22 Appendices

22.1 PSY1 Test Procedure

(1) Place the PSY-1 in a controlled temperature environment, preferably of approximately 25°C. This specific temperature is not essential for testing purposes. The main consideration is a generally stable temperature.

(2) Connect psychrometer chamber to PSY1.

(3) Turn on the Instrument

(4) Open PSY1 Software

(5) Find Device

(6) Connect

(7) Change measurement mode from "Manual" to Live Mode and update settings

(8) In "Live Mode" you will see a continuous output of dT, Chamber Temperature and Thermocouple-C this is refreshed at 10Hz sampling frequency.

(9) If the connections are ok the results should be as follows:

a. dT in the range 0 to 1 µV
b. Chamber Temp, stable and indicative of the ambient conditions (should be within 0.1°C of actual, but not necessary to test this)
c. Thermocouple-C: in the range of 0 to 0.8 µV

(10) Run the Instrument in "Live Mode" for approx. 3 minutes continuously. If all values remain stable within the set range the psychrometer, cable connections and instrument are operating well. You can log this data at any interval of your choosing by clicking on the logging interval icon under the Measurement Mode drop down box. This data will be logged automatically to the SD card named "serial number".lve this will serve as a test of the SD card.

(11) Return the unit to Manual mode and perform a measurement. The Peltier Cooling Pulse should be set to 5 seconds and wait time of 6 seconds as a default in firmware. If not change this in the Measurement protocol tab first.

(12) Use a 1.0 molal NaCl calibration solution on a Whatmans number 1 filter paper punched to the correct size of the well in the calibration lid.

a. An initial measurement is taken of dT and Thermocouple-C.
b. dT should be close to 0 µV (same as for the live test especially if you have not handled the chamber)
c. Thermocouple-C should again be around 0.6 µV and this is used as the electronic Dry Bulb offset (EDBO)
d. Chamber temp should remain the same
e. After the Peltier cooling the Wet Bulb Depression (Thermocouple-C) should reach maximum value in the range of 19 µV (using the 1.0 Molal solution) and then drop to exactly zero after the measurement.

(13) Click on the Get Latest Data icon then plot the graph of the Peltier cooling curve

(14) The graph should exhibit the characteristic curve of a plateau of approx. 19 µV commencing on the graph at 4.5 seconds after Peltier cooling finishes. The plateau should last until approx 10 seconds after cooling and then sharply drop to zero. Once back at zero it should remain until the end of the measurement recording period of 40 seconds after the end of Peltier cooling.

NOTE 60: This long drawn out measurement period is to allow the capture of diagnostics at high water potentials (close to zero) which hold the moisture from the wet bulb depression much longer or dirty thermocouples that slowly drift back to zero or in fact never reach zero.

(15) Repeat 3 manual measurements and verify using the statistics bar in the utility software that the measurements remain stable within (at worst) a few bars from max to min Water potentials. A 1.0 molal solution should return a water potential of -4.64 MPa.

NOTE 61: Allow at least 60 seconds between each of the manual readings as persistent pulsing of the Peltier cooling will add microscopic water to the thermocouple and make the measured water potential less negative (closer to zero MPa). Ideally, 10 minute temporal sampling resolution should be employed but for test purposes 60 seconds is fine as we are just conducting a performance test not an accuracy test.

(16) Again download the data file serial number.csv (this is done automatically by clicking on the Download Data icon) and verify the data was saved.

(17) This completes the functional testing of the PSY.

22.2 Electronic Contact Cleaners

Manufacturer	Product	MSDS	TDS	Picture
CRC	QD Electronic Cleaner	MSDS	TDS	
CRC	XTR Precision Electronic Cleaner	MSDS	TDS	
CRC	CO Contact Cleaner	MSDS	TDS	
Chemtronics	Electro Wash PX	MSDS	TDS	
CRC	NF Contact Cleaner	MSDS	TDS	

22.3 Compressed Air

Manufacturer	Product	MSDS	TDS	Picture
CRC	Air Brush	MSDS	TDS	

22.4 Preparation of Calibration Solutions

Calibration over a range of water potentials is accomplished using sodium chloride (NaCl) solutions (the molecular weight of sodium chloride = 58.4428 g/mole).

The following Table represents a suitable range of molalities (i.e., mass of salt per unit mass of water) of salt solutions with the corresponding water potential equivalent at 25°C.

You can make these solutions yourself using sodium chloride and distilled water by carefully measuring the salt & water exactly on a minimum 4 decimal balance. An instructional video is available on the ICT International web site and the CD shipped with this instrument.

Alternatively, premixed calibration solutions can be purchased directly from ICT International or their distributor in your country.

NaCl Molality	Mass of NaCl (g)	Mass of Water (g)	Water Potential (MPa)
0.1	0.2922	50	- 0.462
0.2	0.5844	50	- 0.915
0.3	0.8766	50	-1.368
0.4	1.1688	50	- 1.823
0.5	1.4610	50	- 2.281
1.0	2.9221	50	- 4.640

22.5 Osmotic Coefficients and Water Potentials of Sodium Chloride Solutions

Water Potential (J/Kg)

Molality	0°C	5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C
0.05	214	218	222	226	230	234	238	242	245
0.1	423	431	439	447	454	462	470	477	485
0.2	836	852	868	884	900	915	930	946	961
0.3	1247	1272	1297	1321	1344	1368	1391	1415	1437
0.4	1658	1693	1727	1759	1791	1823	1855	1886	1917
0.5	2070	2115	2158	2200	2241	2281	2322	2362	2402
0.6	2484	2539	2593	2644	2694	2744	2794	2843	2891
0.7	2901	2967	3030	3091	3151	3210	3270	3328	3385
0.8	3320	3398	3472	3543	3612	3682	3751	3818	3885
0.9	3743	3832	3917	3998	4079	4158	4327	4314	4390
1.0	4169	4270	4366	4459	4550	4640	4729	4815	4001
1.1	4599	4713	4820	4924	5026	5127	5226	5322	5418
1.2	5032	5160	5278	5394	5507	5620	5730	5835	5941
1.3	5470	5611	5742	5869	5994	6119	6239	6354	6471
1.4	5912	6068	6210	6350	6487	6623	6754	6880	7006
1.5	6359	6529	6684	6837	6986	7134	7276	7411	7548
1.6	6811	6996	7163	7330	7491	7652	7805	7950	8007
1.7	7260	7460	7640	7820	8000	8170	8330	8490	8650
1.8	7730	7940	8130	8330	8520	8700	8880	9040	9210
1.9	8190	8430	8630	8840	9040	9240	9430	9600	9780
2.0	8670	8920	9130	9360	9570	9780	9980	10160	10350

1 Bar = 100 J/Kg

Lang, A.R.G, Osmotic Coefficients and Water Potentials of Sodium Chloride Solutions from 0 to 40°C 1967. *Australian Journal of Chemistry*, **20**, 2017-23

22.6 Copper/Constantan Thermocouple Conversion Chart

°C	0	1	2	3	4	5	6	7	8	9	10	°C

MILLIVOLTS

+0	0.000	0.038	0.077	0.116	0.154	0.193	0.232	0.271	0.311	0.350	0.389	+0
10	0.389	0.429	0.468	0.508	0.547	0.587	0.627	0.667	0.707	0.747	0.787	10
20	0.787	0.827	0.808	0.908	0.949	0.990	1.030	1.071	1.112	1.153	1.194	20
30	1.194	1.235	1.277	1.318	1.360	1.401	1.443	1.485	1.526	1.568	1.610	30
40	1.610	1.652	1.694	1.737	1.779	1.821	1.864	1.907	1.949	1.992	2.035	40

22.7 Correction Factors – Ambient Temperature Relationship (MPa/°C)

NOTE 62: These correction factors are included in Firmware in the PSY1 and are automatically applied based on the measured chamber temperature for each measurement.

°C	+0.0	+0.1	+0.2	+0.3	+0.4	+0.5	+0.6	+0.7	+0.8	+0.9
10.0	8.755	8.751	8.747	8.743	8.739	8.735	8.731	8.728	8.724	8.720
11.0	8.716	8.712	8.708	8.704	8.700	8.697	8.693	8.689	8.685	8.681
12.0	8.677	8.673	8.670	8.666	8.662	8.658	8.654	8.650	8.646	8.643
13.0	8.639	8.635	8.631	8.627	8.623	8.620	8.616	8.612	8.608	8.604
14.0	8.601	8.597	8.593	8.589	8.585	8.582	8.578	8.574	8.570	8.566
15.0	8.563	8.559	8.555	8.551	8.548	8.544	8.540	8.536	8.533	8.529
16.0	8.525	8.521	8.518	8.514	8.510	8.506	8.503	8.499	8.495	8.491
17.0	8.488	8.484	8.480	8.476	8.473	8.469	8.465	8.462	8.458	8.454
18.0	8.451	8.447	8.443	8.439	8.436	8.432	8.428	8.425	8.421	8.417
19.0	8.414	8.410	8.406	8.403	8.399	8.395	8.392	8.388	8.384	8.381
20.0	8.377	8.373	8.370	8.366	8.362	8.359	8.355	8.352	8.348	8.344
21.0	8.341	8.337	8.333	8.330	8.326	8.323	8.319	8.315	8.312	8.308
22.0	8.305	8.301	8.297	8.294	8.290	8.287	8.283	8.279	8.276	8.272
23.0	8.269	8.265	8.262	8.258	8.254	8.251	8.247	8.244	8.240	8.237
24.0	8.233	8.229	8.226	8.222	8.219	8.215	8.212	8.208	8.205	8.201
25.0	8.198	8.194	8.191	8.187	8.184	8.180	8.176	8.173	8.169	8.166
26.0	8.162	8.159	8.155	8.152	8.148	8.145	8.141	8.138	8.134	8.131
27.0	8.128	8.124	8.121	8.117	8.114	8.110	8.107	8.103	8.100	8.096
28.0	8.093	8.089	8.086	8.082	8.079	8.076	8.072	8.069	8.065	8.062
29.0	8.058	8.055	8.051	8.048	8.045	8.041	8.038	8.034	8.031	8.028
30.0	8.024	8.021	8.017	8.014	8.010	8.007	8.004	8.000	7.997	7.993
31.0	7.990	7.987	7.983	7.980	7.977	7.973	7.970	7.966	7.963	7.960
32.0	7.956	7.953	7.950	7.946	7.943	7.939	7.936	7.933	7.929	7.926
33.0	7.923	7.919	7.916	7.913	7.909	7.906	7.903	7.899	7.896	7.893
34.0	7.889	7.886	7.883	7.879	7.876	7.873	7.869	7.866	7.863	7.860
35.0	7.856	7.853	7.850	7.846	7.843	7.840	7.836	7.833	7.830	7.827
36.0	7.823	7.820	7.817	7.813	7.810	7.807	7.804	7.800	7.797	7.794
37.0	7.791	7.787	7.784	7.781	7.778	7.774	7.771	7.768	7.765	7.761
38.0	7.758	7.755	7.752	7.748	7.745	7.742	7.739	7.735	7.732	7.729
39.0	7.726	7.723	7.719	7.716	7.713	7.710	7.706	7.703	7.700	7.697
40.0	7.694	7.690	7.687	7.684	7.681	7.678	7.675	7.671	7.668	7.665
41.0	7.662	7.659	7.655	7.652	7.649	7.646	7.643	7.640	7.636	7.633
42.0	7.630	7.627	7.624	7.621	7.618	7.614	7.611	7.608	7.605	7.602
43.0	7.599	7.596	7.592	7.589	7.586	7.583	7.580	7.577	7.574	7.570
44.0	7.567	7.564	7.561	7.558	7.555	7.552	7.549	7.546	7.542	7.539
45.0	7.536	7.533	7.530	7.527	7.524	7.521	7.518	7.515	7.512	7.508

22.8 PSY1 Installation Kit

Object	Overview	Image	Qty
Label Tape	Post insulation the low tack label tape is used to combine the chamber heads.		1
Whatman #1 Filter Paper Discs	Use for calibration procedure and with 1.0 Molal NaCl calibration solution for checking PSY1 operation		20
1.0 Molal NaCl Calibration Solution	A preformulated solution to use in calibration and/or checking of PSY1 operation.		1
Dow Corning Vacuum Grease	Fill the 10 ml Offset Syringe with the grease to create a vacuum seal.		150 gm
Large Clamp Screws	For holding the PSY1 chamber to the large clamp.		X4
Plastic Clip Lock Tool Box	The plastic clip lock tool box protects and stores everything you need for a successful installation.		1

Wash Bottle	Use the wash bottle filled with distilled water to wash off the installation area.		1
Kim Wipes	Use your wipes to make sure the area is completely dry; you may need to rub vigorously.		1
10ml Offset Syringe	Use the syringe filled with Silicon grease to smear around the whole of the wound, thus creating a vapour seal.		1
Polyester Insulation	Use the polyester Insulation to secure the PSY1 Stem Psychrometer after Installation.		1
Single Edge Razor Blades	The razor blade is used to remove bark and excess tissue to create an excessive flat area.		10
ICT Screwdriver	Reversible Philips Head/Flat screwdriver		1

Small Clamp Screws	For holding the PSY1 chamber to the small clamp.		4
Roll of Aluminium Foil	Wrap the foam with aluminium foil to get a radiation shield.		1
Wire Strippers	For Installation of cables		1
Psychrometer User Manual & Software	An Installation disc containing Quick Start Guide, Installation videos, brochures and software.		1
USB Cable	Interface between your computer and the PSY1 Stem Psychrometer.		1
#30 Rubber Bands	For holding the protection cover over the PSY1 chamber to prevent damage to the TS and TC thermocouples.		50
Stainless Steel Tweezers	Use to easily hold and manipulate the filter paper during calibration and checking routines.		1

Micro SD Card Shuttle	The SD Card Reader allows you to transfer your data from the PSY1 to your PC, a quick transfer method.		1

Customer must obtain:

- Distilled water (to go in wash bottle)
- Chloroform
- Compressed Air (moisture free)

22.9 Support Log

Please fill in the information below to assist in troubleshooting

Customer Name:
Customer Comment:

PSY Support Log Started: 30/07/2012 3:26:21 PM
PSY.Ver: 2.0.4.8
INS.Name: ICT PSYCHROMETER
INS.Comment: 24/JUL/2012 9:19 11pF
PSY.Ser#: 1234
APP.Ser#: 55FF3FCD
GCB.Ser#: 010008BC
UNT.Ser#: PSYTC705
APP.Ver#: R1-5-2
GCB.Ver#: R2-2-9
DC: Device Date: 30/07/2012 Device Time (24hr): 15:26
AU.EN: True
AU.START: True
AU.Date:
AU.Avail: False,False
AU.Valid: False,False
SDC: SD OK
BATT.Volt: 4.22 V
BATT.Stat: idle
MEAS.Mode: Manual
MEAS.LiveInterval: Live Mode Logging Interval:
MEAS.Sch: 99999
MEAS.Status: Measurement Stopped
MEAS.Next: 00:00 False
MPROT.CalSN: PSYTC705
MPROT.CalCmnt:
Slope: -1.16
Intercept: 1.28
MPROT.CT: 10 s
MPROT.WT: 6 s
MPROT.PWD: Disabled
MPORT.PWW: 15s
MPROT.CHD: Disabled
MPROT.CHS: 1/01/2000 12:00:00 AM-1/01/2000 12:00:00 AM,True
Logging Options:
DT
WB
Chamber Temp
Correction Factors
Battery Voltage
External Supply Presence
OS: Microsoft Windows NT 6.1.7601 Service Pack 1
Runtime: 2.0.50727.5456
Processor Count: 4
PSY Support Log Complete: 30/07/2012 3:26:21 PM

22.10 Debug File

Computer Information:

ACPI:
DeviceID: ACPI\GENUINEINTEL_-_X86_FAMILY_6_MODEL_28_0, Name: Intel(R) Atom(TM) CPU N270 @ 1.60GHz
DeviceID: ACPI\GENUINEINTEL_-_X86_FAMILY_6_MODEL_28_1, Name: Intel(R) Atom(TM) CPU N270 @ 1.60GHz

DeviceID: ACPI\PNP0C0C\2&DABA3FF&0, Name: ACPI Power Button
DeviceID: ACPI\PNP0C0D\2&DABA3FF&0, Name: ACPI Lid
DeviceID: ACPI\PNP0C0E\2&DABA3FF&0, Name: ACPI Sleep Button
DeviceID: ACPI\PNP0C0A\0, Name: Microsoft ACPI-Compliant Control Method Battery
DeviceID: ACPI\ACPI0003\2&DABA3FF&0, Name: Microsoft AC Adapter
DeviceID: ACPI\PNP0A08\2&DABA3FF&0, Name: PCI bus
DeviceID: ACPI\PNP0C02\4&38462492&0, Name: Motherboard resources
DeviceID: ACPI\PNP0200\4&38462492&0, Name: Direct memory access controller
DeviceID: ACPI\PNP0B00\4&38462492&0, Name: System CMOS/real time clock
DeviceID: ACPI\PNP0103\4&38462492&0, Name: High precision event timer
DeviceID: ACPI\PNP0000\4&38462492&0, Name: Programmable interrupt controller
DeviceID: ACPI\PNP0C04\4&38462492&0, Name: Numeric data processor
DeviceID: ACPI\PNP0100\4&38462492&0, Name: System timer
DeviceID: ACPI\INT0800\4&38462492&0, Name: Intel(R) 82802 Firmware Hub Device
DeviceID: ACPI\PNP0303\4&38462492&0, Name: Standard 101/102-Key or Microsoft Natural PS/2 Keyboard
DeviceID: ACPI\PNP0F13\4&38462492&0, Name: Synaptics PS/2 Port Pointing Device
DeviceID: ACPI\PNP0C09\4&38462492&0, Name: Microsoft ACPI-Compliant Embedded Controller
DeviceID: ACPI\PNP0C14\0, Name: Microsoft Windows Management Interface for ACPI
DeviceID: ACPI\FIXEDBUTTON\2&DABA3FF&0, Name: ACPI Fixed Feature Button

USB (All):
DeviceID: USB\ROOT_HUB\4&FCF8232&0, Name: USB Root Hub
DeviceID: USB\VID_046D&PID_C03D\5&C6F674&0&1, Name: USB Human Interface Device
DeviceID: USB\VID_0403&PID_6001\A8004QQR, Name: USB Serial Converter
DeviceID: USB\ROOT_HUB\4&2EEF2415&0, Name: USB Root Hub
DeviceID: USB\ROOT_HUB\4&1BAA685&0, Name: USB Root Hub
DeviceID: USB\ROOT_HUB\4&4DE82C5&0, Name: USB Root Hub
DeviceID: USB\ROOT_HUB20\4&624C0C7&0, Name: USB Root Hub
DeviceID: USB\VID_0C45&PID_62C0\5&1ECD3563&0&5, Name: Acer Crystal Eye Webcam
DeviceID: ROOT\USB\0000, Name: Nokia Internet Stick DC Control

USB (ICT):
DeviceID: USB\VID_0403&PID_6001\A8004QQR, Name: USB Serial Converter

FTDIBUS :
DeviceID: FTDIBUS\VID_0403+PID_6001+A8004QQRA\0000, Name: USB Serial Port (COM25)

Connecting to ICT PSY on COM25
Message timeout: MSG_SSERIAL
Message timeout: MSG_SSERIAL

Message timeout: MSG_SSERIAL
Message timeout: MSG_SSERIAL
Message timeout: MSG_SSERIAL
Message timeout: MSG_SSERIAL
Message timeout: MSG_SSERIAL
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Message timeout: MSG_SSERIAL

22.11 Extension Cable Specs

As the PSY1 is powered from its internal battery with a non-polarised charging circuit no special power cables are required. A simple 2-core “Figure-8 cable” or “Lamp Cord” of following specifications is ideal: Size: 2 x 24/0.20
Voltage Rating: 300V AC
Current Rating: 7.5 Amps
Dimensions: 2.6 x 5.1mm
Conductor Area: 0.75mm2
Conductor Gauge: 18AWG
Temperature Rating: 90°C
Roll Size: 30m

22.12 SD Card Re-Initialisation

SD Card Initialisation procedure check:

- Initialise SD Card
- Check SD Card Communication / Initialisation
    - If ok, check whether the file system is of correct format
        - If ok, check serial number to see if a valid CSV file can be created
            - If ok, set SD Card status to SD OK
            - If fail, set SD Card status to FILENAME ERROR
        - If fail, set SD Card status to WRONG FORMAT
    - If fail, set SD Card status to SD ERROR