Models TP294, TP781, TP870, TP944, TP994, TP1164, TP1265, TP2555

CRYOGENICALLY COOLED THERMAL PLATFORM

OPERATION MANUAL

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Safety

Power:

Your Sigma Systems thermal platform must be connected to a grounded electrical service of appropriate voltage and current rating. See specifications on identification label at rear of the unit by the power cord.

Fail-safe:

Before each use, set the bimetal fail-safe thermostat in accordance with the instructions listed below under OPERATION, Fail-safe.

Expendable Coolant:

Coolant must always be treated with great caution. Due to the extreme pressures and temperatures involved, improper use and handling of cryogenic coolants can cause severe injury or death.

When using high pressure L-CO_2 cylinders, always restrain tanks to reduce the possibility of tip-over. Keep the protective cap over the valve when not in use. If a cylinder tips over and breaks the valve, escaping gas and liquid will cause an extreme hazard. When testing is done, do not close the valve at the tank unless liquid/gas pressure in hose has been released by pulsing the platform solenoid or carefully opening the hose. Liquid coolant left in a hose that is closed at both ends will expand dramatically as it warms, possibly rupturing the hose.

Use expendable coolant cooled platforms only in well ventilated areas or vent the exhaust port to outside atmosphere. The coolants CO_2 and N_2 are non toxic and found in large quantities in normal breathing air. However, excessive concentrations can reduce levels of breathable oxygen and cause dizziness and even greater concentrations can eventually cause asphyxiation. Always employ an oxygen monitoring device if there is any question as to the concentration of available oxygen in the room where platforms are to be operated.

Since the platform can produce extreme temperatures, thoughtful use is required. Never allow liquid or gaseous coolant to contact the skin as contact can rapidly cause severe burns. Even the expended coolant that flows from the exhaust port during use can cause severe burns. Be very careful about touching the platform surface. When hot, the platform surface looks no different than it does at room temperature. In very dry climates even very cold platforms may not have visible frost to convey a warning. “Hands off” should be an operator habit around thermal platforms. Also, because the operating surface is fully exposed, care must be taken to assure that passers by are not exposed to thermal hazard.

Operation

Fail-safe:

All Sigma thermal platforms are equipped with a bimetal over temp fail-safe thermostat. When its contacts are opened by excessive temperature, platform operation is shut down. The fail-safe thermostat adjustment shaft is accessible with a flat blade screwdriver through the service panel of most platforms and is labeled "OVERTEMP" or "OVERTEMP FAILSAFE ADJUSTMENT". Clockwise rotation of the fail-safe adjustment increases the temperature at which the unit will shut down. To protect at a specific temperature limit, set the temperature controller at that temperature plus three °C and allow the platform temperature to stabilize. Slowly rotate the adjustment counterclockwise until the fail-safe trips. There will be an audible click when this happens, and the controller will have no further effect until the unit is turned off then back on. To reestablish operation, the platform must cool slightly or the fail-safe must be turned clockwise (higher temperature) then cycle the power off then back on. The standard approximate factory adjustment for the fail-safe is 125°C. It is strongly recommended that the fail-safe be adjusted to the maximum operating temperature of each application, but never higher than the rated maximum temperature for the platform. If for any reason a high temperature trip point cannot be established, do not use the platform until proper operation of this safety system can be restored. See Corrective Maintenance section of this manual. Most Sigma platforms have a maximum operating temperature of 200EC.

Sigma thermal platforms can optionally be equipped with different types of precision HI-LO fail-safe systems. These systems are described under the Controller & Fail-Safe section of this document. HI-LO fail-safes are designed to shut down the platform in case of temperature outside the expected operating range. Always set both the high and low limits if the platform is so equipped. As an additional option, the platform may be wired with a redundant series-connected coolant shut-off valve. With this option, power is also removed from the redundant valve, reducing the risk that a failed solenoid valve can cause a run away cooling condition.

Cleaning:

The cabinet of your Sigma Systems platform and controller is epoxy powder coated and is very tough. However, use solvents with caution and avoid abrasives when cleaning these surfaces. A damp cloth is often all that is needed to keep the cabinet looking good. The working surface of the platform is precision ground flat and hard anodized. Avoid abrasives and be cautious with scrapers as maintaining the flatness of the surface is important to good thermal transfer to flat items. Solvents of almost any type can be used on the working surface, but care should be taken to avoid chemicals which react with aluminum. If solvents are used, do not pour the solvent onto the surface. Use a cloth or paper with some solvent already on it to prevent leaking solvent down the sides of the platform where damage could occur.

Coolant, Expendable:

Platforms can be equipped to use any of three different types of expendable coolant; high pressure liquid CO_2, low pressure liquid CO_2, or liquid N_2. Platforms equipped for high pressure L-CO_2 and low pressure L-CO_2 are identical. Conversions between L-CO_2 and L-N_2 coolants require ordering the proper replacement solenoid valve and injector kit from the factory. The appropriate conversion kit can be ordered from stock to adapt the platform to the coolant of your choice. Always specify the direction of conversion, operating voltage, and model number and serial number of the platform. The type of coolant that the platform was originally configured for is specified on the identification label. With any coolant, the standard platform inlet fitting is the same. The coolant inlet fitting, a 1/4" male SAE flare fitting will mate with the high pressure hoses available from Sigma. The hose connects to the fitting on a coolant tank with an adapter (tank outlet to 1/4" SAE flare). Fittings on all L-CO_2 tanks, (high or low pressure) are the same and the fitting on all L-N_2 tanks are unique to L-N_2 tanks. Adapters to make the proper connections are readily available from Sigma or your local gas distributor. High pressure L-CO_2 hose available from Sigma is not recommended for long term L-N_2 usage. L-N_2 hose is available from Sigma or your local gas supplier. Insulation on delivery lines, especially L-N_2 supply line is strongly advised and will always increase the efficiency of the system. Insulation also reduces condensation/frosting on the hose exterior. It is important to keep L-N_2 hose lengths as short as possible. Never use any type of pressure regulator between a coolant source and the platform unless the regulator is specifically built for use with these refrigerated liquids. L-N_2 platforms are designed to operate best at pressures between 75 and 100 psig. L-CO_2 platforms are optimized for 900 - 1000 psig L-CO_2 from room temperature siphon bottles or approxiamtely 300 psig L-CO_2 from refrigerated sources.

L-N_2 and low pressure L-CO_2 supply tanks have built in pressure building/relief systems allowing the optimum pressure to be set at the tank. High pressure L-CO_2 tanks must be of the siphon variety where the liquid is drawn from the bottom of the tank as opposed to taking gas off the top of the tank. Tanks of this type will be generally marked by a label saying "Liquid CO_2" or "Siphon bottle." Likewise on Low pressure L-CO_2 or L-N_2 systems the platform should be connected to the "Liquid" output of the tank for proper operation.

The use of contaminated CO_2 cylinders should be avoided. "Industrial grade" or better is recommended. Most of the problems associated with the platform's coolant injection system are caused by contaminants. Rust, scale, water, water ice, and oil may often be found in lower grades of liquid CO_2, especially welding grade CO_2. Teflon tape is also to be avoided in the installation of these systems. Instead, Teflon paste is recommended as it does not produce the shreds of Teflon material that have been found the most frequent cause of valve malfunctions. A coolant filter is supplied with every Sigma cryogenically cooled platform. Use of this filter is recommended to trap contaminants before they can become lodged in the solenoid valve. Coolant filters are also available from Sigma in kits supplied with a small amount of Teflon paste and a spanner wrench for servicing the valve. It is a good practice to cautiously blow some coolant through the line before finally connecting a new plumbing system up to a platform. This will eliminate many particles that could potentially become lodged in the filter or solenoid valve or the small diameter injection tube.

High pressure L-CO_2 is less efficient than low pressure L-CO_2 but, because the liquid in the tank is kept at room temperature, it can be stored indefinitely. This makes high pressure L-CO_2 the best option for small scale or intermittent usage. Low pressure L-CO_2, is stored in an insulated container at approximately -17°C. Portable low pressure L-CO_2 tanks will automatically vent to the atmosphere as the pressure in the tank increases with the absorption of heat over time. This increase in pressure is due to the evaporation in the tank that occurs as the liquid warms. Regular usage of low pressure L-CO_2 will nearly eliminate losses due to this warming. Losses will typically not be great if the L-CO_2 is used up steadily over a period of one to two weeks.

In the case of large scale L-CO_2 usage, the most efficient and dependable operation is obtained using a carbon dioxide conditioner. This is a distillation device that eliminates contamination and chills the coolant to maintain a more uniform pressure and temperature. Some models of CO_2 conditioners are not equipped with a low temperature cut off switch. In this case the liquid can become extra cold inside the conditioner. This may result in erratic operation or even the solenoid valve temporarily sticking open for a few minutes after startup. This has been known on occasion to result in a potentially dangerous run away cooling condition. When a platform that is being supplied by a conditioner system is used for the first time after a long period of non use, we recommend attended operation for the first five minutes.

L-N_2 performance and ultimate cost is similar to that of 300 psi L-CO_2. Although L-N_2 has more heat removal capability per pound, other losses and price differences will even out the decision of which coolant is the best performance value. Liquid Nitrogen is almost never delivered to the platform purely liquid, however every effort should be maintained to provide Nitrogen of as purely liquid state as possible. Your liquid nitrogen supplier can supply you with vapor stripping devices if liquid delivery is a problem. Otherwise, use properly insulated hose and keep delivery hoses as short as possible (under 6'). Plumbing should be clean, nonferrous and preferably stainless or copper.

Proper training for the installation and use of cryogenic coolants is essential to avoid risk to both personnel and equipment. Your cryogenic coolant supplier should be able to supply such assistance or direct you to the source of such assistance should you not already be fully qualified to deal with these potentially dangerous fluids.

Controllers & Fail-Safes

Model C Controller:

The Sigma Model C controller is the standard controller shipped with Sigma platforms. Operation is simply a matter of turning the power switch on and setting the required temperature on the digit switches (+199 to -99EC). The switch labeled "AUX" is for options such as resistance programming, or voltage programming. Normally keep the AUX switch in the down position for local operation. Never use cleaners or solvents on a model C digit switch assembly as they have been found to dissolve certain plastic materials inside the switch assembly causing malfunction.

Optional Model CC-3 or CC-3$^{.5}$ Controller:

An optional programmable and remotely controllable Model CC-3 or CC-3$^{.5}$ controller may be fitted to Sigma platforms in place of the Model C. In depth discussion of the CC-3/CC-3$^{.5}$ programmable controller is included in the controller operating manual. For basic operation at a single set-point, set the rotary switch to LOCAL and follow the sequence suggested by the numbers in circles on the front panel, press STOP/START once to enable controller action.

Optional Precision Fail-safes:

The two types of precision fail-safe systems are both electronic and function independently of the controller and the standard bi-metal high limit fail-safe.

> The model **PFS-1** is setscrew adjustable with the benefits of lower cost, and it is less likely to have its settings accidentally disturbed by the operator.
>
> The model **PFS-2** is more readily adjustable with digit switches for setting the high and low limits in degrees C.

Both units are highly repeatable and have resolution of 1EC or less.

Platform Data Chart

	TP294	TP781	TP870	TP994 (TP944)	TP1265	TP1164	TP2555
Working surface dimensions	6 3/4" x 6 3/4"	11" x 11"	6 3/4" x 20"	11" x 14"	14" x 14"	6 3/4 " x 6 3/4" & 6 3/4" x 20" (dual zone)	18" x 20"
Heating wattage	1540 watts	2700 watts	2700 watts	2700 watts	4050 watts	3600 watts	4400 watts
Electrical Service Required	120 VAC: 15 Amps 208 VAC: 10 Amps 240 VAC: 10 Amps	120 VAC: 25 Amps 208 VAC: 15 Amps 240 VAC: 15 Amps	120 VAC: 25 Amps 208 VAC: 15 Amps 240 VAC: 15 Amps	120 VAC: 25 Amps 208 VAC: 15 Amps 240 VAC: 15 Amps	208 VAC: 25 Amps 240 VAC: 20 Amps	208 VAC: 20 Amps 240 VAC: 20 Amps	208 VAC: 25 Amps 240 VAC: 25 Amps
Maximum drill depth (See Note)	.22"	.22"	.22"	.22"	.22"	.22"	.22"
Typical temperature change rate (ramp)	35°C per minute	30°C per minute	30°C per minute	30°C per minute	30°C per minute	30°C per minute	20°C per minute

Drill depth note: Maximum depth includes drill point. Check drill mask before drilling any holes.

Options

Thermal platforms may be fixtured for specific applications. A drill mask is available upon request to facilitate drilling into the platform surface without damaging the platform by drilling through heaters, coolant expansion channel or other features. Drilled, tapped holes with stainless steel inserts can be installed by Sigma at reasonable cost. Extra 1/8" plate thickness is an option available that will allow the user to drill at almost any location to a depth of 3/8". This extra thickness will reduce ramping speed by approximately 15% due to the greater mass of metal.

Sigma can design and deliver platforms in almost any custom configuration to meet specialized needs.

Conversion between coolants (L-CO_2 <=> L-N_2) can be accomplished by installing a conversion kit to convert to the appropriate coolant. The conversion is a relatively simple process and can be done by the customer or at the factory for small additional cost. Specify platform model number and direction of conversion when ordering conversion kit.

Other options include clear acrylic cover, dry nitrogen purge, hoses, fittings, spare valves, & exhaust muffler.

Maintenance

Preventative Valve Maintenance:

The only suggested regular maintenance for Sigma platforms is the periodic replacement or rebuilding of the coolant solenoid valve. Under normal use solenoid valves will last many years, but under severe conditions this may be much shorter. The two main causes of premature valve malfunctions are as follows: 1) contamination particles lodged in valve seat, usually Teflon tape. 2) extended periods of operation with the unit in the cooling mode but no coolant supplied to unit. Solenoid valves fouled with contamination can usually be disassembled, cleaned then returned to service. An in line filter is always recommended and is supplied with every Sigma Platform. Additional filters are available from Sigma. Solenoids overheated by extended operation without coolant must be replaced. Rebuilding valves that fail due to excessive use is not always successful. For that reason, Sigma doesn't generally supply customers with rebuilding kits.

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Controller Interchangeability:

Sigma Systems controllers are NOT all interchangeable. Controllers supplied with groups of platforms built at one time will usually be interchangeable. However, care should be taken to be certain that controller features, especially optional features on early production controllers are consistent between units. Exchange of controllers with units deployed for a different application can cause damage to either or both of the controller and platform.

All Sigma Model C and Model CC-3/CC-3$^{.5}$ controllers provide PID control for accurate response and use the same compatible 12-pin interface for power input and control outputs. A model CC-3 controller can usually be directly connected in place of an existing model C controller and vice versa. If you need to exchange controllers on a platform, it is best to contact Sigma technical support before proceeding. Always remove all power from the platform and check for a separate power cord on the controller before attempting any service work such as removing the controller or exposing any areas with potentially dangerous voltages.

The sensing input is configured for the same 500 ohm Platinum RTD (.003902 alpha) for all controllers. These sensors are available from Sigma with certified accuracy of 0.1%, traceable to NIST. The probe input for chamber controllers does not include the shielded probe extension and 6-pin connector as used on thermal platform controllers but the two are typically functionally interchangeable. If one wants to use an available Sigma controller from a chamber, connect the platform probe to the controller directly at the back of the controller. For optimum performance, the gain should be readjusted any time controllers are swapped between units (see controller manual). Since the temperature sensor is an RTD instead of a thermocouple, probe extensions are far less critical. For every 2/10 of an ohm added in the RTD path, 1/10 of a degree C will be added to the reading.

Warranty / Corrective Maintenance:

Other than solenoid valve maintenance, and general cleaning, most required service will be internal to the electronic controller. Two quick checks of the platform operation are as follows: 1) If the unit appears not to function at all or go to an elevated temperature and then quit working, try resetting the overtemp fail-safe as described earlier. 2) To test for a controller malfunction, unhook the probe connector from the platform and temporarily hook a resistor across the input to the controller to simulate the function of the RTD sensor. The enclosed platinum sensor conversion chart shows resistance values for different temperatures. Controller function can be tested by verifying that it responds to an under temperature reading on the probe by applying heat and responds to an over temperature condition by applying coolant. Turn unit off immediately after this test as run away condition may occur without system feedback from a platform probe. Response-time calibrations can be made per the controller instruction manual if slow response or excessive overshoot is experienced. System set-point calibration accuracy is retained to within 0.5EC over a period of two years making periodic calibrations up to the discretion of the user. If your Sigma equipment should need any repair work, the factory can most often provide same or next day turnarounds on repairs at your request. All products carry a one year warranty on components and materials and a lifetime warranty on workmanship

All standard Sigma Systems parts are all available from stock in San Diego. The minimum order is $25. Technical assistance is available from 8:00 a.m. to 5:00 p.m. Pacific Time. If you have questions after reading this manual plus the controller manual, please call (619) 283-3193, send a fax (619) 283-6526, or send email to our technical support department at Support@SigmaSystems.Com.

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NORMALIZED RESISTANCE VALUES
FOR 500 OHM PLATINUM (T4) PROBE
(DEGREES CELSIUS)

- 74	351.683	- 19	462.273	36	570.888	91	677.695	146	782.693
- 73	353.714	- 18	464.264	37	572.846	92	679.620	147	784.586
- 72	355.745	- 17	466.254	38	574.804	93	681.545	148	786.478
- 71	357.775	- 16	468.244	39	576.761	94	683.469	149	788.369
- 70	359.804	- 15	470.234	40	578.717	95	685.392	150	790.259
- 69	361.832	- 14	472.222	41	580.673	96	687.315	151	792.149
- 68	363.859	- 13	474.211	42	582.628	97	689.237	152	794.039
- 67	365.886	- 12	476.198	43	584.582	98	691.159	153	795.927
- 66	367.911	- 11	478.185	44	586.536	99	693.080	154	797.815
- 65	369.936	- 10	480.171	45	588.489	100	695.000	155	799.703
- 64	371.960	- 9	482.157	46	590.442	101	696.920	156	801.590
- 63	373.983	- 8	484.142	47	592.394	102	698.839	157	803.476
- 62	376.006	- 7	486.126	48	594.346	103	700.758	158	805.362
- 61	378.027	- 6	488.110	49	596.297	104	702.676	159	807.247
- 60	380.048	- 5	490.093	50	598.247	105	704.593	160	809.132
- 59	382.068	- 4	492.076	51	600.197	106	706.510	161	811.016
- 58	384.088	- 3	494.058	52	602.146	107	708.426	162	812.899
- 57	386.106	- 2	496.039	53	604.094	108	710.342	163	814.782
- 56	388.124	- 1	498.020	54	606.042	109	712.257	164	816.664
- 55	390.141	0	500.000	55	607.989	110	714.171	165	818.546
- 54	392.157	1	501.980	56	609.936	111	716.085	166	820.427
- 53	394.172	2	503.959	57	611.882	112	717.998	167	822.307
- 52	396.187	3	505.937	58	613.828	113	719.911	168	824.187
- 51	398.201	4	507.915	59	615.773	114	721.823	169	826.066
- 50	400.214	5	509.892	60	617.717	115	723.735	170	827.945
- 49	402.226	6	511.869	61	619.661	116	725.645	171	829.823
- 48	404.238	7	513.845	62	621.604	117	727.556	172	831.700
- 47	406.249	8	515.820	63	623.546	118	729.465	173	833.577
- 46	408.259	9	517.795	64	625.488	119	731.374	174	835.453
- 45	410.269	10	519.769	65	627.430	120	733.283	175	837.329
- 44	412.277	11	521.743	66	629.370	121	735.191	176	839.204
- 43	414.285	12	523.716	67	631.311	122	737.098	177	841.078
- 42	416.293	13	525.688	68	633.250	123	739.005	178	842.952
- 41	418.299	14	527.660	69	635.189	124	740.911	179	844.825
- 40	420.305	15	529.631	70	637.127	125	742.816	180	846.698
- 39	422.310	16	531.602	71	639.065	126	744.721	181	848.570
- 38	424.315	17	533.572	72	641.002	127	746.626	182	850.441
- 37	426.319	18	535.541	73	642.939	128	748.529	183	852.312
- 36	428.322	19	537.510	74	644.875	129	750.432	184	354.182
- 35	430.324	20	539.478	75	646.810	130	752.335	185	856.052
- 34	432.326	21	541.446	76	648.745	131	754.237	186	857.921
- 33	434.327	22	543.413	77	650.679	132	756.138	187	859.789
- 32	436.328	23	545.379	78	652.613	133	758.039	188	861.657
- 31	438.327	24	547.345	79	654.546	134	759.939	189	863.524
- 30	440.326	25	549.310	80	656.478	135	761.838	190	865.391
- 29	442.325	26	551.275	81	658.410	136	763.737	191	867.257
- 28	444.322	27	553.239	82	660.341	137	765.636	192	869.122
- 27	446.319	28	555.202	83	662.272	138	767.533	193	870.987
- 26	448.316	29	557.165	84	664.202	139	769.430	194	872.852
- 25	450.312	30	559.127	85	666.131	140	771.327	195	874.715
- 24	452.307	31	561.089	86	668.060	141	773.223	196	876.578
- 23	454.301	32	563.050	87	669.988	142	775.118	197	878.441
- 22	456.295	33	565.011	88	671.916	143	777.013	198	880.303
- 21	458.288	34	566.970	89	673.843	144	778.907	199	882.164
- 20	460.281	35	568.930	90	675.769	145	780.801	200	884.025