Johnson Controls

Unitary Products Technical Services
Service Tips Letter

Letter: ST-011-16

Date: September 19, 2016

To: All Unitary Products Branch Service, Sales, and Training Managers
All Unitary Products Distribution Service, Sales, and Training Managers

Subject: **Residential Split Heat Pump Unit- Defrost Control Operation and Diagnosis**

Product:
York: YZH, YZF, YHM, YHE, YHJF, YHJD, YHGF, YHGD,

Coleman: HC8B, HC6B, TH4, THE, CH16, THJF, THJD, THJR, THGF, THGD, QH4

Luxaire: HL8B, HL6B, TH4, TH16, THJF, THJD, THE, THJR, THGF, THGD

Champion: HL8B, HL6B, TH4, TH16, THJF, THJD, THE, THJR, THGF, THGD

FJ: HL8B, HL6B, TH4, THJF, THJD, THE, THJR, THGF, THGD

Guardian/Evcon: RHP13J, RHP14J, RHP14L, QH4

Summary: This letter provides information on the Defrost Cycle operation of the York Guard VI, Time/Temp, Legacy/LX Demand, and the Inverter Interface defrost control board as applied in residential split heat pump units.

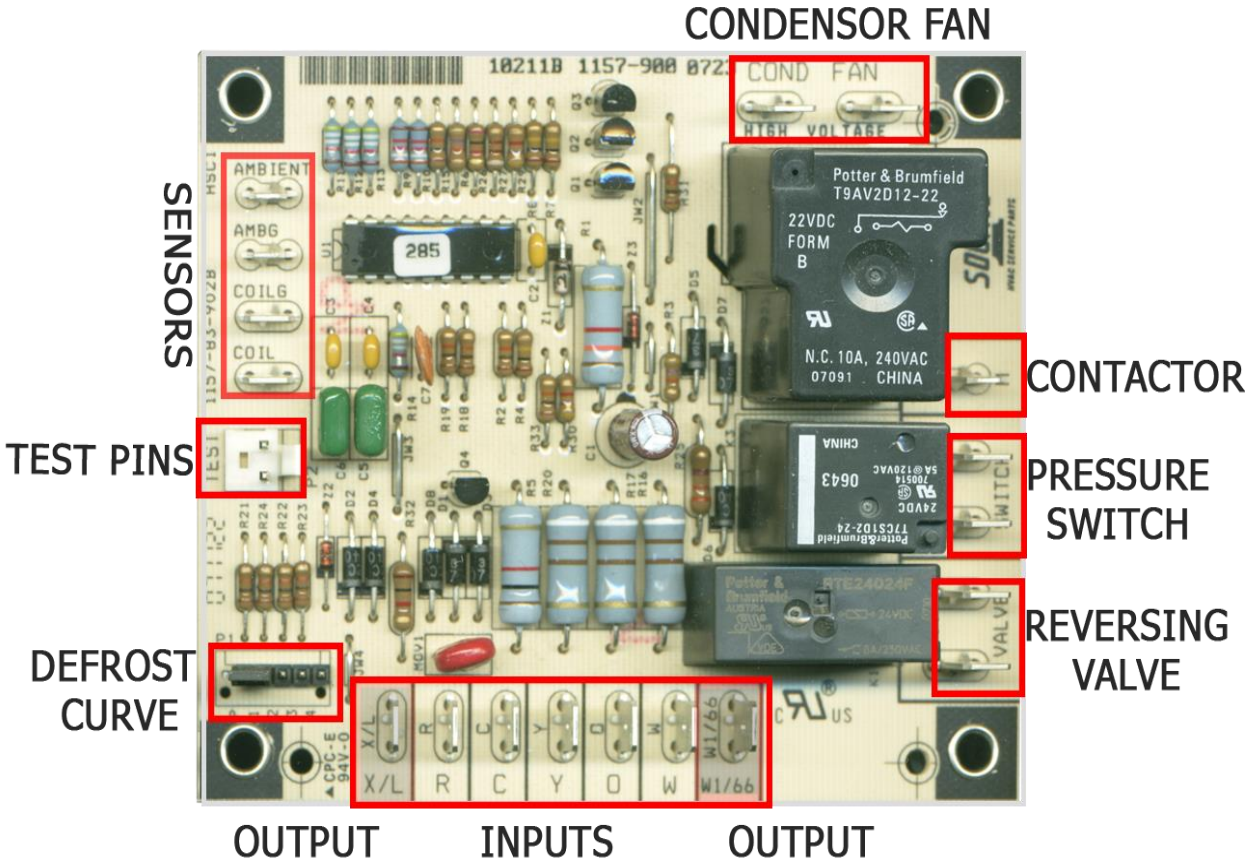
In the heating mode, the split system heat pump is designed to absorb heat from the outside air and move the heat inside to maintain comfort within the conditioned space. Heat pumps operate in heating mode until the thermostat is satisfied or until the right conditions indicate that defrost of the outdoor coil is necessary.

The defrost mode is designed to remove the frost or ice from the outdoor coil. The defrost control system (thermistor/sensor, thermostat, minimum accumulated run timer, and adaptive algorithm) determines when defrost is needed. The defrost cycle duration must be long enough to thaw the frost/ice from the coil and short enough to maintain efficiency.

Defrost control boards used on residential split products will include either the **Time Temp**, **York Guard VI** (Duel Fuel Capability), **Legacy**, **LX Series Demand**, and the new **Inverter Interface** defrost control models. The function of the Legacy, LX Series Demand, and Inverter Interface Defrost control board operation is similar to the York Guard VI, except the York Guard VI has additional features including fossil fuel option, low temperature cut out (LTCO), balance point setting, hot heat pump mode, compressor delay, second stage (Y2 Lock), diagnostic LEDs, and fault code history recall.

The current LX Series Demand features a diagnostic LED and fault code history recall. The new Inverter Interface control will also provide status codes using a LED and a two digit 7-segment display for fault codes. All defrost board selections include a 6 hour accumulated compressor run timer, which forces the unit into defrost to circulate refrigerant oil, and a forced defrost across the two "Test" terminals that bypasses all thermistor/sensor and thermostat conditions and forces the defrost cycle. When the defrost "Test" terminal jumper is removed, the defrost cycle terminates defrost as long as the conditions are met to terminate defrost.

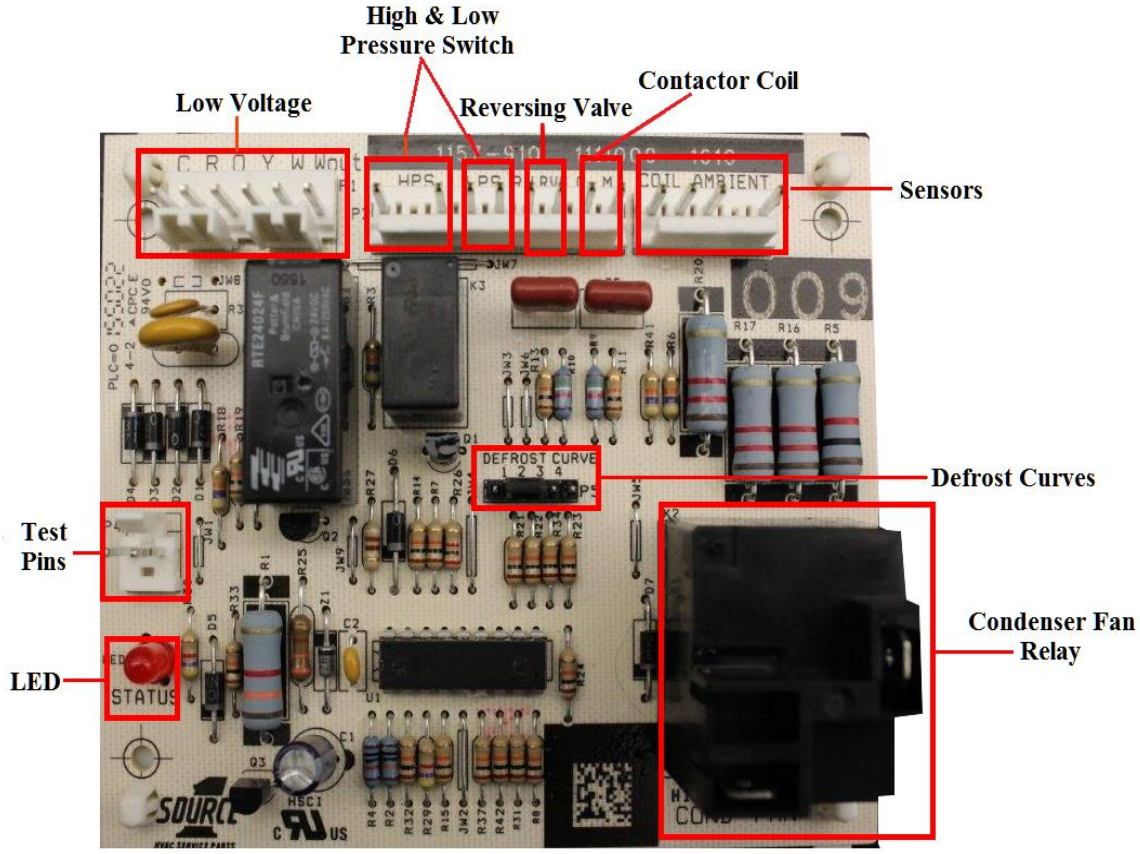
Legacy Demand Defrost Control



The following actions are completed by the Legacy Demand Defrost control board when defrost is initiated:

- De-energizes the outdoor fan
- Energizes the reversing valve
- Energizes W/out (W1/66) output to indoor unit 1st stage heat circuit to temper the circulating Airflow, as the unit is operating in the cooling mode while in defrost
- Begins the timer for maximum defrost duration

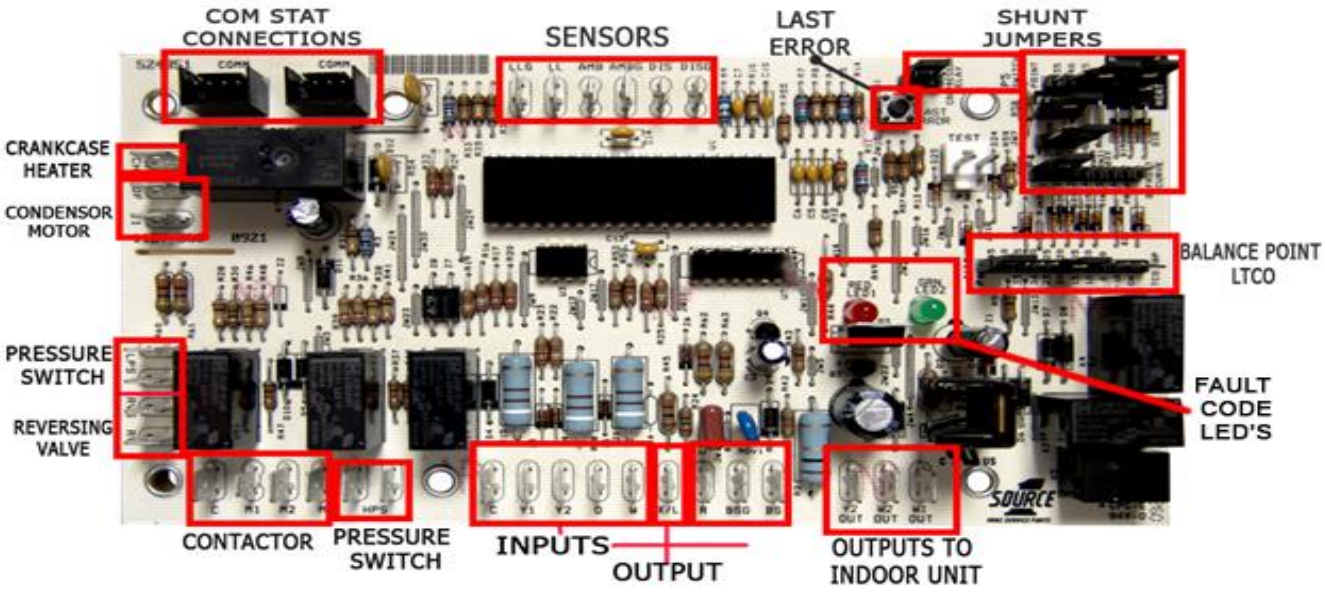
LX Series Demand Defrost Control



The following actions are completed by the new LX Series Demand Defrost control board when defrost is initiated:

- De-energize the outdoor fan.
- Energize the reversing valve
- Energize the auxiliary heat output through the W Out terminal.
- Begin the maximum defrost cycle length timer.

York Guard VI Control Board

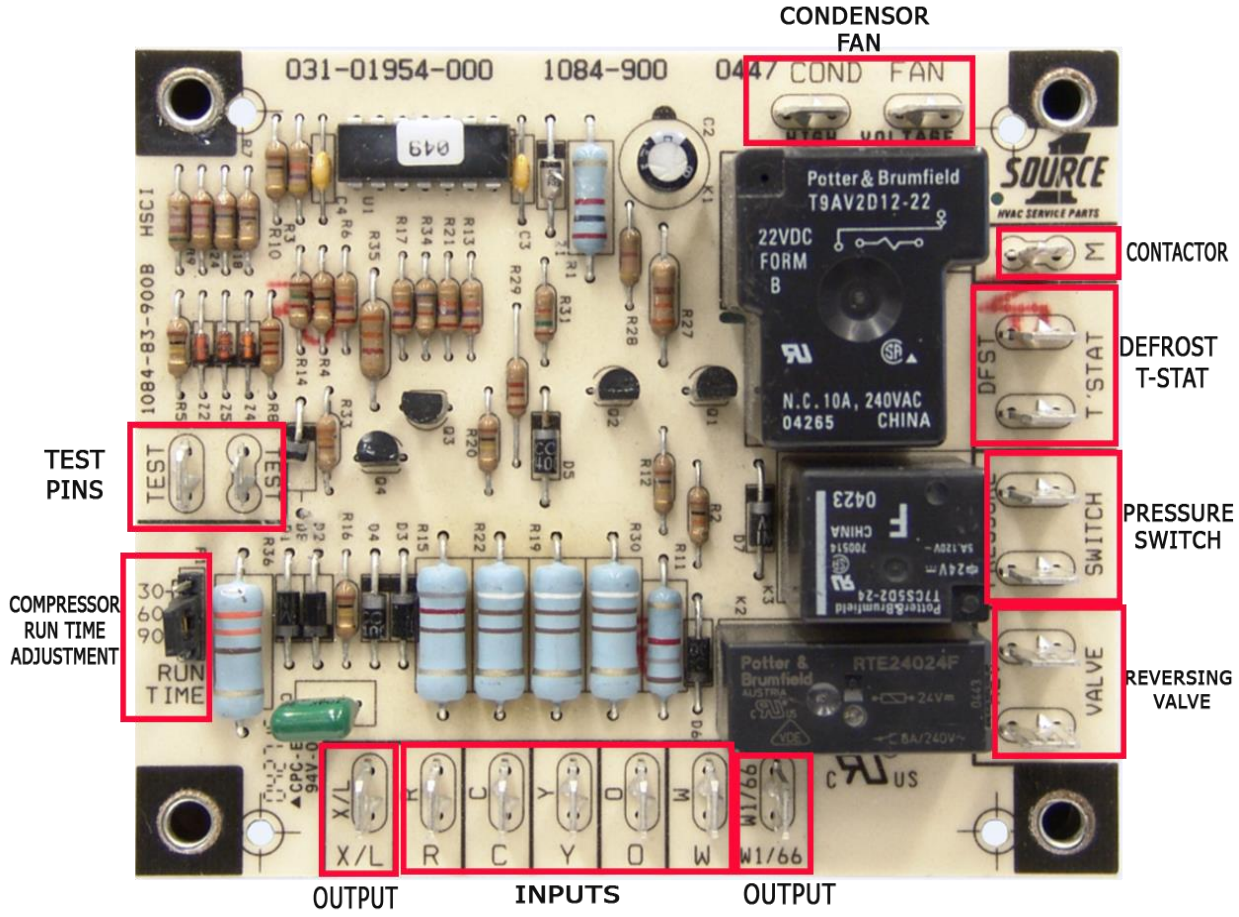


The following actions are completed by the York Guard VI control board when defrost is initiated:

- De-energizes the outdoor fan
- Energizes the crankcase heater
- Energizes the reversing valve
- Energizes the auxiliary heat outputs to temper the circulating airflow
- Energizes second stage (Y2OUT)
- Begins the timer for maximum defrost duration
- De-energizes the compressor for 30 seconds based on compressor delay selection on the board

NOTE: The Legacy and LX Series demand defrost control operate differently from the York Guard VI. These controls enter defrost if the coil sensor (also referred to as the liquid line coil sensor or defrost sensor/thermistor) reads below the initiate point for the measured ambient temperature continually for 4-1/2 minutes. If the control loses the call for heat while in defrost, the defrost cycle will pause. When the call for heating is reapplied, the defrost cycle reinitiates and terminate normally. Defrost also terminates if the unit is in defrost mode and the liquid line coil sensor goes above the "termination curve", or the maximum defrost time. The board will reset the defrost cycle timer at the end of every normal defrost termination.

Time/Temp Defrost Control Board



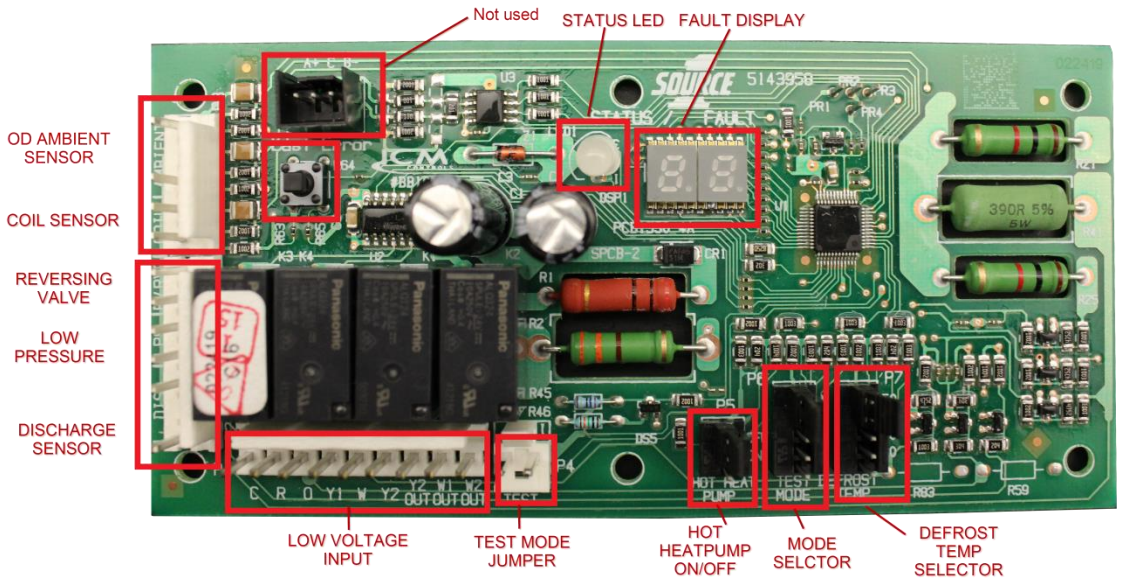
The following actions are completed by the Time/Temp Defrost control board when defrost is initiated:

- De-energizes the outdoor fan
- Energizes the reversing valve
- Energizes W/out (W1/66) output to indoor unit's 1st stage heat circuit to temper the circulating Airflow
- Begins the timer for maximum defrost duration

Caution: Do not confuse the defrost thermostat with the thermistor sensor used on the York Guard VI and the demand Defrost boards. The time selection is established by the technician during system startup, and selected based on temperature, humidity, and regional conditions.

The selectable times represent the length of time the heat pump will run before the board decides to look at the defrost thermostat to determine if defrost is necessary. The defrost switch is a normally "open" switch that closes at 31°F +/- 4°F and opens at 55°F +/- 5°F. The switch will appear "open" when ohmed out, **leading to nuisance faults if installed on the other control boards**. When the time selected (30, 60, or 90 min.) has been reached, the board will read the DFST T-stat and if it reads it as "open" it will not go into defrost. If the run time selected is met and the switch is "closed" the board will then go into defrost. This control board terminates defrost when the defrost thermostat opens or 10 minutes elapse.

Inverter Interface Defrost Control



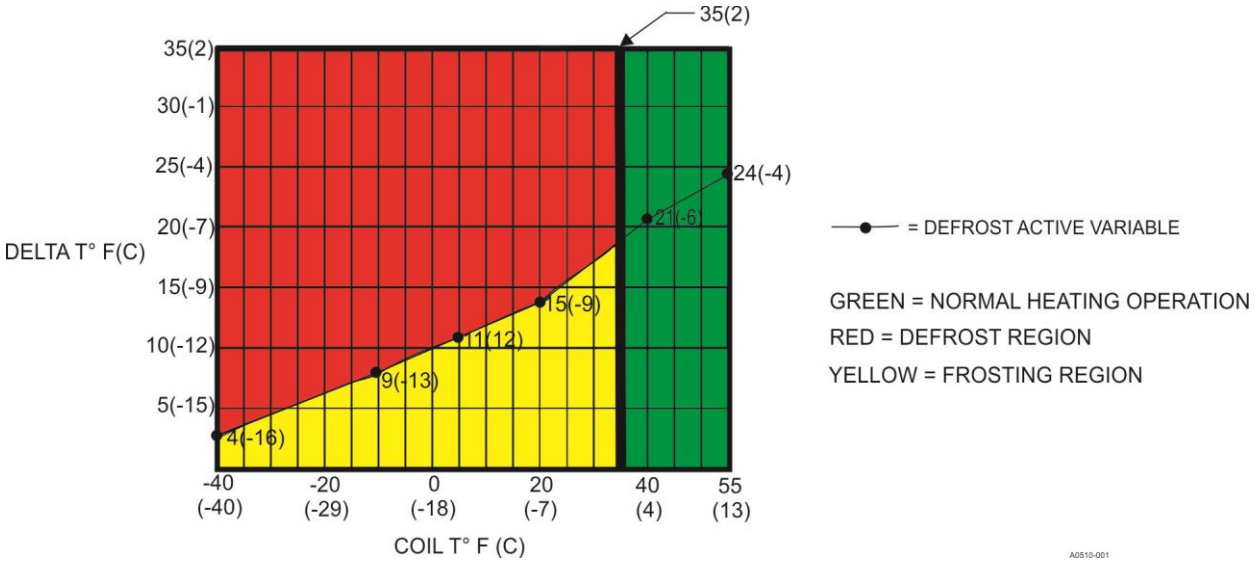
The following actions are completed by the Inverter Interface Defrost control board when defrost is initiated:

- Communicate proper speed of compressor (High Stage- 4th Stage)
- The Low Pressure Switch(LPS) is ignored during defrost
- Begin the "Defrost Cycle Timer"
- De-energize the outdoor fan
- Energize the reversing valve
- Energize "Y2 Out" for high ID airflow (if not already active)
- Energize "W1 Out" for auxiliary heat and "W2 Out" 15 minutes following "W1 Out" being energized.

The new **Inverter Interface Defrost** control uses an adaptive (algorithm) defrost operation. This control will store four unique settings, which allows the control to defrost differently depending on the selected settings. This is done by changing the termination temperature at which, defrost is terminated. This selection is changed through a selectable shunt jumper marked "**Defrost Temp**". If a compressor is energized (**Compressor Run Time**) for six hours in heating mode without a defrost cycle, this control will initiate a defrost cycle immediately. If the OD ambient temperature is less than 50 degrees, at the 6 hour defrost, then the control will force a 6 minute defrost on the system to allow oil return to the compressor. The defrost enable temperature is 35 degrees. If the coil temperature is above 35 degrees and the compressor is energized, the system does not accumulate defrost run time. However the control will accumulate "**Compressor Run Time**" for the purposes of running the 6 hour defrost. If the coil temperature is below 35 degrees and the compressor is energized, the system will accumulate "**Defrost Run time**" and "Compressor Run time" for the purposes of running the 6 hour defrosts.

This control has a calibration mode and is considered uncalibrated when power is applied after a cooling mode operation. Calibration of the control occurs after a defrost cycle to ensure that there is no ice on the outdoor coil. During calibration, the temperature of both the coil and ambient temperature sensors are measured to establish a "Frost Free Delta T (FFD T), which is (Amb T – Coil T). When the control is in a calibrated state, the control initiates a sacrificial defrost after 31 minutes of accumulated compressor run time in heat mode with coil temperature below 35 degrees. The defrost cycle terminates if the coil sensor reaches the selected termination temperature or after 12 minute defrost cycle.

Once the sacrificial defrost is terminated, a non-iced clear coil condition or FFD T is established by averaging coil temperature readings once a minute (for 4 minutes) starting on the 5th minute following termination of the last defrost. At that point, the "FFD T" and the Amb T are stored as the "Calibrated Ambient Temperature" (c Amb T). From this a linear curve called the "Frost Free Curve" is developed. This FFC is the curve the system utilizes for the next defrost cycle. (**Note**: Refer to the Defrost Operation Curves below).



The actual ambient temperature is still a variable and changes the FFC value as the ambient temperature changes until the next defrost occurs. As the ambient temperature changes, a slope of 1 degree Defrost Delta T changes for every 8 degrees ambient temperature change which is used to adjust the detection of frost accumulation. The control detects frost accumulation on the outdoor coil and will initiate a defrost cycle when the current delta T (Amb T minus Coil T) is less than or equal to "Defrost Active Variable" (DAV) for the current outdoor ambient temperature for 5 seconds.

When the "Defrost Run time" timer reaches 31 minutes, the defrost mode is enabled and executes as described depending on what mode of operation the control is in; either "Time/Temperature Defrost Mode" or Demand Defrost Mode. The control enters "**Time/Temperature Defrost Mode**" if the last defrost terminates due to "Defrost Cycle Time" and the Coil T is less than 35 degrees for greater than 4 minutes. When the "Defrost Run Time" timer reaches 31 minutes, the defrost operation initiates immediately. Depending on how the control exits the new defrost cycle, the system determines which defrost mode the control remains in or enters. (**Note**: Refer to the Defrost Operation Curves above).

The control can also enter "**Demand Defrost Mode**" if the last defrost terminates due to "Defrost Temp" (Termination Temperature) or the last defrost terminates due to "Defrost Cycle Time" and the Coil T is above 35 degrees for more than 4 minutes. Then when the "Defrost Run Time" timer reaches 31 minutes, the defrost operation initiates as a result of Frost Detection.

Defrost Application & Troubleshooting Information

Field issues should be addressed upon discovery. The indoor circulating airflow is critical on all equipment, and especially during the defrost process. A static pressure reading indicates if the airflow across the indoor coil is adequate for proper operation. Refer to the Technical Guide to determine the proper airflow. The majority of York systems are designed to operate between 350 to 450 CFM per ton. Another issue often misunderstood is the formation of frost on the grille of the outdoor coil. This frost may look like "ice", but it is simply frost on the grille that will not affect the function or efficiency of the heat pump. Remember that defrost is initiated based on unit operating characteristics and not on appearance.

A properly charged system will ensure the proper operation of the refrigeration circuit and rated efficiencies and also allow for a proper defrost cycle. The technician must ensure the unit has a clean indoor and outdoor coil and that the unit is not overcharged or undercharged. The system must be charged according to the rating plate. Both overcharged and undercharged systems may result in an incomplete defrost cycle. A system low on charge will result in premature frost and will not result in a completely defrosted coil at the end of the defrost cycle. An overcharged system may trip on high head pressure during defrost and may cause a pressure switch lockout prior to defrost termination.

The Legacy, LX Series Demand and York Guard VI defrost controls have a defrost curve shunt that is factory placed in the P position or in a numbered position appropriate for the specific heat pump model. If the jumper is inadvertently moved or not in place, the control will not energize the compressor and the control will output the proper fault code on the X/L terminal. (**NOTE**: when replacing Demand defrost control Board, the tech needs to confirm defrost curve) when a defrost curve jumper error is present. (See Defrost Initiate Curves and X/L Error Codes)

Demand Defrost Curve Selections

	Defrost Curve Selection - Jumper Position			
	Pin 1**	Pin 2**	Pin 3**	Pin 4**
YHJR*, THJR*	None	60	None	None
CHJD*, YHJD*, THJD*, GHGD*, THGD*	None	18, 60	None	None
YHJF*, THJF*	36, 60	18, 24, 30, 42, 48	None	None

*Units not listed use time-temperature defrost boards with jumper at the "60" position.
**Jumper settings 1-3 are different defrost curve settings. 4 & P will not work in application.

LX Series Demand Defrost Curve Selections

Outdoor Unit	18	24	30	35	36	42	48	60
Defrost Jumper Pin Setting	2	2	2	3	3	2	4	2

York Guard VI Defrost Curve Selections

Defrost Curve Selection Jumper Position	1	2	3	4	5	6
Heat Pump Model	2 Ton 2½ Ton	4 Ton 5 Ton	3 Ton 3½ Ton	1½ Ton	11 min. max defrost	13 min. max defrost

- When a lockout condition exists in (heating or cooling) operation the LX Series Demand defrost control board will no longer have the X/L terminal for fault indication but will provide a status or fault LED. Unlike the LX Series Demand control, the Inverter Interface defrost control will provide status codes using LED and the 7-segment displays. (**Note: see installation Manual for definition of status and faults codes**)

- When a lockout condition exists in (heating or cooling) operation the Legacy Demand, York Guard VI, and Time/Temp defrost control board's fault indicator (X/L) terminal will output 24 VAC to an LED or LCD display on the indoor thermostat, this is in addition to the red and green LEDs located on the York Guard VI defrost control board.

- If the fault occurs during heat pump (heating or cooling) operation the fault Indicator X/L terminal will send a signal to the indoor thermostat 2 times, pause 3 seconds, and repeat this action until the fault has been removed.

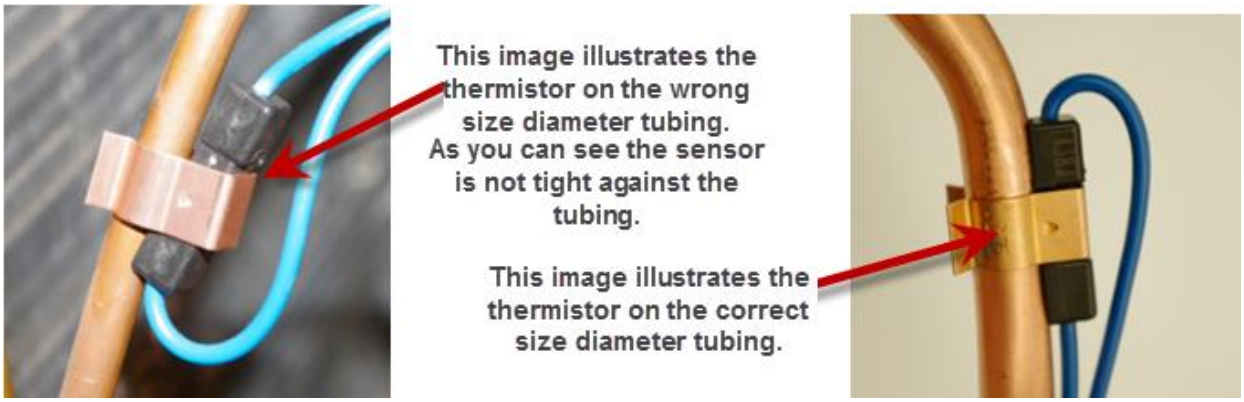
- If the fault occurs during defrost operation, the fault indicator will flash 3 times pause 3 seconds, and repeat this action until the fault has been removed.

- **Note**: If the installing company does not install a wire from the X/L terminal to the thermostat, a 24 VAC LED Test Light can be used to retrieve the fault code.

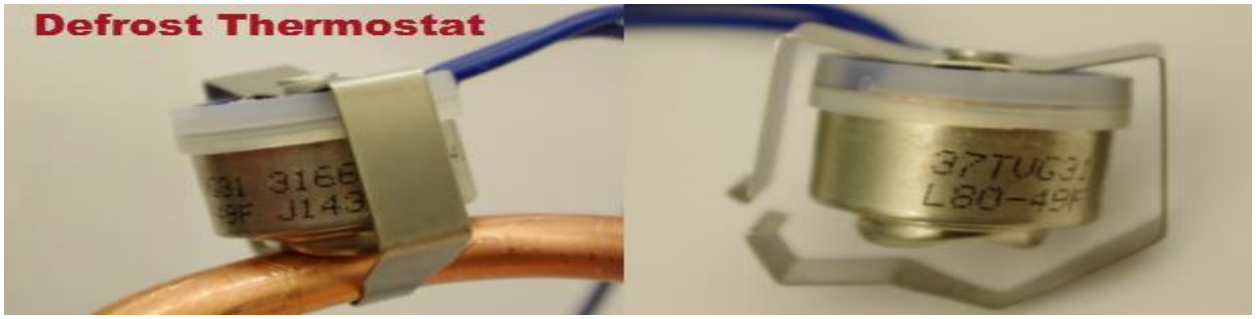
- **Source 1** Part Number S1-03109128000

A number of issues can affect proper defrost operation, including defrost sensors (defrost thermostat or thermistor) positioned in the wrong location. The placement of the defrost coil sensor should be located at the lowest distributor tube coming out of the coil. The sensor is mounted on a 3/8" tube, which is just long enough for the proper mounting. The tube then reduces to the normal 1/8" distributor tube size. The sensor should be a tight fit on the 3/8" line. If not, then either the wrong sensor is on the unit, or the sensor is mounted in the wrong location. If the unit was built without the 3/8" stub tube, the sensor will not function properly and result in defrost issues. The sensor should be well insulated regardless if it is factory or field installed.

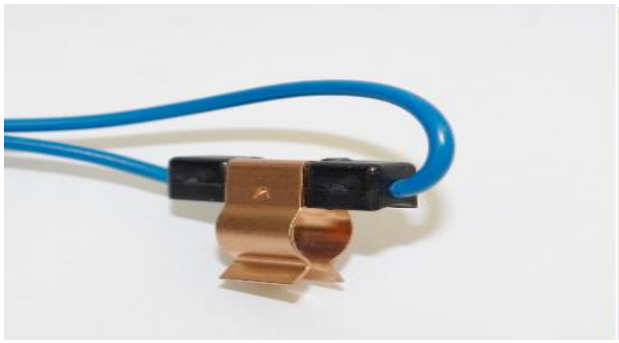
Issues and Concerns



When replacing any part, it is best to order the part using the serial number of the unit. The most common sensor used is a 10k ohm negative coefficient thermistor type sensor, used on Legacy, LX Series demand, York Guard VI and Inverter Interface defrost board. The open/closed switch is used only on the time/temp board. There is a physical difference between the two types of switches. The open/closed switch is round and silver in color and the thermistor is narrow and black in color. The thermistor can be tested using a resistance vs. temperature chart that is found on UPGNET or through your local distributor.

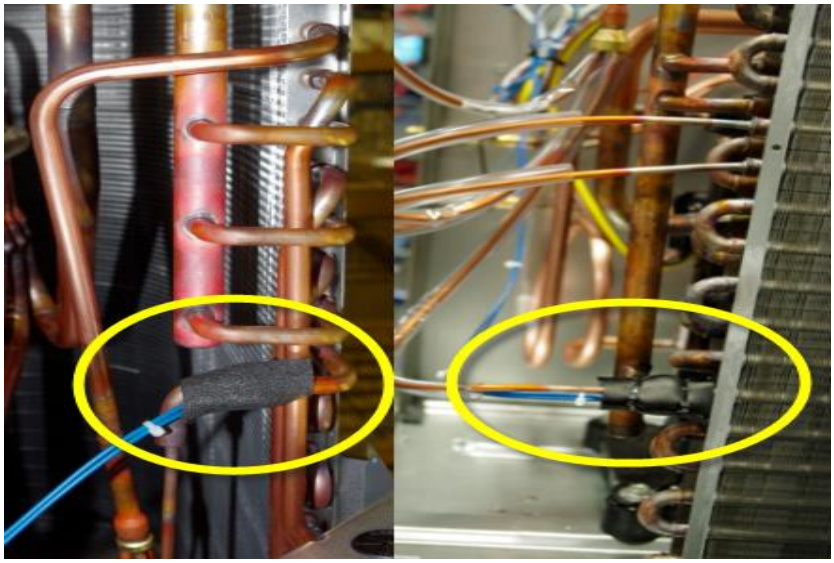


The Defrost Thermostat is Used with the Time/Temperature defrost board.



The Thermistor is used on the York Guard VI, Legacy, LX Series, and Inverter Interface Demand Defrost boards.

Note: The defrost thermostat and thermistor are not interchangeable. You must use the correct type of sensor for the defrost control board application.



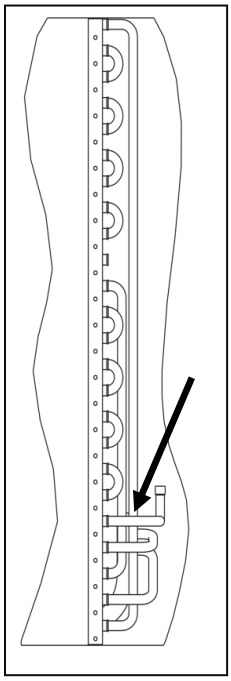
The images above illustrate the sensor at the bottom distributor line with a 3/8” stub for sensor (Thermistor) mounting.

The Legacy, LX Series, York guard IV, and Inverter Interface defrost control all use 10K Ohm Thermistor/Sensor for the defrost cycle. With the Thermistor/Sensor isolated from the board, the Sensor Resistance vs. Temperature chart will allow the tech to verify calibration of the Thermistor/Sensor.

Sensor Resistance vs. Temperature

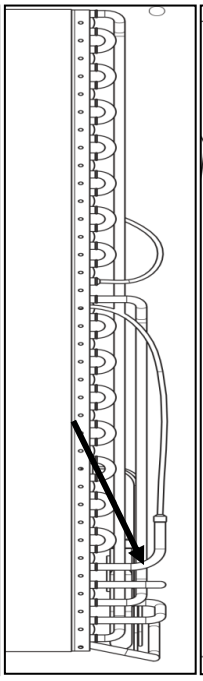
TEMP. °F	RESIST. (OHMS)	TEMP. °F	RESIST. (OHMS)	TEMP. °F	RESIST. (OHMS)	TEMP. °F	RESIST. (OHMS)	TEMP. °F	RESIST. (OHMS)	TEMP. °F	RESIST. (OHMS)
–10	118,050	38	27,586	86	8,057	134	2,808	182	1,128	229	518
– 9	114,230	39	26,831	87	7,868	135	2,751	183	1,108	230	510
– 8	110,540	40	26,099	88	7,685	136	2,696	184	1,089	231	502
– 7	106,990	41	25,390	89	7,506	137	2,642	185	1,070	232	494
– 6	103,560	42	24,703	90	7,332	138	2,589	186	1,051	233	487
– 5	100,260	43	24,036	91	7,163	139	2,538	187	1,033	234	479
– 4	97,070	44	23,390	92	6,998	140	2,488	188	1,015	235	472
– 3	93,994	45	22,763	93	6,838	141	2,438	189	997	236	465
– 2	91,027	46	22,155	94	6,682	142	2,390	190	980	237	458
– 1	88,162	47	21,566	95	6,530	143	2,343	191	963	238	451
0	85,398	48	20,994	96	6,381	144	2,297	192	947	239	445
1	82,730	49	20,439	97	6,237	145	2,252	193	931	240	438
2	80,154	50	19,900	98	6,097	146	2,208	194	915	241	431
3	77,668	51	19,377	99	5,960	147	2,166	195	899	242	425
4	75,268	52	18,870	100	5,827	148	2,124	196	884	243	419
5	72,950	53	18,377	101	5,697	149	2,083	197	869	244	412
6	70,712	54	17,899	102	5,570	150	2,042	198	855	245	406
7	68,550	55	17,435	103	5,447	151	2,003	199	841	246	400
8	66,462	56	16,985	104	5,327	152	1,965	200	827	247	395
9	64,444	57	16,547	105	5,209	153	1,927	201	813	248	389
10	62,495	58	16,122	106	5,095	154	1,891	202	799	249	383
11	60,611	59	15,710	107	4,983	155	1,855	203	786	250	378
12	58,791	60	15,309	108	4,875	156	1,820	204	773	251	372
13	57,031	61	14,920	109	4,768	157	1,785	205	761	252	367
14	55,330	62	14,542	110	4,665	158	1,752	206	748	253	361
15	53,685	63	14,175	111	4,564	159	1,719	207	736	254	356
16	52,095	64	13,818	112	4,466	160	1,686	208	724	255	351
17	50,557	65	13,472	113	4,370	161	1,655	209	712	256	346
18	49,070	66	13,135	114	4,276	162	1,624	210	700	257	341
19	47,632	67	12,808	115	4,184	163	1,593	211	689	258	336
20	46,240	68	12,490	116	4,095	164	1,564	212	678	259	332
21	44,894	69	12,181	117	4,008	165	1,535	213	667	260	327
22	43,591	70	11,881	118	3,923	166	1,506	214	656	261	322
23	42,330	71	11,589	119	3,840	167	1,479	215	646	262	318
24	41,110	72	11,305	120	3,759	168	1,451	216	635	263	313
25	39,929	73	11,030	121	3,680	169	1,425	217	625	264	309
26	38,785	74	10,761	122	3,603	170	1,399	218	615	265	305
27	37,678	75	10,501	123	3,527	171	1,374	219	606	266	300
28	36,607	76	10,247	124	3,454	172	1,349	220	596	267	296
29	35,569	77	10,000	125	3,382	173	1,324	221	587	268	292
30	34,565	78	9,759	126	3,312	174	1,301	222	578	269	288
31	33,592	79	9,526	127	3,243	175	1,277	223	569	270	284
32	32,650	80	9,298	128	3,177	176	1,255	224	560	271	280
33	31,738	81	9,077	129	3,111	177	1,232	225	551	272	276
34	30,854	82	8,862	130	3,048	178	1,210	226	542	273	273
35	29,998	83	8,653	131	2,986	179	1,189	227	534	274	269
36	29,168	84	8,449	132	2,925	180	1,168	228	526	275	265
37	28,364	85	8,250	133	2,866	181	1,148				

The following drawings show the current location of the coil thermistor or Defrost Thermostat, including generation, tonnage, and model in our residential split heat pump products. (**Note**) generation (GEN) callouts- sensor locations will vary by product family; tonnage and generation.



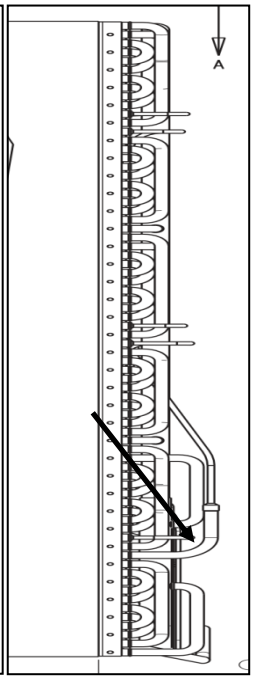
(GEN. 2, 3)

18 – 42
YHJR
THJR
THRD
RHP13R
YHJD
THJD
THGD
RHP13J
YHJF
THJF
THGF
RHP14J



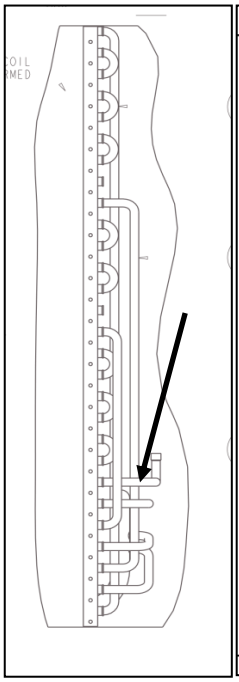
(GEN. 2, 3)

24 – 36
YZF
HC6B
HL6B



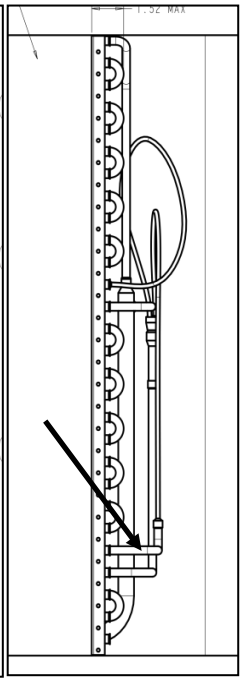
(GEN. 3, 4)

24 – 60
YZH
HC6B
HL8B
HC8B



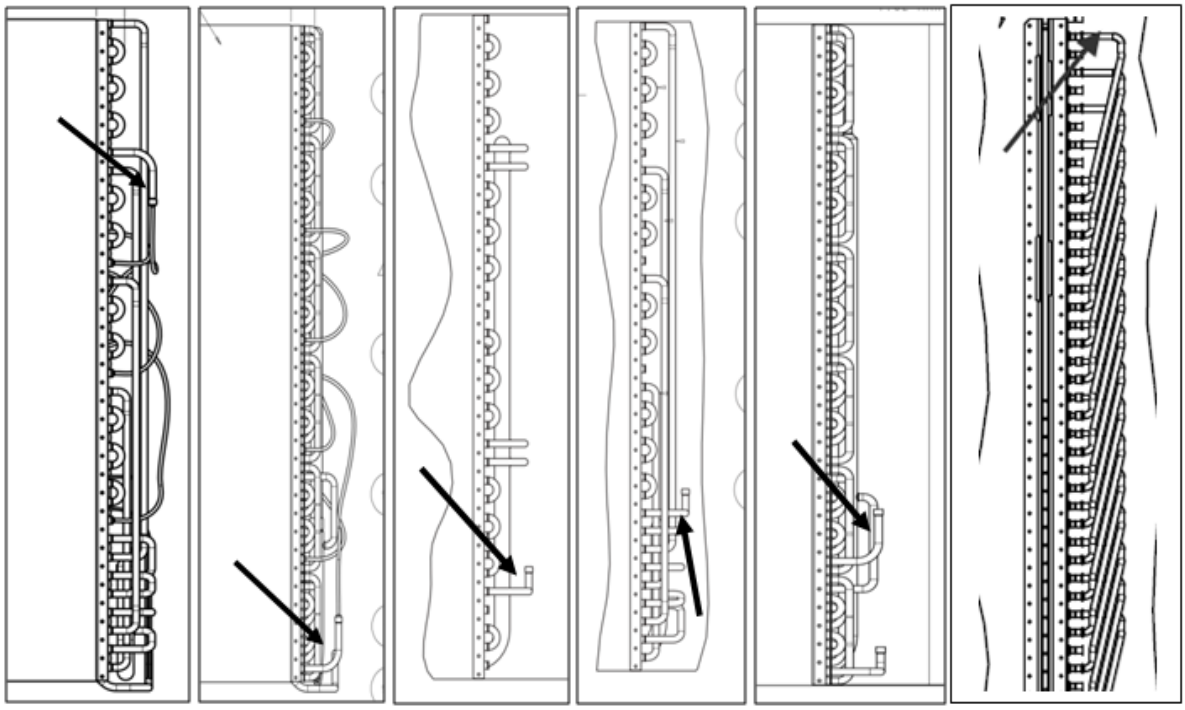
(GEN. 4)

24 - 42
YHJD
THJD
THGD
YHJD
THJD
THGD
RHP13J
YHJF
THJF
THGF
RHP14J



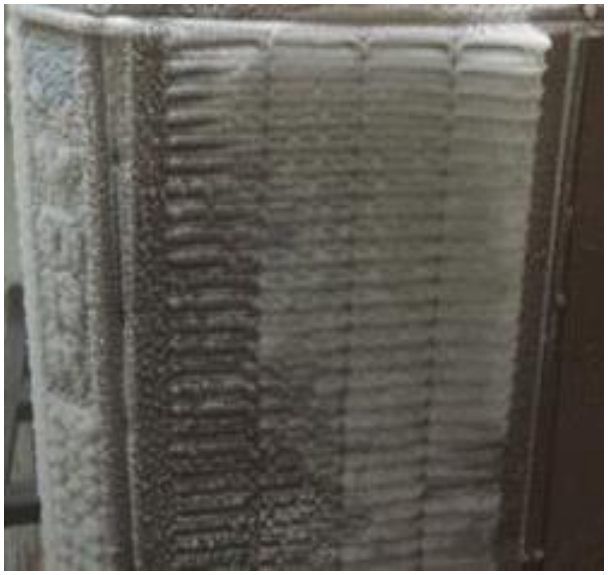
(GEN. 5)

24 - 30
YHJD
THJD
RHP13J



(GEN. 4)	(GEN. 3)	(GEN. 5)	(GEN. 3, 4)	(GEN. 2, 4, 5)	(GEN. 1)
42	42-48	42-48	42	48-60	18-60
YZF	YZF	YHJF	YHJF	YHJD	YHE
HC6B	HC6B	THJF	THJD	THJD	YHM
HL6B	HL6B	THGF	RHP14J	THGD	TH4
		YHJR		YHJF	THE
		THJR		THJF	RHP14L
		THRD		THGF	
		RHP13J		YHJR	
				THJR	

The following images show the residential split Heat Pump product in various states of operation. (**NOTE**): The defrost mode is only initiated by the defrost control board based on the unit's operating conditions and defrost control board parameters. The images shown below has the appearance of frost and ice on the grille of the unit, although the grille is frosted over, the coil itself is 100% clear. The images shown below are units operating in our Highly Accelerated Lifecycle Testing (HALT) Chamber.

The images shown below is the beginning of the heat pump coil frosting due to normal operating conditions. Once the conditions meet the designed parameters of the defrost control board, the defrost cycle will be initiated.


For further information on the residential split heat pump, including the defrost control boards, functionally, and tips for troubleshooting, please refer to the ProficienTech Unitary Products Heat Pump Training Manual #(PUBL-6071) and the York Guard VI Operation Instruction Manual # (501062-UAI-C-0311) or feel free to contact UPG Technical Services at 1-877-874-7378 if you have any questions.

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