Fridge Defend® by ARP

Refrigerated Space

Q3

Condenser

Cooling Fin

Evaporator

Absorber Coil

Q2

Q1

Boiler Assembly

Percolator Pump

LIQUID: Water; Ammonia; Sodium Chromate

Boiler

$$Q1 = Q2 + Q3$$

v5.x ARP & ARP + Fan Control

Troubleshooting Guide

Please click here for Online ARP Video Operation Manual

User Web Search Engine:

Click here for Web Search before Contacting ARP Control

Terms -- Conditions & Contact Information

Cover Diagram

The diagram on the cover is a block diagram showing the flow of the refrigerant fluids. **Q1** is the liquid water and ammonia which enters the boiler. Within the boiler ammonia is changed from liquid to gas **Q3**, and in turn forces the remaining water **Q2** up the pump tube. At the top of the pump tube the two paths for the fluids **Q2** and **Q3** diverge. The ammonia gas **Q3** cools the refrigerated space and then returns to the absorber coil where the water **Q2** enters. Within the absorber coil the two fluids are recombined to reconstitute the refrigerant **Q1** to repeat the cycle.

CONTENTS

SAFETY

1.1 Acronyms and Abbreviations

ARP: ARP Control = Fridge Defend
RTD: ARP Control temperature sensor; Resistance Temperature Detector is the type of sensor used.
Q: Flow of fluid either as a gas or liquid.
SPAR: Single Pressure Absorption Refrigerator.

1.2 Hazard Information

Hazard information includes terms, symbols and instructions used in this manual or on the equipment to alert operating and service personnel to the recommended precautions in the care, use and handling of the ARP Control.

1.3 Terms & Warnings Symbols

⚠ DANGER	Imminent hazards which, if not avoided, will result in serious injury or death.
⚠ WARNING	Potential hazards which, if not avoided, could result in serious injury or death.
⚠ CAUTION	Potential hazards which, if not avoided, could result in minor or moderate injury.

1.4 Work Safely

There are many ways to install the ARP Control. **Make safety your first priority!** The installer's knowledge, skill, and ability are important for safely installing the system and maintaining or troubleshooting it. If you are unsure of your ability to use the ARP as a diagnostic tool, have a qualified individual do the work.

1.5 Operation Safety

The ARP Control and 'ARPrvSafe' infer that the use and operation of this control can add a level of safety to your absorption refrigeration system in your RV. No other RV absorption refrigerator control monitors the boiler temperature, and turns off the heat source to the refrigerator before damage can be done to the internal fluids in the refrigerator cooling unit. The ARP cannot prevent RV refrigerator failure if the manufacture built the cooling unit in a manner that would result in premature failure. In addition, if damage to the cooling unit has occurred before the ARP was installed; the ARP cannot remedy this damage

_____

SETUP MODE

2.1 Activate SetUp Mode
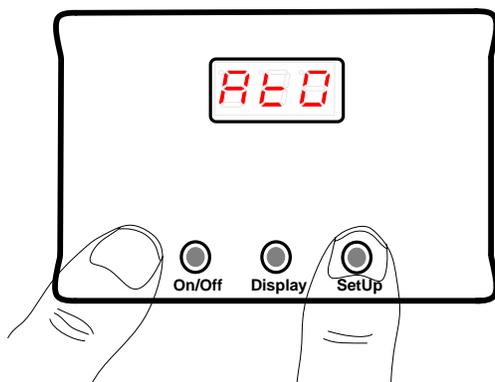
To place the control into SetUp mode, begin by **turning off the ARP Control** (Please see User Guide → Turn off ARP Control). When the control is off, the SetUp mode is activated by holding* the right **SetUp** button and then momentarily* pressing the **On/Off** button. When **AtO** is displayed, release the **SetUp** button.

* Please see **User Guide** section **BUTTON FUNCTION** & **Ancillary Graphical User Instructions** section **Turn ON Control in SetUp Mode**   .

2.2 Types of SetUp Mode Variables

There are 3 types of SetUp mode variables as follows:

1) **Reading Variable:** Example, AtO is a reading type variable because the user can only read the value. Its value is dependent upon another setting.

2) **Process Value*:** Example, the ARP stores values such as AbS. AbS is calculated by the ARP and stored for diagnostics. The user cannot change the value of AbS, the value can only be reset to zero in order to clear the present value so that the ARP can record new values in the future.

3) **Setting*:** Example, C-H is a setting that the operator can change/toggle to modify the setting. C-H setting changes the ARP set-point function. The present choice for the set-point will be displayed in the Reading Variable AtO.

* Please note that all Process Values and Setting changes need to be stored before exiting the SetUp mode. See 2.22 Store Settings.

2.3 SetUp Mode Button Operation

The three buttons on the ARP Control that performs the following functions when in the SetUp mode:

On/Off Button: Turn off the control by pressing and holding till **OFF** is displayed, and then cleared.

Display Button: The display button is used to advance to the next SetUp variable. By repeated pushing of the display button the variables will advance to the store function (**S--**), then **Er0**, and then rotate back to the first variable **AtO**.

SetUp Button: The SetUp button will change the value of either a Process Value or a Setting variable. Each push of the SetUp button will increment the value by 1 up to the maximum value, and then rotate back to either zero or 1 to restart the sequence.

2.4 AtO Reading
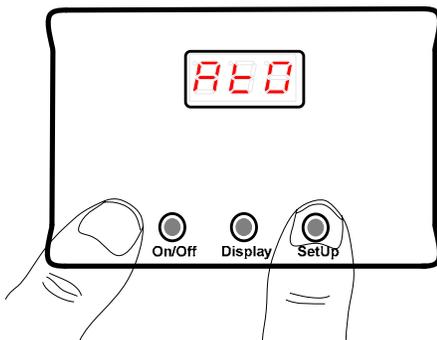
AtO will display followed by the present value or Set-Point function* selection, see 2.16 Set-Point Function Setting. The following table shows the default values for AtO:

Set-Point Function	*AtO* Value
C-H	C-H
C-L	196
PID	196

Example of default value being displayed:

*Use the charts for both **AtO** and **AtS** to determine the present Set-Point function and values.

2.5 AtS Reading
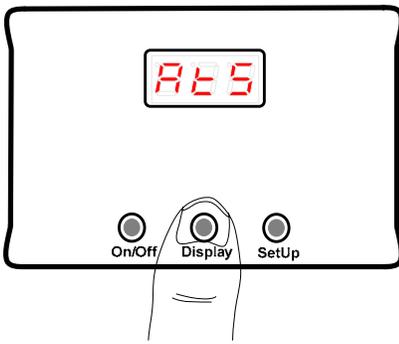
AtS complements the AtO reading by providing further Set-Point function selection information as follows:

Set-Point Function	*AtS* Value
C-H	217
C-L	C-L
PID	231*

* If the Set-Point function has been set to PID, AtS will display a value. The default value is 231, more on this subject in the Auto Tune and OS sections.

2.6 AbS Process Value
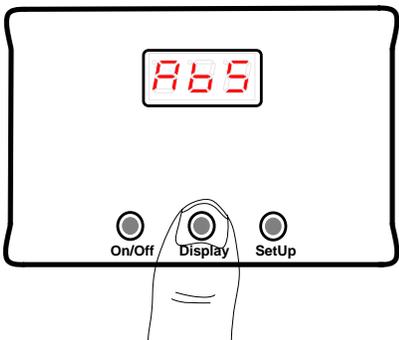
AbS is the maximum temperature the boiler has reached. The example below, 200C (See 2.15 Temperature Units) would be the maximum temperature recorded by the ARP since the last time that AbS was cleared.

Please see section 7.3 for detailed information.
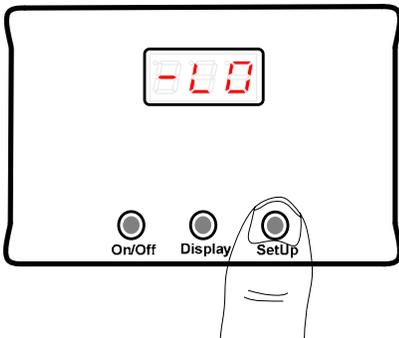
By pressing the **SetUp** button, the *AbS* value will be cleared. When the AbS value has been cleared, *-LO* will flash on the display until the control is put into the ARP mode to record a new maximum value.

Any changes must be stored, see 2.22 Store Setting.

Please note that if *AbS* is greater than 250°C (482°F) there may be a wiring or cooling unit issue, please contact ARP technical support.

2.7 tr Process Value
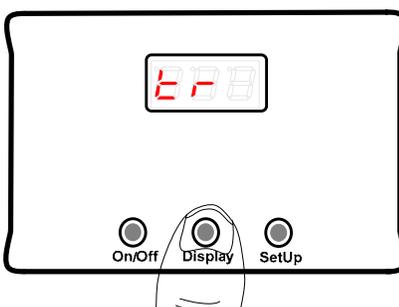
Tr is the number of times that the ARP Control has triggered since the value was last cleared. The following example shows that the ARP turned off the fridge twice:

Please see section 7.4 for further info.

Push the SetUp button to zero the tr value. Also see 7.4.

Any changes must be stored, see 2.22 Store Setting.

2.8 OPn Process Value
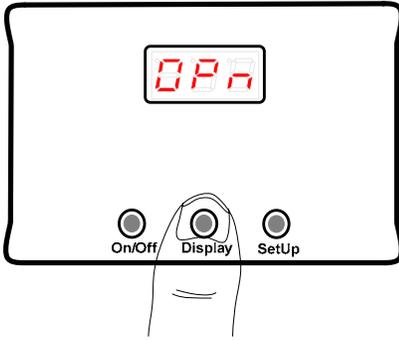
The **OPn** value is a count of how many times the ARP boiler sensor has had a wiring or sensor open condition.

Please see section 3.4 OPn for further information.

If there is an intermittent problem due to vibration or a bad crimp connection, OPn will record the total number of times the circuit opens and closes. Push the SetUp button to zero the OPn value. Any changes must be stored, see 2.22 Store Setting.

2.9 SHt Process Value
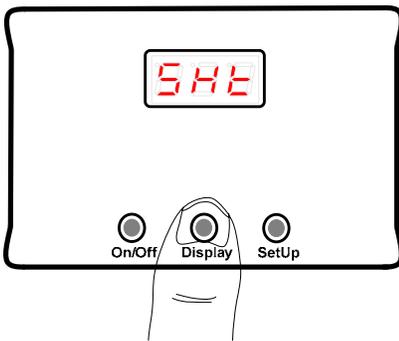
The **SHt** value is a count of how many times the ARP boiler sensor has had a short circuit. When the ARP Control is in the ARP mode of operation, and either the wiring or sensor is measured as a short circuit, **SHt** will flash on the screen. SHt will record the total number of times the boiler sensor has an intermittent short circuit and then returns to normal operation. A short in the sensor circuit is usually do to either the two sensor wires touching or a sensor wire shorted to chassis ground.

See 3.5 SHt and RTD TROUBLESHOOTING for further information.

2.10 SSH Process Value
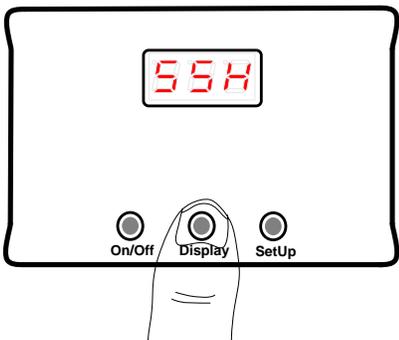
The **SSH** value measures the boiler steady-state maximum temperature. This value is only valid if the control has been set to the PID control mode, see **Set-Point Function Setting** section below.

If the control is tripping in the PID control mode, this variable is very valuable for troubleshooting when combined with the above **AbS** value. If the AbS value is greater than the **AtS** value, the start up is tripping the fridge. If the **SSH** value is greater than **AtO** value, the control is tripping when in steady-state operation.

2.11 FAn Setting
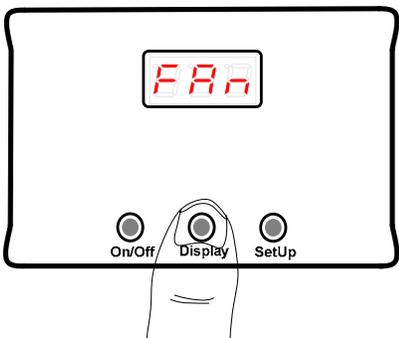
FAn is the temperature setting at which the ARP will turn On/Off the fan. There are six fan temperature settings to select from.

For a non-fan type ARP Control, the fan setting is a fixed number 0 and cannot be changed.

By momentarily pressing the **SetUp** button the fan control temperature can be set to a desired value. Any changes must be stored, see 2.22 Store Setting.

4 is the default fan setting value.
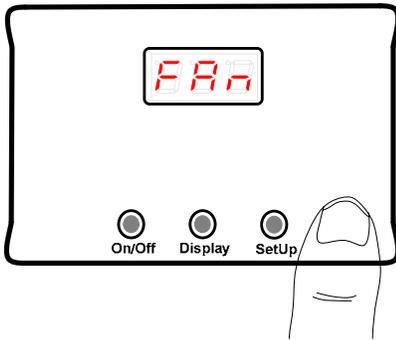
Fan Setting	ON Temperature °F	OFF Temperature °F
000	Fan Off	
001	110	95
002	115	100
003	120	105
004	125	110
005	130	115
006	135	120

2.12 SP Setting
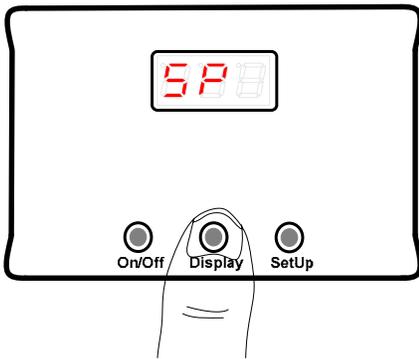
SP raises the set-point value of the ARP Control. The default setting for **SP** is **5**.

See section 8.2 for further information.

2.13 OS Setting
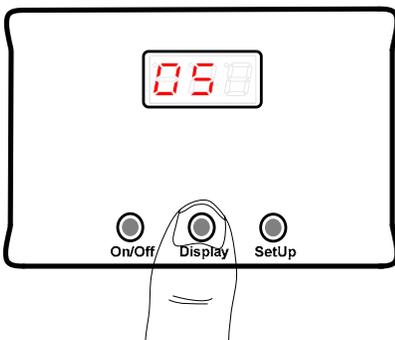
The OS setting is used for the restart of the refrigerator. This value is rarely, if ever changed.

The default setting of OS is 5.

See section 8.3 for further information.

2.14 Adjustment of SP or OS Settings
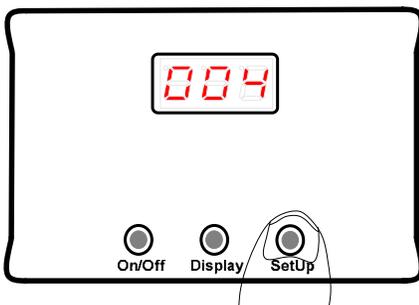
By pressing the **SetUp** button the control enters into the adjustment mode. Both *SP* and *OS* are adjusted in the same manner as described below.
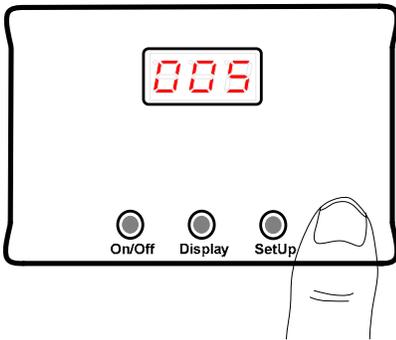
When in adjustment mode, each subsequent press of the **SetUp** button will increment the value by 1.

Store any setting change, 2.22 Store Setting

2.15 Temperature Units
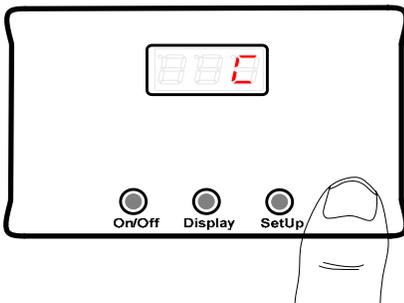
The boiler temperature units can be changed from degrees Celsius (**C**) to degrees Fahrenheit (**F**). **C** is the default value.

Press the **SetUp** button to change the setting. Following is an example of the display for each setting:

Please see 9.1 for further info.

Store any setting change, 2.22 Store Setting.

2.16 Set-Point Function Setting
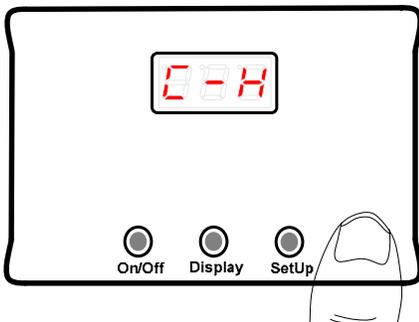
The ARP has three Set-Point control functions as follows:

1) *C-H* is the Set-Point control high mode. This is the default mode and would be considered the plug-n-play mode. This setting works on most refrigerators.

2) *C-L* is the Set-Point control low mode. This mode is for fine tuning your control so that the maximum protection for your fridge is achieved on smaller refrigerators.

Please see 2.4 AtO Reading and section 9.2
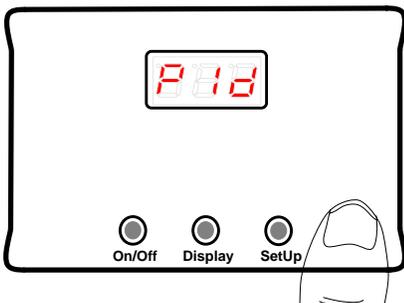
3) The *PID* Set-Point control function is used on particular refrigerators. A partial list of cooling units that may need this control setting are some Dutch Aire (Amish) cooling units, Norcold 1210 & 2118 cooling units made after the year 2013, and some older Dometic cooling units.

Please use the Contact Us form on www.ARPrv.com website for any questions or concerns.

2.17 Defrost Setting/IEC Periodic Test

the Norcold 1200, 2110, N3150, …. the **PEr** setting can override the defrost cycle thereby providing improved cooling in warm weather.

$$PEr \leftrightarrow on$$

on is the default setting. **Per** = **on** means the IEC periodic test of the ARP occurs every 24 hours. In addition, the factory defrost cycle is defeated resulting is a cooler fridge in hot weather. See our defrost fans for fridge.
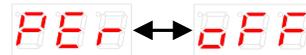
$$PEr \leftrightarrow oFF$$

Use the right button to toggle to the **oFF** setting. When **PEr** = **oFF**, the IEC periodic test of the ARP is not preformed. Nor does the ARP defeat the defrost cycle, thus the fridge runs with its factory defrost cycle.

For refrigerators that have a defrost cycle that is timed to turn off the fridge for 2 hours, such as

2.18 Software Version Reading
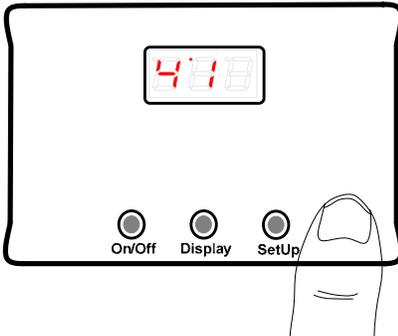
The next setting is the software version of the control. This software version example is **4.1** which is the ARP + Fan Control version**.**
For the non fan-control version this value would be **4.0.** If you are using this manual your software version should be either **5.0** or **5.1**.

2.19 Serial Number Reading
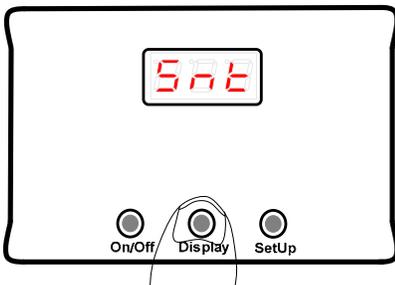
The next two settings display the ARP control serial number. Following is an example of what the display will flash out for the serial number **65,535**:

$$Snt \leftrightarrow 065$$

$$SnH \leftrightarrow 535$$

2.20 Audible Alarm (5.1 only)
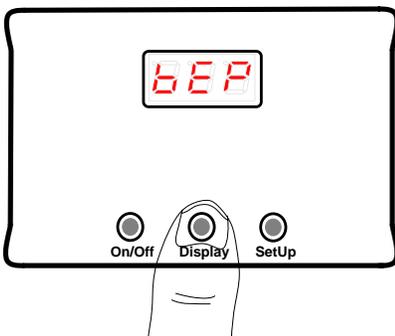
This setting controls the Audible Alarm or beeper.

$$bEP \leftrightarrow on$$
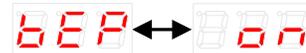
on is the default setting. For some IEC tests the alarm will sound while the display shows the error that resulted in the alarm.

$$bEP \leftrightarrow oFF$$

Use the SetUp button to toggle the alarm to **oFF** to prevent the alarm from sounding. Save setting with S--.

2.21 Restore ARP Defaults
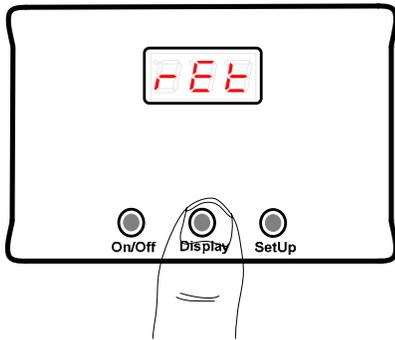
This setting restores the default settings that came with the ARP when new. If Auto Tune is run by mistake, the original settings can be restored by pressing the SetUp button.
The display will flash:
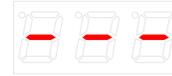
and then return to the original screen. Proceed to the next step to save your new settings.

2.22 Store Settings
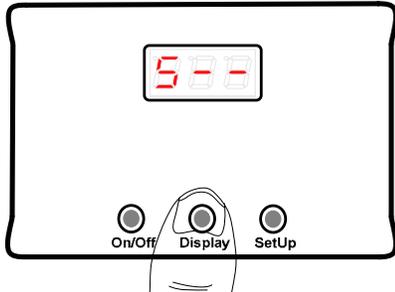
The variable to save changes to SetUp is *S--*; any settings that have been changed can be stored by momentarily pressing the **SetUp** button as seen in the next figure.
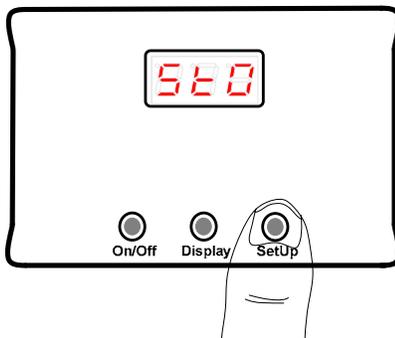
Release the **SetUp** button as soon as *StO* is displayed. *StO* has to be displayed for the control to save the new settings. If you do not want to save settings, proceed to **Exit SetUp Mode** section.

2.23 Display Error Messages
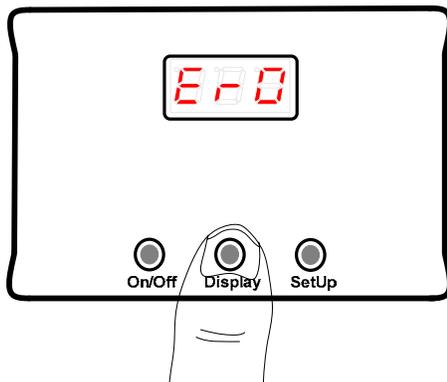
The *Er0* variable holds any IEC error messages stored for the life of the control. Thus, always write down the date any errors are viewed for future reference. It is not unusual to see some errors recorded due to the nature of RV electrical systems.
The **SetUp** button will toggle through all errors recorded.
Er0↔ will be display if no errors are recorded.
If there are errors recoded, the first error message will immediately appear, followed by the number of times this particular error has been recorded. Use the **SetUp** button to toggle through all of the error messages. Once the error messages roll back to the first error recorded, use the **Display** button to exit the *Er0* and return to *AtO*.

2.24 Exit SetUp Mode

If you do not want to save any changes, just turnoff the control by holding the **On/Off** button without storing changes. This feature is so that one can exit SetUp without making any changes if it is thought a mistake was made.

Otherwise, after using the above **Store Settings**, hold down the **On/Off** button until *OFF* advances across the screen as seen in the figure to the left.

Remember to turn on the ARP Control in the ARP mode after using the SetUp mode.

ARP ERROR MESSAGES

IEC Type Accessory; Redundancy; Systematic Faults & Self-Checks

The ARP Control is a hybrid single channel IEC type accessory safety controller with a periodic self-test structure. Software is designed using a single microcontroller unit (MCU) compliant to ISO TS 16949:2009 to execute functions as required with optional periodic self-tests which will occur every 24 hours when activated. The self-test checks most of the critical functions of the electronic control. The reason that the ARP Control is referenced as a hybrid is that it is similar to a dual MCU controller in that the ARP has an external watchdog timer (exWDT) that will turn off the refrigerator and sound an alarm (v5.1) if the MCU becomes stuck and stops processing code. The exWDT will try and restart the MCU, but if it is unsuccessful, depending on the version of control, the operator is alerted to take appropriate action based on the operator's discretion. Because the ARP is an accessory safety controller, the ability to control the refrigerator process is similar to a thermal fuse on the power supply to the fridge which limits the controls ability for testing and self-checks.

Fridge OFF; Buzzer Sounding (v5.1); Right Dot Illuminated
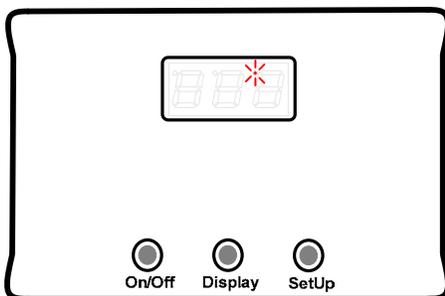
If the Fridge Defend MCU has a critical error, and the external watchdog timer (exWDT) asserts control, the control will turn off power to the yellow wire which controls the fridge. The right dot will be illuminated without flashing. This is the only occurrence of the right dot being illuminated without flashing. Check to see that the control has 12VDC at the red wire. If so, disconnect red wire; wait 30 seconds, reconnect. If the error does not go away please contact support.

3.1 Error Message List

The following charts are divided up into the types of error messages:

- *Operational Errors*: These are errors that will display as the control is running or the user is performing a test with one of the buttons.
- *Startup or Periodic Test Errors* (SPT): These are errors that will be tested at startup, and thereafter every 24 hours when PEr = on, see section 2.17.

The **Nature of Error** column gives a brief description of the error. Go to the *Section* column to find where to read more about the particular error. The **Audible Alarm** (V5.1 only) column gives a definition of the alarm when it is turned on, see **2.20** for alarm setting.

Operational Error	Section	Nature of Error	Audible Alarm (v5.1 only)
XYZ	*3.2*	Numbers on Display (not an error)	
*Err	**3.3**	Control Variable Erasure	
Opn	**3.4**	Boiler Sensor Error	Short beep every second

SHt	**3.5**	Boiler Sensor Error	Short beep every second
-LO	**3.6**	Boiler Sensor Out Of Range	
*O*F*8	**3.7**	ARP Has Attempted to Restart Fridge 5 Times and Failed	Fast and short beep
*H*O*8	**3.8**	Excess Temperature Shutdown (Boiler has reached 250 C)	Fast and short beep
OR (OA)	**3.9**	Fan Sensor Out Of Range (not an error)	
bAd	**3.10**	Auto Tune Failure	
F4 or F5	**3.11**	Contact ARP Control (only tested by operator with SetUp button)	
E 8	**3.12**	Contact ARP Control	
E10	**3.13**	ARP Relay Error	Short beep every second
E11	**3.14**	Contact ARP Control	Continuous alarm

SPT Error (IEC type test)	*Section*	*Nature of Error*	*Audible Alarm* (v5.1 only)
F1	**3.15**	MCU ADC Error Checker	
F2	**3.16**	ARP Relay Error	Short beep every second
F3	**3.17**	Boiler Sensor ADC Cal	Short beep every second
F6	**3.18**	MCU Set-Point Memory CRC	Short beep every second
F7	**3.18**	MCU Set-Point Tune Memory CRC	Short beep every second
E12	**3.19**	MCU Port Registry	
E13	**3.18**	MCU Code Memory CRC	
E14	**3.19**	MCU Program Counter	
E15	**3.19**	MCU CPU Register	

3.2 *123* Numbers on Display (not an error)

If the fridge is off, and the operator views numbers on the display, this is not an error message. The ARP has detected an overheat situation and is in a countdown period until the ARP restarts the fridge. The countdown period is the time until the ARP attempts a safe restart of the refrigerator. For example, if **056** is displayed on the screen, it is 56 minutes until the control will restart the fridge, just keep the door of the fridge closed. Do not turn off the ARP Control, please allow the ARP to restart the fridge. By turning off the ARP one prevents the ARP from doing its job. If the ARP is turned off and then back on the fridge will overheat again. See **ARP User Guide** section **ARP Protection Period** (What are the numbers on the display?) for more information on the overheat event.

3.3 **Err* (first dot on upper left)

In ARP Mode a single dot followed by **Err** indicates that the ARP memory is cleared. This can happen if the device has been Auto

Tuned incorrectly, or on rare occasions surges/brown-outs less than minimum voltage level of 10.5VDC or greater than 22VDC. Proceed to Restore ARP Defaults section to reload default values.

3.4 *OPn* Boiler Sensor

This message will be flashed on the LED display to warn the operator that there is an error with the RTD and/or the RTD wiring. The ARP is disabled because it cannot function without the RTD. Thus, the cooling unit is **not** protected by the ARP at this point; the refrigerator operates just as it did when it came from the manufacture. See 2.8 OPn Process Value to clear the error after fixing any issues or to use the recorded value for diagnostics.

⚠ **DANGER** Operator must take action to resolve the cause of the RTD error.

Possible causes of RTD error:

a) RTD has failed OPEN. Test RTD resistance with Ohm meter that has less than 0.3mA current for the Ohm test function. Use

the RTD Table at the end of this document for reference.

b) RTD wires from control to the sensor are broken or have a bad connection. A resistance test from the control to the wire connections at the RTD should show open or high resistance in this case. If RTD wire has become frayed or has an intermittent connection, moving the wire while observing the resistance of the wire under test should show a change of resistivity. Replace any wires that indicate high resistance.

3.5 *SHt* Boiler Sensor

If the RTD sensor is shorted, **SHt** will be flashed out. See 2.9 SHt for further info. User should disconnect the sensor and check its resistance value by using the table at the end of this document. If the resistance substantially differs from the table, the sensor has failed. Please contact ARP Control for a new RTD. Also see RTD TROUBLESHOOTING and perform these tests.

3.6 *-LO* Boiler Sensor Reading

The ARP boiler temperature sensor is measuring a value lower than 0°C (32°F).

3.7 **O*F*8*

Depending on the conditions, it will take about 4-5 hours, and many restart attempts, before the ARP turns off the system and warns the operator by displaying ***O*F*8** on the display. At this point the operator must restart their system by turning off the ARP after the boiler has cooled. As a rule of thumb, using **caution** to avoid being burnt, one should be able to touch the boiler housing without burning your hand when the boiler has cooled to a safe temperature.

⚠️ **DANGER** Care must be exercised during a restart in this situation. It may be that the refrigeration unit needs maintenance that is beyond the abilities of the operator. Or, the cooling unit has failed, and by turning off the Fridge Defend, the boiler will experience unsafe runaway temperatures. If the ARP keeps trigging due to high boiler temperatures at each successive attempt to restart the refrigerator, the ammonia in the system may need to be remixed, or the cooling unit may have completely failed. Because one cannot easily remove the refrigerator and tip it over to mix the fluids such as described in the burping section 4.5, the motion of driving may resolve this situation. The motion of driving helps mix the fluids and will help cool the boiler thereby mix the ammonia back into the system fluids. **It is emphasized that you are in charge of safety**, please take your problems to a qualified service facility if you do not feel qualified to **resolve any issues that may affect safety**.

3.8 **H*O*8*

If **HO8** is displayed with all of the dots illuminated, the ARP has turned off the refrigerator at a very high temperature. It is important to check the fridge for failure before attempting to resume operation. The cooling unit must be allowed to cool to ambient temperature if this event occurs. Please seek a qualified RV technician if you are not qualified to make safe decisions. See 3.20 ARP Reset Procedure for additional information.

3.9 *OR* (OA) Fan Temp Reading

When measuring the fan temperature in the ARP mode with the center button, if **OR** (OA) is displayed the fan sensor is outside of its normal measurement range, which is from 35 F to 155 F.

3.10 *bAd*

If the ARP Control is in the Auto Tune mode, and the boiler sensor exceeds 250 C (482 F), the **bAd** error will flash. A possible cause for this message is the ARP boiler sensor is too close or touching one of the heat sources, either the electric heaters or the flue tube. Check the sensor and reposition before running Auto Tune again.

3.11 *F4* or *F5* SetUp Button Test

When the control is in the ARP Control mode, the SetUp button performs tests of the controller. If during the automatic controller test **F4** or **F5** is displayed, contact ARP

Control by using our Contact Us form at
www.ARPrv.com

3.12 *E8* Error

It would be rare if ever that E8 would appear.
If E8 does appear the first step is to turn off
the control and turn back on to see if the
error clears? If the error does not clear after
this procedure please contact ARP Control
by using our Contact Us form at
www.ARPrv.com.

3.13 *E10* Flashing when Test ARP with SetUp Button

If one is testing the ARP internal relay with
the SetUp button while in ARP control mode,
and **E10** flashes, there is an internal relay
failure or the control has been installed
parallel with a recall device, see solution
below in the F2 at ARP Startup section.

3.14 *E11* Trigger Event

The ARP Control detected an overheat
situation and the power was not turned off to
the fridge. See solution in F2 at ARP Startup
section, if solution cannot be found, contact
ARP and remove the ARP Control from
service.

3.15 *F1* MCU ADC Error Checker

This error can occur due to electrical noise
on the RV wiring. This error will not affect the
ability for the control to measure boiler
temperature. Thus, it is not a critical error.
The best way to test if there is an issue, go to
the User Guide section 1.4, or below section
10.1 to read the fridge voltage with the ARP,
then check this voltage reading with an
accurate DMM. The readings should be
within +/-0.2 volts.

3.16 *F2* at ARP Startup

F2 is tested at startup, and if the periodic
testes are enabled, this test checks that the
ARP internal relay can turn power off to the
yellow wire controlling the fridge.

If this error is seen after installation of the
ARP, the control has been wired incorrectly.

Solution: The control needs to be turned off
by disconnecting the ARP red wire. Next,
disconnect ARP yellow wire; be sure not to
ground this wire during testing. Reconnect

the ARP red wire so that control turns back
on. Check to see if F2 is still displayed? If F2
is not displayed, internal relay is functioning.
Solution, rewire ARP to be in series with
recall. If F2 is still displayed during startup
test while ARP yellow wire is disconnected,
contact ARP and discontinue use of control.

3.17 *F3* Boiler Sensor ADC Cal

This error can occur due to electrical noise
on the RV wiring. This error can be checked
by service personnel by putting the control
into SP0 mode and perform a senor check,
section 10.3 below.

3.18 CRC Tests

These tests check the code within the MCU
for integrity.

F6 MCU Set-Point Memory CRC:

This test can fail for a number or reasons,
including but not limited to power supply
brown out (electrical noise on the RV wiring),
user operator error during Auto Tune, or
other events that result in a memory
corruption. This error can generally be fixed
by restoration of the factory default settings,
see section 2.21, Restore ARP Defaults.

F7 MCU Set-Point Tune Memory CRC:

Use the same set of rules stated above for
the F6 error. Also, this error is specific to an
improper Auto Tune session. If this is the
case, run Auto Tune again or see section
2.21, Restore ARP Defaults.

E13 MCU Code Memory CRC:

This error can occur due to electrical noise
on the RV wiring. The first step is to turn off
the control and restart it while viewing the
ARP display for error messages. If the
control passes all of the functional tests, then
this error may have been recorded due to
noise on the system during the automatic
test procedure. If this is the case, this error
will be cleared. Also, perform all of the
manual functional tests, see User Guide
section 1.7.

3.19 *E12, E14, E15* MCU Tests

These errors can occur due to electrical
noise on the RV wiring. See **E13** MCU Code
Memory CRC above for test procedure.

3.20 ARP Reset Procedure

The ARP can be turned off, and the refrigerator will resume operation as it did from the factory. We do not recommend turning off the ARP if it has detected an over heat situation, **please let the ARP do its job** and allow it to restart the fridge. By turning the ARP off and then back on, the control will be reset and resume monitoring boiler temperature.

⚠️ **DANGER** Please remember that when the ARP is turned off, the refrigerator will resume operation if the fridge main power button is not turned off before the reset procedure. If your fridge has overheated, there is a problem that should be addressed by qualified persons.

_____

INTRODUCTION to FRIDGE REPAIR

4.1 Refrigerant

The SPAR RV refrigerator, when constructed properly is extremely reliable due to the fact that the process is quite simple. The refrigerant (working fluids) consists of water, ammonia, and sodium chromate.

4.2 Boiler Operation

The heart of your RV refrigerator is at the boiler. The boiler can also be called the *generator* because the boiler 'generates' the ammonia refrigerant. The boiler performs a distillation process, the ARP monitors this process and detects when ammonia is not being generated. Think of the ARP as a heart monitor keeping your fridge alive.

4.3 Boiler Pump

The heat source that drives your SPAR simply separates the water and ammonia (distillation). Ammonia boils at a lower temperature than water, thus the heat source boils the ammonia. Just like a coffee percolator, the ammonia gas transports the liquid water up a pump tube, at the top of the pump tube the ammonia gas raises and the water descends by the effect of gravity.

4.4 ARP Control and the Boiler

The ARP control is effective because of the simple physics. If there is no ammonia in the boiler assembly of your SPAR, the boiler pump will not work. The result, the normal temperatures required to drive the SPAR system will rise. It takes heat energy to

change the ammonia from liquid to gas, when this heat energy is not changing the ammonia from liquid to gas; the heat energy starts to destroy the SPAR. Restated, without ammonia in the boiler, the heat energy will cause the boiler temperature to rise until the water in the SPAR starts to boil, this damages your refrigerator. The ARP control prevents the water from boiling in the SPAR when installed and setup correctly.

4.5 Burping a SPAR

Folks that have been around RV and stationary refrigerators such as a Servel have heard of '*burping*' the refrigerator. Burping is necessitated by the fact that the ammonia has not completed the SPAR process and returned to the boiler. Burping consists of turning the refrigerator over onto its top. The burping procedure simply will remix the ammonia and water in your SPAR. As long as the system has not been damaged by overheating and blockage of the system, the refrigerator will resume operation once the ammonia is returned to the boiler. In most cases, burping is not necessary when the ARP controls the boiler temperature.

4.6 Abnormalities and Operator Discretion

The ARP will turn off the heat source driving your SPAR process before burping is necessary. But it must be taken into account that the ARP has sensed a rise in temperature due to an abnormality in your

SPAR. The ARP cannot determine the cause of the abnormality. This is the responsibility of the operator. Other than off-level operation of the SPAR, and boiler over heating due to wind currents that result in stagnation within the cooling unit compartment, it is beyond the scope of this document to cover all of the causes for the SPAR boiler to overheat.

In the following sections of the Troubleshooting Guide are *suggestions* to help you resolve situations that may arise. Again, it is the operator's responsibility to

insure that safe operation of the SPAR is in effect. Although the ARP can give an operator feedback, the operator must have discretion to make decisions responsibly and act on one's own. If there is doubt, please take your RV to a qualified RV service center. Following are *ideas* to consider that could get you up and running, these suggestions are circumstantial and are solely provided as assistance to help you make good decisions while on the road.

_____

HEAT SOURCES

5.1 Temperature & Pressure

The boiler temperature is an over all indicator of your refrigerator health. It is advised to check and adjust your LP gas pressure, check your gas flame and adjust if necessary. Only then record your '*normal*' boiler temperatures using both LP gas and the electric heat source for future troubleshooting reference. Please note, for the following discussion, the LP gas temperature measured by the ARP is generally about 10°C (18°F) higher than the temperature measured by the 120VAC. A rule of thumb is that the LP gas temperature will range from 170°C (338°F) to 190°C (374°F) depending on the make and model of your SPAR. The boiler temperature can vary with the RTD location on the boiler tube also.

There are few causes of low boiler temperature, low LP gas pressure, failed electric heaters, and low cooling unit pressure. Low cooling unit pressure is covered in section 6.1.

5.2 Low LP Gas Pressure

Low LP gas pressure results in a cold gas flame. The simple test for this problem is to check the LP gas pressure with a manometer and make sure there is 11 inches water column pressure. See our LP Gas Safety Video for filter cleaning.

5.3 Test Each Heat Source

An alternative to testing the gas pressure, use the shore power (120VAC) heater to run your refrigerator. If your ARP control measures *"normal"* temperatures in the range given above, but the LP gas does not, one can deduce that there is an issue with the LP gas portion of your refrigerator.

To test the electric heater, use the gas flame. If the boiler temperature is at its normal value using gas, but lower than normal using 120VAC, there may be a problem with your 120VAC operation

SPAR PRESSURE

6.1 Low Cooling Unit Pressure

The temperature at which a liquid changes phase from liquid to gas (boils) is dependent on two physical qualities: temperature and pressure. The temperature measured at your boiler is dependent upon your cooling unit pressure. If the pressure inside your cooling

unit goes down, the temperature at which your boiler will boil the refrigerant goes down also. Previous to the ARP, the pressure inside the cooling unit could only be measured by a cooling unit rebuilder. Now, the ARP can be used as an indicator by which to measure the cooling unit pressure. The first telltale sign of cooling unit failure is

low temperatures measured at the boiler of your cooling unit. If your heat sources are confirmed to work fine, and you are measuring low boiler temperatures, there may be low cooling unit pressures indicating failure of the cooling unit.

⚠️ **WARNING** Please take your refrigerator to be checked by a qualified service technician to rule out any cause that will result in abnormally low or high temperature readings by the ARP.

_____

DIAGNOSTIC VARIABLE

7.1 AtO Value

The AtO value is preset to default values if the control has not been Auto Tuned. Otherwise, AtO is calculated during an Auto Tune session, the base AtO value is not adjustable other than by running Auto Tune again. The value of AtO can be changed by the C-H, C-L, and PID set-point function in combination with the SP value.

7.2 AtS

AtS is only used for the PID set-point function. AtS will not need to be changed ordinarily. If fridge is in the PID mode, and the ARP turns off the fridge consistently at the startup, the AtS value can be raised manually changing the OS setting. Also, the AtS value is recalculated during an Auto Tune session if the default setting is not working. See 'SSH' value, AtS and SSH work together for PID function.

7.3 AbS

The AbS value is the maximum temperature measured at the boiler since the last time that the value was zeroed. This variable is very handy for testing and setting the refrigeration control values. Auto Tune always zeros this value.

Adjustment

The AbS value may be zeroed by pressing **SetUp** button. Please store any new settings as described in section 2.22.

Purpose:

This variable is handy for recording the cooling unit boiler temperature while the cooling unit is in a known phase of its process. For example, one wants to know the absolute maximum temperature of a cooling unit after the ARP has shut down the

system due to an off-level overheat situation. This will aid the operator in setting the value of OS for a particular refrigerator installation. Use the AbS variable in combination with the No Set-Point mode when the ARP is not equipped with data collection capability for the recording of restart temperatures.

7.4 tr

The tr value is simply the number of times that the ARP has triggered since the last time the value was zeroed. When Auto Tune is run, tr value is zeroed.

Purpose:

Knowing the number of times the control has triggered helps the owner understand situations where overheating of the cooling unit boiler occurs. For example, climbing steep grades in hot weather often will result in an ARP trigger event. Another example, RV rental firms can use this information for damage deposit and other bookkeeping purposes.

See section 2.7 for clearing this variable.

7.5 SHt & Fuses: General Electrical Short Troubleshooting

Most RV techs are skilled at electrical short diagnostics. This section is a brief set of instructions on troubleshooting procedures if repeated SHt errors are encountered.

If a short is occurring, the most likely cause is a wire touching a ground somewhere. One can disconnect the wire, thereby isolating the ARP control from the short, and see if the issue is still occurring? If the issue goes away by disconnecting the wire, visually inspect the wire for where the short circuit may be? The most common cause of a short is when wires rub on sharp metal and the

wire insulation is cut thereby resulting in what is referred to as a dead short to ground. Often it is faster to replace a wire all together than test it.

Over amperage can come from a failing component like bearings in a fan or a resistive type short to ground. The best way to test components is to measure the actual amperage draw of a component. The trouble with the amperage measurement is that intermittent issues with components can occur. Restated, intermittently the component will draw high amperage resulting in a trip, often this is caused by an event such as turning on a fan, the fridge controller switching from one mode of operation to another such as activation of a defrost cycle or switching from an AC heater to LP Gas operation.

It is an art to diagnose electrical issues. The artisan needs an intimate knowledge of the system under consideration, the ability to read wiring diagrams, along with the knowledge, skills, and abilities to use electrical test equipment.

7.6 SSH

Where the 'AtS' value controls the startup set-point when in PID control function, SSH records the maximum steady-state value for the fridge. By using the AbS to see if the control has tripped at fridge start, that is AbS ≥ AtS, this will inform one if the OS value needs to be increased. On the other hand, if AbS < AtS, then the control is tripping at steady-state and the SSH value will give an indication of how to change the SP value to raise the AtO value to avoid control trips during steady-state.

_____

CONTROL VARIABLES

8.1 Introduction to Control Variables

The ARP sets the following control variables to default values during an Auto Tune session. If the default values need to be adjusted, this section explains the variables and their function. Please note that most fridges work fine with the default settings.

8.2 SP

The SP variable simply raises or lowers the set-point value depending on the setting. Tuning the ARP for the maximum protection for your refrigerator installation mostly consists of finding the optimum value for SP. If the value is too low, the control will shut off your refrigerator unnecessarily. If the value of SP is too high, the refrigerator will not restart easily.

For a majority of refrigerators, the default SP value for the C-L or PID Set-Point functions is the best. Only if the fridge is being turned off by the ARP Control when the user feels that the fridge should remain running shall Auto Tune be used. Please see 2.12 for adjustment method for SP. SP is used only

for the C-L or PID mode of operation, C-H is not affected by this setting; see 2.16 for adjustment of C-L/PID Set-Point functions.

Basics for the SP Variable:

- Auto Tune sets SP to a default value of 5.

- SP may be changed to any value between 0 and 30, where each increment is ~1°C (~1.8°F).

- It is recommended to set SP to a minimum setting of SP= 1.

Factors that Affect the SP Variable:

- Auto Tune Elevation: Some refrigerators, not all, have a colder gas flame at high altitude. Thus, if the ARP is Auto Tuned at an elevation greater than 1000' above sea-level, the SP variable should be raised by about 2°C per 1000' of elevation decrease. This adjustment will allow the operator to drive from an altitude that the ARP was Auto Tuned at to sea-level without a false trigger of the control due to the rise of the gas flame temperature.

- Ambient Temperature: The air temperature has a slight effect on the

refrigerator boiler temperature. If Auto Tune is preformed at temperatures lower than 16°C (~60°F), it is possible that SP will have to be set higher than the default value of 5 to compensate for a raise in ambient temperature.

8.3 OS

The OS value is the temperature overshoot value. The default setting of 5 is adequate for most Norcold and Dometic refrigerators; a

higher value is needed for <u>some</u> older Dometic refrigerators and Dutch Aire cooling units.

<u>Purpose</u>:

Because the ARP turns off the refrigerator heat source when the ammonia is not returning to the boiler, when the heat source is turned back on, a higher temperature is needed to re-start the refrigeration process.

_____

ADJUSTMENT VARIABLES

9.1 C or F

This function simply toggles between Celsius and Fahrenheit. Default is Celsius. This setting only changes the LED display by toggling the units of temperature measurement. The ARP does not change its operation, just the manner in which it calculates temperature on the display.

Please see 2.15 for adjustment.

9.2 C-H, C-L, or PID Set-Point Methods

This function toggles between set-point control methods. Also see 2.16 for setting.

C-H is control-high method. This is the default setting and one should only need to use the other control methods if one wants to fine tune the ARP for C-L, or your particular fridge requires the PID Set-Point function.

C-L is the control-low method. C-L allows the operator of the ARP Control to fine tune their control for higher sensitivity.

PID is the proportional-integrated-derivative method. A PID control is necessary on Amish (Dutch Aire) and newer Norcold

side-by-side fridges and older Dometic side-by-side. The PID control method precisely adjusts the Set-Point for the startup peak and steady-state on these fridges. **Purpose:** The ARP is designed to work on any absorption refrigeration system. Therefore, the operator has the ability to choose between the default (C-H) and the Operator Adjustable Control Method (C-L). C-L will take on the default Auto Tune values and increase the sensitivity of the ARP. Whereas, the PID setting is required on some newer style cooling units.

Please see 2.16 for adjustment method.

9.3 Fan Temperature Diagnostic

This function controls the temperature at which the fan will be turned on/off.

See section 2.11 and the **User Guide** for more fan control details. The preferred location for the fan thermistor is on the absorber coils. Combining the fan temperature with the boiler temperature reading will help diagnose problems with the cooling unit. We will post more on our website www.ARPrv.com on troubleshooting methods using these two instrumentation inputs.

_____

NO SET-POINT MODE (SP0)
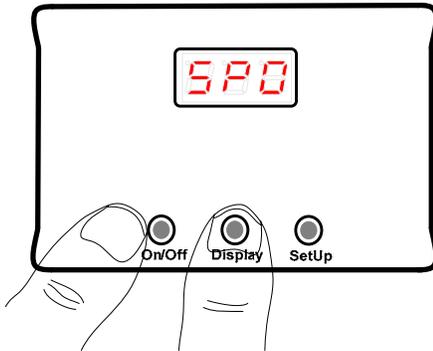
The No Set-Point mode is used for testing of the refrigerator.

⚠️ **Caution** must be used because the fridge has no overheat protection other than the factory thermal management methods.

To place the control in the No Set-Point mode, first turn off the control (See User Guide), then hold down the **Display** button and then momentarily press the **On/Off** button. **SP0** will display briefly, and then flash the dot in upper left and center every 2 seconds thereafter. Always turn this mode off when tests are completed, restart in the ARP mode so that your fridge has protection from overheating.

10.1 Test Fridge Voltage

The Display button has the same functions as in the ARP Control mode; please see the User Guide for more on this subject. Use of the **SP0** mode is handy for diagnostics without the fridge turning off.

When in the ARP or **SP0** mode, there is a 3rd function for the Display button; the 3rd function reads the fridge voltage. This is handy for diagnosing a fridge that will not turn on. If either a Dometic or Norcold has less than 10.5 volts, the fridge will not turn on.

In addition, reading the voltage on the ARP yellow wire has the advantage of deterring if there is AC current on the line. When there is excessive AC current on the RV 12VDC line, appliances like the fridge will not function properly. If AC is present, the voltage value will jump around. For example, the sequence of readings may look like this:

16.5, 12.1, 9.8, 14.0, 12.0…

If AC is detected on the line, unplug the RV from AC, if this corrects the problem your inverter many have an issue.

10.3 Sensor Troubleshooting Test

The 4th value viewed by the Display button is for checking the wiring installation. Use this reading in combination with the RTD Troubleshooting below. The value should read 280, if the value is not 280; contact ARP Control for further information to solve sensor issues.

10.4 MAX/MIN Fridge Voltage Record

The 5th value viewed by the Display button is the maximum and minimum voltages seen while in this display mode. The display will keep alternating & updating the highest voltage and the lowest voltage seen by the control when in this mode of operation.

This gives the user the ability to run a test for an extended period of time without being present.

AUTO TUNE MODE
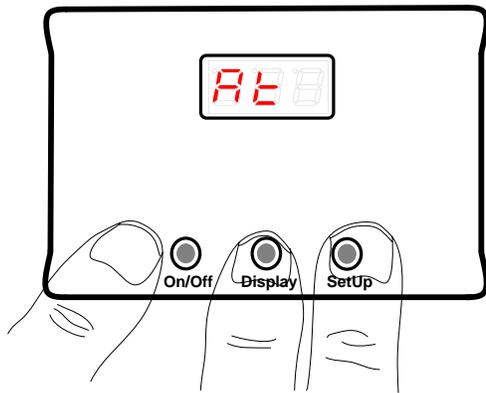
Auto Tune is only necessary if the default ARP Control settings <u>do not work</u>. **98%** of fridges will work with the default settings.

If the default C-H Set-Point function is not working on your fridge, please change & test the Set-Point Function Setting to PID before contacting ARP Control.

To start Auto Tune, hold down both the right **SetUp** and the center **Display** buttons. Then momentarily press the **On/Off** button. Wait until **At** is displayed to release the **Display** and **SetUp** buttons. **At** will be shown for 3 seconds, and then flashes shortly every other second thereafter when the control is in the Auto Tune mode.

11.1 Auto Tune Procedure

The ARP control ships preset for a majority of refrigerators. But, each fridge can have different control parameters even between two refrigerators that are the same make and model. For this reason, Auto Tune should be run only if the pre-programmed control functions (C-H, C-L, or PID) are not working.

It must be noted that Auto Tune procedures requires the cooling unit to be working properly and the ARP Control to be installed correctly. Auto Tune will automatically determine your fridge unique control parameters. We recommend using Auto Tune in the following manner:

> **1)** Level fridge and make sure any auxiliary cooling fans are functioning properly. The fans are extremely important for any fridge in a slide-out installation. Also, we are told that some slide-outs do not always have the same level as the coach, check the fridge level according to your fridge user manual.

> **2)** Run Auto Tune for a period of 24 hours in the following manner:

>> 12 hours with the fridge in the LP gas mode.

>> 12 hours with the fridge in the 120VAC mode. We prefer to run the 120VAC (shore power) overnight as most fridges fail in the early morning hours on shore power.

> **3)** Only use the On/Off button to turn off Auto Tune, otherwise an *F7* error occurs.

The above recommendation is a rule of thumb, do what is convenient. Please use both heat sources during a 24 hour period so that the Auto Tune procedure is accurate.

⚠️ **WARNING** Auto Tune must run continuously, if there is an interruption in the power supply to the ARP Control during the Auto Tune process it is imperative that Auto Tune be run again.

11.2 Auto Tune & Set-Point Function

Each time Auto Tune is run, the control will retain one of two settings as follows:
> C-H Set-Point Function Setting: If the ARP Control is in either the C-H or the C-L Set-Point function settings upon entering the Auto Tune mode, after the Auto Tune session the control will default to the C-H Set-Point setting.
> PID Set-Point Function Setting: If the ARP Control is in the PID Set-Point function setting upon entering the Auto Tune mode, after the Auto Tune session the control will default to the PID Set-Point setting

RV STORAGE & STARTUP TIPS

Storing your RV properly is very important. Taking your RV out of storage is equally important. This section focus on your RV living space electrical system, which should be disconnected (isolated) from your RV engine electrical system during storage. We only address the RV fridge in this section, consult the manufactures information for all recommended procedures for your RV. Each RV is made different and has unique features for storage. This is just a short list of items that pertain to your fridge.

12.1 Storage – RV Batteries; LP Gas; Fridge

For both of the aforesaid battery systems, the batteries should have a trickle charger that maintains a small amount of charge on the batteries. If the batteries are not charged during storage the batteries life is shortened. We would like to note that often weak batteries will fail while the RV is in storage, thus it is a good idea to be able to measure your battery voltage so that if things are not working it is fast and easy to see if voltage is an issue. Always start your storage procedure by turning off the LP Gas at the tank valve in addition to all appliances such as hot water heater, stove, and refrigerator. If your RV has a transfer-switch to isolate the RV living space batteries from the engine batteries, turn off the transfer-switch. Some RVs have an automatic isolator to separate the two batteries systems, if your RV does not have a method of isolation just take the positive battery terminal off of the battery to isolate the battery. Finally, it is critical that you defrost the fridge and leave the doors open on the fridge. A day before we store our fridge we turn the fridge off and allow all ice to thaw out. Use a towel at the bottom of the fridge compartments to soak up any water. Make sure that all water is out of fridge before storage, water is your refrigerator's enemy. Water will cause corrosion that can result in cooling unit failure. This is why the fridge should always be stored with the doors open.

12.2 Get Ready to Go – Dry Run

The ARP Control can measure your RV living space battery voltage, but we only recommend doing this after getting the RV engine and drive train are ready for safe operation. We suggest starting the RV engine before addressing the RV living space electrical system. Here is a suggestion list for a dry run before leaving on your trip:

1. If the batteries are disconnected upon storage, reconnect the batteries. Do not turn on the transfer-switch until after the engines has started if your RV has this feature.
2. Get the engine and drive train ready for travel; start the RV engine so that the engine charging system is on.
3. After the engine has run for 3-5 minutes the engine charging system should be supplying power to the RV. Flip the transfer-switch on at this time. All appliances should be off from your storage procedure, but check to make sure.
4. Once you have done a walk around to make a check, turn on your LP Gas that was turned off at the tank valve. Some RVs also have an electrical switch to turn on/off the LP, turn on the LP with this switch and then check at your stove top to make sure you can light a burner. This will confirm you have LP pressure.

12.3 RV Battery Voltage & Fridge

Because most RV refrigerators require at least 10.5 volts to work, and 10.5 volts means that your batteries are in trouble, it is important to only turn on your fridge when you know that the RV living space batteries are healthy and being charged. The RV living space battery voltage can be checked with the ARP Control. See User Guide, View Boiler Temperature section to start the process of measuring the RV living space battery voltage. If the voltage is low, or the battery does not have enough energy to start of the fridge, issues can occur. Always check the

ARP Control before leaving on a trip, the ARP Control troubleshooting features can help solve any issues before you leave.

12.4 Get Fridge Ready for Travel

We like to freeze two gallons of water in our household freezer to speed up our departure when we go camping. After the dry run of checking the engine and charging system, make sure there is enough voltage to run your fridge, start the fridge on either LP Gas or shore power. Place a gallon of frozen water in both the refrigerated and freezer spaces and shut the door. This reduces the time to about 4 hours of running the fridge before driving. Load the fridge with pre-chilled food; we like to put frozen food in our fridge to thaw out for our first or second night meal to help the fridge while driving. Your fridge does cool while driving, but just not as well as when the fridge is stationary.

RTD TROUBLESHOOTING

13.1 Check Boiler Sensor
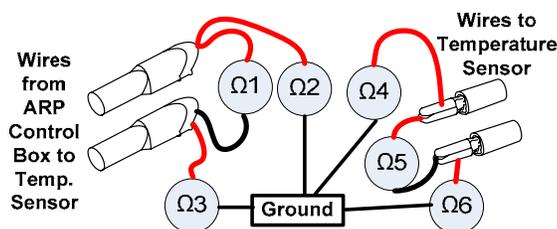
Start by turning off the ARP Control by disconnecting the ARP red wire. Each of the Ω1, Ω2, Ω3,…is a representation of using a multi-meter to measure the resistance either between the two wires or from the respective wire to the ground. Please note that the color code of the wire has no meaning because there is no polarity for the temperature sensor. Thus, Ω2 or Ω3 maybe either the white or purple wire.

Ω1 ≈ 2.2M

Ω2 ≈ 2.2M or 1k

Ω3 ≈ 2.2M or 1k

Ω4 = OPEN or OL on typical multi-meter

Ω5 ≈ Use RTD Table to determine this value.

Ω6 = OPEN or OL on typical multi-meter.

See 2.9 SHt for more RTD wiring info.

13.2 *SHt* Error

The most common causes of the *SHt* error is the sensor wire rubbing on the sheet metal boiler housing. Where the sensor wire exits the boiler housing insulation can be used to keep the wire from rubbing on the sheet metal housing.

RTD TABLES

Temp. (ºC)	Temp. (ºF)	ARP RTD (Ω)
1	33.8	1003.9
2	35.6	1007.8
3	37.4	1011.7
4	39.2	1015.6
5	41.0	1019.5
6	42.8	1023.4
7	44.6	1027.3
8	46.4	1031.2
9	48.2	1035.1
10	50.0	1039.0
11	51.8	1042.9
12	53.6	1046.8
13	55.4	1050.7
14	57.2	1054.6
15	59.0	1058.5

16	60.8	1062.4
17	62.6	1066.3
18	64.4	1070.2
19	66.2	1074.0
20	68.0	1077.9
21	69.8	1081.8
22	71.6	1085.7
23	73.4	1089.6
24	75.2	1093.5
25	77.0	1097.3
26	78.8	1101.2
27	80.6	1105.1
28	82.4	1109.0
29	84.2	1112.9
30	86.0	1116.7
31	87.8	1120.6
32	89.6	1124.5
33	91.4	1128.3

34	93.2	1132.2
35	95.0	1136.1
36	96.8	1140.0
37	98.6	1143.8
38	100.4	1147.7
39	102.2	1151.5
40	104.0	1155.4
41	105.8	1159.3
42	107.6	1163.1
43	109.4	1167.0
44	111.2	1170.8
45	113.0	1174.7
46	114.8	1178.6
47	116.6	1182.4
48	118.4	1186.3
49	120.2	1190.1
50	122.0	1194.0
51	123.8	1197.8

52	125.6	1201.7	105	221.0	1404.0	158	316.4	1603.1
53	127.4	1205.5	106	222.8	1407.8	159	318.2	1606.8
54	129.2	1209.4	107	224.6	1411.6	160	320.0	1610.5
55	131.0	1213.2	108	226.4	1415.4	161	321.8	1614.3
56	132.8	1217.1	109	228.2	1419.1	162	323.6	1618.0
57	134.6	1220.9	110	230.0	1422.9	163	325.4	1621.7
58	136.4	1224.7	111	231.8	1426.7	164	327.2	1625.4
59	138.2	1228.6	112	233.6	1430.5	165	329.0	1629.2
60	140.0	1232.4	113	235.4	1434.3	166	330.8	1632.9
61	141.8	1236.3	114	237.2	1438.0	167	332.6	1636.6
62	143.6	1240.1	115	239.0	1441.8	168	334.4	1640.3
63	145.4	1243.9	116	240.8	1445.6	169	336.2	1644.0
64	147.2	1247.8	117	242.6	1449.4	170	338.0	1647.7
65	149.0	1251.6	118	244.4	1453.1	171	339.8	1651.4
66	150.8	1255.4	119	246.2	1456.9	172	341.6	1655.1
67	152.6	1259.3	120	248.0	1460.7	173	343.4	1658.9
68	154.4	1263.1	121	249.8	1464.5	174	345.2	1662.6
69	156.2	1266.9	122	251.6	1468.2	175	347.0	1666.3
70	158.0	1270.8	123	253.4	1472.0	176	348.8	1670.0
71	159.8	1274.6	124	255.2	1475.8	177	350.6	1673.7
72	161.6	1278.4	125	257.0	1479.5	178	352.4	1677.4
73	163.4	1282.2	126	258.8	1483.3	179	354.2	1681.1
74	165.2	1286.1	127	260.6	1487.0	180	356.0	1684.8
75	167.0	1289.9	128	262.4	1490.8	181	357.8	1688.5
76	168.8	1293.7	129	264.2	1494.6	182	359.6	1692.2
77	170.6	1297.5	130	266.0	1498.3	183	361.4	1695.9
78	172.4	1301.3	131	267.8	1502.1	184	363.2	1699.6
79	174.2	1305.2	132	269.6	1505.8	185	365.0	1703.3
80	176.0	1309.0	133	271.4	1509.6	186	366.8	1707.0
81	177.8	1312.8	134	273.2	1513.3	187	368.6	1710.7
82	179.6	1316.6	135	275.0	1517.1	188	370.4	1714.4
83	181.4	1320.4	136	276.8	1520.9	189	372.2	1718.0
84	183.2	1324.2	137	278.6	1524.6	190	374.0	1721.7
85	185.0	1328.0	138	280.4	1528.4	191	375.8	1725.4
86	186.8	1331.8	139	282.2	1532.1	192	377.6	1729.1
87	188.6	1335.7	140	284.0	1535.8	193	379.4	1732.8
88	190.4	1339.5	141	285.8	1539.6	194	381.2	1736.5
89	192.2	1343.3	142	287.6	1543.3	195	383.0	1740.2
90	194.0	1347.1	143	289.4	1547.1	196	384.8	1743.8
91	195.8	1350.9	144	291.2	1550.8	197	386.6	1747.5
92	197.6	1354.7	145	293.0	1554.6	198	388.4	1751.2
93	199.4	1358.5	146	294.8	1558.3	199	390.2	1754.9
94	201.2	1362.3	147	296.6	1562.0	200	392.0	1758.6
95	203.0	1366.1	148	298.4	1565.8	201	393.8	1762.2
96	204.8	1369.9	149	300.2	1569.5	202	395.6	1765.9
97	206.6	1373.7	150	302.0	1573.3	203	397.4	1769.6
98	208.4	1377.5	151	303.8	1577.0	204	399.2	1773.3
99	210.2	1381.3	152	305.6	1580.7	205	401.0	1776.9
100	212.0	1385.1	153	307.4	1584.5	206	402.8	1780.6
101	213.8	1388.8	154	309.2	1588.2	207	404.6	1784.3
102	215.6	1392.6	155	311.0	1591.9	208	406.4	1787.9
103	217.4	1396.4	156	312.8	1595.6	209	408.2	1791.6
104	219.2	1400.2	157	314.6	1599.4	210	410.0	1795.3

211	411.8	1798.9	225	437.0	1850.1	239	462.2	1901.1
212	413.6	1802.6	226	438.8	1853.8	240	464.0	1904.7
213	415.4	1806.3	227	440.6	1857.4	241	465.8	1908.4
214	417.2	1809.9	228	442.4	1861.1	242	467.6	1912.0
215	419.0	1813.6	229	444.2	1864.7	243	469.4	1915.6
216	420.8	1817.3	230	446.0	1868.4	244	471.2	1919.2
217	422.6	1820.9	231	447.8	1872.0	245	473.0	1922.9
218	424.4	1824.6	232	449.6	1875.6	246	474.8	1926.5
219	426.2	1828.2	233	451.4	1879.3	247	476.6	1930.1
220	428.0	1831.9	234	453.2	1882.9	248	478.4	1933.7
221	429.8	1835.5	235	455.0	1886.6	249	480.2	1937.4
222	431.6	1839.2	236	456.8	1890.2	250	482.0	1941.0
223	433.4	1842.8	237	458.6	1893.8			
224	435.2	1846.5	238	460.4	1897.5			

This manual has been provided courtesy of
My RV Works, Inc.

www.myrvworks.com

You can find more RV service manuals here:

www.myrvworks.com/manuals

Over the years of running a mobile RV repair service, having a dedicated place to access service manuals for all the different appliances and components found on RVs was something that I always had a desire to create.

I hope this resource makes your RV repairs easier, as it has mine, but please be careful and follow proper safety practices when attempting to repair your own RV.

If in doubt, please consult with a professional RV technician!

DARREN KOEPP - OWNER, MY RV WORKS, INC.

All service manuals provided on www.myrvworks.com are believed to be released for distribution and/or in the public domain.