



**Middleby
Marshall®**

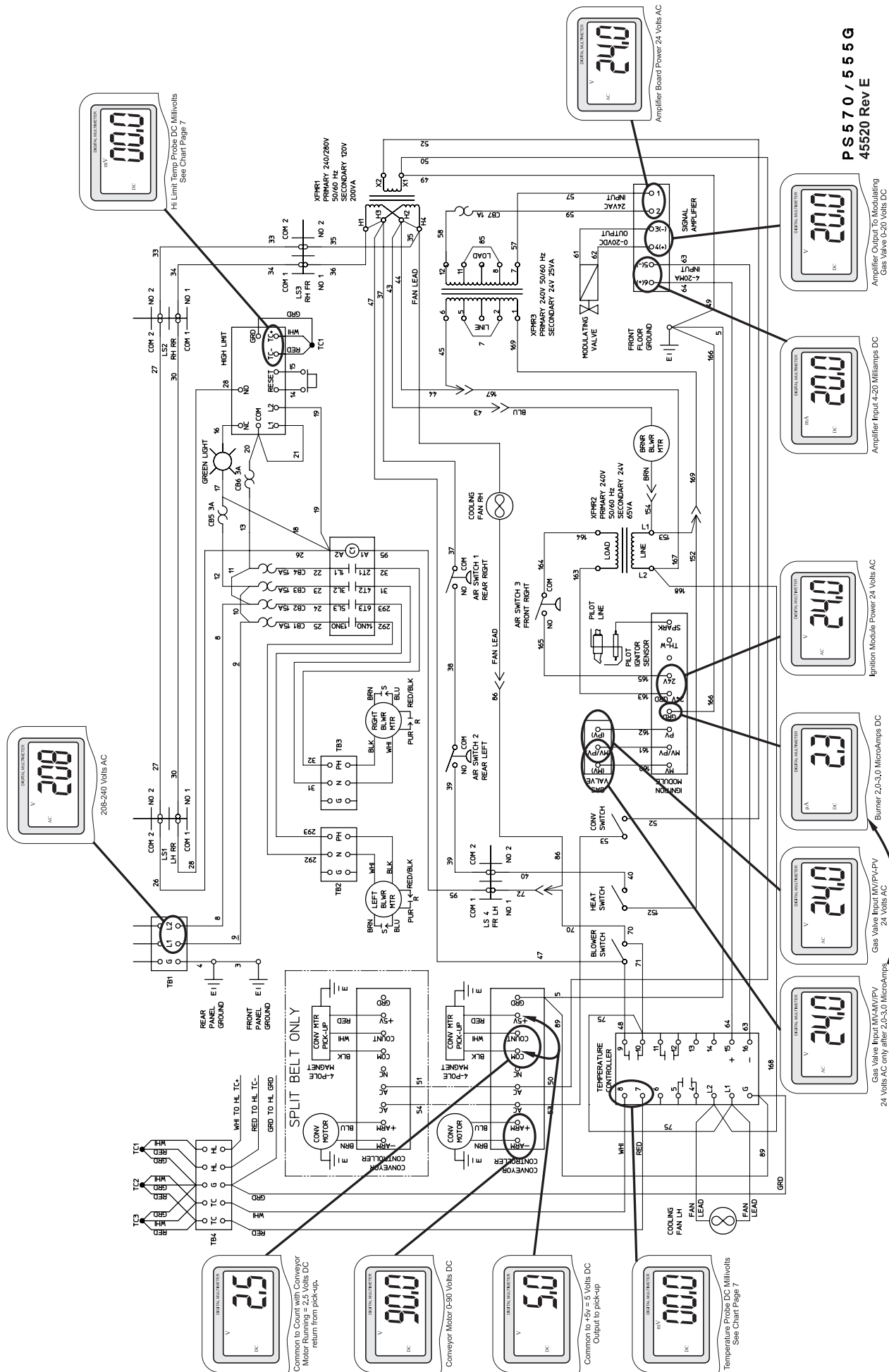
Training Flash Cards

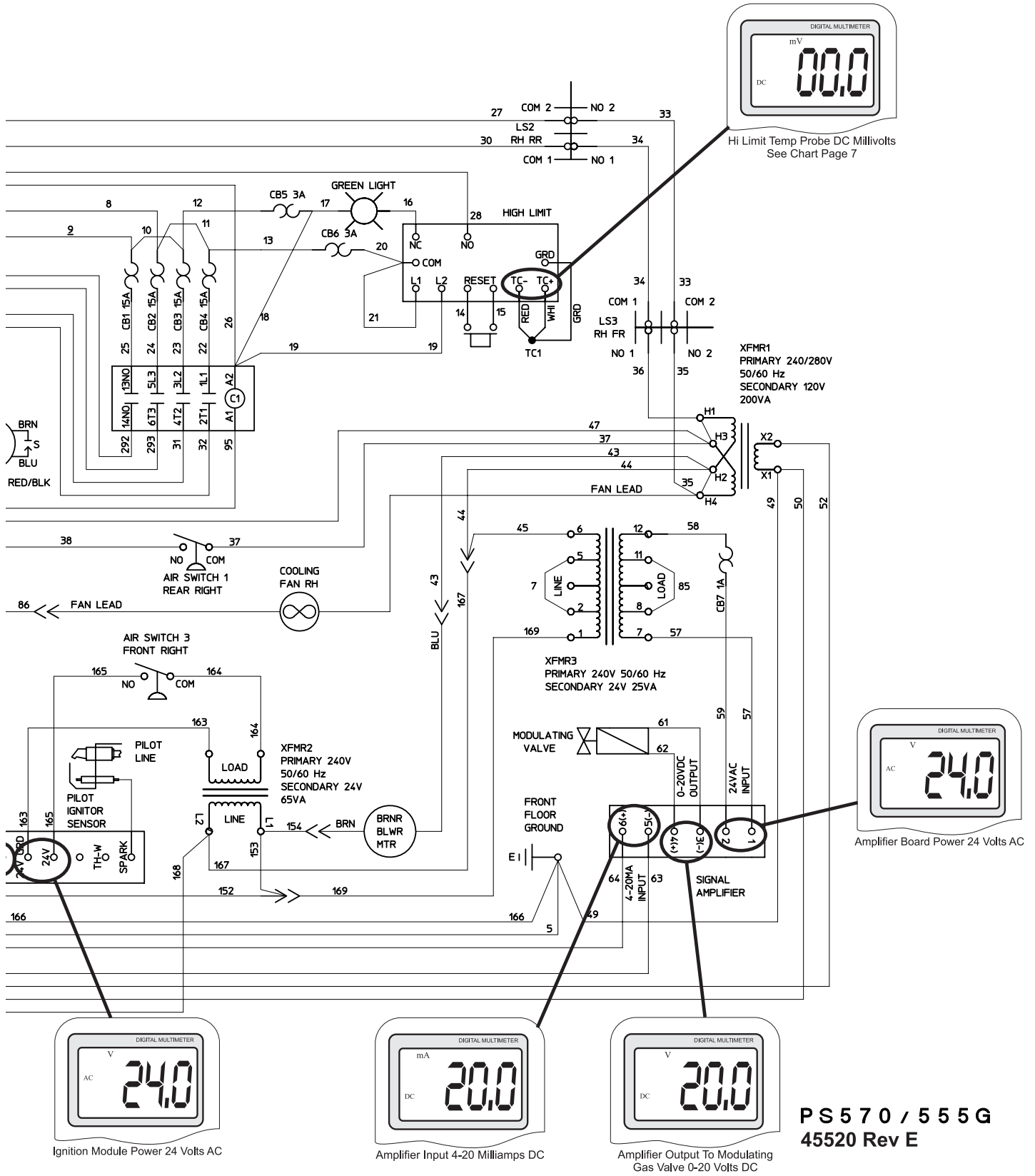
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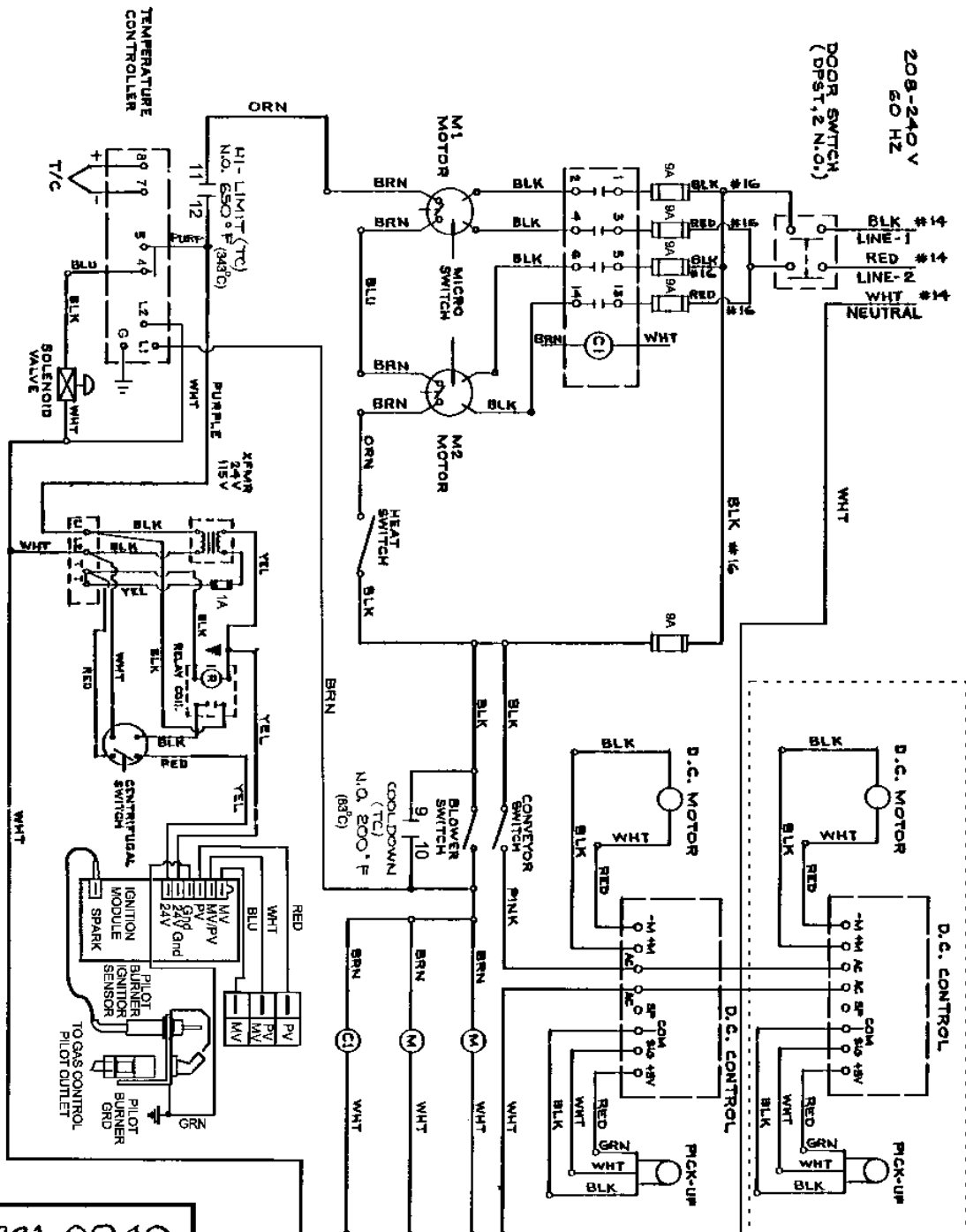
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FOR SPLIT BELT APPLICATIONS ONLY

NOTES: 1) ALL WIRES ARE TO BE #18 AWG UNLESS OTHERWISE SPECIFIED.
 2) W/D LABEL P/N 22500-0061.

PART NO
83221-0040

REV	DATE	DESCRIPTION	BY	CHKD
1	12/14/05	CHG'D LEADS BY BLOWER SW & HI-LIMIT	F	ECON 005427
2	12/09/98	UPDATED MODULE & ADDED FOR SPLIT BELT ALT	E	ECON 560967
3	4-18-90	W/S USED ON 3500/304/550 - UPDATED TO 310/350/310/550 - ECU 30047	C-D	
4	8-18-88	W/D: 110 ORN, 110 YEL, 110 BRN, 110 WHT, 110 BLU, 110 PURPLE	A	

SCALE	DRWING	CHECKED	APPROVED	DESCRIPTION
CA	CA	CA	W/D	WD, GAS 208-240/60/1 3W PS360

Middleby
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 Middleby Marshall Oven Co., Inc.
 8000 Austin Ave. • Madison Grove, MI 48003

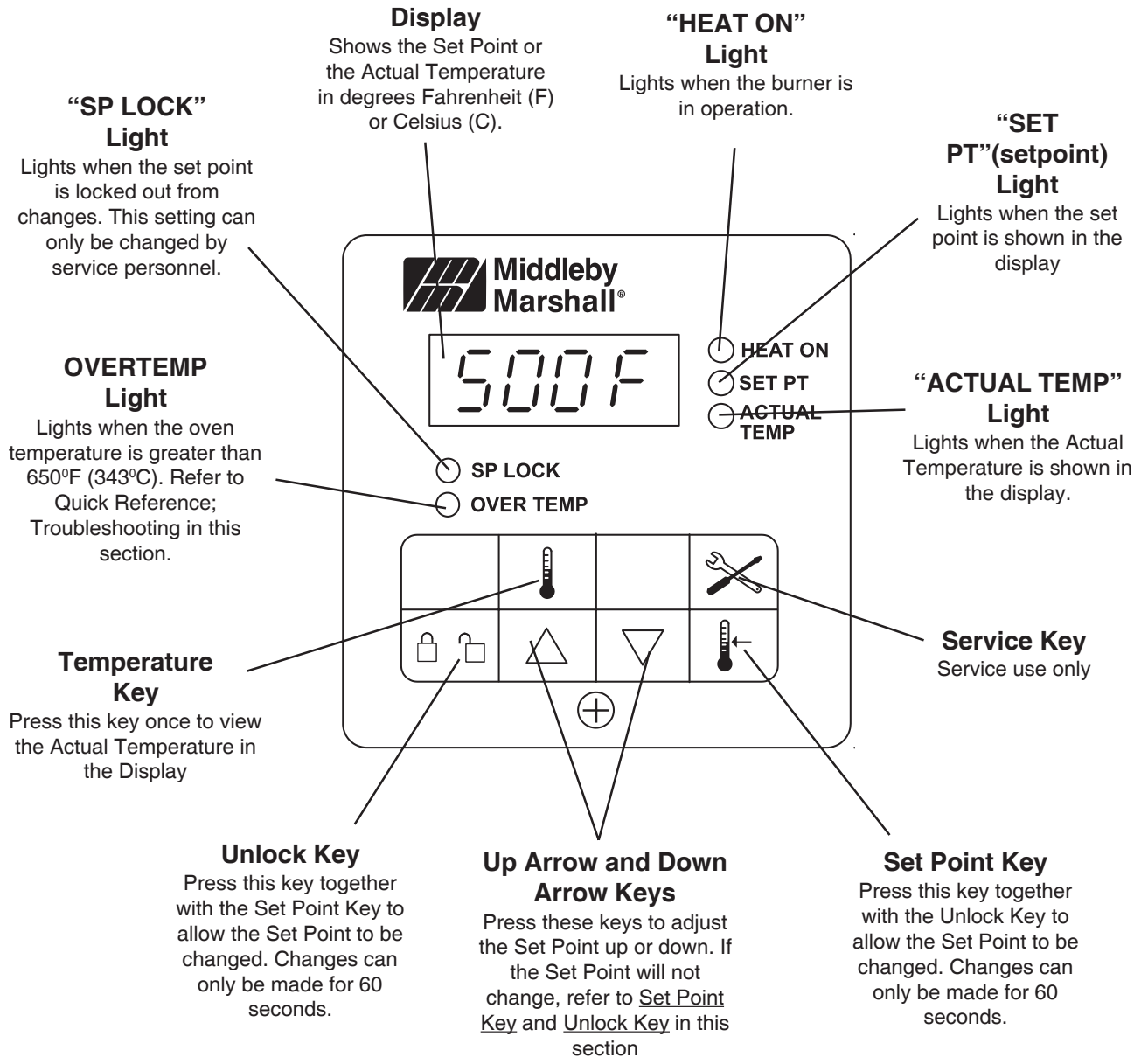
W/D, GAS 208-240/60/1 3W
 PS360

TOLERANCES UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS 2.1" DISCRETE 20K & 50K
 FRACTIONS 1/16" 20K & 50K

Digital Temperature Controller

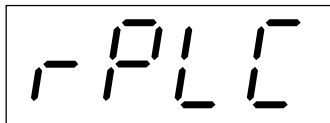
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Operating Instructions



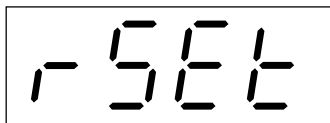
Diagnostic Error Messages

The controller runs background tests during normal operation. If any problems occur during the tests, an error message flashes in the display. A listing of these diagnostic error messages is shown below.



Flashes on the display (alternating with the temperature) indicating that the internal diagnostic test has failed.

1. Turn the Blower Switch (HEAT Switch for PS536 ovens with the two-switch configuration) OFF for 2 minutes.
2. Turn the Blower Switch (or HEAT Switch, as per Step 1) ON.
3. If necessary, repeat Steps 1 and 2 up to two additional times.
4. If the problem does not clear after 3 attempts, replace the controller.



The oven temperature has not reached 200°F/93°C within 15 minutes of startup. On gas ovens, this is usually a result of the burner not lighting.

1. Turn the Blower Switch (HEAT Switch for PS536 ovens with the two-switch configuration) OFF for 2 minutes.
2. Turn the Blower Switch (or HEAT Switch, as per Step 1) ON.
3. If the problem does not clear, contact the Middleby Technical Service Department for assistance.

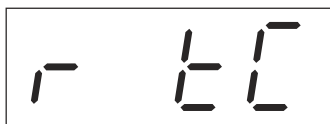


Caused by an open in the thermocouple circuit.

1. Check that the thermocouple leads are properly connected to Terminals 7 & 8 of the temperature controller.
2. Check the continuity of the thermocouple at room temperature. You should measure 9-20 Ohms of resistance.
3. If the reading was outside the correct range, the thermocouple has an open. Remove and replace the thermocouple.

If the reading was inside the correct range, contact the Middleby Technical Service Department for assistance.

4. With a 3-4" piece of wire, jump terminals 7 and 8 together with the thermocouple connected. Display should read ambient temperature



Polarity of the thermocouple leads is reversed.

1. Check the polarity of the thermocouple leads. The red wire (-) should be attached to Terminal 7 on the temperature controller. The white wire (+) should be attached to Terminal 8.
2. If the polarity connections are incorrect, connect the thermocouple properly.

If the polarity connections are correct, replace the thermocouple.

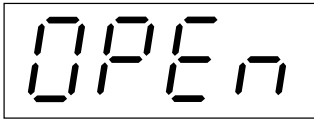
IN1RNG

Check Thermocouple Wiring

To check a thermocouple, there are 2 (two) things we need. One is continuity and the other is a proper millivolt reading. Please refer to the table on the next page for the proper millivolt reading for the various operating and junction temperatures. Take your reading with the thermocouple disconnected and check each one individually, for many of our models have more than one thermocouple.

Diagnostic Error Messages

The controller runs background tests during normal operation. If any problems occur during the tests, an error message flashes in the display. A listing of these diagnostic error messages is shown below.



This alternating code, displayed on the temperature controller indicates that there is open circuit on the temperature sensing portion of the control.



Thermocouple millivolt readings at various operating and junction temperatures.

		OVEN TEMPERATURE										
		200°F 93°C	250°F 121°C	300°F 149°C	325°F 163°C	350°F 177°C	400°F 204°C	425°F 218°C	450°F 232°C	500°F 260°C	550°F 288°C	600°F 315°C
JUNCTION TEMPERATURE	90°F (32°C)	3.25	4.77	6.30	7.06	7.83	9.37	10.14	10.91	12.46	14.00	15.53
	88°F (31°C)	3.32	4.83	6.36	7.12	7.89	9.43	10.20	10.97	12.51	14.05	15.59
	86°F (25°C)	3.37	4.88	6.41	7.17	7.94	9.49	10.26	11.03	12.57	14.11	15.65
	84°F (29°C)	3.43	4.94	6.47	7.23	8.00	9.54	10.31	11.09	12.63	14.19	15.71
	82°F (28°C)	3.49	5.00	6.53	7.29	8.06	9.60	10.37	11.14	12.69	14.23	15.76
	80°F (27°C)	3.55	5.06	6.59	7.35	8.12	9.66	10.43	11.20	12.74	14.28	15.82
	78°F (26°C)	3.60	5.11	6.64	7.40	8.17	9.72	10.49	11.26	12.80	14.34	15.88
	76°F (24°C)	3.66	5.17	6.70	7.46	8.23	9.77	10.55	11.32	12.86	14.40	15.94
	75°F (24°C)	3.69	5.20	6.73	7.49	8.26	9.80	10.57	11.35	12.89	14.43	15.97
	74°F (23°C)	3.72	5.23	6.76	7.52	8.29	9.83	10.60	11.37	12.92	14.46	15.99
	72°F (22°C)	3.78	5.29	6.82	7.58	8.35	9.89	10.66	11.43	12.97	14.51	16.05
	70°F (21°C)	3.83	5.34	6.87	7.63	8.40	9.95	10.72	11.49	13.03	14.57	16.11
	68°F (20°C)	3.89	5.40	6.93	7.69	8.46	10.00	10.78	11.55	13.09	14.63	16.17
	66°F (19°C)	3.95	5.46	6.99	7.75	8.52	10.06	10.83	11.61	13.15	14.69	16.23
	64°F (18°C)	4.01	5.52	7.05	7.81	8.58	10.12	10.89	11.66	13.20	14.74	16.28
62°F (17°C)	4.06	5.57	7.10	7.86	8.63	10.18	10.95	11.72	13.26	14.80	16.34	
60°F (16°C)	4.12	5.63	7.16	7.92	8.69	10.24	11.01	11.78	13.32	14.86	16.40	

Thermocouple Troubleshooting

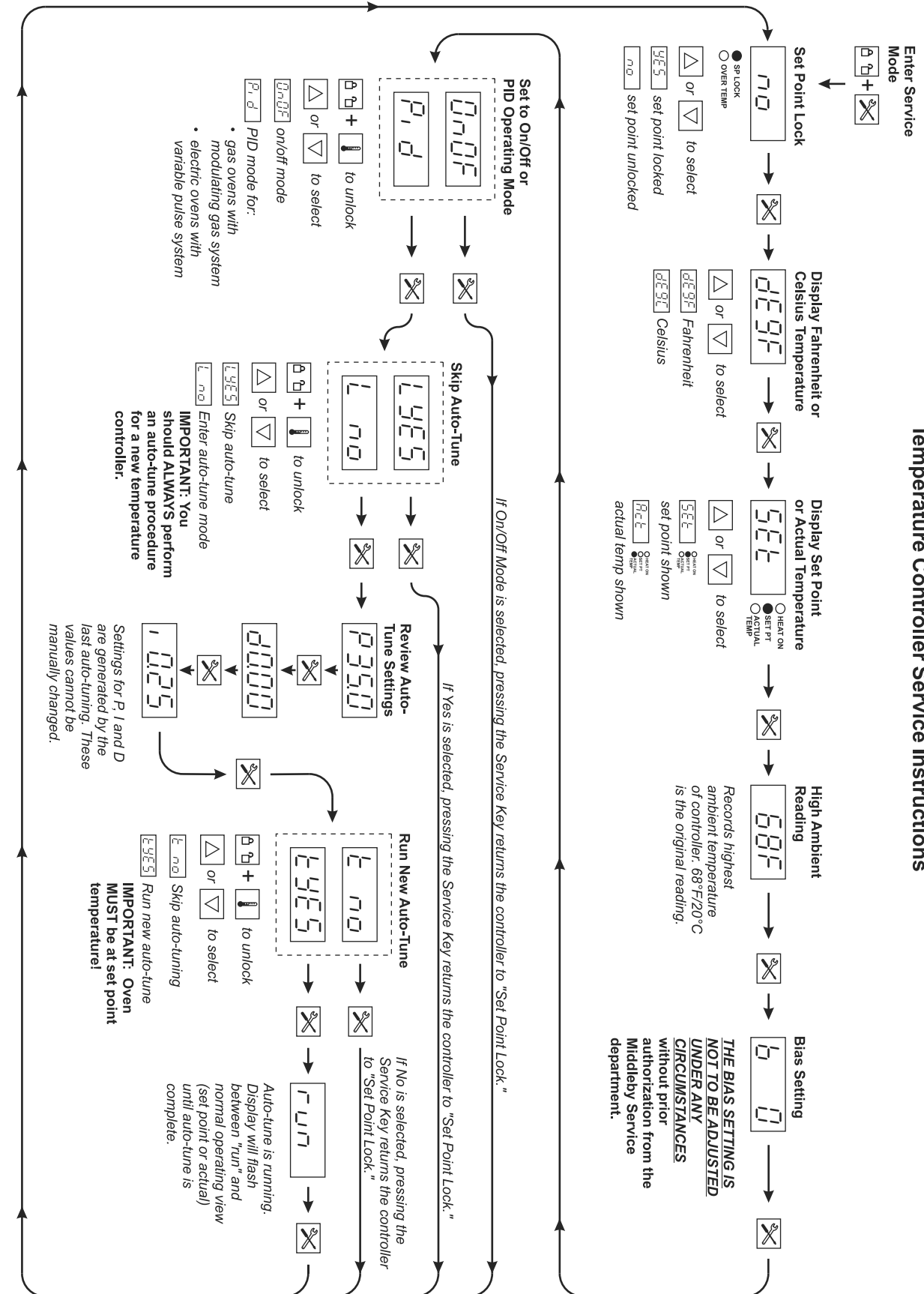
Open Thermocouple

- An open thermocouple will cause the temperature controller to read the maximum temperature (usually 909°F/ 487°C). This causes the following:
- On ovens without a separate high limit control module, an open thermocouple triggers the high limit alarm. This shuts down the burner. After the open has been corrected, the high limit will need to be reset to allow the oven to resume operation.
- On ovens with a sperate high limit control module, an open temperature-sensing thermocouple causes the temperature controller to stop calling for heat. This shuts down the burner.
- On ovens with a sperate high limit control module, an open high limit thermocouple will trigger the high limit control module to shut down the burner. Note that the high limit control will need to be reset after the open is corrected before the oven can return to operation.

Checking the Thermocouple With A DC Millivolt meter

- It is possible to check that a thermocouple is reading accurately by using a multimeter set to read DC millivolts. At 32°F/0°C the thermocouple should read 0 mVDC. This can be checked by inserting the thermocouple into an ice bath for several minutes. At 72°F/22°C the reading should be 1.134mVDC.
- You can use the chart above by checking the temperature at the thermocouple's junction terminals. This is called the Junction Temperature.

Temperature Controller Service Instructions



Display % of Valve Opening (modulating valve only)

F7 + F8
 then F8 % of valve open will be displayed

Reset High Ambient Temp Alarm

F7 + F8

Trouble Shooting Middleby Conveyor Ovens

Quick Check list

Modulating Gas Valve

- Is Temperature Controller in PID mode?
- Confirm you have 24VAC input on amplifier board are terminals 1 and 2 - if not, check transformer.
- Confirm 0-20VDC output voltage at terminals 3 and 4 on the amplifier board - if not, check for 4-20mA input to amplifier board from temperature controller at terminals 5 and 6.
- Confirm 4-20mA signal on terminals 5 and 6 of the amplifier board - temperature controller must be in PID mode. - Refer to Middleby Marshall Temperature Controller hand-out, section 4.

Ignition Circuit PS300 Series and PS200 Series

1. The following sequence of events must happen for the oven to light.
 - Each of the main blower motors must either trip a centrifugal switch or an air switch.
 - Once the above occurs, next the transformer on the burner blower motor should be supplied voltage
 - Next, the time delay relay
 - The burner blower motor should come up to speed and trip either a centrifugal switch or an air switch.
 - 24 volts to the ignition module
2. 24 volts between MV/PV and PV terminals
3. Once you have a pilot, you will have 24 volts between MV/PV and MV
4. If these steps have been proven, you have completed the Ignition sequence.

Conveyor

Runaway Condition

- Confirm distance between Sensor and Magnet – business card thickness
- Check common to +5 terminals on speed control – should be 5 VDC
- Check common to count terminal on speed control–2.5VDC with motor running
- If a thumbwheel display, and you do not achieve proper bake time, it is most likely the contacts in the thumbwheel.

Drive Motor Stopping

- Confirm input to AC terminals on speed Control – should be 115 V
- Confirm output voltage from ARM+ and ARM-
- If no voltage, disconnect one ARM, check for voltage. If you have voltage, check drive motor for shorts and also check brushes for wear.

Ohm's Law Equation Wheel

Using this wheel, you can calculate any one of the following four basic factors of electricity, as long as two of the others are known.

- Power - Watts (W), shown as "W"
- Current - Amperes (A), shown as "I"
- Voltage - Volts (V), shown as "E"
- Resistance - Ohms (Ω), shown as "R"

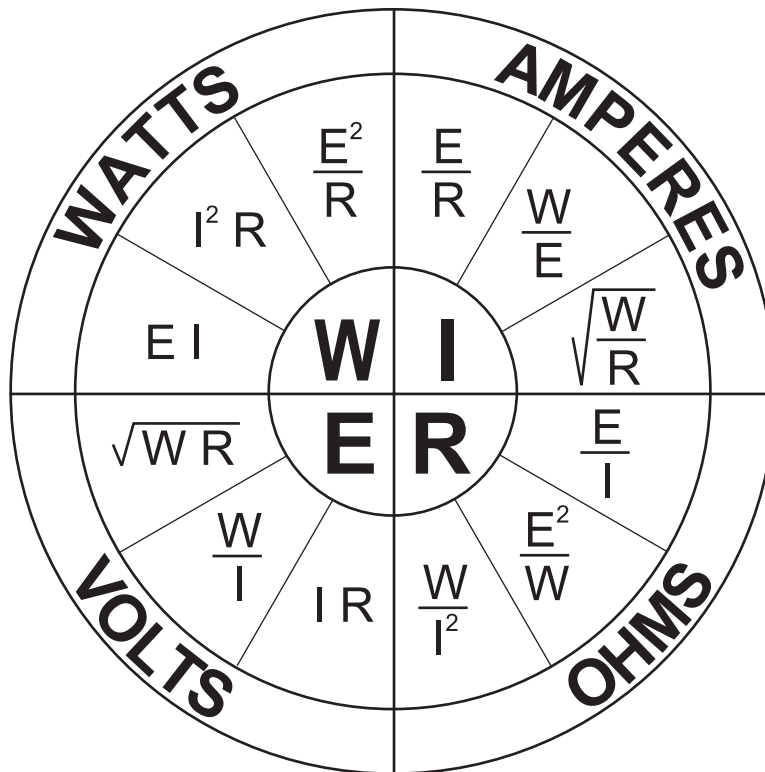
choose an equation that will give you the value that you need based on what values are already known.

MICRO = 1/1,000,000 (one millionth) e.g., microamps

MILLI = 1/1,000 (one thousandth) e.g., millivolts

KILO = 1,000 x (one thousand times) e.g., kilowatts

MEGA = 1,000,000 x (one million times) e.g., megohms



GAS

PIPE SIZING TABLE

MAXIMUM CAPACITY OF PIPE IN CUBIC FEET OF GAS PER HOUR
(Based upon a Pressure Drop of 0.3 inch Water Column and
0.6 Specific Gravity Gas)

NOMINAL IRON PIPE SIZE, INCHES	INTERNAL DIAMETER, INCHES	LENGTH OF PIPE, FEET									
		10	20	30	40	50	60	70	80	90	100
1/2	.622	132	92	73	63	56	50	46	43	40	38
3/4	.824	278	190	152	130	115	105	96	90	84	79
1	1.049	520	350	285	245	215	195	180	170	160	150
1 1/4	1.380	1050	730	590	500	440	400	370	350	320	305
1 1/2	1.610	1600	1100	890	760	670	610	560	530	490	460
2	2.067	3050	2100	1650	1450	1270	1150	1050	990	930	870
2 1/2	2.469	4800	3300	2700	2300	2000	1850	1700	1600	1500	1400
3	3.068	8500	5900	4700	4100	3600	3250	3000	2800	2600	2500
4	4.026	17500	12000	9700	8300	7400	6800	6200	5800	5400	5100

NATURAL GAS - BOTTLED GAS COMPARISON

BOTTLED GAS

1 CUBIC FOOT
1 DECITHERM
1 POUND
1 GALLON
1 THERM

NATURAL GAS

2.4 CUBIC FEET
9.52 CUBIC FEET
20.57 CUBIC FEET
87.22 CUBIC FEET
95.23 CUBIC FEET







































































One Cubic Foot Natural Gas = 1050 BTU
One Cubic Foot LP Gas = 2500 BTU

BTU VALUES - BOTTLED GAS

One Cubic Foot	=	2,520 BTU
One Decitherm	=	10,000 BTU
One Pound	=	21,560 BTU
One Gallon	=	91,584 BTU
One Therm	=	100,000 BTU

STANDARD ELECTRICAL PLUG AND RECEPTACLE CONFIGURATIONS

STRAIGHT BLADE DEVICES

		15 AMPERE		20 AMPERE		30 AMPERE		50 AMPERE									
		RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG								
2-POLE 3-WIRE GROUNDING	5	125 V 5-15R		5-15P		5-20R		5-20P		5-30R		5-30P		5-50R		5-50P	
	6	250 V 6-15R		6-15P		6-20R		6-20P		6-30R		6-30P		6-50R		6-50P	
	7	277 V AC 7-15R		7-15P		7-20R		7-20P		7-30R		7-30P		7-50R		7-50P	
	24	347 V AC 24-15R		24-15P		24-20R		24-20P		24-30R		24-30P		24-50R		24-50P	
	8	480 V AC	(RESERVED FOR FUTURE CONFIGURATIONS)														
	9	600 V AC	(RESERVED FOR FUTURE CONFIGURATIONS)														
3-POLE 3-WIRE	10	125/250 V			10-20R		10-20P		10-30R		10-30P		10-50R		10-50P		
	11	3 Ø 250 V		11-15P		11-20R		11-20P		11-30R		11-30P		11-50R		11-50P	
	12	3 Ø 480 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
	13	3 Ø 600 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
3-POLE 4-WIRE GROUNDING	14	125/250 V		14-15P		14-20R		14-20P		14-30R		14-30P		14-50R		14-50P	
	15	3 Ø 250 V		15-15P		15-20R		15-20P		15-30R		15-30P		15-50R		15-50P	
	16	3 Ø 480 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
	17	3 Ø 600 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
4-POLE 4-WIRE	18	3 Ø 120 V 208Y/120 V		18-15P		18-20R		18-20P		18-30R		18-30P		18-50R		18-50P	
	19	3 Ø 277 V 480Y/277 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
	20	3 Ø 347 V 600Y/347 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
4-POLE 5-WIRE GROUNDING	21	3 Ø 120 V 208Y/120 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
	22	3 Ø 277 V 480Y/277 V	(RESERVED FOR FUTURE CONFIGURATIONS)														
	23	3 Ø 347 V 600Y/347 V	(RESERVED FOR FUTURE CONFIGURATIONS)														

LOCKING DEVICES

		20 AMPERE		30 AMPERE		50 AMPERE		60 AMPERE	
		RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG
2-POLE 3-WIRE GROUNDING	125 V	L5-20R	L5-20P	L5-30R	L5-30P	L5-50R	L5-50P	L5-60R	L5-60P
	250 V	L6-20R	L6-20P	L6-30R	L6-30P	L6-50R	L6-50P	L6-60R	L6-60P
	277 V AC	L7-20R	L7-20P	L7-30R	L7-30P	L7-50R	L7-50P	L7-60R	L7-60P
	347 V AC	L24-20R	L24-20P						
	480 V AC	L8-20R	L8-20P	L8-30R	L8-30P	L8-50R	L8-50P	L8-60R	L8-60P
	600 V AC	L9-20R	L9-20P	L9-30R	L9-30P	L9-50R	L9-50P	L9-60R	L9-60P
3-POLE 3-WIRE	125/250 V	L10-20R	L10-20P	L10-30R	L10-30P				
	3 Ø 250 V	L11-20R	L11-20P	L11-30R	L11-30P				
	3 Ø 480 V	L12-20R	L12-20P	L12-30R	L12-30P				
	3 Ø 600 V			L13-30R	L13-30P				
3-POLE 4-WIRE GROUNDING	125/250 V	L14-20R	L14-20P	L14-30R	L14-30P	L14-50R	L14-50P	L14-60R	L14-60P
	3 Ø 250 V	L15-20R	L15-20P	L15-30R	L15-30P	L15-50R	L15-50P	L15-60R	L15-60P
	3 Ø 480 V	L16-20R	L16-20P	L16-30R	L16-30P	L16-50R	L16-50P	L16-60R	L16-60P
	3 Ø 600 V			L17-30R	L17-30P	L17-50R	L17-50P	L17-60R	L17-60P
4-POLE 4-WIRE	3 Ø 208Y/120 V	L18-20R	L18-20P	L18-30R	L18-30P				
	3 Ø 480Y/277 V	L19-20R	L19-20P	L19-30R	L19-30P				
	3 Ø 600Y/347 V	L20-20R	L20-20P	L20-30R	L20-30P				
4-POLE 5-WIRE GROUNDING	3 Ø 208Y/120 V	L21-20R	L21-20P	L21-30R	L21-30P	L21-50R	L21-50P	L21-60R	L21-60P
	3 Ø 480Y/277 V	L22-20R	L22-20P	L22-30R	L22-30P	L22-50R	L22-50P	L22-60R	L22-60P
	3 Ø 600Y/347 V	L23-20R	L23-20P	L23-30R	L23-30P	L23-50R	L23-50P	L23-60R	L23-60P

COMMON VOLTAGE / PHASE ELECTRICAL COMBINATIONS (U.S.)

Electrical codes require that each of the following systems have ground connections.

110 - 120 VOLTS - SINGLE PHASE

Consists of one hot and one neutral wire. The voltage between the hot wire and the neutral wire is 120 volts.

220 - 240 VOLTS - SINGLE PHASE

Consists of two hot wires. The voltage between the two hot wires is 240 volts.

110 - 120/220 - 240 VOLTS - SINGLE PHASE

Consists of two hot wires and one neutral wire. The voltage between either hot wire and the neutral wire is 120 volts and the voltage between the two hot wires is 240 volts.

110 -120 / 208 VOLTS - THREE PHASE

Consists of three hot wires and one neutral wire. The voltage between any of the hot wires and the neutral wire is 120 volts. The voltage between any two hot wires is 208 volts single phase. The voltage created by combining all three hot wires is 208 volts three phase.

220 - 240 VOLTS - THREE PHASE

Consists of three hot wires. The voltage created by combining any two hot wires is 240 volts.

440 - 480 VOLTS - THREE PHASE

Consists of three hot wires. The voltage created by combining any two hot wires is 480 volts.

Contact a qualified electrician or your electric utility if you are in doubt about your service.

APPROXIMATE AMPERE RESISTANCE LOAD

This chart is provided for guideline purposes only. Consult the manufacturers specification sheet for the actual amp load for the particular piece of equipment being considered.

		WATTS		KILOWATTS									
		500	750	1	2	3	5	7.5	10	15	20	25	30
VOLTS	PHASE												
110-120	1	4.2	6.3	8.4	16.7								
208	1	2.5	3.7	4.9	9.7	14.5	24.1	36.1	48.1				
220-240	1	2.1	3.2	4.2	8.4	12.5	21	31.3	41.7	50			
208	3			2.8	5.6	8.4	13.9	20.9	27.8	41.7	55.6		
220-240	3			2.5	4.9	7.3	12.1	19.7	24.1	36.2	48.2		
440-480	3			1.3	2.5	3.7	6.1	9.9	12.1	18.1	24.1	30.2	36.2

Electricity flows as a current along a conductor very much like water flows through a pipe. The current is measured in **amperes** (amps) which gives the amount of electricity passing through the conductor in one second. The pressure which causes the current to flow is measured in **volts**, just as water pressure is measured in pounds per square inch. The amount of energy produced is called power and is measured in **watts**. Some handy formulas to remember about electricity are shown below.

$W = \text{Power in Watts}$

$A = \text{Current in Amperes}$

$V = \text{Pressure in Volts}$

$1,000 \times W = 1 \text{ Kilowatt}$

$\text{Total Wattage} + \text{Voltage} = \text{Amperes (Single Phase)}$

$(\text{Total Wattage} + \text{Voltage}) + 1.7321 = \text{Amperes (Three Phase)}$

$1 \text{ Horsepower} = 746 \text{ Watts or } .746 \text{ Kilowatts}$

$1 \text{ Kilowatt} = 1.34 \text{ Horsepower}$

ELECTRICAL GUIDELINES

There are many different combinations of voltage, phase, plugs, and wire size available today. It is very important that all of these factors be matched to the piece of equipment.

If a piece of equipment rated for operation at a specific voltage is connected to a smaller voltage line, the equipment will function sluggishly at best because the output required is not present.

Example: A piece of equipment rated at 240 volts is connected to a 120 volt line. The piece of equipment is receiving only about 25% of the power required for it to function properly.

If a piece of equipment rated for operation at a specific voltage is connected to a larger voltage line, the life expectancy of the equipment is greatly reduced. Elements and motors are prone to burn out much faster.

Example: A piece of equipment rated for 208 volts is connected to a 240 volt line. The piece of equipment is receiving approximately 25% more power than it was designed to need.

DEMAND CHARGES:

Typically food service operations are large consumers of electricity and are subject to two charges on their electric bill. One charge is for the amount of electricity actually consumed during the billing period. The other charge, called a demand charge, is based on the costs the utility company incurs to maintain the generating capacity to accommodate the maximum short term demand of large users. It is advisable to discuss demand charges with a reputable energy management firm to determine what means are available to reduce these charges without affecting the functioning of the operation.

NOTES

NOTES

CFESA

Commercial Food Equipment Service Association

Middleby is proud to support the Commercial Food Equipment Service Association (CFESA). We recognize and applaud CFESA's ongoing efforts to improve the quality of technical service in the industry.

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