Advanced Refrigerator Troubleshooting

This information is published for experienced repair technicians only and is not intended for use by the public. It does not contain warnings to advise non-technical individuals of possible dangers in attempting to service a product. Only experienced professional technicians should repair products powered by electricity. Any attempt to service or repair the product or products dealt with in this information by anyone else could result in serious injury or death. Information provided in this bulletin is subject to change or update without notice.

This training is provided to assist the student in servicing Samsung refrigerators. The training covers common failure mode, diagnostic procedures and efficient troubleshooting. This course is not written for a specific model rather it covers the variety of Samsung refrigeration products.

Course Syllabus

1. Identifying the Product
2. Time Divided Multiplex (TDM) Valve
    1. Operation Information
    2. Common Failure Modes
    3. Troubleshooting
3. Inverter Compressor
    1. Circuit Explanation
    2. Compressor Troubleshooting
    3. Drive Circuit Troubleshooting
4. Temperature Control Function
    1. Sensor operation
    2. Diagnostic Mode
    3. Sensor Testing
    4. Damper Operation
5. Defrost Circuit
    1. Forced Operation Mode
    2. Troubleshooting
6. No Cool, Poor Cooling and Too Cold Troubleshooting

The course is broken into 6 chapters, most chapters include a learning assessment to measure knowledge retention. The certification exam contains questions from each chapter.

Identifying the Product

Model Code

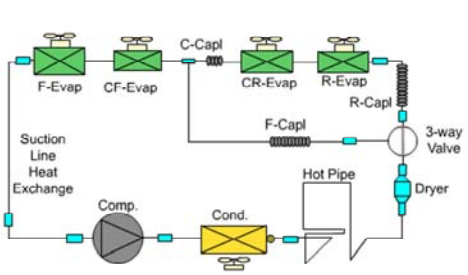
- Samsung refrigerators must be identified using the model code
- Using any other number when ordering parts can lead to incorrect parts deliveries and repair delays
- This sticker is located on the left side wall of the refrigerator compartment.

Samsung refrigerators must be identified using the model code

Using any other number when ordering parts can lead to incorrect parts deliveries and repair delays.

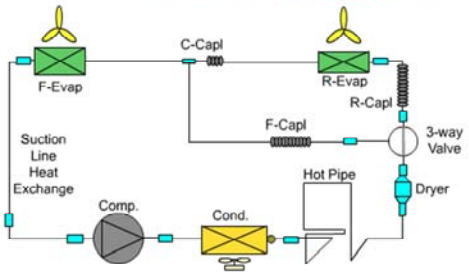
TDM Valve Operation explanation

The Time Divided Multi-cycle (TDM) System (Stepper Valve) is used to switch refrigerant flow in the a few different Samsung models. This design improves temperature control and energy efficiency.



Standard Mode Operation

Quad Cooling RM Model



Standard Mode Operation

Twin Cooling RS/RF/RB Models

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The Time Divided Multi-cycle (TDM) System

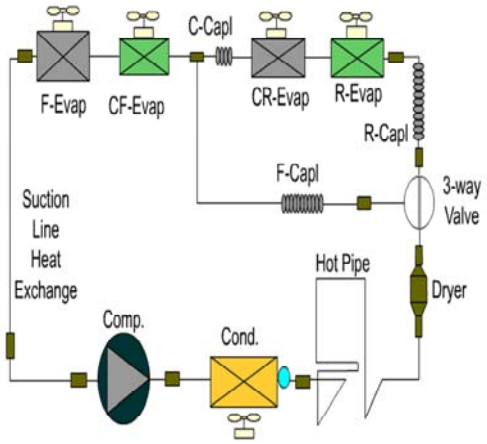
(Stepper Valve) is used to switch refrigerant flow in the a few different Samsung models. This design improves temperature control and energy efficiency.

If the freezer gets warm but the fridge stays cool, the TDM valve switches to send the majority of the coolant to the freezer evaporator. If both sections are warm the valve switches so refrigerant runs to both evaporators. By controlling the refrigerant flow the refrigerator is able to maintain the temperature more accurately while saving energy. In most cases the freezer needs more cooling. This system runs the compressor a shorter time than the conventional cooling system.

TDM Valve Failure Mode 1

If the TDM Valve fails in the full system mode, the fridge should work properly, however using more energy. Depending on the temperature settings the refrigerator section might freeze due to the excess cooling.

- **For testing, set the fridge temp warmer thai the actual temp, monito the defrost sensor(s) to see if voltage drops.**



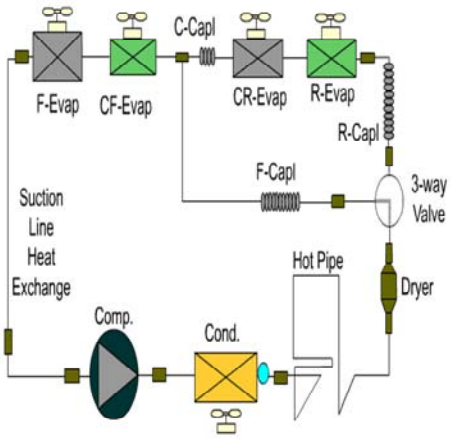
Full System Mode Operation

In this scenario the TDM Valve sticks in the full position. This means refrigerant flows through the entire cooling loop. In general the refrigerator will operate normally however in extreme occasions the refrigerator might be colder than normal. Additionally the unit will use more energy.

TDM Valve Failure Mode 2

If it fails in the Freezer evaporator loop only mode, there will be a Fridge no cool symptom

- **Force on the Fridge with the "Pwr Cool" option. Monitor the Fridge evap(s) temperature by using the Defrost Sensor(s). If the temp doesn't decrease, then suspect the Main PCB is not supplying signal to switch the diverter valve.**

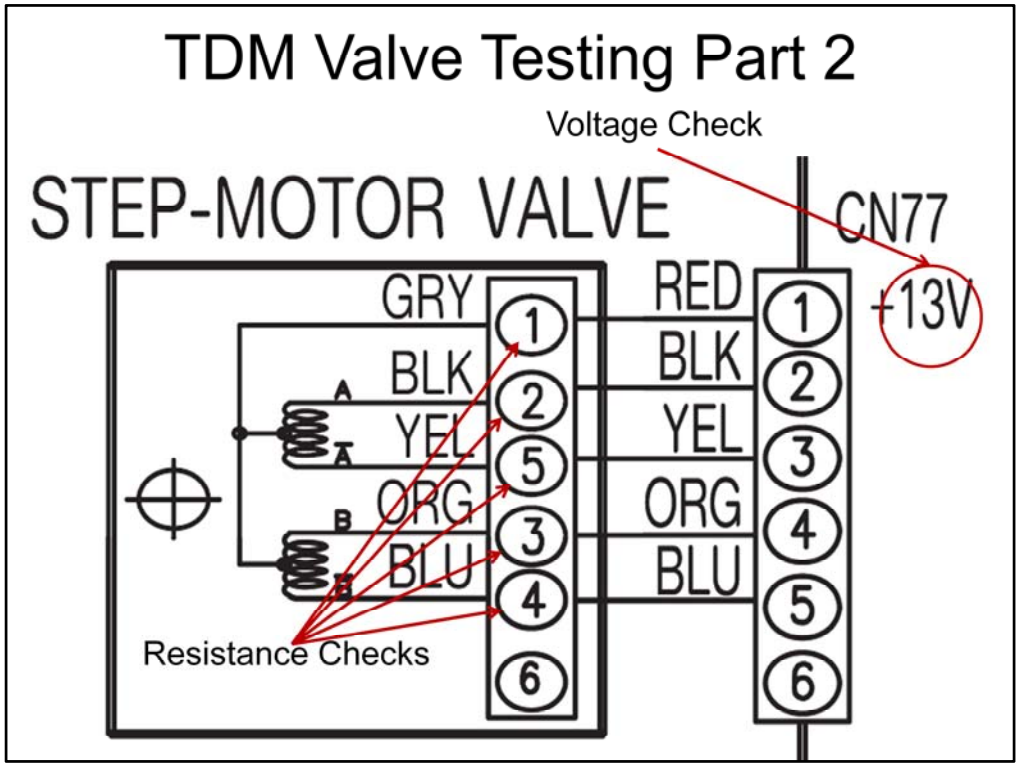


Freezer Mode Operation

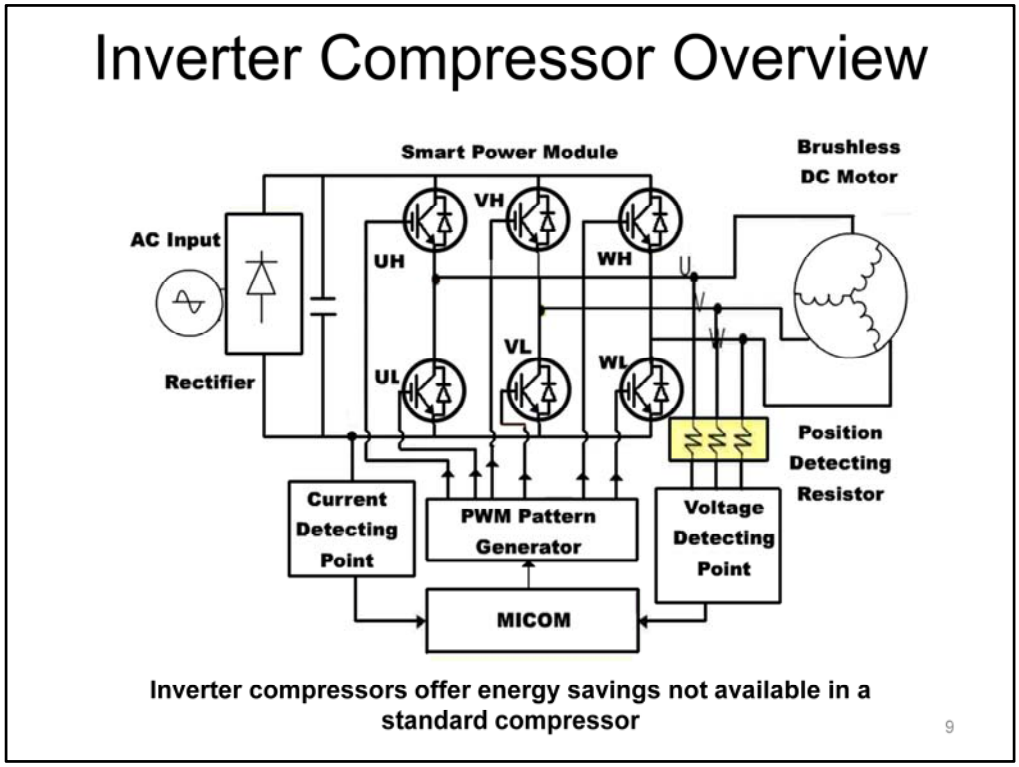
In this scenario the TDM Valve sticks in the freezer only position. This means refrigerant flows through the freezer loop only. The refrigerator section will not maintain the proper temperature but the fans and compressor will run normally.

TDM Valve Testing Part 1

The TDM Valve can be tested by unplugging the fridge for 1 minute. Place your finger on the axle shaft of the rotating valve. When power is reapplied you should feel the axle shaft rotate.

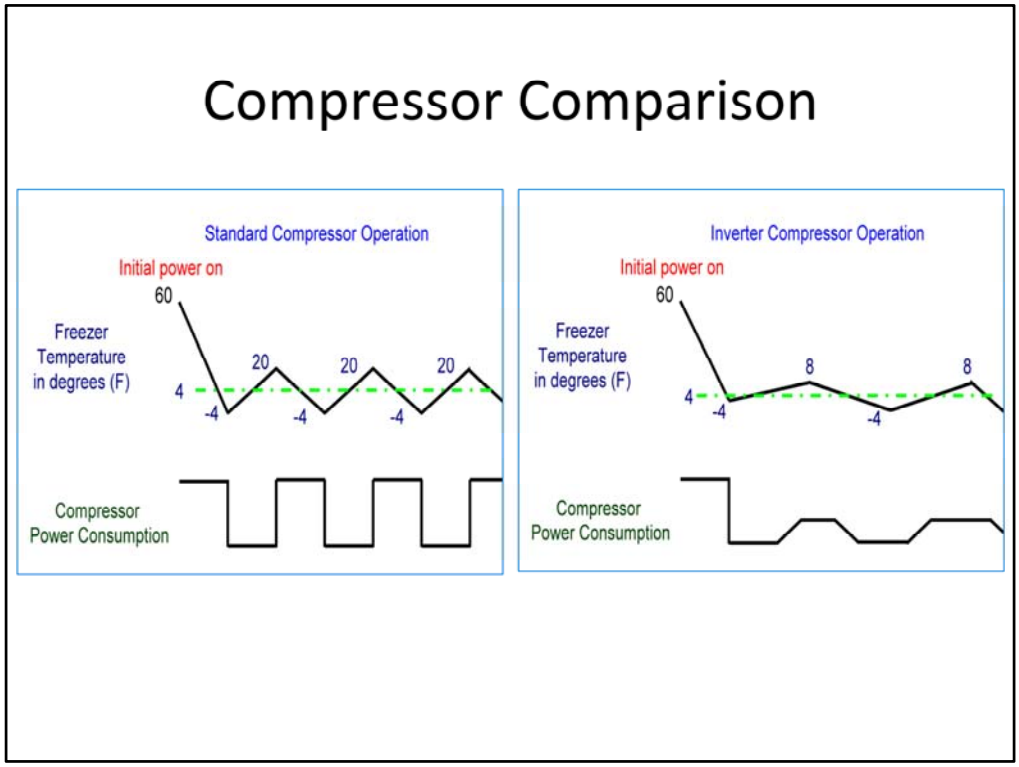


The TDM valve is controlled by a stepper motor. A simply continuity test across the windings should read similar values across each coil. During the power on cycle 13V is applied from the Main PCB.

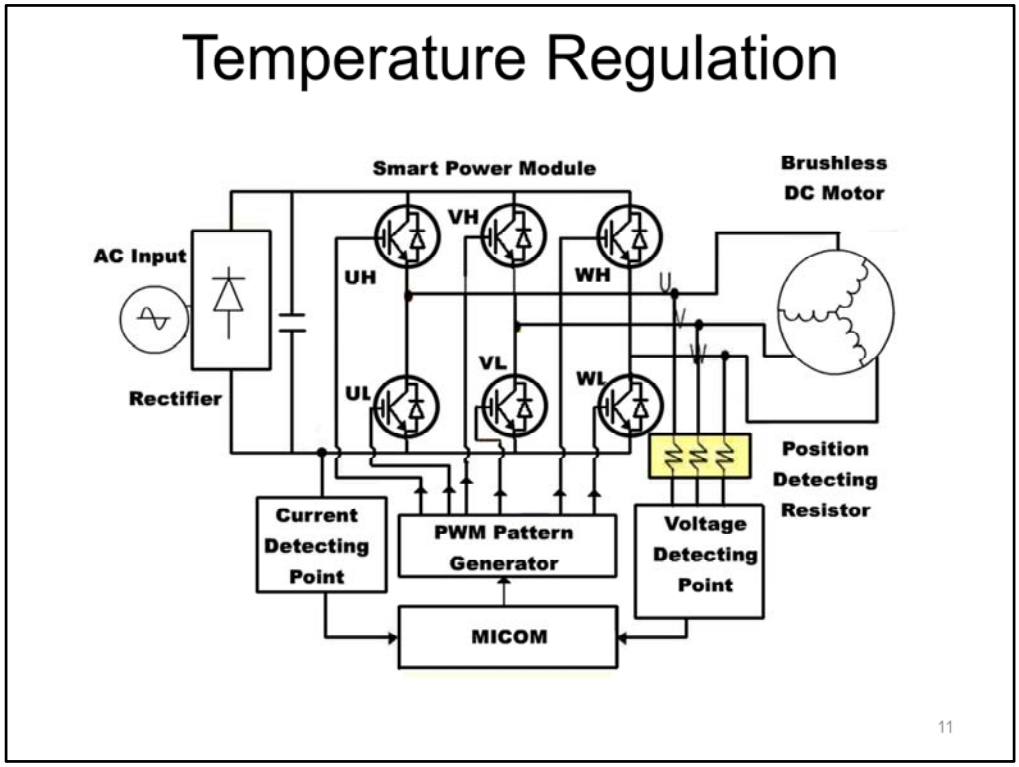


In a standard model refrigerator the compressor operates at only one speed. Temperature regulation is achieved by cycling the compressor on and off.

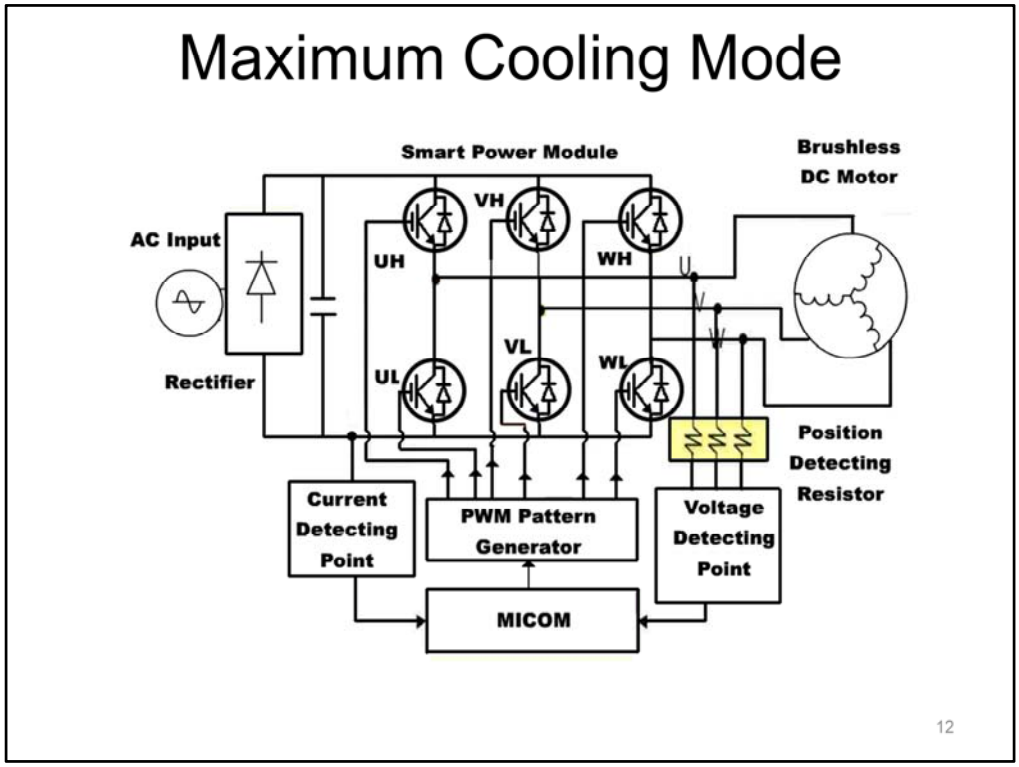
RFG and RSG models incorporate the Inverter compressor. The Inverter compressor saves energy by operating at multiple speeds. Depending on cooling requirements the compressor can run slower using less power. The inverter compressor runs longer but at a significantly lower speed.



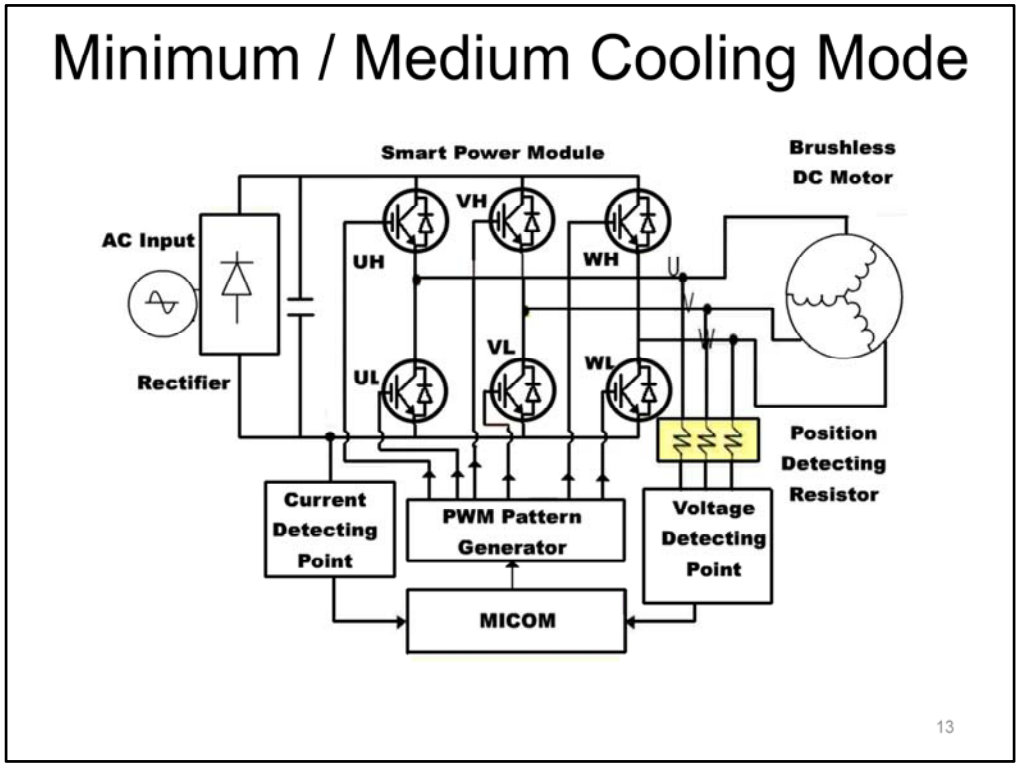
Standard compressors monitor the compartment temperature turning on as temperature rises and off as the temperature goes down. The temperature raises and lowers throughout the cycle but the average remains consistent. The power consumption is highest at the compressor turn on points. turn By comparison the inverter compressor stays on longer but at a much lower speed. The temperature level does not vary as widely and the amount of power consumed is significantly lower. Normal operation of this design is very slow speed compressor used to maintain a fixed temperature. It is also normal for the refrigerant pressure values to be significantly lower.



The Microprocessor reads a series of temperature sensors to determine the correct compressor speed. The compressor confirms the speed value to the Microprocessor using the voltage detector network. At the same time the drive current value is fed back to the Microprocessor. The current feedback loop prevents an over current condition in the event the compressor motor is damaged or obstructed. As temperature increases the Microprocessor varies the duty cycle which in turn controls the compressor speed. As the temperature drops the compressor speed drops and eventually turns off.



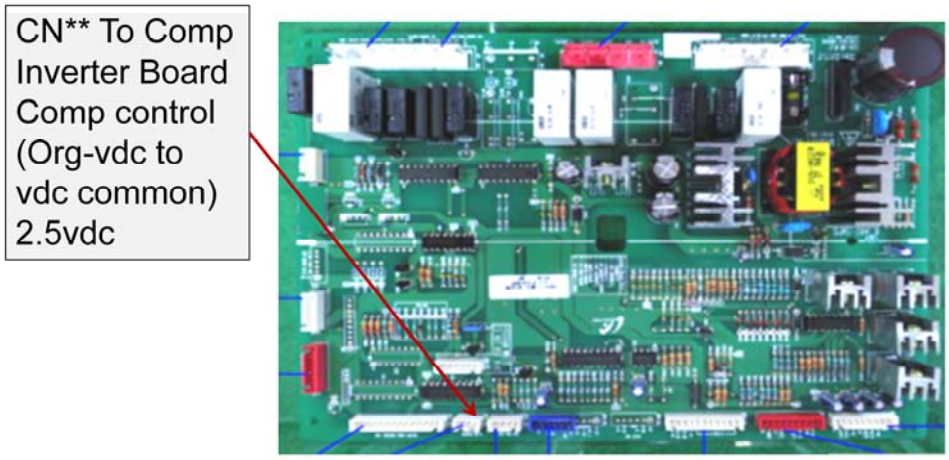
The Smart power module uses drive information from the Microprocessor as well as feedback information from the motor to determine the optimal drive signal. During initial operation all the drive transistors are on driving the DC motor to maximum speed.



During normal cooling only one set of transistors is switched on running the compressor at slow speed, drawing minimum current. Operating the compressor at slow speed allows the refrigerant to circulate through the system at a very low pressure level while still absorbing heat. Medium speed operation uses two sets of transistors operating the compressor at an in between speed and an in between current level.

Inverter Compressor Troubleshooting – Compressor Dead

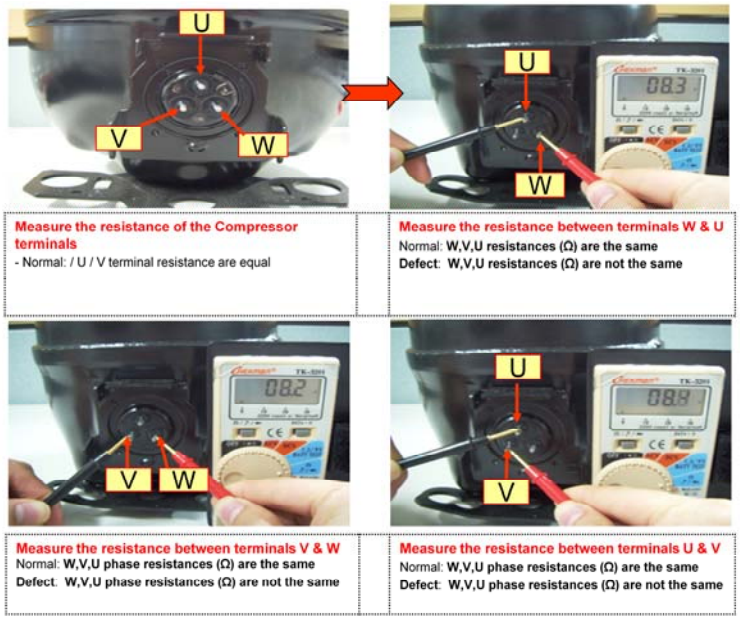
In this scenario the Compressor is not working and the monitor LED on the drive board is not lit.



1. Activate Forced Compressor Operation, and monitor the operation. If the compressor does not come on wait 3 minutes and try it again. (high head pressure might inhibit operation temporarily)

2. If compressor still doesn't start, and LED is out, check Compressor Control pin for 2.5vdc. If this voltage is missing or low the Main PCB is probably defective.

Inverter Compressor Testing

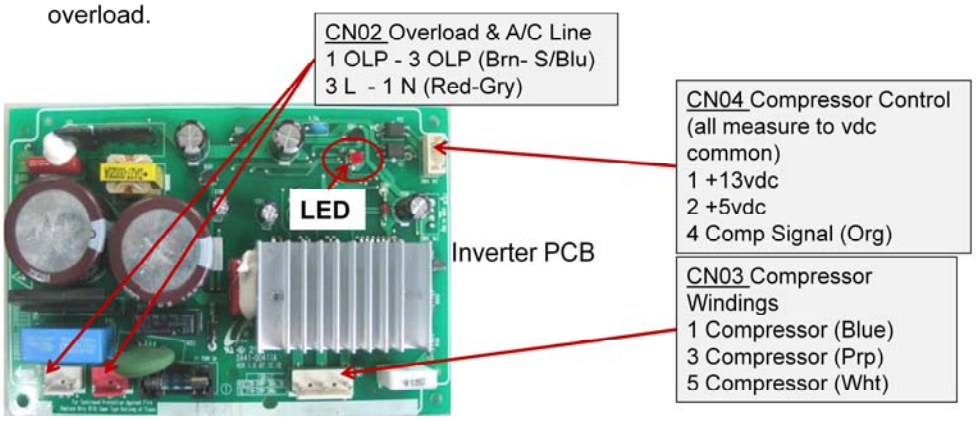


Measure the resistance of the Compressor terminals - Normal: / U / V terminal resistance are equal	**Measure the resistance between terminals W & U** Normal: **W,V,U resistances (Ω) are the same** **Defect**: **W,V,U resistances (Ω) are not the same**
Measure the resistance between terminals V & W Normal: **W,V,U phase resistances (Ω) are the same** **Defect**: **W,V,U phase resistances (Ω) are not the same**	**Measure the resistance between terminals U & V** Normal: **W,V,U phase resistances (Ω) are the same** **Defect**: **W,V,U phase resistances (Ω) are not the same**

The best way to test the compressor is a simple resistance measurement of the three phase wiring. Each coil should measure less than 10 ohms, a short circuit or an open circuit indicates a defective compressor.

Inverter Compressor Testing

1) Activate Forced Compressor operation, wait 3 min. (in case of high head pressure)
2) Check for 120vac at CN02 Red and Gray wires.
3) If voltage is OK, remove power, disconnect CN03 (Inverter PCB) and check resistance to the windings. Aproxametly10 ohms. If not correct , inspect wire harness, if OK replace compressor.
4) Disconnect CN02 (Inverter PCB), check resistance to Overload , if open replace overload.



In this scenario the compressor is not running but the Monitor LED is blinking.

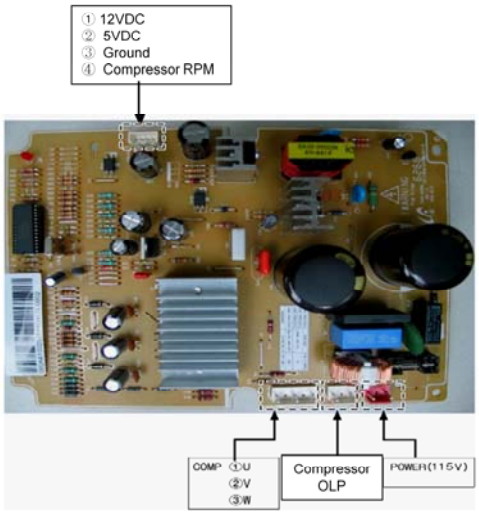
1. Activate Forced Compressor Operation, and monitor the operation. If the compressor does not come on wait 3 minutes and try it again. (high head pressure might inhibit operation temporarily)
2. Check for 120vac at the Red and Gray wires of CN02. If the voltage is OK, remove power and disconnect CN03 of the Inverter PCB, check the resistance to the windings, a value of approximately 10 ohms is expected. Additionally check the wiring harness for continuity.
3. Finally check the Overload protect circuit at CN02 the overload protector acts like a circuit breaker and should measure close to zero ohms.

Inverter Driver Troubleshooting

Forced Mode Current Draw values:

FF1 - Compressor high speed - 2.7 amps
FF2 - Compressor low speed - 1.6 amps
FF3 - Compressor medium speed - 2.0 amps
FD - All defrost elements on - ~ 4.0 amps

NOTE: FF2 & FF3 could be reversed.



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Listed on this page is the nominal current draw for all of the forced diagnostic modes. The exact current level is not as important as measuring distinct levels for each of the modes FF1 through FF3 and Defrost modes. If you measure three different current values for ff1 – ff3 this indicates the drive PCB and the compressor are operating properly.

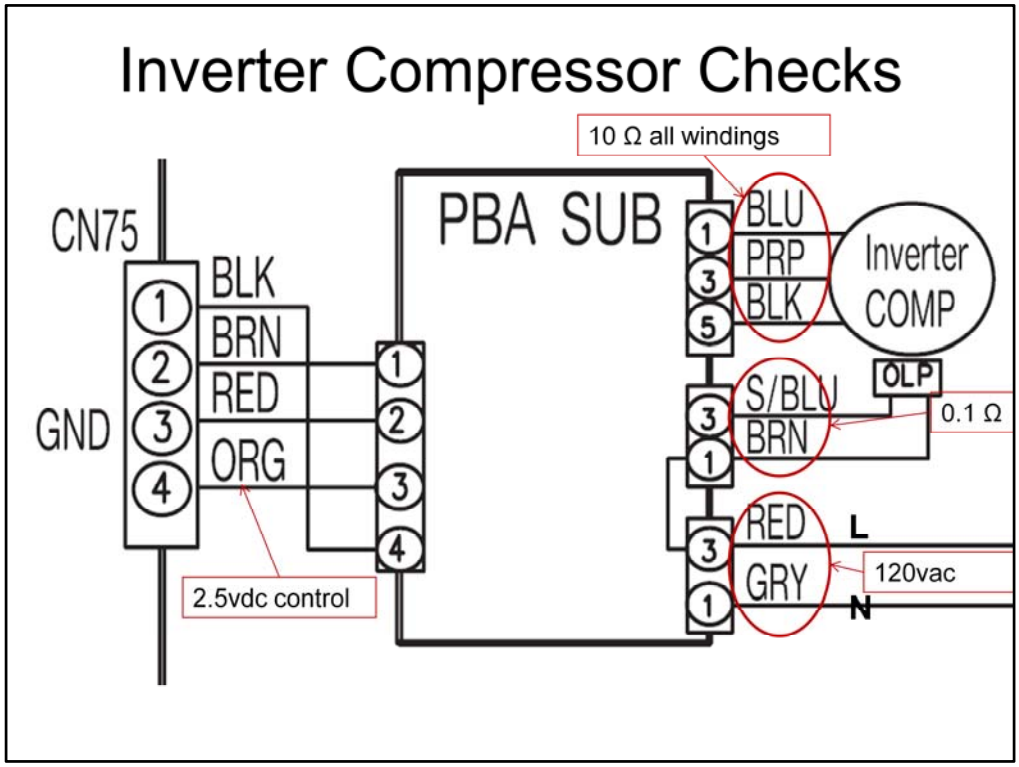
Inverter Driver Error Code Truth Table

Samsung Refrigerators

All Inverter type models use the same codes

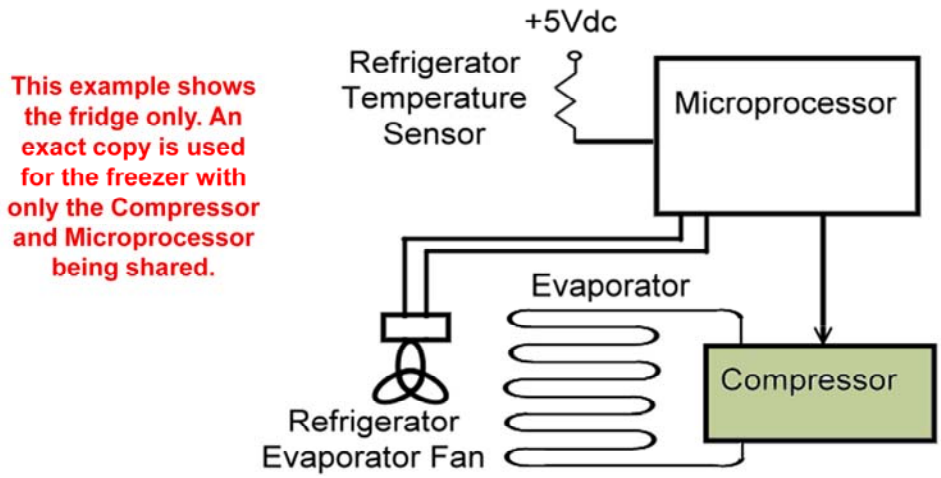
Protection Function	LED Blink Frequency	Test Procedure	Suspected Defective Part
Starting Failure	1x	Check the connections from the between the inverter PCB and the Compressor	Wiring harness or Relay
SPM Fault	2x	Check for a Sealed System restriction	Various
Position Detector Failure	3x	Check the connections from the motor to the Inverter drive PCB	Wiring harness
Motor Locked	4x	Verify the compressor can spin freely	Compressor
Low Voltage	5x	Verify the Input Voltage is correct	Main PCB or Inverter Drive PCB
Over Voltage	6x	Verify the Input Voltage is correct	Main PCB or Inverter Drive PCB

Once you have established that the power supply and compressor are operating properly the next step is to monitor the LED on the drive PCB. The blink rate of the LED might provide some insight into the defective component. Use the truth table here to narrow down the peripheral device that is creating the problem. Note: The Failure rate for inverter compressors and drive PCBs are very low. If the error blink rate is 4X through 6x double check the wiring harness and the connectors.



To summarize, testing this design begins by measuring the 120 V supply. Continue by measuring the 2.5V dc control voltages from the main PCB, verify the overload protector is not open. Finally measure the winding of the compressor looking for less than 10 ohms.

Temperature Control Function



Samsung refrigerators monitor the temperature using a negative temperature coefficient sensor. The compartment temperature is fed back as a voltage level to the microprocessor. Once the temperature in the compartment exceeds a preset value the fans are activated to bring cold air off the evaporator. If more cooling is required the compressor is activated to pull heat from the compartment and replace it with cold refrigerant. If the temperature sensor is defective or unplugged the compartment temperature will go up.

Temperature/Resistance/Voltage Chart - ALL Fridge Sensors

Temp. (°F)	Resistance (kΩ)	Voltage (V)	Temp. (°F)	Resistance (kΩ)	Voltage (V)	Temp.(°F)	Resistance (kΩ)	Voltage (V)
-20.2	50.2	4.17	17.6	18.7	3.26	55.4	7.90	2.20
-18.4	47.8	4.13	19.4	17.9	3.21	57.2	7.60	2.15
16.6	45.5	4.10	21.2	17.2	3.16	59.0	7.30	2.10
-14.8	43.3	4.06	23.0	16.4	3.11	60.8	7.00	2.06
-13.0	41.2	4.02	24.8	15.7	3.06	62.6	6.70	2.01
-11.2	39.2	3.99	26.6	15.1	3.01	64.4	6.50	1.97
-9.40	37.4	3.95	28.4	14.5	2.96	66.2	6.20	1.92
-7.60	35.7	3.91	30.2	13.9	2.90	68.0	6.01	1.88
-5.80	34.0	3.86	32.0	13.3	2.85	69.8	5.79	1.83
-4.00	32.4	3.82	33.8	12.7	2.80			
-2.20	30.9	3.78	35.6	12.2	2.75			
-0.40	29.5	3.73	37.4	11.7	2.70			
1.40	28.1	3.69	39.2	11.3	2.65			
3.20	26.9	3.64	41.0	10.8	2.60			
5.00	25.7	3.60	42.8	10.4	2.55			
6.80	24.5	3.55	44.6	10.0	2.50			
8.60	23.4	3.50	46.4	9.60	2.45			
10.4	22.4	3.46	48.2	9.20	2.40			
12.2	21.4	3.41	50.0	8.80	2.35			
14.0	20.5	3.36	51.8	8.50	2.30			
15.8	19.6	3.31	53.6	8.20	2.25			

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The table shown here applies to any temperature sensor used in a Samsung refrigerator. This includes defrost sensors, ambient sensor or compartment sensors. The best way to test the sensor is in circuit measuring the voltage at the Main PCB. Compare the voltage read to the table to verify the feedback to the microprocessor is correct. If the measured temperature is 45 degrees and the voltage at the sensor is 3.3 Volt DC the sensor is out of tolerance and needs to be replaced.

Compartment Temperature Sensor Testing

- Compartment sensors can be verified quickly by monitoring the front display. The display will show actual compartment temperature for a short time after power on. Compare the actual temperature at the top rear of the compartment to the display if they match the sensor is functioning correctly.

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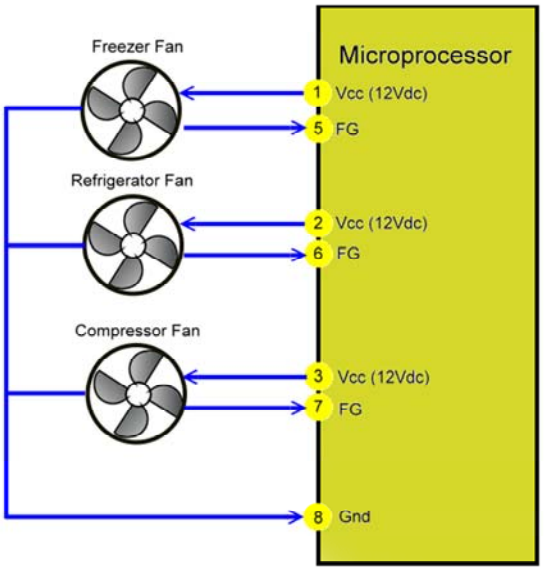
FAN MOTORS

- The fans operate at two speeds to save energy, High when the ambient temperature is high and Low when the temperature is low.
- Fan speed information is read by the Main PCB. If the fan speed exceeds 600 RPM or the speed is too slow, or stopped, the fan drive circuit is disabled. After 10 seconds the circuit tries again with 3 seconds of DC voltage If the fan continues this for 5 on/off cycles, 10 seconds off 3 seconds on, then fan drive circuit is disabled for 10 minutes.



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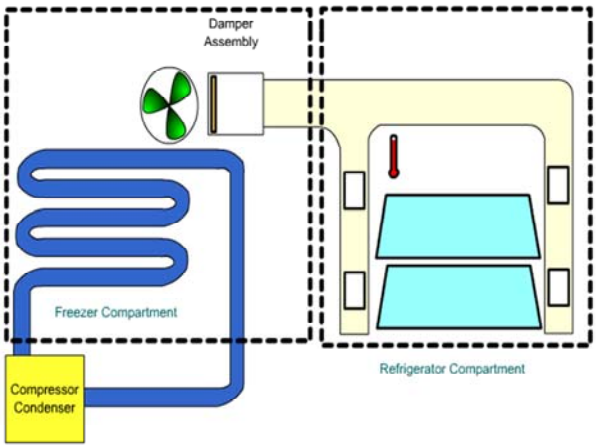
Besides the compressor circulating refrigerant the other method of controlling temperature is the operation of the fans. Most refrigerators use between 8 and 10 volts from the Main PCB.

Damper Operation

- The example here shows a single evaporator fridge, the same concept can be applied to a coolselect pantry as well.

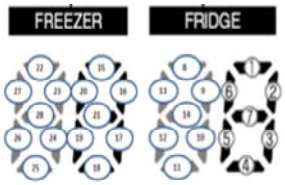


Single Evaporator models and Models that use a coolselect Pantry use a damper assembly to pull cold air off the freezer evaporator to maintain the fridge temperature. The damper assembly is triggered by a sensor opening with the temperature rises and closing when the temperature is low.

If the damper sticks open the compartment will freeze. If the damper sticks closed the compartment will not cool.

Self Diagnostics

Press both buttons simultaneously for ~8 seconds



The exact buttons to access the diagnostic mode vary depending on the model, generally it is the top two buttons on either side of the display.
The details are located in the service manual or Fast track troubleshooting manual.

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The Diagnostic Mode is the most valuable troubleshooting tool you have for troubleshooting a refrigerator. When you are at the product this is the first test you should do. If an open or shorted sensor, heater or fan is detected it will lock the display and flash the code in the display. This allows the technician to quickly identify the possible source of a problem.

Refrigeration Troubleshooting

- A sample fault code would be 

this is an example of an Ice Maker Sensor failure.

Error message	Defective component	Explanation
	DEFROSTING SENSOR OF REFRIGERATOR COMPARTMENT	Refrigerator Defrost Sensor measures open or shorted.
	FREEZER DEFROST SENSOR	Freezer Defrost Sensor measures open or shorted

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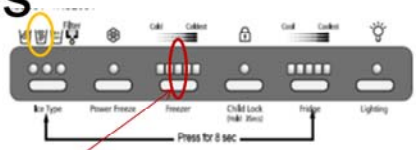
Be sure to identify the exact segment that is blinking. Blinking segments on the freezer temperature display indicate different items compared to the refrigerator temperature displays. If there are no faults, the display will be blank or have all four 8's showing.

Bar Graph Display Diagnostic Codes



Item	Display LED	Explanation
Fridge Sensor	Fridge "Mid"	Fridge Sensor Open or Shorted
Ambient Sensor	Fridge "Min"	Ambient Temp. Sensor open or shorted
Freezer Sensor	Freezer "Max"	Freezer Sensor Open or Shorted
Freezer Defrost Sensor	Freezer "Mid"	Freezer Defrost Sensor Open or Shorted
Freezer Defrost Error	Freezer "Min"	Freezer Defrost Heater open or shorted
I/M Function Error	"No Ice" light	Ice Maker did not return to level after a harvest
I/M sensor Error	"Cubed Ice" light	I/M Sensor Open or Shorted

Models that do not have a numeric display offer the same diagnostic tool however the key stroke sequence and the display method varies. The temperature bars will blink instead of one of the numeric segments. The exact information is in the service or the fast track troubleshooting manuals.

Forced Mode Troubleshooting

Forced Operation Mode

Test Mode

Press both buttons simultaneously for ~8 seconds! Then press the Freezer Temp to cycle through the modes.

Display Code	Function	
FF	Forced Compressor Run	
RD	Forced Refrigerator Defrost	
FD	Forced Freezer Defrost	
--	Test Mode active	
FF1	Slow Speed	Inverter Compressor Models Only
FF2	Medium Speed	
FF3	Fast Speed	

Unplug the unit to exit Forced Operation Mode

Cancellation

Forced Operation → *Forced Defrost for Fridge* → *Forced Defrost for both compartment*

Press any button One time at the Test Mode

Press any button One time at the Forced Operation

Press any button one more time at the Forced Defrost for Fridge

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The Forced Operation Mode is a valuable troubleshooting tool for testing compressor operation, defrost & fan operation.

Forced Freeze (FF) Mode allows the compressor to be started without the 5 minute delay. Using a current monitor you can check the compressor current draw or check voltage at the main PCB in this mode.

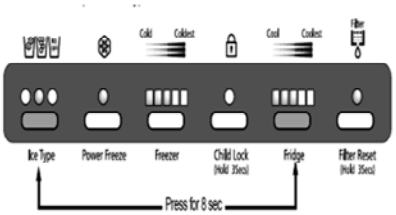
You can accurately check the operation of the defrost circuit by accessing FD or RD modes, listen for the relay click to verify Turn on. Use a current monitor to verify heater operation.

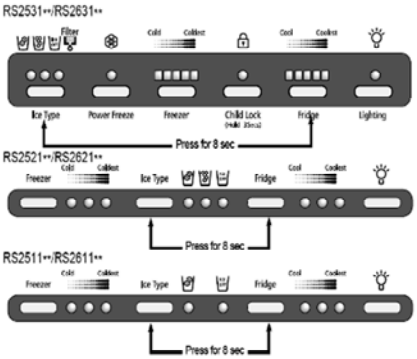
Inverter compressor Models add extra modes allowing you to access all three speeds (FF1 – FF3). As with the defrost circuit a current monitor works well to verify speed selection.

Forced Mode for Single Evaporator units

Use Freezer Key as a Test Key

Wait 5 seconds between button pushes





RS26/2530**

Models that do not have a numeric display offer the same diagnostic tool however the key stroke sequence and the display method varies. The exact information is in the service or the fast track troubleshooting manuals.

Defrost Circuit Troubleshooting

Samsung refrigerators use an adaptive defrost circuit. Simply stated the defrost circuit is not controlled by a timer instead analyzing a variety of parameters to control the number of defrost cycles along the length of each cycle. This design saves energy.

Testing Defrost Circuits

Access the main PCB for voltage/resistance testing

- With the compressor running test the sensors
- Enter Forced Mode Defrost
- Measure the heater voltage
- Remove the power and heater connector and check the heater circuit resistance

- Defrost Sensor
  - The sensor shuts off the heater At 50°F in Freezer, 63°F in Fridge
  - If the sensor is bad it may shut off the defrost circuit in a few minutes or not start, causing ice build-up, or it could lock up in defrost mode and become a total no cool.

Note: A defective sensor may check OK at room temperature, test at operating temperature only.

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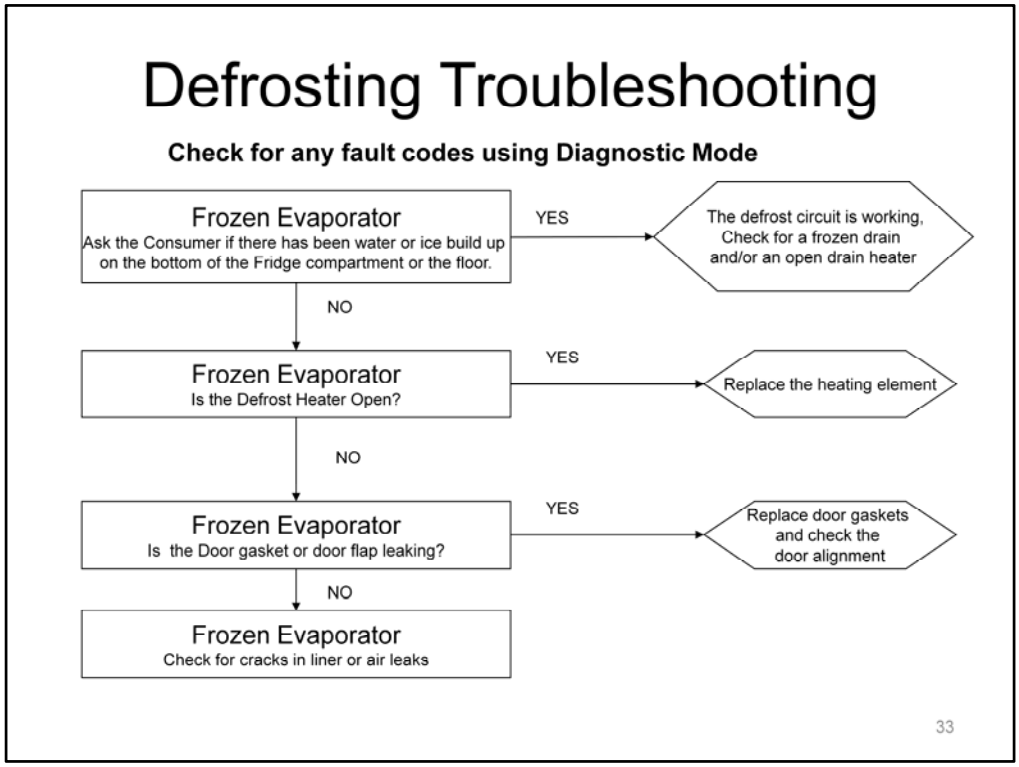
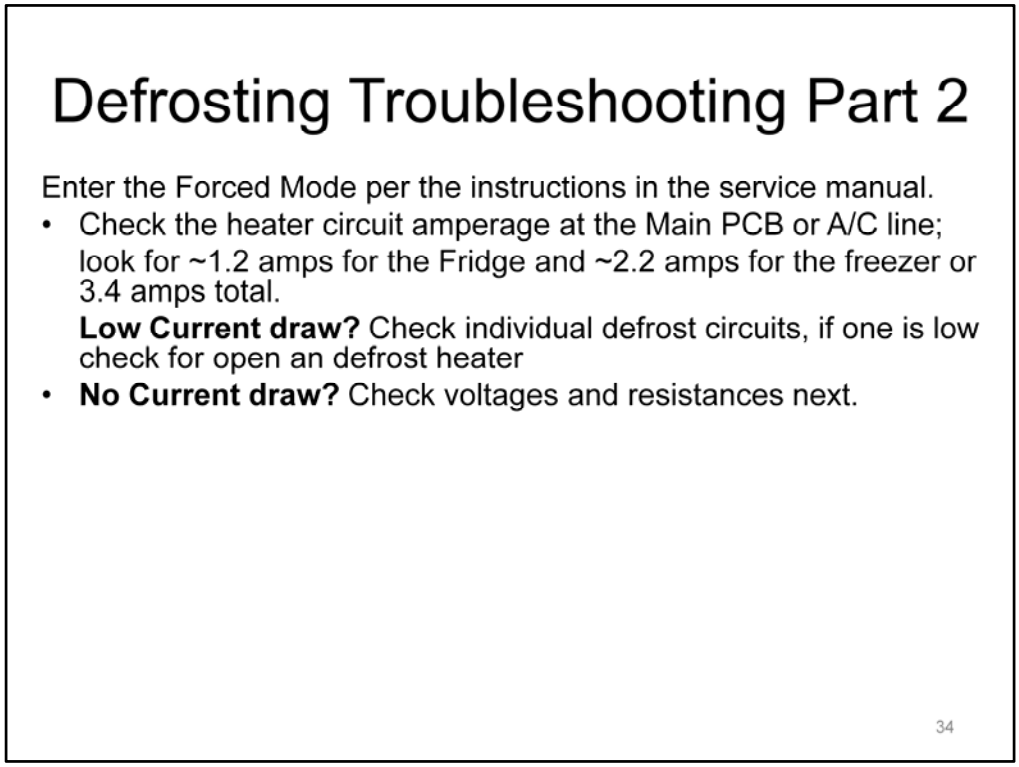
The most accurate way to verify operation of the defrost circuit is to use the forced operation mode. Depending on the model you can test the defrost circuit in one or both compartments. Additional methods include measuring the resistance of the defrost heater, measuring current draw and finally measuring the defrost heater voltage.



The drain heater is used in some models to prevent the melted frost from freezing in the drain.

The defrost heater generally raises the temperature at the evaporator to approximately 50 degrees.

Models with a built in dispenser can build up frost from a flap that is partially open.

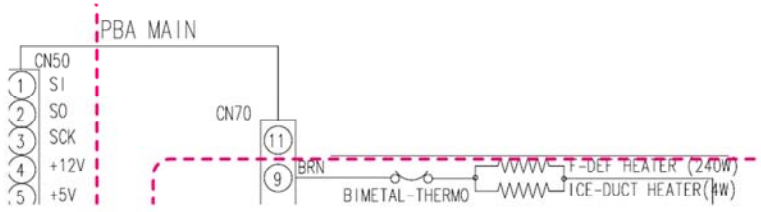


The defrost heater can be tested externally using an amp probe or similar device . Accessing forced defrost mode can turn on 1 or both heaters. A corresponding increase in current indicates the heater is working.

Defrosting Troubleshooting Part 3

Heater circuit resistance - Unplug the refrigerator. Remove the defrost heater connector from PCB.

- **Freezer** - Check heater circuit resistance at the Main PCB, look for 35–50 Ω average.
- **Fridge** - Check heater circuit resistance at the Main PCB, look for 60-95 Ω average.
- **Freezer & Fridge** - If resistance is around 2600 Ω, Thermo-Fuse (Bi-metal) is good, Defrost heater is open.
- **Open Circuit** - Check the Thermal Fuse (Bi-metal), Heater and Connectors



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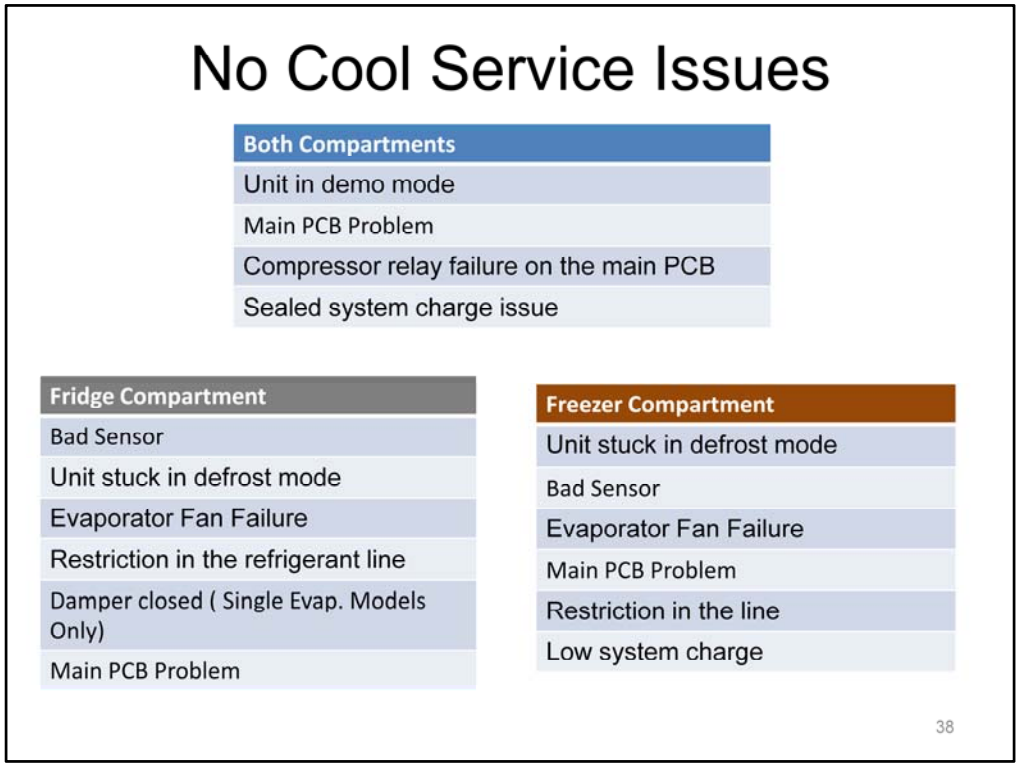
If an amp probe is not available a resistance check should confirm if the heater is working properly. Remember however that a thermal fuse or bi-metal is in series to prevent catastrophic failure.

Defrost Cycle Timing

Model Series	First Defrost Cycle, Both Fridge & Freezer	Defrost Cycle Fridge only	Defrost Cycle Fridge & Freezer
RSG	6 hrs, Pause Time 10 minutes	6~12 hrs (varies according to conditions)	12~24 hrs (varies according to conditions)
RS	4 hrs, Pause Time 10 minutes	6~12 hrs (varies according to conditions)	12~24 hrs (varies according to conditions)
RF	6 hrs, Pause Time 12 minutes	6~17 hrs (varies according to conditions)	12~34 hrs (varies according to conditions)
RFG	6 hrs, Pause Time 12 minute	6~11 hrs (varies according to conditions)	12~23 hrs (varies according to conditions)
RB 2009	6 hrs, Pause Time 12 minutes	6~11 hrs (varies according to conditions)	12~23 hrs (varies according to conditions)
RB Pre 2009	4 hrs, Pause Time 10 minutes	6~11 hrs (varies according to conditions)	12~22 hrs (varies according to conditions)
RS2530	4 hrs, Pause Time 7 minutes	N/A	6~11 hrs (varies according to conditions) * Single Evaporator in Freezer
RS2630	4 hrs, Pause Time 7 minutes	N/A	6~11 hrs (varies according to conditions) * Single Evaporator in Freezer

The chart shown here displays the average defrost cycle timing for a variety of models, understand that the exact timing will dependent of how the unit is used.

Common Refrigerator / Freezer Problem Troubleshooting



If both compartments are not cooling the compressor is not being turned on or the compressor control circuits have failed.

If the fridge compartment is not cooling generally the sealed system is probably okay. However if the freezer only is not cooling this can be a sealed system issue but not commonly.

Low Cool Service Issues

Both Compartments
Low refrigerant charge
Condenser Fan problem
Evaporator Iced Over (single Evap. Models)

Fridge Compartment
Sensor out of tolerance
Unit stuck in defrost mode
Evaporator Fan restriction
Evaporator Iced Over
Restriction in the refrigerant line
Damper closed (Single Evap. Models Only)

Freezer Compartment
Sensor out of tolerance
Evaporator Iced Over
Unit stuck in defrost mode
Evaporator Fan restriction
Restriction in the line
Damper stuck open (Single Evap. Models Only)

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Low cooling in both compartments is often caused by a problem with the compressor or the compressor control circuit. Low cooling in either the freezer or fridge can often be related to control circuitry. Be sure the defrost circuit is operating normally as this can also create problems.

Too Cold Service Issues

Both Compartments
Main PCB Problem

Fridge Compartment Only
Sensor out of tolerance
Evaporator Fan restriction
Ice Maker On with no water supply connected
Damper stuck open (Single Evap. Models Only)
Main PCB Problem

Freezer Compartment Only
Sensor out of tolerance
Unit stuck in defrost mode
Evaporator Fan restriction
Restriction in the line
Damper stuck open (Single Evap. Models Only)

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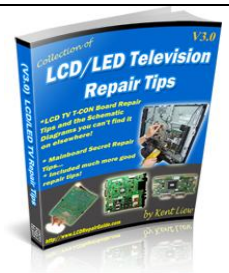
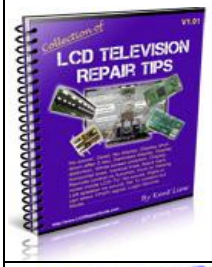
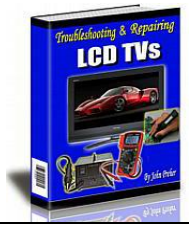
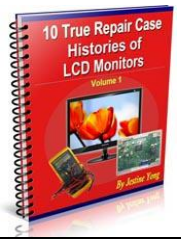
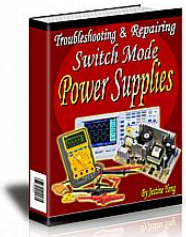
Units that consistently too cold should be checked for defective sensors or poor connections.

Recommended Troubleshooting & Repairing Guide:

 V3.0 –LED & LCD TV Repair Tips ebook "More information on T-con Board & Mainboard Secret Repair Tips!"	 V2.0- LCD TV Repair Tips & Case Histories
 V1.0- Collection of LCD TV Repair Tips	 Vol-3 LCD/LED Monitor Repair Case Histories by Jestine Yong
 LCD/LED & 3D TV Repair Membership Site	 Plasma & 3D TV Repair Membership Site
 Projection TV & DLP/LCD Projector Repair Membership Site	 Troubleshooting & Repairing LCD TV Guide
 Plasma TV Repair Guide-Display Fault Troubleshooting Basic	 LCD TV Repair Secrets Revealed
 LCD Monitor Repair Guide	 Vol .1- 10 Trus Repair Case Histories of LCD Monitor
 SMPS-Switch Mode Power Supply Repair Guide	 Testing Electronic Components like a Pro-For Beginner

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