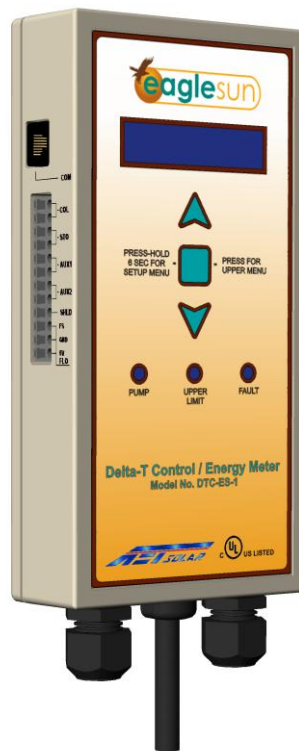




EagleSun Systems

by Alternate Energy Technologies, LLC.

Delta-T Control / Energy Meter



Operation and Installation Manual

Model No. DTC-ES-1

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IMPORTANT SAFETY INSTRUCTIONS

When using this electrical equipment, basic safety precautions should always be followed, including the following:

- READ AND FOLLOW ALL INSTRUCTIONS
- Disconnect all AC power during installation.
- If connecting a communications cable, it is recommended that the control be unplugged from the electrical power supply.
- Warning – To reduce the risk of injury, children should not be permitted to use this product.

SAVE THESE INSTRUCTIONS

Delta-T Control / Energy Meter

The EagleSun Delta-T Control / Energy Meter is designed for use on a solar thermal system. It will monitor collector and storage water temperature sensors and operate their respective water pump(s) in order to maintain desired differential temperature between them; integral variable speed drive on the collector pump and turn on/off on the storage pump; read from the flow sensor and auxiliary (2) temperature sensors to calculate the BTU; transmit data to the PC via RS-232 for the purpose of data logging and long term diagnostics; power and transmit data to the remote display panel.

SPECIFICATIONS

Inputs

Line voltage; Power cord	115Vac (L, N, G), 15Amps
Collector sensor, COL	10k Thermistor, 5Vdc circuit
Storage sensor, STO	10k Thermistor, 5Vdc circuit
Auxiliary sensor 1, AUX1	10k Thermistor, 5Vdc circuit
Auxiliary sensor 2, AUX2	10k Thermistor, 5Vdc circuit
Flow sensor; FLO, FS, GND, 5V	5Vdc circuits

Outputs

Variable speed pump, VAR SPEED	Phase controlled line voltage, Triac: 4Amps max
Fixed speed pump, FIXED SPEED	Line voltage, Relay contacts: 20A (or 2HP motor)@240VAC, NO
Communication: COM	5Vdc power, TX (RS-232) at 10Vdc, RJ45 jack

User Interface

The control has three buttons used to navigate the values of the adjustable settings. The different temperature readings will be displayed when pressing the MENU button (■) multiple times. The Setup menu is entered when the MENU button (■) is pressed and held for 6 seconds. The UP button (▲) is used to increase the values of settings in the setup menu and the DOWN button (▼) is used to decrease the values of the settings in the setup menu.

The control has 3 LED lights to indicate pump engagement, high limit temperature exceeded, and a fault. They are labeled as: PUMP, UPPER LIMIT and FAULT.

The display is an LCD type with 2x16 characters, backlit for easy viewing in low-light conditions.

Setup Menu

The Setup menu is entered when the MENU button is pressed and held for 6 seconds. The following are the adjustable settings which are modified in the Setup menu:

On Differential - the on differential temperature sets the desired temperature differential between the collector supply sensor and storage tank sensor during running state. The setting is adjustable from 8°F to 24°. (*Default is 8° F*)

Off Differential - the off differential temperature sets the desired temperature differential during off state in order to turn on. The setting is adjustable from 2°F to 8°F. (*Default is 2° F*) If the On Differential is set to 8° F, the maximum Off Differential is 7° F.

Storage Hi Limit – the storage high limit setting is used to control the maximum temperature desired in the storage tank. The setting is adjustable from 110°F to 200°F. (*Default is 150° F*)

Collect Lo Limit – the collector low limit setting is used to control the minimum temperature required at the collector in order for the pump(s) to energize. The setting is adjustable from OFF, 50°F to 70°F. (*Default is 50° F*)

Minimum Speed – the minimum variable speed setting controls the minimum operational speed of the collector pump. This setting is % value of full speed and is adjustable from 20% to 50%. (*Default is 30%*)

Minimum Off Time – the minimum pump off time setting controls the minimum amount of time required before the pump can be re-energized. This prevents short cycling of the pump during cloudy conditions. The setting is adjustable from 3 to 10 minutes. (*Default is 5 min*)

Flow Sensor – the flow sensor setting (VFS 1-20, VFS 2-40, VFS 5-100, VFS 10-200 and VFS 20-400) enables the AUX1 sensor terminal to accept temperature input from the flow sensor and enables BTU calculation. Alternatively, the Flow Sensor setting will allow for manual adjustments between 0.0 and 106.0 gpm (in 0.1 increments). The installer must measure the actual flow rate by using an ultrasonic flow meter, or similar equipment, before manually setting the control. (*Default is 0.00 GPM – no BTU calculation*)

Drainback – the drainback setting alerts the controller to de-energize the pump(s) if the collector loop temperature exceeds 200°F. The setting is YES or NO. (*Default is NO*)

OPERATION

When initially energized, the control will flash an introductory screen showing the software version (shown below) and then the default screen appears displaying collector and storage temperatures.

D	I	F	F		T	E	M	P		C	O	N	T	R	L
A	E	T											V	0	1

The control can operate in one of three modes: OFF, AUTO and ON. By pressing MENU button (■) the CONTROL MODE screen will be reached. With Up and Down buttons the setting can be changed to OFF, AUTO or ON.

In OFF mode all outputs are turned off. This mode is useful for servicing. Limit conditions are not considered.

In AUTO mode the control operates automatically to reach and maintain desired temperature. All settings are considered. This specification further describes the operation of the control in AUTO mode.

In ON mode the control turns on the pump(s) with collector pump at full speed. This mode is useful to purge air out of the system on start up upon installation. Limit conditions are not considered.

The control will energize the pump(s) when the On Differential setting is exceeded. The green LED labeled PUMP turns on to indicate when power to the pump(s) is present. The COL pump will run at full speed for a minimum of 30 seconds or until sufficient flow is established. As the temperature differential decreases and gets within 6°F of the desired differential, the variable speed on the collector pump is adjusted down by means of phase control. The minimum speed on the collector pump is dictated by the respective setting in the Set Up menu. Minimum speed insures sufficient flow throughout the solar heating system and prevents the motor from overheating. As the temperature differential increases the variable speed on the collector pump is adjusted up and crosses into full speed. The minimum running time for the pump(s) is 2 minutes

When the temperature differential falls below the On Differential setting the pump(s) will shut off. The pump(s) will remain off for the time period designated by the Pump Minimum off time setting.

Temperature sensor readings and the BTU are displayed by pressing MENU button one after another. After 15 seconds of inactivity the screen will go back to display collector and storage temperature readings.

Holiday feature: when activated, this feature allows for continued pump operation above the storage high limit temperature, until the temperatures fall off and the Holiday feature setting is reached. The recommended temperature setting is that of the backup electric heat. The setting is accessed by pressing the MENU button (■) three (3) times and is adjustable from OFF to between 100 and 150°F.

BTU calculation: BTU's are calculated using the following formula: $BTU = FLOW (GPM) * 500 * (AUX2 - AUX1)$. The flow rate (GPM) is recorded automatically if a flow sensor is used (control input = VFS selection), else, the manual input value (X.Y GPM) is used in the calculation. A manual input value of 0.0 results in no BTU's recorded. Delta-T temperatures are derived from the AUX2 and AUX1 sensors terminals.

Communication: the control transmits data to the PC via built-in RS-232 in ASCII, 8-N-1 code for the following: pump run time, control mode, collector and storage sensor temperatures, auxiliary 1 and 2 sensor temperatures, holiday feature, flow rate, BTU's calculated, differential hi/low settings, storage high limit setting, collector low limit setting, collector and storage pump status and fault conditions. Power to the control should be disconnected prior to attaching/detaching the communications cable.

TROUBLESHOOTING

The control will not turn on the pumps or will shut them off if already running when either Storage or Collector probe is short or open. The "short or open" message is displayed instead of temperature readings.

Auxiliary 1 or Auxiliary 2 probes do not disable control output if they are short or open. "Short or open" is displayed instead of temperature readings.

If Flow sensor reading is out of range indicating short or open then the control will display the fault.

The red LED labeled FAULT will be flashing either Storage or Collector probe is short or open.

When storage high temperature limit is reached the control will disengage the pumps to prevent the tank from overheating. The yellow LED labeled UPPER LIMIT will turn steady on and the HIGH STORAGE TEMPERATURE condition is displayed alternating with the default screen. Control resumes operation when storage tank temperature drops below the limit temperature.

Freeze protection applies when collector temperature sensor drops below 42°F and is terminated when it rises back to 52°F. During freeze protection, fluid circulation is required to maintain non-freezing temperatures in the collector and interconnect piping. Freeze Protection is displayed alternating with the default screen. Freeze protection is overridden when control is configured for drainback.

If the setting for Drainback is ON, the collector pump is turned OFF should collector sensor reading exceed 200°F

INSTALLATION

All wiring connections must be made in accordance with all applicable electrical codes. Overload and over-current protection of electrically operated components shall be consistent with the maximum current rating of the device and with the provisions of Article 240, Chapter 2 of the National Electrical Code. Power to the control should remain un-connected until the unit is securely mounted and all wiring is completed.

Operation and Storage conditions

Power supply:	120VAC +10%/-15%, 60Hz
Operating temperature:	-32°F (0°C) to 140°F (60°C)
Storage temperature:	-40°F (-40°C) to 185°F (85°C)
Humidity:	10%RH to 90%RH non-condensing

The control is to be mounted against or adjacent to the water storage tank in a dry, sheltered environment. The box is mounted using two #6 screws (provided) spaced vertically, 7-9/16" apart. The control hangs on the mounting screws using the keyhole slots on the reverse side of the control.

The control is equipped with distinct wiring blocks for communications (COM), sensor and pump wiring. Low voltage connects (COM and sensors) are located on the side of the control, whereas, the pump connections (line voltage) are internal to the control and labeled for variable and fixed speed functions (see Figure 1). Variable speed pumps should utilize the variable speed wiring and fixed speed pumps should use the fixed speed connections.

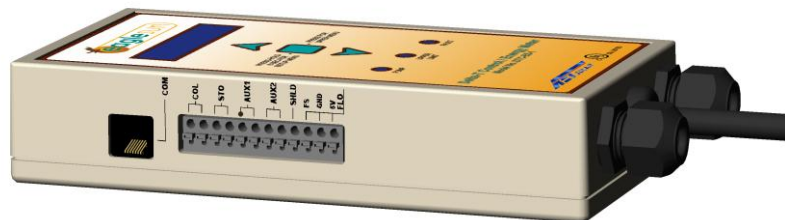


Figure 1

The COM terminal is used to provide communications to an individual PC/Laptop, remote display or connection to a web-enabled data transfer device used for online data viewing. The COM port accepts a standard CAT5e ethernet patch cable. For PC/Laptop interface, the connection requires a cable adapter (as shown in Figure 2) connected to the DB9 serial port on the host computer. **DO NOT** connect the communications cable to the internet port on the host PC as no data will be viewable.

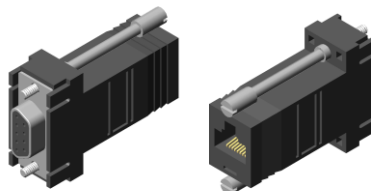


Figure 2

For remote display connections, the remote Energy Meter (as shown in Figure 3) accepts an RJ45 connector from the control unit.
 NOTE: the patch cable is not included with either the control or remote display as the length will vary with the distance between the units.



Figure 3



Figure 4

The control is designed for BTU measurement/recording using a Grundfos, type VFS, Vortex Flowsensors (as shown in Figure 4). The flow sensor is to be plumbed into the feed line to the collector(s), within ten (10) pipe diameters from the storage tank and a minimum of four (4) pipe diameters from an upstream bend in the plumbing. For flow sensor wiring, flow and temperature signals share the same ground, therefore, only one wire (yellow) is required to connect across the sensor terminal. Secure the yellow wire to the AUX1 terminal adjacent to STO as indicated by the dot in Figure 1. Flow sensor wire connections are as follows:

Grundfos Direct Sensors: VFS 1-20, VFS 2-40, VFS 5-100, VFS 10-200 and VFS 20-400

Flow sensor wire	Color	Control terminal
Power supply (+5V DC)	Brown	5V Flow
GND (0 V)	Green	GND
Flow signal (0.5 to 3.5 V)	White	FS
Temperature signal (0.5 to 3.5V)	Yellow	AUX1 (terminal indicated by dot – Fig 1)

WARNING: DO NOT connect the GND (green) wire to the Pipe system as indicated in the graphic on the Grundfos Data Sheet. Connect only to the GND terminal on the control wiring block.

A second sensor, 10k thermistor type, is required for BTU calculation and should be mounted within six (6) pipe diameters of the storage tank on the return line from the collector(s) and connected to the AUX2 terminals on the control.

BTU measurement should always be taken from the pipe work leaving and entering the storage tank (as shown in Figure 5). This will provide a measurement of the heat delivered to the storage tank. **DO NOT** use the wire leads from the storage tank or collector mounted sensors as they are used to determine when the solar system energizes and de-energizes.

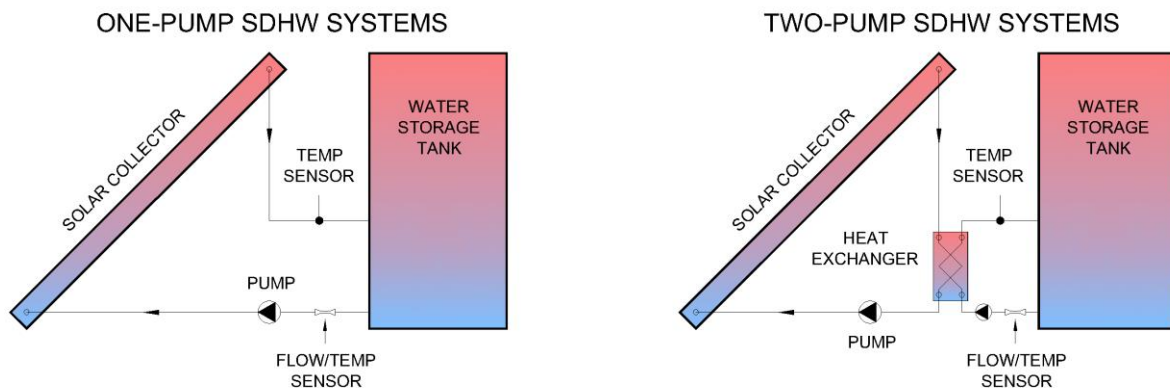


Figure 5

Pump terminal selection will differ with flow sensor usage. When using the flow sensor option (VFS Select), use the VARIABLE terminal connection as it offers variable speed operation and the control will automatically adjust the flow rate value for BTU calculation. If the flow rate is manually input (X.Y GPM), use the FIXED terminal connection as this offers a constant speed operation for a constant flow rate value when calculating BTUs. In two pump systems, the loop with the flow sensor should use the VARIABLE terminal connections and the opposing loop pump should use the FIXED terminal connections. Alternatively, pump wiring can be "daisy-chained" to allow for a fully fixed or fully variable 2-pump system operation.

WARRANTIES

Limited Warranty

This warranty statement is applicable to the EagleSun, DTC-ES-1 solar control distributed by Alternate Energy Technologies, LLC, herein referred to as AET. See the appropriate warranty statement for other EagleSun products or solar controls.

Solar Controls installed in USA or Canada:

AET warrants its solar control, installed within the USA or Canada, to be free from defects in material or workmanship, under normal use and service for **five years** from date of the initial system installation, provided it is installed in accordance with the EagleSun Systems - Operation and Installation Manual provided with the product. If written proof of the date of the initial system installation is not provided to AET, the Sales Order Invoice date will be the sole determinant of the date of the initial system installation.

If a product is defective, in workmanship or materials and is removed and returned freight prepaid within three (3) years after the date of the initial system installation, AET will, at its option, either repair or replace the defective product and return it freight prepaid. If the defective product is returned freight prepaid to AET more than three (3) years but within five (5) years of the date of the initial system installation, AET, at its option, will either repair or replace the defective product and will charge sixty percent (60%) of the current list price for such repairs or replacements, plus shipping charges. The costs incurred in removal and/or reinstallation of the product is NOT covered under this warranty.

Solar Controls installed outside of the USA or Canada:

AET warrants its solar control installed outside of the USA or Canada to be free from defects in material or workmanship, under normal use and service for **one year** from date of the initial system installation, provided it is installed in accordance with the EagleSun Systems - Operation and Installation Manual provided with the product. If written proof of the date of the initial system installation is not provided to AET, the serial number, on the product, will be the sole determinant of the date of the initial system installation.

If a product is defective, in workmanship or materials and is removed and returned freight prepaid within one (1) year after the date of the initial system installation, AET will, at its option, either repair or replace the defective product and return it freight prepaid. The costs incurred in removal and/or reinstallation of the product is NOT covered under this warranty.

Warranty exclusions:

1. Material supplied or workmanship performed by others in the process of installation
2. Damage resulting from improper installation or control of loads exceeding the product rating.
3. Problems resulting from failure to operate the products in accordance with recommended instructions contained in product's owners manual.
4. Problems resulting from tampering, accident, abuse, negligence, unauthorized repairs or alterations, fire, flood, lightning, freezing, external water, voltage or current spikes and surges, war, or acts of God.
5. In the event of a defect, AET's liability is strictly limited to the furnishing of repair or replacement part(s) as provided herein.
6. Damage to property or persons as a result of use of an improperly maintained heat transfer fluid, is not covered under this warranty and shall not be the responsibility of AET.

THE EXPRESS LIMITED WARRANTY ABOVE CONSTITUTES THE ENTIRE WARRANTY OF ALTERNATE ENERGY TECHNOLOGIES, LLC. WITH RESPECT TO ITS SOLAR CONTROL AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL ALTERNATE ENERGY TECHNOLOGIES, LLC. BE RESPONSIBLE FOR ANY CONSEQUENTIAL, SPECIAL OR INCIDENTAL DAMAGES OF ANY NATURE WHATSOEVER.

NO WHOLESALE, AGENT, DEALER, CONTRACTOR, OR OTHER PERSON IS AUTHORIZED TO GIVE ANY WARRANTY ON BEHALF OF ALTERNATE ENERGY TECHNOLOGIES, LLC. THIS WARRANTY IS VOID IF THE PRODUCT HAS BEEN ALTERED IN ANY WAY AFTER LEAVING THE FACTORY.

APPENDIX
Temperature vs Resistance Conversion Chart for 10k Thermistors

°F	OHMS	°F	OHMS	°F	OHMS	°F	OHMS	°F	OHMS	°F	OHMS	°F	OHMS
-50	491,142	0	85,387	50	19,900	100	5,827	150	2,044	200	829	250	378
-49	472,642	1	82,719	51	19,377	101	5,697	151	2,005	201	815	251	373
-48	454,909	2	80,142	52	18,870	102	5,570	152	1,966	202	802	252	367
-47	437,907	3	77,656	53	18,377	103	5,446	153	1,929	203	788	253	362
-46	421,602	4	75,255	54	17,899	104	5,326	154	1,892	204	775	254	357
-45	405,965	5	72,937	55	17,435	105	5,208	155	1,856	205	763	255	352
-44	390,966	6	70,696	56	16,985	106	5,094	156	1,821	206	750	256	347
-43	376,577	7	68,535	57	16,548	107	4,982	157	1,787	207	738	257	342
-42	362,770	8	66,447	58	16,123	108	4,873	158	1,753	208	726	258	337
-41	349,522	9	64,428	59	15,711	109	4,767	159	1,720	209	714	259	332
-40	336,804	10	62,479	60	15,310	110	4,664	160	1,688	210	702	260	327
-39	324,597	11	60,595	61	14,921	111	4,563	161	1,657	211	691	261	323
-38	312,876	12	58,774	62	14,543	112	4,464	162	1,626	212	680	262	318
-37	301,622	13	57,014	63	14,173	113	4,368	163	1,596	213	669	263	314
-36	290,813	14	55,313	64	13,820	114	4,274	164	1,567	214	658	264	309
-35	280,433	15	53,669	65	13,473	115	4,183	165	1,538	215	648	265	305
-34	270,460	16	52,078	66	13,136	116	4,094	166	1,509	216	637	266	301
-33	260,878	17	50,541	67	12,809	117	4,007	167	1,482	217	627	267	296
-32	251,670	18	49,054	68	12,491	118	3,922	168	1,455	218	617	268	292
-31	242,821	19	47,616	69	12,182	119	3,839	169	1,428	219	607	269	288
-30	234,316	20	46,225	70	11,882	120	3,758	170	1,402	220	598	270	264
-29	226,138	21	44,879	71	11,589	121	3,679	171	1,377	221	588	271	280
-28	218,276	22	43,577	72	11,305	122	3,602	172	1,352	222	579	272	276
-27	210,716	23	42,318	73	11,029	123	3,527	173	1,328	223	570	273	273
-26	203,445	24	41,099	74	10,761	124	3,454	174	1,304	224	561	274	269
-25	196,451	25	39,919	75	10,500	125	3,382	175	1,281	225	553	275	265
-24	189,722	26	38,777	76	10,246	126	3,312	176	1,258	226	544	276	262
-23	183,248	27	37,671	77	9,999	127	3,244	177	1,235	227	536	277	258
-22	177,019	28	36,601	78	9,758	128	3,177	178	1,213	228	527	278	255
-21	171,023	29	35,565	79	9,525	129	3,112	179	1,192	229	519	279	251
-20	165,251	30	34,561	80	9,297	130	3,049	180	1,171	230	511	280	348
-19	159,696	31	33,590	81	9,076	131	2,987	181	1,150	231	503	281	244
-18	154,347	32	32,648	82	8,861	132	2,926	182	1,130	232	496	282	241
-17	149,197	33	31,737	83	8,651	133	2,867	183	1,110	233	488	283	238
-16	144,236	34	30,853	84	8,447	134	2,809	184	1,091	234	481	284	235
-15	139,458	35	29,998	85	8,249	135	2,752	185	1,072	235	473	285	232
-14	134,855	36	29,169	86	8,056	136	2,697	186	1,054	236	466	286	229
-13	130,420	37	28,365	87	7,867	137	2,643	187	1,035	237	459	287	225
-12	126,147	38	27,587	88	7,684	138	2,591	188	1,017	238	452	288	223
-11	122,030	39	26,832	89	7,506	139	2,539	189	1,000	239	445	289	220
-10	118,061	40	26,100	90	7,333	140	2,489	190	983	240	439	290	217
-9	114,235	41	25,391	91	7,164	141	2,440	191	966	241	432	291	214
-8	110,547	42	24,704	92	6,999	142	2,392	192	950	242	426	292	211
-7	106,991	43	24,037	93	6,839	143	2,345	193	933	243	420	293	208
-6	103,561	44	23,391	94	6,683	144	2,299	194	918	244	413	294	206
-5	100,254	45	22,764	95	6,530	145	2,254	195	902	245	407	295	203
-4	97,063	46	22,156	96	6,382	146	2,210	196	887	246	401	296	200
-3	93,986	47	21,566	97	6,236	147	2,167	197	872	247	395	297	198
-2	91,017	48	20,993	98	6,097	148	2,125	198	857	248	390	298	195
-1	88,152	49	20,438	99	5,960	149	2,084	199	843	249	384	299	193
												300	190

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