with an inlet airflow of 46 SCFM.
- Step 1: Find Maximum Inlet Flow at 120 psig by multiplying Maximum Inlet Flow at Rated Conditions from Table 9-1 by Inlet Pressure Correction Factor for 120 psig from Table 9-2 and Inlet Temperature from Table 9-3:
$$60 \times 1.08 \times 1.00 = 64.8 \text{ SCFM.}$$
- Step 2: Find Maximum Purge Flow by multiplying Maximum Inlet Flow at Rated Conditions from Table 9-1 by Maximum Purge Flow Factor from Table 9-6:
$$60 \times 0.162 = 9.7 \text{ SCFM.}$$
- Step 3: Find Minimum Outlet Flow available by subtracting Maximum Purge Flow (Step 2) from actual inlet flow:
$$46 - 9.7 = 36.3 \text{ SCFM.}$$

MODEL	40	60	90	115	165	260	370	450	590	750	930	1130	1350	1550	2100	3000	4100	5400
SCFM	40	60	90	115	165	260	370	450	590	750	930	1130	1350	1550	2100	3000	4100	5400
m ³ /hr	68	102	153	195	280	442	629	765	1002	1274	1580	1920	2294	2633	3568	5097	6966	9175

Table 9-1 Maximum Inlet Flow at Rated Conditions

INLET PRESSURE	psig	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
	barg	4.1	4.8	5.5	6.2	6.9	7.6	8.3	9.0	9.7	10.3	11.0	11.7	12.4	13.1	13.8	14.5	15.2	15.9	16.5	17.2
MULTIPLIER		0.65	0.74	0.83	0.91	1.00	1.04	1.08	1.12	1.16	1.20	1.23	1.27	1.30	1.34	1.37	1.40	1.43	1.46	1.49	1.52

Table 9-2 Inlet Pressure Correction Factors

INLET TEMPERATURE	°F	100 and below	105	110	115	120	125	130	135	140
	°C	38 and below	41	43	46	49	52	54	57	60
MULTIPLIER		1.00	0.98	0.96	0.93	0.89	0.85	0.81	0.76	0.70

Table 9-3 Inlet Temperature Correction Factor

DRYER MOP			150 psig (10.3 barg)							250 psig (17.2 barg)													
INLET PRESSURE	psig	barg	60-100	110	120	130	140	150	120	130	140	150	160	170	180	190	200	210	220	230	240	250	
			CYCLE	ISO CL.1	4 min.	psig	35	33	31	29	28	27	8.3	8.0	7.6	7.4	7.1	6.9	6.6	6.4	6.3	6.1	5.9
barg	2.4	2.3				2.1	2.0	1.9	1.9	5.7	5.5	5.2	5.1	4.9	4.8	4.6	4.4	4.3	4.2	4.1	4.0	3.9	3.8
ISO CL.2	10 min.	psig		20	19	18	17	16	15	44	42	40	39	37	36	35	33	32	31	31	30	29	28
		barg		1.4	1.3	1.2	1.2	1.1	1.0	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.1	2.1	2.0	1.9
ISO CL.3	16 min.	psig		18	17	16	15	14	13	35	33	32	30	29	28	27	26	25	25	24	23	23	22
		barg		1.2	1.2	1.1	1.0	1.0	0.9	2.4	2.3	2.2	2.1	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.5
ISO CL.4	24 min.	psig		16	15	15	14	13	13	30	29	28	26	25	24	24	23	22	21	21	20	20	19
		barg		1.1	1.0	1.0	1.0	0.9	0.9	2.1	2.0	1.9	1.8	1.8	1.7	1.7	1.6	1.5	1.4	1.4	1.4	1.4	1.3

Table 9-4 Purge Pressure (Note: For units with the Level 2 Controller operating in the Demand Cycle Mode, use the ISO Class 2 (10 min.) purge pressure settings only, regardless of ISO Class operating mode.)

INLET TEMPERATURE	°F	35	40	50	60	70	80	90	100	110	120
	°C	2	4	10	16	21	27	32	38	43	49
OUTLET P.D.P.	°F	-34	-28	-22	-16	-10	-4	3	9	15	21
	°C	-37	-33	-30	-27	-23	-20	-16	-13	-9	-6

Table 9-5 Outlet Pressure Dew points at Moisture Indicator Color Change

DRYER MOP			150 psig (10.3 barg)							250 psig (17.2 barg)												
INLET PRESSURE	psig	barg	60-100	110	120	130	140	150	120	130	140	150	160	170	180	190	200	210	220	230	240	250
			CYCLE	ISO CL.1	4 min.	0.249	0.239	0.230	0.222	0.214	0.208	0.361	0.348	0.337	0.326	0.317	0.308	0.300	0.293	0.286	0.279	0.273
ISO CL.2	10 min.	0.175		0.168	0.162	0.156	0.151	0.146	0.218	0.210	0.203	0.197	0.191	0.186	0.181	0.177	0.172	0.169	0.165	0.162	0.158	0.155
ISO CL.3	16 min.	0.161		0.154	0.148	0.143	0.138	0.134	0.182	0.175	0.169	0.164	0.159	0.155	0.151	0.147	0.144	0.141	0.138	0.135	0.132	0.129
ISO CL.4	24 min.	0.153		0.147	0.141	0.136	0.132	0.128	0.164	0.158	0.153	0.148	0.144	0.140	0.137	0.133	0.130	0.127	0.124	0.122	0.119	0.117

Table 9-6 Maximum Purge Flow Factor

DRYER MOP		150 psig (10.3 barg)										
INLET PRESSURE (psig)		60	70	80	90	100	110	120	130	140	150	
INLET PRESSURE (barg)		4.1	4.8	5.5	6.2	6.9	7.6	8.3	9.0	9.7	10.3	
ISO CLASS 1 4 MIN. CYCLE -100°F / -73°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.147	0.149	0.151	0.153	0.155	0.151	0.148	0.145	0.143	0.141
		10%	0.134	0.136	0.137	0.139	0.141	0.138	0.135	0.133	0.131	0.129
		20%	0.120	0.122	0.124	0.125	0.127	0.124	0.122	0.120	0.119	0.118
		30%	0.106	0.108	0.110	0.112	0.114	0.111	0.110	0.108	0.107	0.106
		40%	0.093	0.095	0.096	0.098	0.100	0.098	0.097	0.096	0.095	0.095
		50%	0.079	0.081	0.083	0.084	0.086	0.085	0.084	0.084	0.084	0.084
		60%	0.065	0.067	0.069	0.071	0.072	0.072	0.072	0.072	0.072	0.072
ISO CLASS 2 10 MIN. CYCLE -40°F / -40°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.141	0.142	0.143	0.143	0.144	0.139	0.135	0.131	0.128	0.125
		10%	0.127	0.128	0.129	0.130	0.130	0.126	0.122	0.119	0.116	0.113
		20%	0.114	0.114	0.115	0.116	0.117	0.113	0.110	0.107	0.104	0.102
		30%	0.100	0.101	0.101	0.102	0.103	0.100	0.097	0.095	0.092	0.091
		40%	0.086	0.087	0.088	0.088	0.089	0.087	0.084	0.082	0.081	0.079
		50%	0.073	0.073	0.074	0.075	0.076	0.073	0.072	0.070	0.069	0.068
		60%	0.059	0.060	0.060	0.061	0.062	0.060	0.059	0.058	0.057	0.056
ISO CLASS 3 16 MIN. CYCLE -4°F / -20°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.140	0.140	0.140	0.141	0.141	0.136	0.132	0.128	0.124	0.121
		10%	0.126	0.126	0.127	0.127	0.128	0.123	0.119	0.115	0.112	0.109
		20%	0.112	0.113	0.113	0.113	0.114	0.110	0.106	0.103	0.100	0.098
		30%	0.098	0.099	0.099	0.100	0.100	0.097	0.094	0.091	0.089	0.087
		40%	0.085	0.085	0.086	0.086	0.087	0.084	0.081	0.079	0.077	0.075
		50%	0.071	0.072	0.072	0.072	0.073	0.071	0.068	0.067	0.065	0.064
		60%	0.057	0.058	0.058	0.059	0.059	0.057	0.056	0.054	0.053	0.052
ISO CLASS 4 24 MIN. CYCLE +38°F / +3°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.139	0.139	0.139	0.140	0.140	0.135	0.130	0.126	0.122	0.119
		10%	0.125	0.125	0.126	0.126	0.126	0.121	0.117	0.114	0.110	0.107
		20%	0.111	0.112	0.112	0.112	0.112	0.108	0.105	0.101	0.098	0.096
		30%	0.098	0.098	0.098	0.098	0.099	0.095	0.092	0.089	0.087	0.084
		40%	0.084	0.084	0.084	0.085	0.085	0.082	0.079	0.077	0.075	0.073
		50%	0.070	0.071	0.071	0.071	0.071	0.069	0.067	0.065	0.063	0.062
		60%	0.057	0.057	0.057	0.057	0.058	0.056	0.054	0.053	0.051	0.050
70%	0.043	0.043	0.043	0.044	0.044	0.043	0.041	0.040	0.039	0.039		

DRYER MOP		250 psig (17.2 barg)														
INLET PRESSURE (psig)		120	130	140	150	160	170	180	190	200	210	220	230	240	250	
INLET PRESSURE (barg)		8.3	9.0	9.7	10.3	11.0	11.7	12.4	13.1	13.8	14.5	15.2	15.9	16.5	17.2	
ISO CLASS 1 4 MIN. CYCLE -100°F / -73°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.148	0.145	0.143	0.141	0.139	0.138	0.137	0.136	0.135	0.135	0.135	0.134	0.134	0.134
		10%	0.135	0.133	0.131	0.129	0.128	0.127	0.126	0.126	0.125	0.125	0.125	0.125	0.125	0.125
		20%	0.122	0.120	0.119	0.118	0.117	0.116	0.116	0.116	0.115	0.115	0.115	0.116	0.116	0.116
		30%	0.110	0.108	0.107	0.106	0.106	0.106	0.105	0.105	0.105	0.106	0.106	0.106	0.107	0.107
		40%	0.097	0.096	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.096	0.096	0.096	0.097	0.098
		50%	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.085	0.085	0.086	0.086	0.087	0.088	0.088
		60%	0.072	0.072	0.072	0.072	0.073	0.073	0.074	0.075	0.075	0.076	0.077	0.078	0.079	0.080
ISO CLASS 2 10 MIN. CYCLE -40°F / -40°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.135	0.131	0.128	0.125	0.122	0.120	0.118	0.116	0.114	0.113	0.111	0.110	0.109	0.108
		10%	0.122	0.119	0.116	0.113	0.111	0.109	0.107	0.106	0.104	0.103	0.102	0.101	0.100	0.099
		20%	0.110	0.107	0.104	0.102	0.100	0.098	0.097	0.095	0.094	0.093	0.092	0.091	0.090	0.090
		30%	0.097	0.095	0.092	0.091	0.089	0.088	0.086	0.085	0.084	0.083	0.083	0.082	0.081	0.081
		40%	0.084	0.082	0.081	0.079	0.078	0.077	0.076	0.075	0.074	0.074	0.073	0.072	0.072	0.072
		50%	0.072	0.070	0.069	0.068	0.067	0.066	0.065	0.065	0.064	0.064	0.063	0.063	0.063	0.063
		60%	0.059	0.058	0.057	0.056	0.056	0.055	0.055	0.054	0.054	0.054	0.054	0.054	0.054	0.054
ISO CLASS 3 16 MIN. CYCLE -4°F / -20°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.132	0.128	0.124	0.121	0.118	0.115	0.113	0.111	0.109	0.107	0.105	0.104	0.102	0.101
		10%	0.119	0.115	0.112	0.109	0.107	0.105	0.103	0.101	0.099	0.097	0.096	0.095	0.093	0.092
		20%	0.106	0.103	0.100	0.098	0.096	0.094	0.092	0.090	0.089	0.088	0.086	0.085	0.084	0.083
		30%	0.094	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.079	0.078	0.077	0.076	0.075	0.074
		40%	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.070	0.069	0.068	0.067	0.066	0.066	0.065
		50%	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.060	0.059	0.058	0.058	0.057	0.057	0.056
		60%	0.056	0.054	0.053	0.052	0.051	0.051	0.050	0.049	0.049	0.048	0.048	0.048	0.047	0.047
ISO CLASS 4 24 MIN. CYCLE +38°F / +3°C PRESSURE DEWPOINT	ENERGY (PURGE) SAVINGS SETTING	0%	0.130	0.126	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.104	0.102	0.100	0.099	0.097
		10%	0.117	0.114	0.110	0.107	0.105	0.102	0.100	0.098	0.096	0.094	0.093	0.091	0.090	0.088
		20%	0.105	0.101	0.098	0.096	0.093	0.091	0.089	0.088	0.086	0.084	0.083	0.082	0.081	0.079
		30%	0.092	0.089	0.087	0.084	0.082	0.081	0.079	0.077	0.076	0.075	0.073	0.072	0.071	0.070
		40%	0.079	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.066	0.065	0.064	0.063	0.062	0.061
		50%	0.067	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.054	0.053	0.052
		60%	0.054	0.053	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.045	0.044	0.044	0.043
70%	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.036	0.035	0.035	0.035	0.034		

Table 9-7 Average Purge / Repressurization Flow Factors (150 and 250 psig MOPs)

10. MAINTENANCE

WARNING - The heatless desiccant dryer is a pressure-containing device. De-pressurize before servicing. (See Section 3.3)

NOTE: Level 1 and 2 Controllers are equipped with Service Reminder functions for filters, desiccant and valves.

10.1 Desiccant Replacement

NOTE: The use of the correct replacement desiccant is necessary for proper dryer operation. Never use hygroscopic salts of the type commonly used in “deliquescent” type dryers.

10.1.1 Frequency Of Desiccant Replacement

Desiccant should be replaced whenever the required dew point cannot be maintained while the dryer is being operated within its design conditions and there are no mechanical malfunctions. Refer to Section 11.0 for troubleshooting hints.

NOTE: Desiccant life is determined by the quality of the inlet air. Proper filtering of the inlet air will extend the life of the desiccant. Typically desiccant life is 3 to 5 years.

10.1.2 Procedure for Desiccant Charge Replacement

- De-pressurize and de-energize the dryer.
- Remove the fill and drain plugs from desiccant tower and drain the spent desiccant. Place a container at the base of the vessel to collect the desiccant. If necessary tap the sides of the vessels with a rubber mallet to loosen desiccant.

NOTE: Use extreme care when inserting rods or other tools through the desiccant fill or drain ports to loosen packed desiccant. Internal flow diffusers at the ends of the desiccant beds can be damaged or punctured by sharp instruments. These diffusers are necessary to distribute the airflow and keep the desiccant beads within the tower. Desiccant beads in exhaust mufflers, afterfilters, or the piping connected to the desiccant towers may indicate a perforation of a diffuser.

- Replace the drain plug using Teflon tape or another pipe thread sealant suitable for compressed air service.
- Fill the desiccant tower as full as possible with dry desiccant. Do not tamp or otherwise pack the desiccant.
- Replace the fill plug using Teflon tape or another pipe thread sealant suitable for compressed air service.
- Repeat this procedure for the other tower.

10.1.3 Insuring Desiccant Dryness

Replacement desiccant is shipped in airtight containers. Keep the covers on these containers tightly closed until use to avoid moisture contamination. If desiccant is exposed to air it can be heated in an oven at 400°F (204°C) for four hours before use. Alternatively, if the dryer is not refilled with dry desiccant, it may be necessary to operate the unit with an inlet flow rate of less than 50% of maximum rated inlet capacity until the desiccant has regenerated fully.

10.2 Purge Mufflers

- Purge mufflers should be checked regularly, changed annually. Muffler disseminator elements become clogged with desiccant dust over time, creating back pressure and restricted purge flow.
- Refer to section 9.2.7.

10.3 Valves

- Process and pilot valves should be checked frequently for leaks and proper operation.
- Purge pressure adjustment valve should be checked frequently for proper adjustment.
- Refer to section 9.2.8.

10.4 Pilot Air Filter Element Replacement

10.4.1 Frequency of replacement

The pilot air filter contains a filter element that should be changed yearly. Replacement may be required sooner if pressure drop across cartridge prevents valves from actuating properly. Pilot air pressure should be in the range of 60-120 psig (4.1-8.3 barg) and is controlled by a pressure regulator that has been set and sealed at 120 psig (8.3 barg).

Warning – The pilot air filter housing is a pressure-containing device, de-pressurize before servicing. Slowly open manual drain valve on bottom of filter bowl by turning clockwise to verify that the housing is de-pressurized before removing bowl.

10.4.2 Procedure for element replacement

10.4.2.1 Models 40 through 3000

- Isolate dryer from air supply
- De-pressurize dryer by running dryer and allowing system pressure to purge to atmosphere. Loss of pilot pressure will eventually prevent purge/repressurization valves from opening. Remaining pressure can be vented to atmosphere through the manual vent on the pilot air filter. The system must be fully de-pressurized before removing the bowl.
- Remove the filter bowl by turning counterclockwise and then pulling straight down.
- Clean the filter bowl.
- Replace the element. Reassemble in reverse order.

10.4.2.2 Models 4100 through 5400

- Isolate dryer from air supply
- De-pressurize dryer by running dryer and allowing system pressure to purge to atmosphere. Loss of pilot pressure will eventually prevent purge/repressurization valves from opening. Remaining pressure can be vented to atmosphere through the manual drain on the pilot air filter. The system must be fully de-pressurized before removing the bowl.
- Remove the filter bowl by pushing up, turning counterclockwise and then pulling straight down.
- Clean the filter bowl.
- Replace the element – Pull off the old element and discard. Make certain O-ring inside top of replacement element is lubricated and in place and then push element onto filter head.
- Clean and lubricate O-ring at top of bowl and reassemble in reverse order.

NOTE: Wave spring ends should be pointed down to prevent the wave spring from interfering with reassembly.

11. TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
11.1 Indicator lights not illuminated	No power to unit.	Check voltage at terminal board.
	Off/On switch turned off.	Turn on.
	Blown fuse.	Replace fuse.
	Off/on switch or board malfunction.	Replace board.
11.2 Moisture indicator turns yellow (elevated outlet dew point)	Design conditions exceeded.	Refer to Sections 4 & 9 to determine if dryer is being outside of design limitations.
	Spent desiccant (useful service life has ended).	Replace desiccant.
	Contaminated desiccant (e.g. with oil)	Take corrective action. Refer to Section 4.1 to determine proper prefiltration before changing desiccant.
	Saturated desiccant (saturated with water)	Refer to 11.3 for corrective action. Operation at reduced flow may reactivate desiccant beds until desired outlet dew point is achieved.
11.3 Premature saturation of desiccant	Insufficient purge flow - Purge pressure too low	Refer to Section 9 to determine correct Purge Pressure Indicator setting.
	Incomplete tower depressurization (tower pressure greater than 2 psig) - clogged mufflers	Replace muffler inserts.
	Incomplete tower depressurization - Purge/repressurization valve fails to open	Verify voltage to pilot solenoid valve. Check pilot air pressure (60-120 psig required). Verify proper actuator operation.
	Insufficient purge time - Incorrect controller settings	Refer to Section 7 or 8 to determine correct controller cycle settings.
	Insufficient purge time - Faulty controller	Refer to Section 7 or 8 to verify proper time sequence. Replace controller board as required.
11.4 Tower fails to repressurize to line pressure	Purge/repressurization valve fails to close (air loss from mufflers during tower repressurization portion of cycle)	Verify removal of voltage to pilot solenoid valve. Verify proper actuator operation. This is a spring-assisted, normally closed valve. Check valve for obstruction or seat damage.
	Insufficient purge flow - Purge pressure too low	Refer to Section 9 to determine correct Purge Pressure Indicator setting . Purge Pressure Adjustment Valve should never be completely closed.
11.5 Excessive purge is discharged during purge cycle	Excessive purge flow - Purge pressure too high	Refer to Section 9 to determine correct Purge Pressure Indicator setting .
	Inlet switching valve fails to close.	Verify voltage to pilot solenoid valve. Check pilot air pressure (60-120 psig required.) Verify proper actuator operation. Check valve for obstruction or seat damage.
	(Models 40 through 3000) Shuttle Valve; or (Models 4100 through 5400) same tower Outlet Check or opposite tower Purge Check Valves fail to close	Repair or replace valve(s) as needed.
11.6 Excessive desiccant dust downstream	Fluidization of desiccant bed - design conditions for maximum rated flow exceeded	Refer to Section 4 or 9 to determine if dryer is being operated outside of design limitations.
	Fluidization of desiccant bed - Rapid repressurization of offstream tower due to: Faulty timer	Refer to Section 7 or 8 to verify proper time sequence.
	Insufficient purge flow - purge pressure too low	Refer to Section 9 to determine correct Purge Pressure Indicator setting .
11.7 Switching Failure Alarm (Level 1 & Level 2 Controllers only)	Faulty pressure switches or control board	Replace components
	Offstream tower did not de-pressurize in time and/or below 10 psig	Check mufflers, check or shuttle valve(s), inlet switching and purge/repressurization valves, purge pressure adjustment, and controller settings.
	Offstream tower did not re-pressurize in time and/or above 10 psig	Check air supply to dryer, purge/repressurization valve, purge pressure adjustment, and controller settings.

12. NOTES

Information from the dryer serial number tag can be recorded in the following table. This information may be necessary when communicating with Service representatives.

Serial Number Tag Fields	Allowable Values from Serial Number Tag	Actual Values at Installation
Model Number:		
Serial Number:		
Service Code:		
Rated Capacity:		
Maximum Operating Temperature:		
Desiccant Type:		
VAC (AC Voltage):		
AC Phase:		
AC Frequency:		
AC Wattage:		
AC Holding Current:		
VDC (DC Voltage)		
DC Wattage:		
DC Holding Current:		
ETO DCF- Code (If Listed, Btm RH Corner)		
EC- Code (If Listed, Btm RH Corner)		

Additional information that may be useful when dealing with Service:

Location of installation (address and phone number): _____

Distributor purchased from: _____

Repair Parts List Number and Revision: _____

Indoors or outdoors installation: _____

Ambient temperature range: _____

Prefilters: _____

Drains: _____

Delta-P devices: _____

Afterfilters: _____

Delta-P devices: _____

Blocking or Isolation Valves: _____

ISO Class Operating Mode: _____

Fixed or Demand Cycle Mode (Level 2 controller only): _____

Outlet pressure dew point reading: _____

Additional accessories or special features: _____

WARRANTY

The manufacturer warrants the product manufactured by it, when properly installed, operated, applied, and maintained in accordance with the procedures and recommendations outlined in the manufacturer's instruction manuals, to be free from defects in material or workmanship for a period of one (1) year from the date of shipment from the manufacturer or the manufacturer's authorized distributor, or eighteen months from the date of shipment from the factory, whichever occurs first, provided such defect is discovered and brought to the manufacturer's attention within the aforesaid warranty period.

The manufacturer will repair or replace any product or part determined to be defective by the manufacturer within the warranty period, provided such defect occurred in normal service and not as the result of misuse, abuse, neglect, or accident. Normal maintenance items requiring routine replacement are not warranted. The warranty covers parts and labor for the warranty period unless otherwise specified. Repair or replacement shall be made at the factory or the installation site, at the sole option of the manufacturer. Any service performed on the product by anyone other than the manufacturer must first be authorized by the manufacturer.

Unauthorized service voids the warranty and any resulting charge or subsequent claim will not be paid. Products repaired or replaced under warranty shall be warranted for the unexpired portion of the warranty applying to the original product.

The foregoing is the exclusive remedy of any buyer of the manufacturer's product. The maximum damages liability of the manufacturer is the original purchase price of the product or part.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WRITTEN, ORAL, OR STATUTORY, **AND IS EXPRESSED IN LIEU OF THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.** THE MANUFACTURER SHALL NOT BE LIABLE FOR LOSS OR DAMAGE BY REASON OF STRICT LIABILITY IN TORT OR ITS NEGLIGENCE IN WHATEVER MANNER INCLUDING DESIGN, MANUFACTURE, OR INSPECTION OF THE EQUIPMENT OR ITS FAILURE TO DISCOVER, REPORT, REPAIR, OR MODIFY LATENT DEFECTS INHERENT THEREIN.

THE MANUFACTURER, HIS REPRESENTATIVE OR DISTRIBUTOR SHALL NOT BE LIABLE FOR LOSS OF USE OF THE PRODUCT OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE BUYER, WHETHER ARISING FROM BREACH OF WARRANTY, NEGLIGENCE OR STRICT LIABILITY IN TORT.

The manufacturer does not warranty any product, part, material, component, or accessory manufactured by others and sold or supplied in connection with the sale of the manufacturer's products.

AUTHORIZATION FROM THE SERVICE DEPARTMENT IS NECESSARY BEFORE MATERIAL IS RETURNED TO THE FACTORY OR IN-WARRANTY REPAIRS ARE MADE.

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