HVAC GUIDE®

SYSTEM ANALYZER

Model HG3

Field Manual

Fieldpiece

PETITIONERS' EXHIBIT 1013

HVAC Guide® System Analyzer Field Manual Model HG3

Do it right the first time!

The HVAC Guide® System Analyzer will reduce call-backs by giving you a wide variety of tests to diagnose HVACR systems and lower your customer's energy bills. It walks you step-by-step through each test procedure to make your job easier, faster and better.

The New HG3 model has wireless capabilities. Set up the Fieldpiece Accessory Heads at multiple locations on the system with the wireless transmitters (products ET2W or EH4W) and have all of the measurements and calculations in the palm of your hand!

Test procedures are included for Superheat, Subcooling, Combustion Analysis, Target Evap Exit Temperature (temperature drop across the evaporator coil), CFM (air balancing), CheckMe!® Evaluation and Service light set up are built into the HVAC Guide to streamline each test. You select a test on the dial, enter data on the INPUT FORM and view the results on the OUTPUT FORM. Tests can be saved, downloaded to a PC and printed for customer tracking or to hand back to customers.

The HVAC Guide® System Analyzer also has a data logging switch position to record up to 13 measurements at one time. With the Display switch position view one parameter by connecting any Fieldpiece Accessory Heads directly or wirelessly.

Do it right the first time, do it faster, easier, more completely, and avoid call-backs in the process.

Table of Contents

HVAC Guide® System Analyzer Control 4
Switch Positions 6
How it Works 8
Inputting Data 10
Wireless Testing 12
Tests 14
- Example Test 14
- **1.1** Target Evaporator Exit Temperature 16
- **2.1** Superheat 22
- **3.1** Subcooling 28
- **4.1** Combustion 34
- **5.1** CheckMe!® 40
- **6.1** CFM 48
- **7.1** Service Light 54
- **8.1** Data Logger and Display 56

Setup Switch Position
- Com with PC 60
- Setup 60
- Power Savings 60
- Version (about) 61
- Time/Time Setup 61

Advanced Operations
- Units 62
- Saving Tests 62
- Recalling Saved Tests 62
- Contrast Adjustment 62
- Clearing a Single Input for INPUT FORM 63

What's Included 64
Features and Specifications 64
Limited Warranty 64
Obtaining Service 65
Appendix 66
- CheckMe! Diagnostics 66
- Accessory Heads 72
- K-Type Thermocouples 73
- Refrigerants 73

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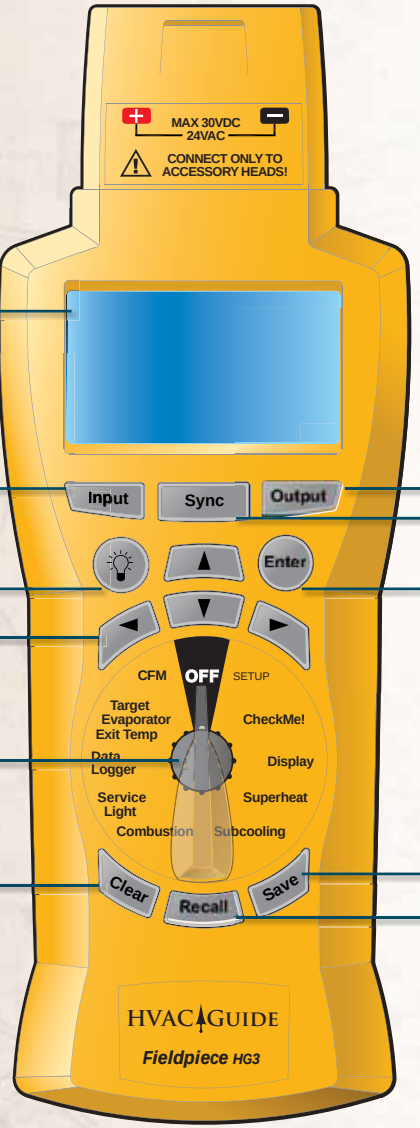
HVAC Guide Controls



Dot Matrix LCD Screen
Displays INPUT FORMS and OUTPUT FORMS.

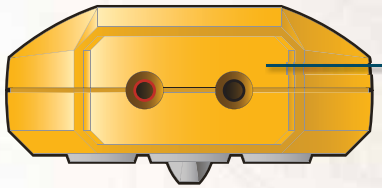
Input Button
Returns to the INPUT FORM.

Backlight Button
Turns on the backlight for 30 sec.

Arrow Buttons
Navigates within FORMS and screens.

Switch Position Dial
Rotates to select test.

Clear Button
Clears a single input or the entire INPUT FORM by holding for 3 seconds.



Input Jacks
Connect Accessory Heads here.

Output Button
Triggers calculations based on the INPUT FORM and takes you to the OUTPUT FORM.

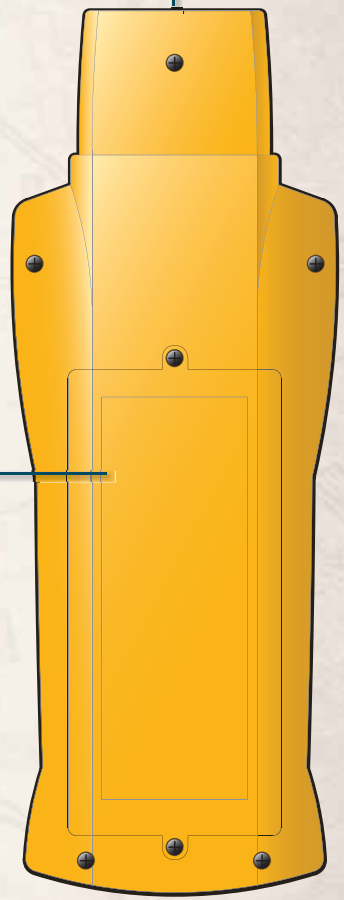
Sync Button
Connects with Fieldpiece Wireless instruments. Press to lock in a wireless value.

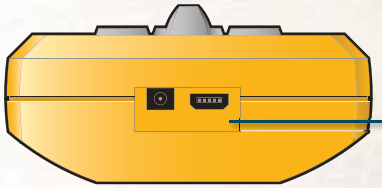
Enter Button
Makes a selection or enters data.

Battery Cover
After "POWER OFF" clears, unscrew the two screws to replace the 6AA batteries.

Save Button
Saves the current INPUT FORM. Inputs are saved with Customer ID and Time Stamp. See Saving Data section for details.

Recall Button
Recalls previous tests within each switch position. Previous tests can only be accessed through the switch position in which they were performed.





PC and Power Inputs
Use the PC cable to transfer data. Use the DC power input for extended testing sessions.

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Switch Positions

1. **Setup:** Set current time and date for internal clock. All tests are time stamped and cannot be changed. Setup memory management, version verification and connecting to a PC.

2. **CheckMe!®:** The most advanced A/C system diagnostics and gives suggests for fixing problems.

3. **Display:** Displays readings taken from a Fieldpiece product. Wireless or direct connection.

4. **Superheat:** Charge a fixed restrictor A/C system by comparing the actual superheat to the calculated target superheat.

5. **Subcooling:** Charge a TXV/EXV A/C system using the manufacturer's target subcooling.

6. **Combustion:** Use full combustion analysis to set up combustion equipment such as a natural gas furnace.

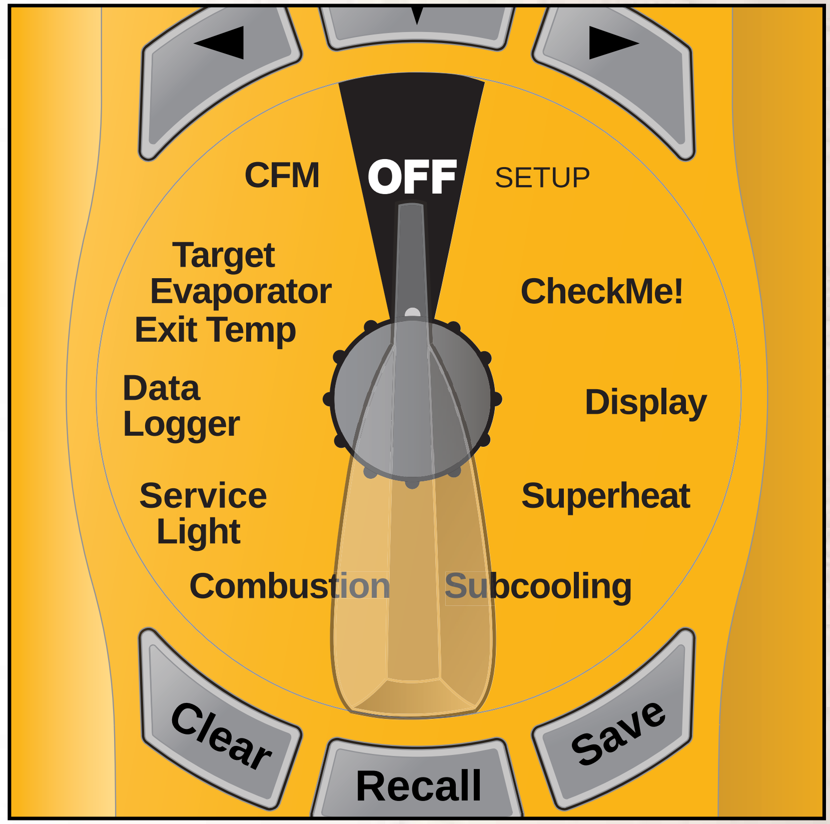
7. **Service Light:** Connect to setup the Fieldpiece Service Light.

8. **Data Logger:** Record up to 13 parameters using Fieldpiece Accessory Heads. Connect wirelessly or directly.

9. **Target Evaporator Exit Temp:** Check airflow by comparing the actual evaporator exit temperature to the target evaporator exit temperature (Target Temp Split).

10. **CFM:** Calculates the CFM on each grille to balance the airflow.

Select the Test



Select a test with the HG3 Dial.

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How it Works

Step 1: Select a Test on the Dial

Select the test on the dial that you want to perform.

Step 2: Enter Data on the INPUT FORM

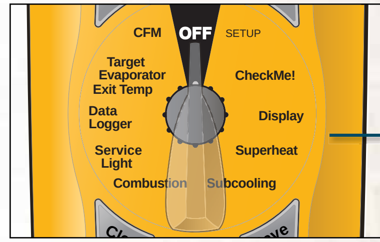
The INPUT FORM is displayed when a test is selected. Each input line is a step in the test. Fill out each line using Fieldpiece products, drop down menus or manual entry. See Inputting Data on page 10-11 for more information.

Step 3: View the Results on the OUTPUT FORM

The OUTPUT FORM displays the results of the calculations and references this guide for each test. Recommended actions are displayed to fix problems or confirm system is running properly.

Step 4: Save, Download and Print Test

Tests can be saved onto the HVAC Guide. It then can be connected to a computer to download the tests and print. All data and information from INPUT FORM and OUTPUT FORM is printed.

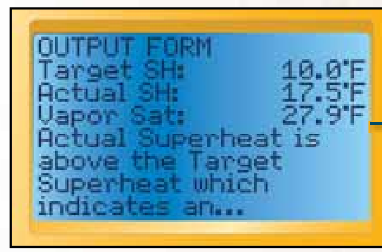


The HG3 dial.

Step 1: Switch the dial to the test you want to perform.

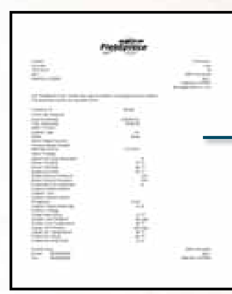
Superheat INPUT FORM.

Step 2: Inputs can be entered using Fieldpiece products, manual entry or drop down menus.



Superheat OUTPUT FORM.

Step 3: Outputs show you the results of the test. Scroll down using the arrows to see full results.


Printout Form.

Step 4: Save the test, download it to a PC and printout to hand back to your customer.

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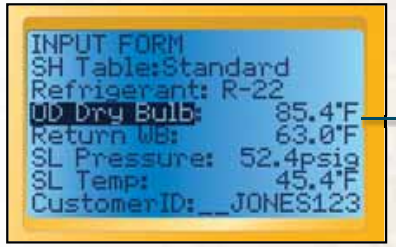
Inputting Data

Automatically with Fieldpiece Accessory Heads: Select a test on the dial to view the INPUT FORM. Connect appropriate head by sliding onto HG3 and switch the Accessory Head to parameter to be measured. Select the Input to be measured on the HVAC Guide by scrolling and highlighting the desired measurement using the UP/DOWN Arrows. Press ENTER to start taking a measurement. Press ENTER again to lock it in.

Wirelessly Using a Fieldpiece Transmitter: Fieldpiece Accessory heads slide onto a wireless transmitter (ET2W or EHW4), Measurements are taken by the Accessory head and sent wirelessly to the HG3. The HG3 can receive up to 12 wireless signals at one time. See Wireless Testing Section (Pages 12-13).

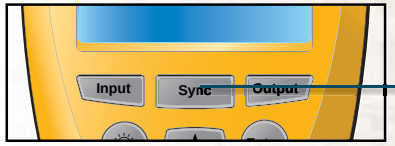
Drop Down Menus: Some input lines are choices (such as R-22 in the Superheat test) and can be changed by selecting from a list. To get to the list, highlight the input line you want to change with the UP/DOWN arrows and press ENTER or the RIGHT arrow. Use the UP/DOWN arrows to highlight the appropriate input and press ENTER to select it.

Manual Entry: Enter system data, Customer IDs or test data measured with another instrument. Highlight the input line using the UP/DOWN arrows and press the RIGHT arrow. Then use the UP/DOWN arrows to 'type' in the first digit or character. Press the Right arrow to get to the next character. Press ENTER to lock it in.



Connect Accessory Head. Scroll to highlight desired input. Press enter to start taking measurement. Press enter to lock it in.

Superheat INPUT FORM.

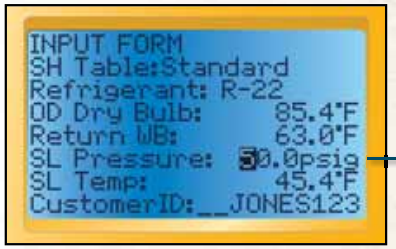


Use the Sync button to connect to Fieldpiece wireless products.

Use Sync button to wirelessly connect the HG3 to a Fieldpiece wireless enabled product.

Use the arrows to highlight an option in a drop down menu. Press enter to select desired option.

Refrigerant list Drop Down Menu.



Use the arrows to highlight an input. Press right arrow to start manual entry. Then use arrows to "type" in each character.

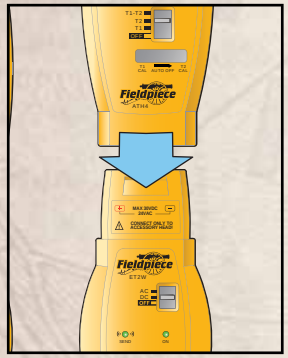
Superheat INPUT FORM. Manual entry for SL pressure input.

Wireless Testing

Overview

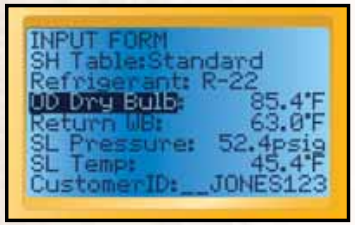
Attach any Fieldpiece Accessory Head to the ET2W or EH4W to view or log measurements on your HG3 in real-time. The HG3 has the capability to wirelessly and simultaneously read up to 12 signals. A 13th accessory head can be attached directly to the HG3 and gives you the ability to record 13 parameters at the same time.

1



Attach Accessory Head to the ET2W and power on both devices. It's usually a good idea to disable Auto-Off on the accessory head when testing wirelessly.

2



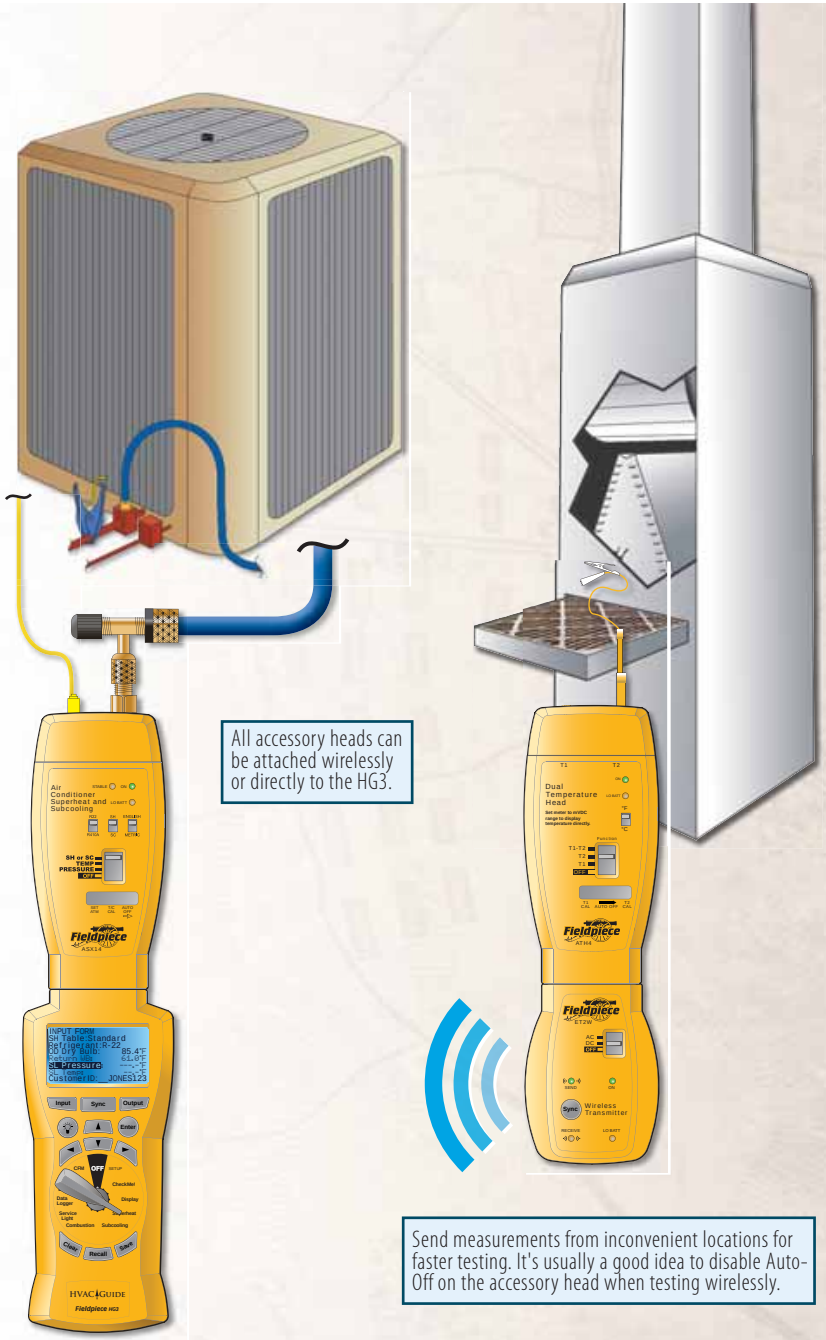
For guided tests, select the INPUT FORM line you want to enter.

3

Hold SYNC on the HG3 and then SYNC on the ET2W. The SYNC LED will be illuminated and a real time measurement will appear.

4

For guided tests, Press OUTPUT to lock in all measurements simultaneously and view the OUTPUT FORM. Or Press SYNC to lock in a single measurement and move to the next parameter.



All accessory heads can be attached wirelessly or directly to the HG3.

Send measurements from inconvenient locations for faster testing. It's usually a good idea to disable Auto-Off on the accessory head when testing wirelessly.

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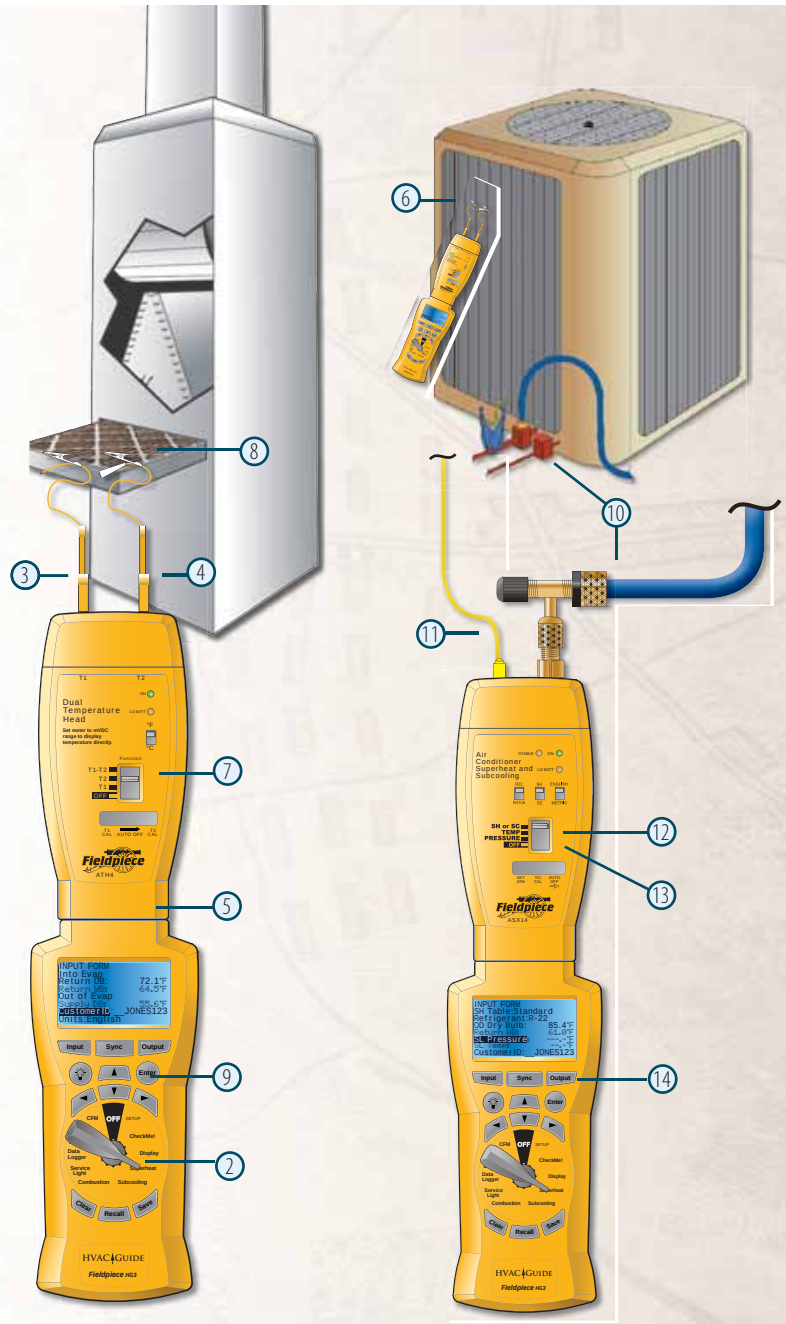
Tests

Example Test

Below is an example step-by-step procedure for a Superheat test on a fixed restrictor system using the ATH4 and ASX14 accessory heads. As with all tests on the HVAC Guide, accessory heads or manual entry can be used to complete the test. Match the steps to their respective number in the diagram to the right.

Step-by-Step Instructions for Superheat

1. Let system stabilize for 15 minutes prior to measuring superheat.
2. Select Superheat test.
3. Plug the ATA1 into T1 on the ATH4.
4. Plug the ATWB1 into T2 on the ATH4.
5. Slide the ATH4 onto the HVAC Guide and switch the ATH4 to T1.
6. Measure the OD Dry Bulb going into the condenser. Once the reading has stabilized press Enter to lock it in.
7. Select T2 on the ATH4.
8. Measure the Wet Bulb close to the inlet of the Evaporator. Wet the ATWB1 and insert it close to the inlet of the evaporator.
9. Press Enter to start taking the measurement. Once the reading has stabilized press Enter to lock it in.
10. Detach the ATH4 and attach the ASX14 to the HVAC Guide. Attach one side of your low side hose to the ASX14 and attach the other end to the Suction Line (SL) service port.
11. Plug the ATC1 into the ASX14 and clamp it onto the SL between the evaporator and compressor. Place at least 6" from compressor.
12. Switch ASX14 to Pressure. Press Enter on the HG3 to start taking the SL Pressure. Press Enter to lock it in.
13. Switch ASX14 to Temp. Press Enter on the HG3 to start taking the SL temperature. Press Enter to lock it in.
14. Press OUTPUT to view the results on the OUTPUT FORM. Compare the Actual Superheat to the Target Superheat and read Suggested Actions by scrolling down the OUTPUT FORM. See page 22 for more information on the Superheat Test.



PETITIONERS' EXHIBIT 1013

1.1 Target Evaporator Exit Temp Overview

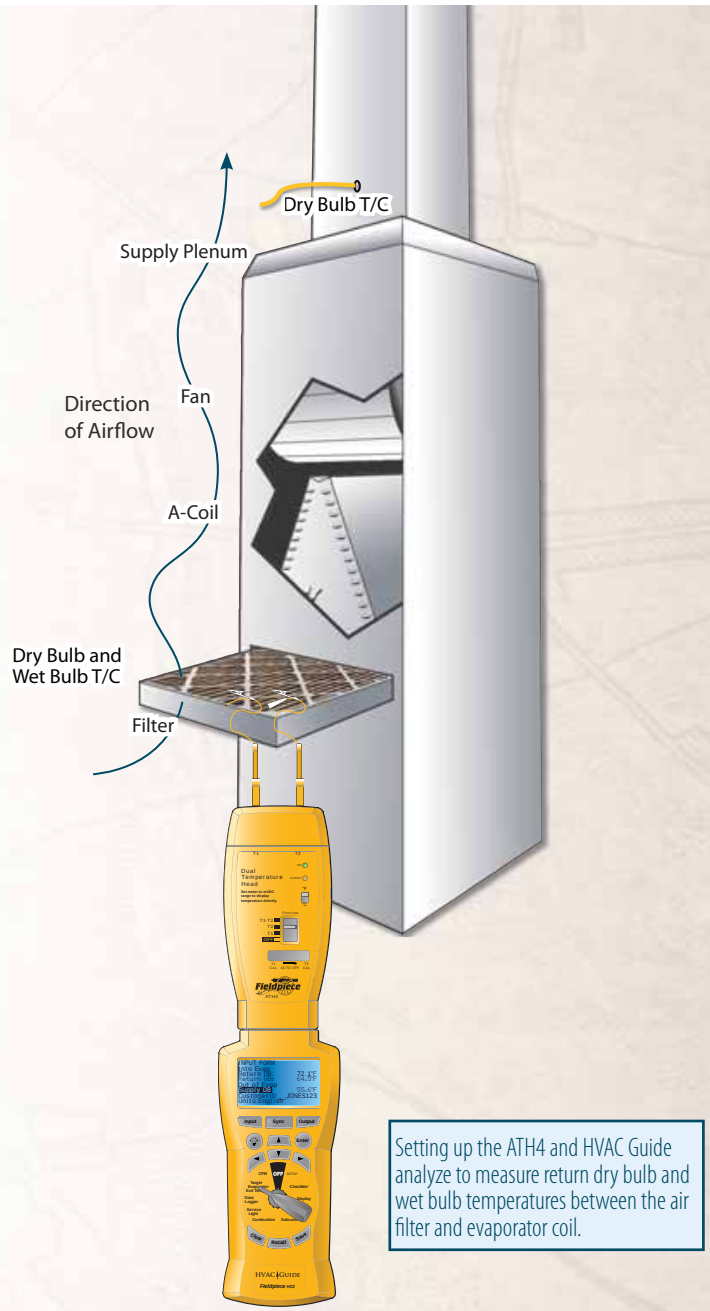
Target Evaporator Exit Temp (aka temperature drop or delta T) is used to determine if the evaporator is getting the optimum airflow.

The HVAC Guide calculates the Target Evaporator Exit Temperature so the technician can compare it to the Actual Evaporator Exit Temperature. If the charge is correct and Actual Evaporator Exit Temperature is more than 3°F above or below the Target Evaporator Exit Temperature, an airflow problem may exist. The Target Evaporator Exit Temperature switch position is Title 24 compliant.

An Actual Evap Exit DB Temp below the Target Evap Exit DB Temp is an indication of low airflow.

Increasing airflow can be accomplished by eliminating restrictions in the duct system, increasing blower speed, cleaning filters or opening registers. After corrective measures are taken, repeat measurement procedures as often as necessary to establish adequate airflow range. Allow system to stabilize for 15 minutes before repeating measurement procedure.[1]

An Actual Evap Exit DB Temp above the Target Evap Exit DB Temp usually indicates low capacity. Occasionally airflow is higher than expected. Look for causes of low capacity such as refrigerant mischarge or dirty condenser coil. If the airflow is high, correct by lowering the fan speed.



Setting up the ATH4 and HVAC Guide analyze to measure return dry bulb and wet bulb temperatures between the air filter and evaporator coil.

1 2005 Residential ACM Manual, Page RD-5, (#5-7)

1.2 Target Evap Exit Temp INPUT FORM

Inputs

Into Evap Return DB (Into Evaporator Return Dry Bulb) Air temperature going into the evaporator. Take measurements as close to the air handler as possible. If the filter is directly before the air handler clip the included dry bulb thermocouple (ATA1) onto the filter. If the filter is not just before the air handler drill small holes in the return plenum and take measurements. Seal any holes before leaving the job site. Suggested Accessories: ATH4, ATA1.

Into Evap Return WB (Into Evaporator Return Wet Bulb) Use the wet bulb thermocouple (ATWB1) and take measurement at the same place as the Into Evap Return DB. Suggested Accessories: ATH4, ATWB1.

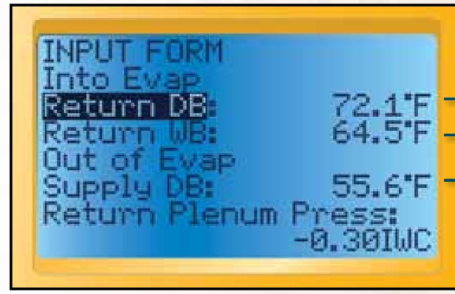
Out of Evap Supply Dry Bulb Air temperature coming out of the evaporator. Punch or drill a small hole in the supply plenum and measure in the center of the plenum. Suggested Accessories: ATH4, ATB1.

Ret Plen Pres (Return Plenum Pressure) Optional. Static pressure in the return plenum before the evaporator. Suggested Accessories: ADMN2, ASP2.

Sup Plen Pres (Supply Plenum Pressure) Optional. Static pressure in the supply plenum after the evaporator. Suggested Accessories: ADMN2, ASP2.

Customer ID Used in the file name to save, recall and download tests. Use arrow buttons to "type" in each character.

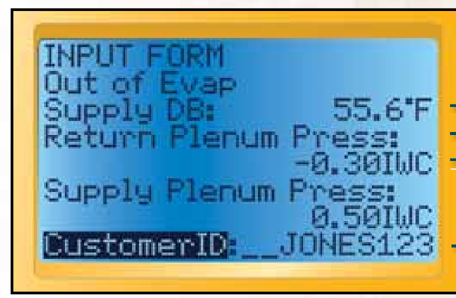
Units Select English or Metric units.



Take measurements using Fieldpiece Accessory Heads to automatically input onto the INPUT FORM. Measurements can also be taken wirelessly. See page 12 for wireless instructions.

Connect Accessory Head. Scroll to highlight desired parameter. Press enter to start taking measurement. Press enter again to lock it in.

Target Evaporator Exit Temperature Test INPUT FORM filled.



You can also enter measurements manually with the arrow buttons. The negative sign is found between 9 and 0.

Press enter to see a list of saved Customer IDs or use arrows to enter a new ID.

Target Evaporator Exit Temperature Test INPUT FORM continued from above.

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1.3 Target Evap Exit Temp OUTPUT FORM

Outputs

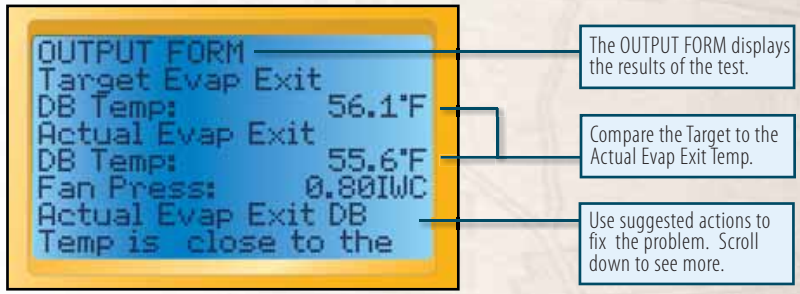
Target Evap Exit DB Temp The target air temperature exiting the evaporator based on the measured Return Air Wet Bulb and Dry Bulb. If charge and airflow are adjusted properly, the Actual Evap Exit Temp should be close to the Target Evap Exit DB Temp.

Actual Evap Exit Temp The measured air temperature leaving the evaporator. This is the same as Out of Evap Supply Dry Bulb (See page 18).

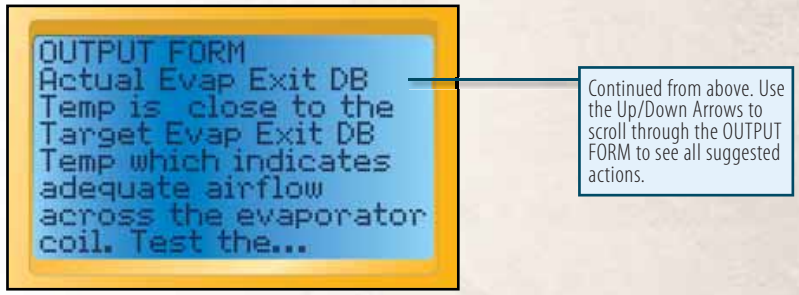
Fan Press (Fan Pressure) The pressure difference between the supply plenum pressure and the return plenum pressure.

Suggested Actions Suggested actions are displayed to correct the problem. Use the down arrow to scroll down the OUTPUT FORM.

See Sec (See Section) The section numbers at the end of the OUTPUT FORM refer to the sections in this manual with more detailed information about each test.



Target Evap Exit Temp OUTPUT FORM.



Target Evap Exit Temp OUTPUT FORM continued from above.

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2.1 Superheat Overview

Superheat is the temperature rise above the boiling point of the refrigerant. Too high, and the refrigerant boils off early in the evaporator and wastes most of the capacity of the evaporator. Too low, and you risk liquid going into the compressor.

Using superheat is the best way to obtain proper refrigerant charge for a fixed restrictor metering device system.

If the air conditioner is in good working order and the airflow is adjusted properly, comparing the actual and target superheat will tell you if refrigerant needs to be added or recovered. Ensure the pressure never exceeds the manufacturer's maximum overload pressure guidelines.

On a fixed restrictor system, the target superheat is determined based upon the indoor wet bulb and outdoor dry bulb temperatures.

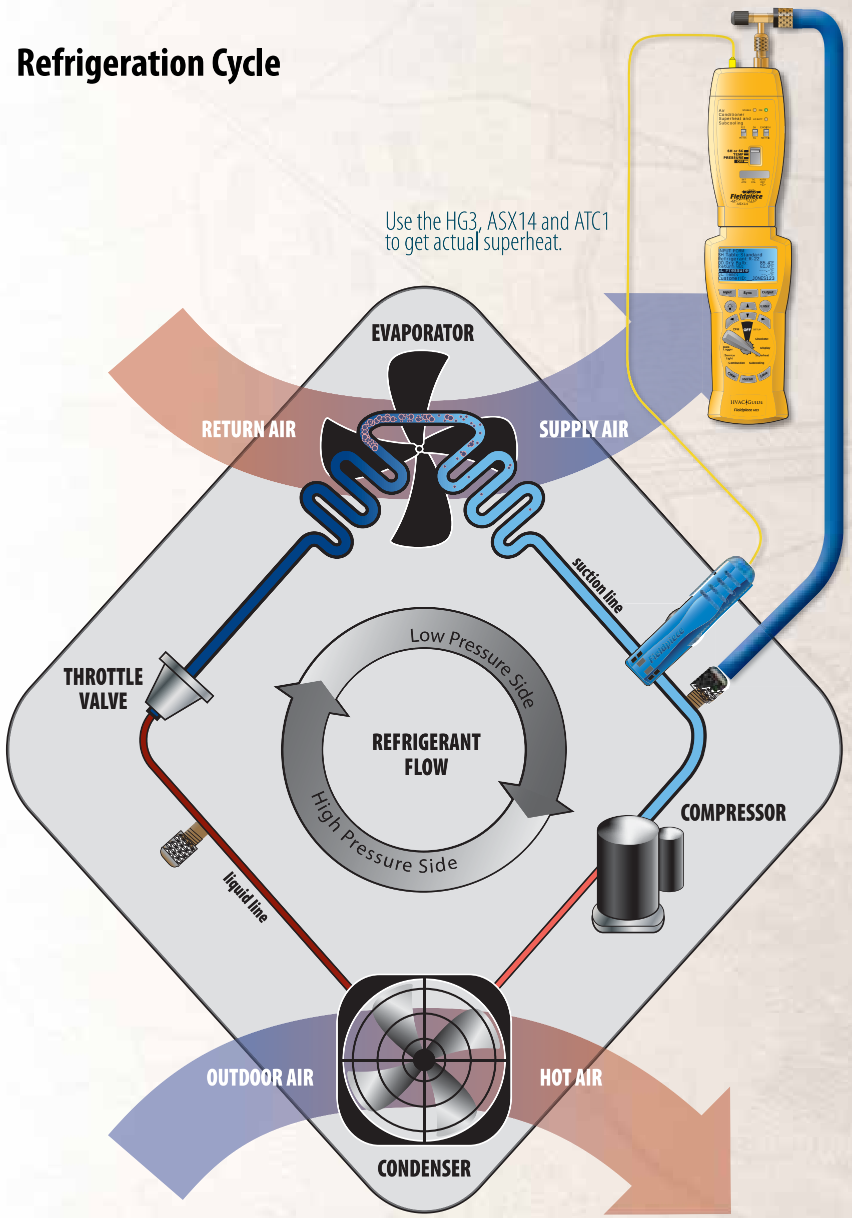
The Actual SH (superheat) should be within ±5°F of the Target SH to ensure optimum performance. If the actual SH is outside this range, modifications to the charge or adjustments to the restrictor (TXV) are necessary.

Adding refrigerant lowers Actual SH. Recovering refrigerant increases your Actual SH. The amount of refrigerant necessary to add or recover will vary based on the size of the system and the difference between the Actual and Target SH.

To get Actual Superheat, you need to measure suction line pressure and suction line temperature. To get Target Superheat heat for fixed restrictor systems you need to measure return air wet bulb and outdoor dry bulb.

Because everything within the system is interdependent, one adjustment can affect other parts of the system. For example, increasing airflow increases the superheat, which may require adding refrigerant. After modifications, allow 15 minutes to stabilize and then retest.

Refrigeration Cycle



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2.2 Superheat INPUT FORM

Inputs

SH Table (Superheat Table) Select Standard or Custom. Standard calculates the Target Superheat using charts from California's Title 24. Custom allows the technician to enter in the Target Superheat.

Target SH (Target Superheat) if you selected Custom on SH Table and then type in the Manufacturer's recommended superheat in the Target SH input.

Refrigerant Select from the 39 Refrigerants available.

OD Dry Bulb (Outdoor Dry Bulb) Air temperature going into the condenser. Suggested Accessories: ATH4, ATA1.

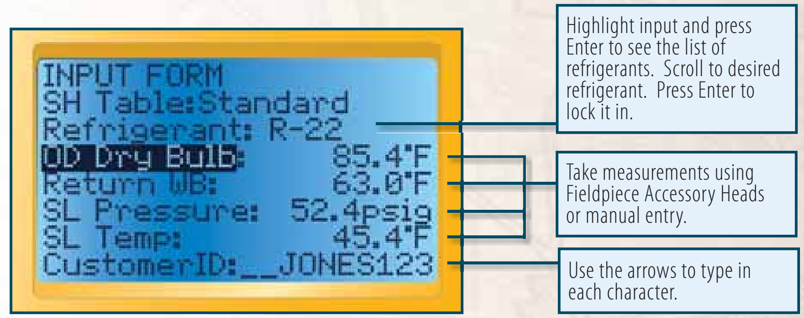
Ret Wet Bulb (Return Wet Bulb) Take the wet bulb temperature at the inlet of the evaporator. Generally right before the filter is a good location. Suggested Accessories: ATH4, ATWB1.

SL Pressure (Suction Line Pressure) Pressure of the suction line taken at the suction line service port. Suggested Accessories: ASX14.

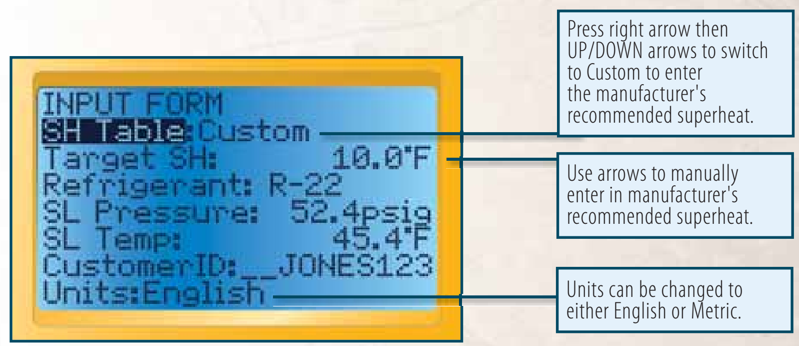
SL Temp (Suction Line Temperature) Take the suction line temperature between the evaporator and compressor. Make sure to be at least 6 inches away from the compressor. Suggested Accessories: ATC1.

Customer ID Used in the file name to save, recall and download tests. Use arrow buttons to "type" in each character. Press RIGHT arrow to get to the first character. Once complete, press ENTER to lock it in.

Units Select English or Metric units



Superheat INPUT FORM using the Standard superheat table from Title 24.



Superheat INPUT FORM using the Custom superheat table which allows the technician to enter in the manufacturer's recommended superheat.

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2.3 Superheat OUTPUT FORM

Outputs

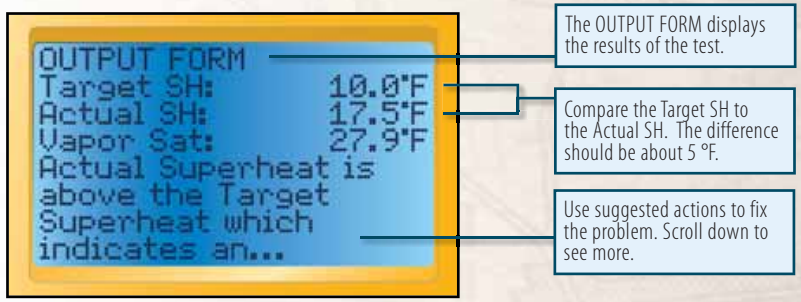
Target SH (Superheat): Indicates what the superheat should be. For Custom SH Table it is the manufacturer's recommended superheat entered by the tech. For Standard SH Table it is calculated from Return Wet Bulb and Outdoor Dry Bulb.

Actual SH (Superheat): Shows the superheat calculated from the measured suction line temperature and suction line pressure.

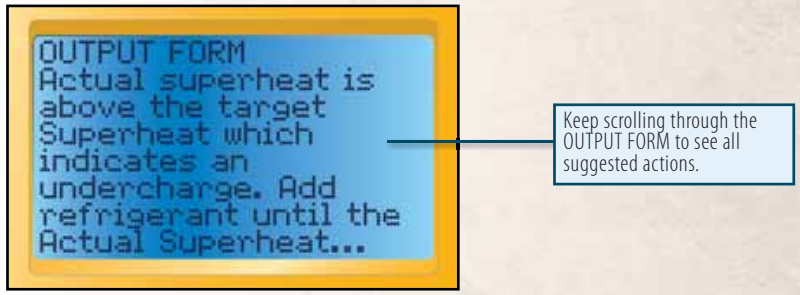
Vapor Sat: This is the vapor saturation temperature (boiling point) of the refrigerant in the evaporator coil. Calculated from SL Pressure.

Suggested Actions: Suggested actions are displayed to correct the problem. Use the down arrow to scroll down OUTPUT FORM. Because everything within the system is interdependent, one adjustment can affect the whole system. Tests should be used together such as Superheat to correct refrigerant charge and Target Evap Exit Temp to correct airflow across the evaporator coil.

See Sec (See Section): The section numbers on the OUTPUT FORM refer to the sections in this manual with more detailed information about each test.



Superheat OUTPUT FORM.



Superheat OUTPUT FORM continued from above.

3.1 Subcooling Overview

Subcooling is the temperature decrease below the saturation temperature (same as the condensing point) in the condenser. Too high, and refrigerant condenses too early in the condenser and 'wastes' most of the capacity of the condenser. Too low, and a mixture of gas and liquid can be delivered to the expansion valve, reducing efficiency.

In a properly working TXV/EXV system, the superheat is held constant. This is why subcooling is the best way to obtain proper refrigerant charge for a TXV/EXV system. If the air conditioner is in good working order and the airflow is adjusted properly, comparing the actual and target subcooling will tell you if refrigerant needs to be added or recovered (ensure the pressure never exceeds the manufacturer's maximum overload pressure guidelines).

Make sure the TXV/EXV bulb is installed properly, there is proper refrigerant to obtain target subcooling, and there are no liquid line restrictions.

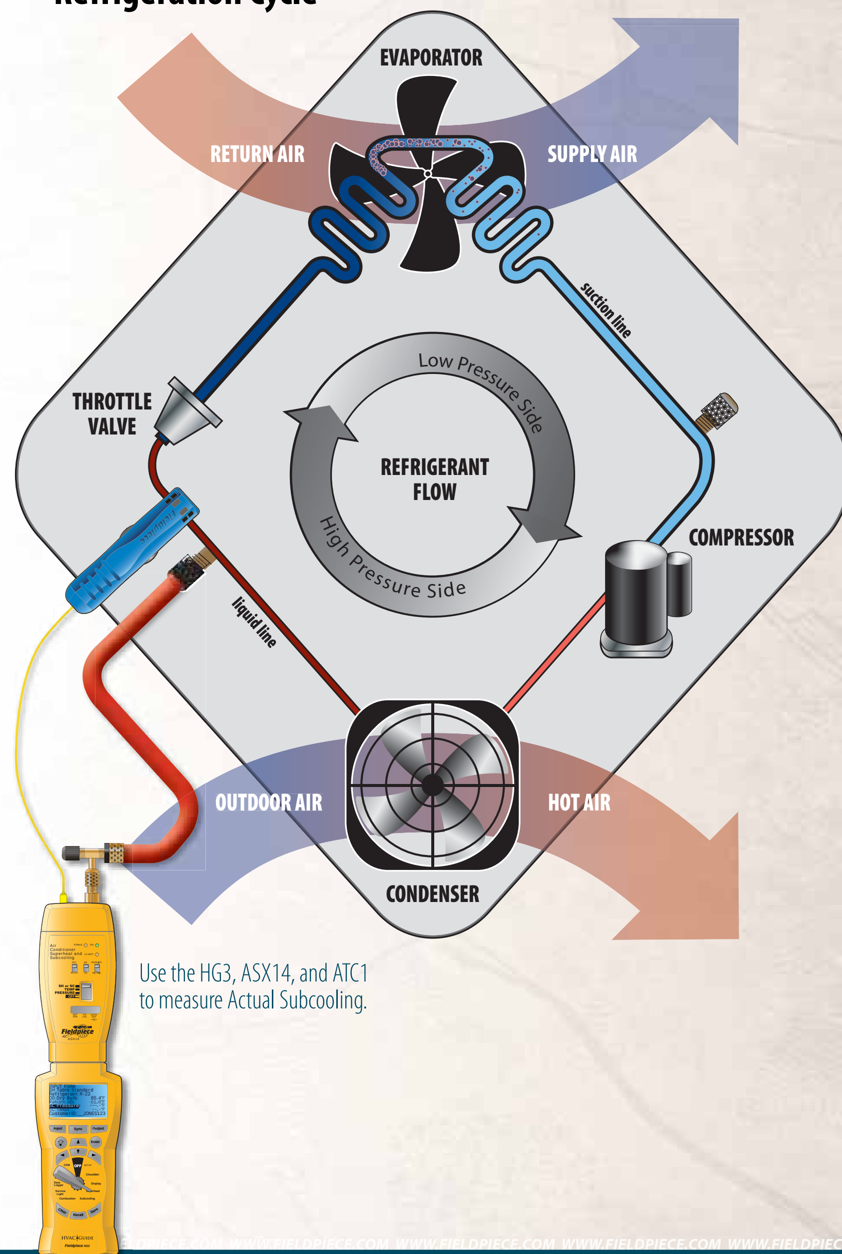
The **Actual SC** (subcooling) should be within ±3°F of the **Target SC** for correct refrigerant charge.

For Actual Subcooling, you need to measure liquid line pressure and liquid line temperature. Target Subcooling is usually specified by the manufacturer and if not the HG3 uses conservative Target Subcooling tables.

Adding refrigerant increases your **Actual SC**. Recovering refrigerant decreases your **Actual SC**. The amount of refrigerant necessary to add or recover will vary based on the size of the system and the difference between the Actual and Target SC.

Because everything is interdependent, changes in one part of the system affect other parts of the system. For example, increasing airflow decreases the subcooling, which may require adding refrigerant. After modifications, allow 15 minutes for the system to stabilize; and then retest.

Refrigeration Cycle



Use the HG3, ASX14, and ATC1 to measure Actual Subcooling.

3.2 Subcooling INPUT FORM

Inputs

Target Subcooling Find this value on the equipment manufacturer's name plate. If it's not listed, the HVAC Guide will make a conservative estimate.

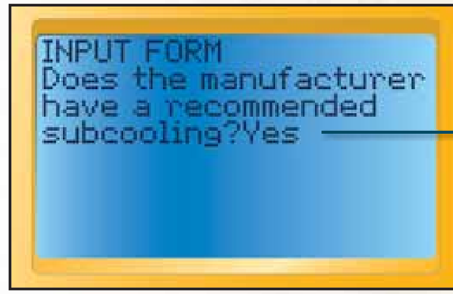
Refrigerant 39 Refrigerants available. Press Enter to get to the list. Use the UP/DOWN arrows to select refrigerant. Press ENTER to lock it in.

LL Pressure Liquid Line Pressure taken at the liquid line service port.

LL Temp Taken after the condenser near the liquid line service port.

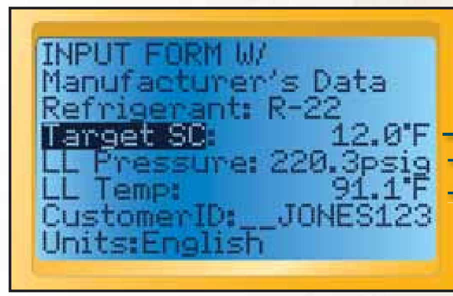
Customer ID Used in the file name to save, recall and download tests. Use arrow buttons to key in each character. Press RIGHT arrow to get to the first character. Once complete press ENTER to lock it in.

Units Select English or Metric units.



Select Yes or No and press Enter. If you select No the HVAC Guide will base the Target SC on a conservative chart.

Subcooling INPUT FORM asks the technician if the manufacturer's recommended subcooling is available before proceeding with the test.



Use Arrows to enter Target SC.

Take measurements using Fieldpiece Accessory Heads enter them manually.

Subcooling INPUT FORM with manufacturer's data.

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3.3 Subcooling OUTPUT FORM

Outputs

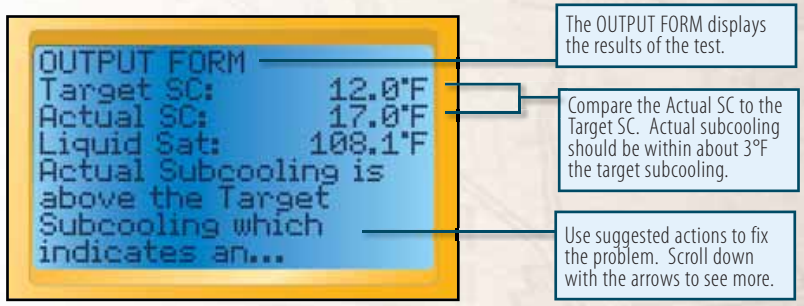
Target SC (Subcooling) Indicates what the subcooling should be from the manufacturer's specifications. The HVAC Guide uses a built in conservative estimate when manufacturer's specifications are not available.

Actual SC (Subcooling) Displays the subcooling calculated from the measured liquid line temperature and liquid line pressure.

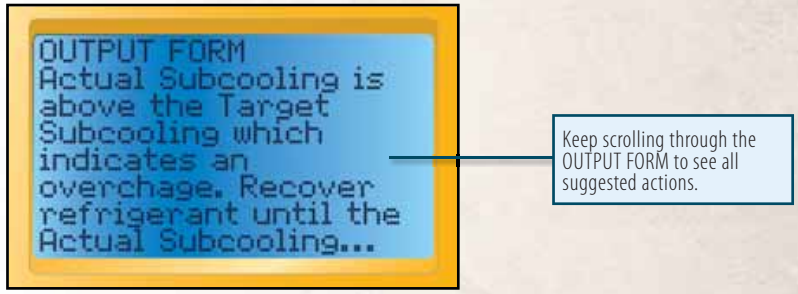
Liquid Sat This is the saturation temperature of the refrigerant in the condenser coil. It is one of the temperatures from which subcooling is calculated.

See Sec (See Section) The section numbers on the OUTPUT FORM refer to the sections in this manual with more detailed information about each test.

Suggested Actions Suggested actions are displayed to correct the problem. Use the down arrow to scroll down the OUTPUT FORM. Because everything within the system is interdependent, one adjustment can affect the whole system. Tests should be used together such as Subcooling to correct refrigerant charge and Target Evap Exit Temp to correct airflow across the evaporator coil.



Subcooling OUTPUT FORM.



Subcooling OUTPUT FORM continued from above.

4.1 Combustion Overview

Combustion Test helps you determine the effectiveness of the combustion by analysis of combustion products and temperature.

The Combustion Test will only tell you about combustion and does not take into account any losses from poor insulation, or cycling and standby losses. It does not measure any losses in the distribution system such as uninsulated hydronic piping, air duct leakage or insulation levels.

Properly tuned gas combustion equipment will produce little or no carbon monoxide, no soot, and will consume less fuel.

Combustion gases should be sampled close to the exit from the heat exchanger within an area where all gases would be well mixed and before dilution air enters the venting systems (i.e. draft hoods, barometric dampers, etc). Testing within 18 inches of the breech is a typical location for most oil-fired equipment. If the appliance is an atmospheric gas type with a draft hood, the test would be taken in the top flue passage prior to mixing with dilution air.

After testing is complete, the hole in the flue/stack must be plugged appropriately.

Use the HG3, AOX2, ACM3, and AOXP2 to perform combustion analysis.

4.2 Combustion INPUT FORM

Inputs

Fuel Select Natural Gas, Oil #2 or Propane.

Type Default: Condensing. Other selection: Non-Condensing. The presence of a condensate line indicates a condensing unit, otherwise it is a non-condensing unit.

Primary Temp (Primary Temperature) Measure the temperature of the air being introduced to the combustion process.

O_2 (Oxygen) Connect the AOX2 with the switch on $\%O_2$ and take a sample of the combustion products in the flue/stack (within 18 inches from the start of the flue).

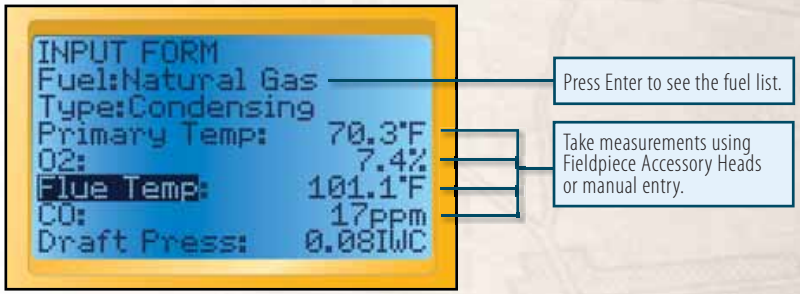
Flue Temp (Flue Temperature) Connect the ATR1 temperature probe to the AOX2. Set the AOX2 on TEMP and measure the temperature of the combustion products in the flue/stack (18 inches from the start of the flue).

CO (Carbon Monoxide) Connect the ACM3 and take a sample of the combustion products in the flue/stack in the same location as the O2% measurement (within 18 inches from the start of the flue).

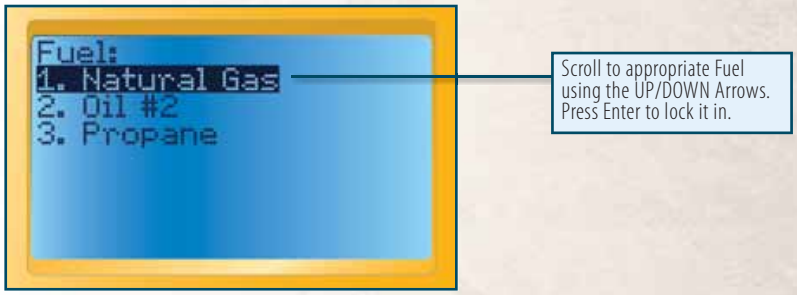
Draft Press (Draft Pressure) Air pressure taken in the flue. Suggested Accessories: ADMN2, ASP2.

Customer ID Used in the file name to save, recall and download tests. Use arrow buttons to "type" in each character. Press RIGHT arrow to get to the first character. Once complete press ENTER to lock it in.

Units Select English or Metric units.



Combustion Analysis INPUT FORM.



Fuel drop down menu.

4.3 Combustion OUTPUT FORM

Outputs

CO_2 (carbon dioxide) The %CO_2 in the combustion products.

Excess O_2 (Excess Air) The amount of O_2 above the minimum theoretical amount needed for complete combustion. For complete and efficient combustion, Excess O_2 must be adjusted to manufacturer's specifications.

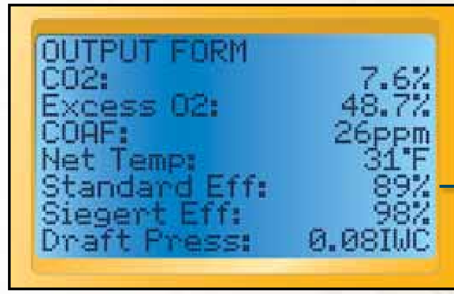
COAF (Carbon Monoxide Air Free) The amount of CO in the combustion products taking into account the dilution effect of excess O_2.

Net Temp (Net Temperature) The stack (vent) temperature minus the primary air temperature.

Standard Eff (Efficiency) The actual efficiency of the combustion equipment calculated by analyzing the losses up the exhaust.

Siegert Eff (Efficiency) The European standard for combustion efficiency.

See Sec (See Section) The section numbers on the OUTPUT FORM refer to the sections in this manual with more detailed information about each test.



Combustion OUTPUT FORM.

The OUTPUT FORM displays the results of the test. Standard Efficiency should be close to manufacturer's specifications.

Atmospheric Fan Assisted Natural Gas or LPG	
Oxygen (O_2)	6-9%
Stack Temperature	325-500°F
Condensing Natural Gas or LG	
Oxygen (O_2)	6-9%
Stack Temperature	90-140°F
Natural Gas/LPG Power Burners	
Oxygen (O_2)	3-6%
Stack Temperature	275-500°F
Fuel oil Flame Retention Power Burners	
Oxygen (O_2)	3-7%
Stack Temperature	325-500°F
Fuel Oil Non-Flame Retention Power Burners	
Oxygen (O_2)	6-9%
Stack Temperature	400-600°F
Condensing Oil	
Oxygen (O_2)	3-7%
Stack Temperature	90-140°F

Appropriate levels for combustion equipment chart. Manufacturer's specifications should always be determined before adjusting the system.

5.1 CheckMe!®

The CheckMe!® test is included on model HG2 and HG3. It is available for purchase on model HG1.

CheckMe!® evaluation was developed by Proctor Engineering Group and is the most advanced real-world method for troubleshooting A/C systems. It looks at the big picture to diagnose problems. Superheat, Subcooling, and Target Evaporator Exit Temperature tests look at individual performance indicators to determine if they are within proper range. CheckMe!® looks at the system as a whole to give a more complete diagnosis. CheckMe!® saves time and money by quickly diagnosing a range of potential problems or even multiple problems. CheckMe!® recommends actions to tune the air conditioner or heat pump to its optimum performance with minimal retests. This leads to even fewer call backs.

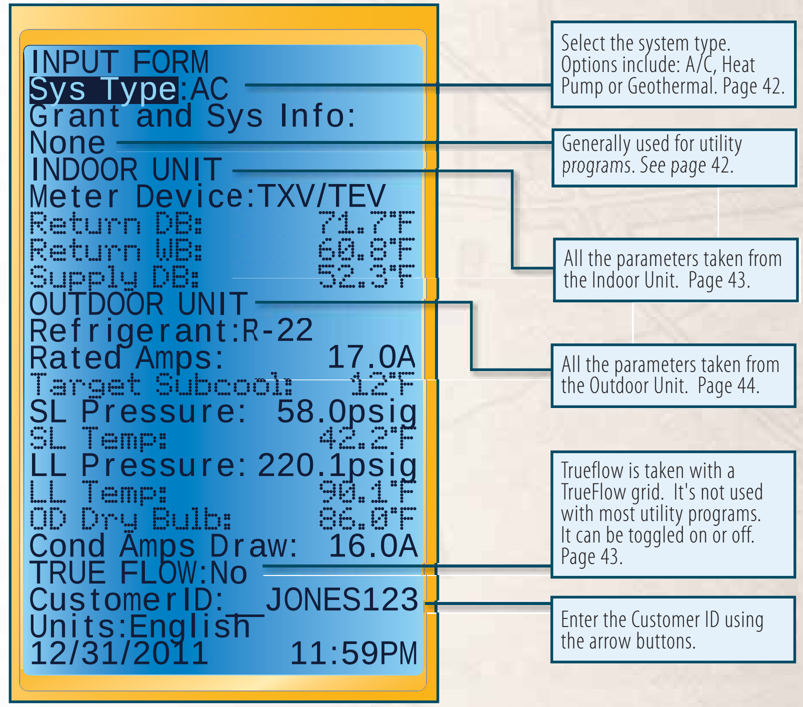
The algorithms built into CheckMe!® are based on the real world test data of over 250,000 air conditioners. The testing procedure and accuracy of the diagnosis have been refined over many years by Proctor Engineering. The CheckMe!® switch position is a real time-saver because it can give you a more accurate diagnosis than looking at individual aspects of the air conditioner. Great way to avoid call-backs.

The CheckMe!® position has diagnoses that will help you pinpoint problems with the system. Besides providing better diagnoses, it also checks the test numbers and warns you if there is a likely testing error. In these cases, you will want to retake some measurements.

CheckMe!® in the HG3 will analyze with almost any amount of data. The more information supplied, the more accurate and comprehensive the diagnoses. CheckMe!® determines the current state of the equipment. It is recommended that you pretest before repairs and test after repairs to confirm the improvement.

5.2 CheckMe!® INPUT FORM

Below is a picture of the extended CheckMe! INPUT FORM. The following sections cover each part of the INPUT FORM in more detail. Refer to the page numbers in the blue boxes.



CheckMe! ® INPUT FORM.

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5.2 CheckMe!® INPUT FORM (continued)

Sys Type (System Type): Default: AC (Air Conditioning). Other selections: H Pump Heat (heat pump in heating mode), H Pump Cool (heat pump in cooling mode) or Geothermal.

Grant and Sys Info: Default: None. Other selections: New or a previously created Grant. Unless you are working under a Grant program, usually through a utility or government, then the Grant will remain as None. You can also use this feature to track extra measurements or system information.

GRANT FORM

In parts of the United States, CheckMe!® is used to verify that a system is tuned to the highest standards and qualify the work for grants. Grants typically require you to track additional information about the system in order to qualify for the tax rebates or other incentives. Contact your local utility to learn how to become a grant participant.

After you have selected "New" or a pre-existing grant from the list of grants you will be taken to the GRANT FORM. The Grant form allows you to create new grants in accordance with particular specifications.

Grant and Sys Info: Use alpha-numeric characters to manually input and name this grant. Once created you can access this grant for future tests.

Optional Inputs: Optional inputs can be added to the INPUT FORM for the new grant you have created. By turning these to "Yes" you will see them on the INPUT FORM when this grant is selected.

List of inputs: Indoor Model No. (number), Furnace Model No. (number), ID VOLTS (voltage of indoor unit), ID Full Ld Amps (full load running amperage of indoor unit), Sup Plen Press (supply plenum pressure, static), Ret Plen Press (return plenum pressure, static), Evap Fan Amp (evaporator fan amperage), Test (initial or after repair), Outdoor Model No (number), Outdoor Year (year manufactured of the outdoor unit), Outdoor Serial No (serial number of the outdoor unit), OD Volts (voltage of the outdoor unit).

Advanced Tolerances: These are some of the basic error tolerances which the CheckMe! program uses to determine if a system is performing properly. Some grants have different tolerances on parameters such as superheat and airflow. This is where you can adjust the tolerances. By adjusting these numbers you will change the way systems are evaluated by the CheckMe! for this particular grant.

Press the SAVE button to save your changes and return to the CheckMe! INPUT FORM.

INDOOR UNIT

All temperature and pressure measurements must be taken after the unit reaches steady state (generally 15 minutes of continuous operation).

Metering Device: Default: TXV/EXV. Other selection: Fixed.

Return DB (dry bulb) and **Return WB** (wet bulb):Take measurements very close to or within the return air side of the air handler (not at the return grille since temperatures and humidity change by the time the air reaches the indoor coil). Wet the wet bulb sensor (ATWB1) and insert it after 15 minutes of continuous running. Insert the dry bulb sensor (ATA1) through the same hole. They can be clipped together between the filter and the evaporator coil if the filter is upstream from the coil.

Watch the wet bulb temperature; it will drop and then stabilize. The wet bulb temperature is the stabilized reading. If the sensor starts to dry out, the reading will rise and the wrong temperature will be recorded. If the filter is not directly upstream of the air handler, make small holes in the return plenum just big enough for the probes. Seal any holes before leaving the job site.

Supply DB (dry bulb leaving the indoor coil): Measure in the center of the supply plenum. Make a small hole in the supply plenum and insert a calibrated dry bulb thermocouple such as the ATA1 or ATB1. Determine the average air temperature in the supply plenum.

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OUTDOOR UNIT

Refrigerant: Default: R-22. Other selection: R410A.

Rated Amps (rated amperage of the outside unit): This can be found on the nameplate along with the outdoor voltage and the refrigerant.

Target Subcool: Manufacturer's recommended subcooling for TXV/EXV systems. This varies by manufacturer, and may also change depending on weather conditions. Always charge to the equipment manufacturer's specifications when available. If no target subcooling is available then the HVAC Guide will make a conservative estimate.

SL Pressure (suction line pressure): Connect the ASX14 to the suction side service port. Select pressure mode on the ASX14 head. The system must be stabilized before taking the measurements. Enter data manually if you want to get pressure from your gauges. The analysis is only as good as the measurements. The Fieldpiece ASX14 has better resolution than most gauge sets.

SL Temp (suction line temperature): Measure near SL service port (within 6 inches). Use the ATC1 or ATC2 to get a good pipe temperature. The clamp should be perpendicular to the pipe and should be securely seated with the sensor in contact with the suction line. On a package unit make sure you are at least 6 inches away from the compressor and not on the hot gas discharge line.

LL Pressure (liquid line pressure): Connect the ASX14 to the liquid line service port. Set the accessory head to measure pressure and ensure the reading stabilizes before locking in the reading. Enter data manually if you want to get pressure from your gauges. The analysis is only as good as the measurements. The Fieldpiece ASX14 has better resolution than most gauge sets.

LL Temp (liquid line temperature): Measure near the location that the LL Pressure was taken. Use the ATC1 to get a good pipe temperature. The clamp should be perpendicular to the pipe and should be securely seated with the sensor in contact with the liquid line.

OD Dry Bulb (outdoor dry bulb temperature): Clip a calibrated ATA1 to the inlet of the condenser (typically on the side of the condenser), in the shade if possible. Note that the temperature of the air entering the outdoor coil can be considerably different than the ambient temperature due to recirculation of air exiting the unit. Determine the average temperature of the air entering the condenser.

Cond Amps Draw (actual condensing unit amp draw): For a package system this is the total amp draw of the unit. With a factory HG2 or HG3, use an ACH4 amp clamp and take measurement automatically. To use another amp clamp (such as the SC77) and for HG1s upgraded to an HG2, input this measurement manually.

TrueFlow® [2]

The TrueFlow® meter measures the airflow directly via a grid installed in place of the filter (or other location that has all the indoor unit airflow through it). For more information please visit www.energyconservatory.com.

TrueFlow®: Default: NO. If NO, skip ahead to the Customer ID. Answering YES unlocks the inputs for this section.

Nom Ton: Nominal tonnage of the A/C system.

Grid Size: Default: 14 inches. Other selection: 20 inches.

Sup Plen Pres: TrueFlow® system operating pressure with the filter installed and no TrueFlow® grid. This is the normal supply operating pressure (NSOP) and is measured using the static pressure probe included with the TrueFlow® plate.

Flow Pressure: True Flow Supply Operating Pressure (TFSOP) using the True Flow plate.

Sup Plen Pressure with Grid: TrueFlow® operating pressure with the filter and TrueFlow® grid installed. This is the TF SOP and is measured using the static pressure probe included with the TrueFlow® plate.

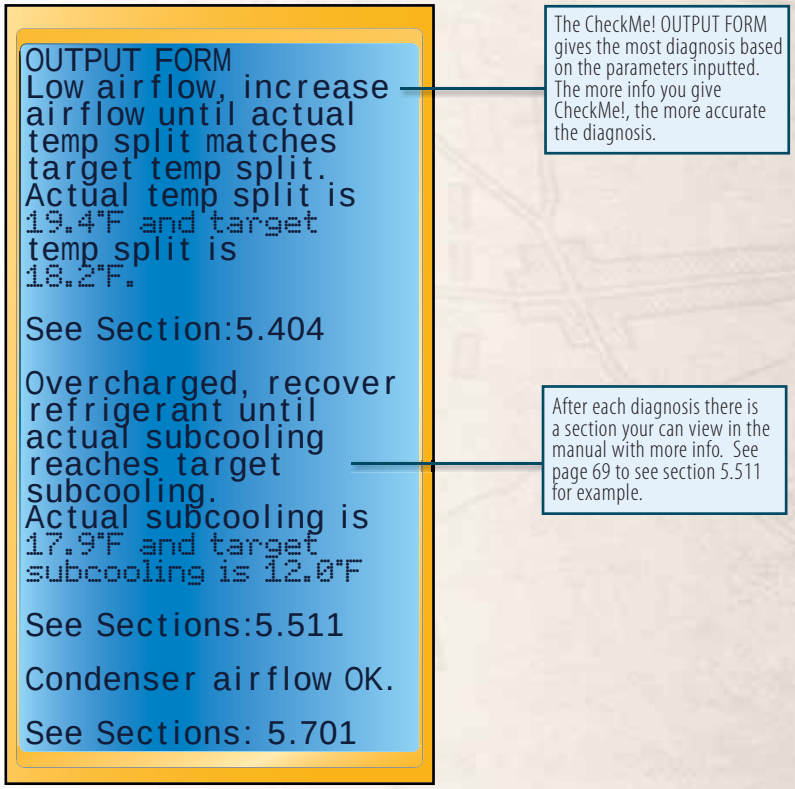
2 TrueFlow® is the registered trademark of The Energy Conservatory.

5.3 CheckMe!® OUTPUT FORM Overview

Press the OUTPUT for the CheckMe!® OUTPUT FORM. The diagnoses and recommendations are listed in order with the most likely diagnosis first. They are displayed in plain English to show the customer right on the job.

See page 66 for all CheckMe! diagnostics and more information about each diagnostic.

Because all parts of an A/C system are interdependent, changes made to one part of the system can influence other parts of the system. For example, increasing airflow may increase the superheat, which may require adding refrigerant. After modifications, allow 15 minutes to stabilize before your final test.



CheckMe OUTPUT FORM.

6.1 CFM Overview

The CFM (Cubic Feet per Minute) test is used to determine how much air is being supplied to, and returned from, the conditioned space. Check manufacturer's specifications and engineering designs to determine the target CFM for the space. The right amount of CFM will keep temperatures comfortable, stable and enable the right amount of air changes per hour throughout the space.

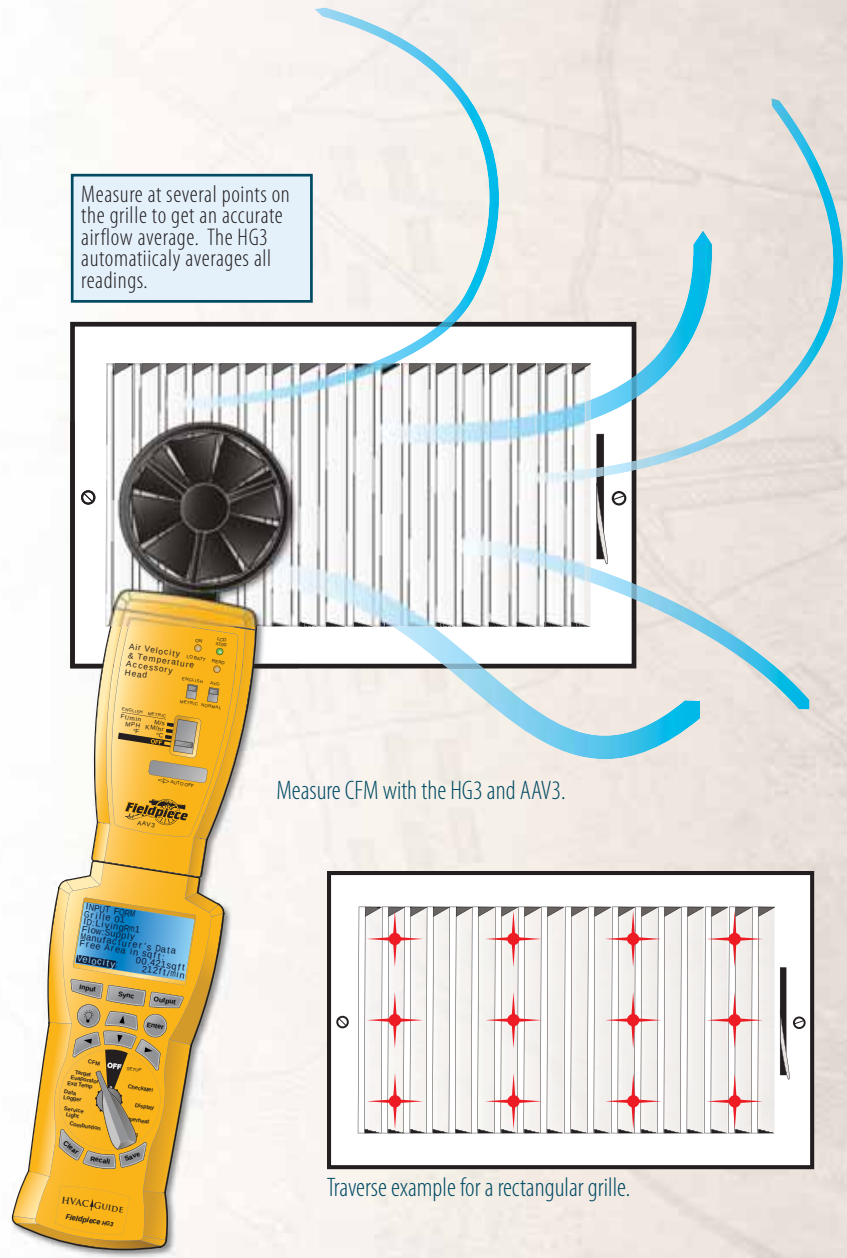
Measuring the CFM at the grilles is the best way to determine the amount of air being delivered to or taken out of the conditioned space.

Every system requires the right amount of system CFM to efficiently deliver the correct amount of heating or cooling. This can be checked through the Target Evap Exit Temp test or Check Me! switch position.

Measuring CFM can be a difficult task. Air coming out of the duct is turbulent and the velocity widely varies across the grille. The Airflow test on the HVAC Guide works with Fieldpiece airflow accessory head(s), AAV3, employing a sophisticated algorithm to calculate a more accurate CFM.

The CFM test can measure up to 13 different grilles. On the INPUT FORM the technician chooses either supply or return grille and enters in the manufacturer's size and free area specifications or uses Fieldpiece algorithms based on the size and type of grille. Always use the manufacturer's specifications when available since they will lead to the most accurate measurements and diagnosis. The technician can take several readings per grille to ensure an accurate average air velocity is obtained.

The HVAC Guide takes all the readings and calculates the CFM based on average air velocity and size and type of grille. The OUTPUT form lists the CFM for each grille, average, min, and max air velocity for each grille, total return and total supply for each multiple grille test.



6.2 CFM INPUT FORM

Inputs

Grille 01 Each grille has a numbered label.

ID Each grille has an alphanumeric customizable ID.

Flow Choose Supply or Return.

Manufacturer's Data This is the free area correction for each grille.

Selections

None: No area is used and CFM cannot be calculated.

No Corrections: No corrections are made and CFM is based on the size of the grille entered i.e. no grille on duct exit.

Free Area: Use Manufacturer's free area in square feet (sqft), inches(sqin), centimeters(sqcm), or meters (sdm).

Area Multiplier: Enter the manufacturer's Area Multiplier and grille dimensions.

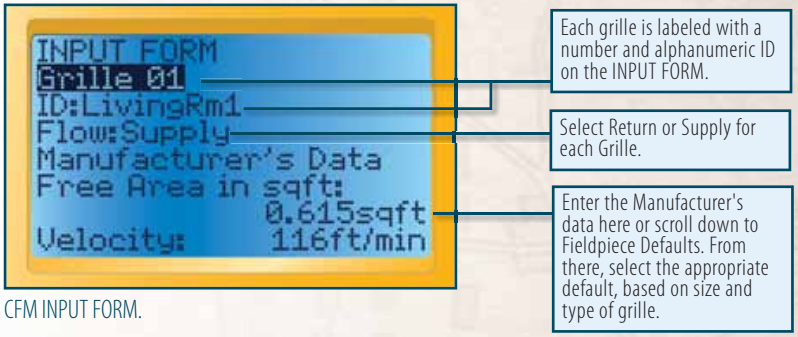
Fieldpiece Defaults: Use the Fieldpiece Defaults for grille type and input size if no manufacturer's data is available.

Velocity The velocity can only be entered with Fieldpiece airflow accessory head(s) such as the AAV3. This is for convenience and to ensure accurate measurements. It allows for multiple measurements per grille. Hold the vane perpendicular to the grille, set the AAV3 to velocity and press Enter to start taking the measurement.

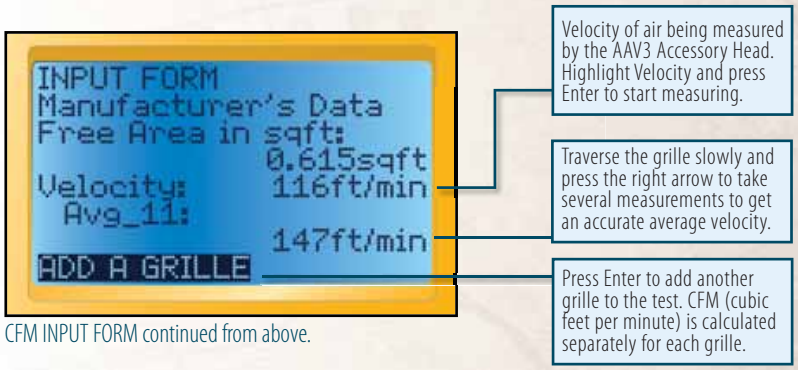
Avg While the velocity is being measured press the Right Arrow to take additional readings to get a more accurate average. You can take up to 99 readings per grille.

Add a Grille Highlight ADD A GRILLE and press Enter.

Customer ID Used in the file name to save, recall and download tests.



CFM INPUT FORM.



CFM INPUT FORM continued from above.

6.3 CFM OUTPUT FORM

Outputs for Each Grille

Grille 01: Each grille measured will have the Grille number and Grille ID displayed on the OUTPUT FORM.

CFM: The calculated Cubic Feet per Minute will be displayed for each grille.

Average: The average air velocity of all the readings taken at each grille.

Minimum: The minimum air velocity of all the readings taken at each grille.

Maximum: The maximum air velocity of all the readings taken at each grille.

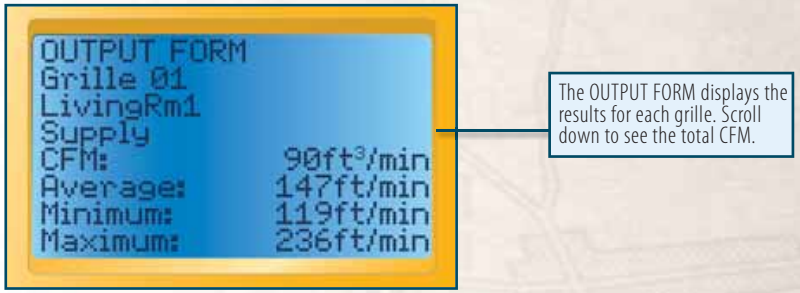
See Sec (See Section) The section numbers on the OUTPUT FORM refer to the sections in this manual with more detailed information about each test.

Number of Readings: The number of readings taken at each grille.

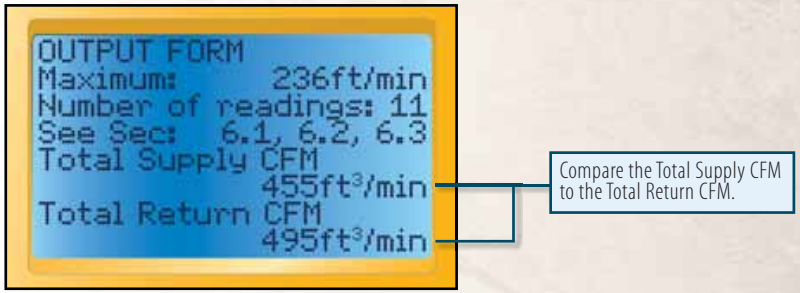
Outputs For Each Test

Total Supply CFM: The total CFM for all the supply grilles.

Total Return CFM: The total CFM for all the return grilles.



CFM OUTPUT FORM.



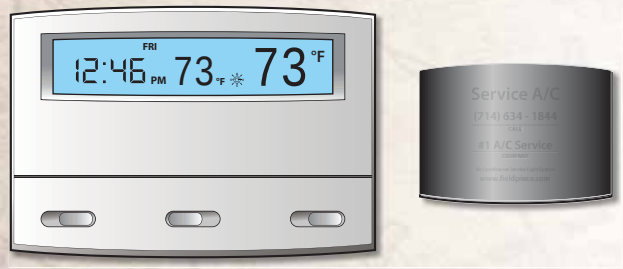
CFM OUTPUT FORM continued from above.

7.1 Service Light Overview

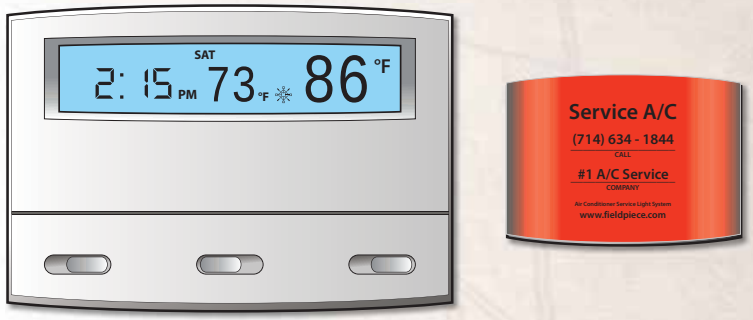
The Service Light is just like a "check engine" light that you can install onto your customer's air conditioning system. The Service Light is installed near the thermostat and will light up when a problem exists. There is a convenient place to put your company name and phone number on the Service Light so your customer can easily contact you to come fix the problem.

Transmitters get installed onto the system and continuously measure and send data to two boxes, one for the condenser and one for the evaporator. These boxes collect data from the transmitters to look at the whole system while it's running and if a problem exists will turn the Service Light on.

The Service light is setup and programmed using the HG3. Switch the dial to Service Light and connect the HG3 to the Service Light to begin. For more information, please see the Service Light Operator's manual. Please visit www.fieldpiece.com/operator-manuals to download the Service Light operator's manual.



The Service Light is installed next to the thermostat. It will turn on when there is a problem and notify the building owner to contact you.



The Service Light is installed next to the thermostat. The light will turn on when there is a problem. Your contact info will be visible when the light is on.

The HG3 connects to the service light boxes for setup and data retreival.

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8.1 Data Logger and Display

Inputs

Looking at a system over a period of time sometimes is the only way to determine a problem. The HVAC Guide can log any parameter measured from a Fieldpiece Accessory Head. Accessory Heads can be attached directly or wirelessly. The HVAC Guide can log up to 12 wireless signals and 1 direct signal at the same time. This makes it easy to see how the whole system is operating and easily move about the job site without disconnecting any test instruments.

The tech decides how long the HVAC Guide test will run (span) and then how often a measurement will be taken (per). Once the data is saved in the HVAC Guide the technician can download it to a PC into a Microsoft Excel spreadsheet. Each reading is displayed on the spreadsheet along with the average, minimum, and maximum reading for each parameter.

Display

The HVAC Guide can display any parameter from any Fieldpiece Accessory head. Switch the dial to Display and select the desired parameter on the accessory head. The reading will be displayed in big bold numbers for easy reading.

Select ACV (AC Volts) or DCV (DC Volts) by pressing the UP/DOWN arrows. Almost every head uses DCV except for the ACH4, which uses ACV.

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8.2 Data Logger INPUT FORM

Inputs

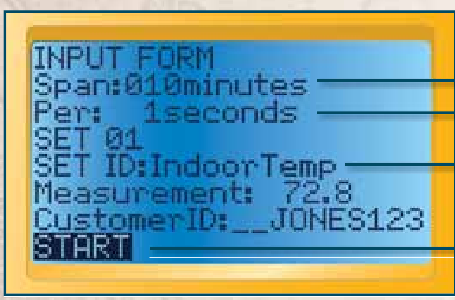
1. **Span:** The full length of time for the test. Select days, hours, minutes or seconds.

2. **Per:** How often the measurement(s) are taken during the span of the test.

3. **Set ID:** The name of the set of data for each parameter.

4. **Measurement:** Select Volts AC or volts DC. See Accessory Head instruction manual to determine Volts AC or Volts DC.

5. **CustomerID**: Used in the file name to save, recall and download tests. Use arrow buttons to "type" in each character. Press RIGHT arrow to get to the first character.

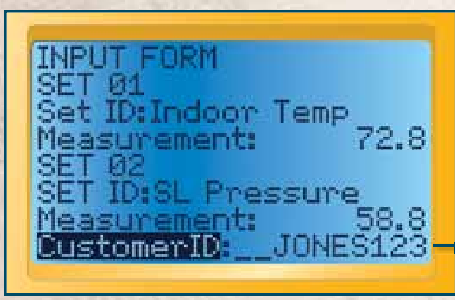


Set the Span for the entire length of the test. Set the Per to how often a reading is taken.

Each test can record up to 13 different measurements, called Sets. Each Set can be labeled with an ID.

Fill out the INPUT FORM and Press Enter when Start is highlighted to start recording.

Data Logger INPUT FORM.



Each test is labeled with a Customer ID. Use Arrows to type in Customer ID.

Data Logger INPUT FORM continued from above.

8.3 Data Logger OUTPUT FORM

Outputs

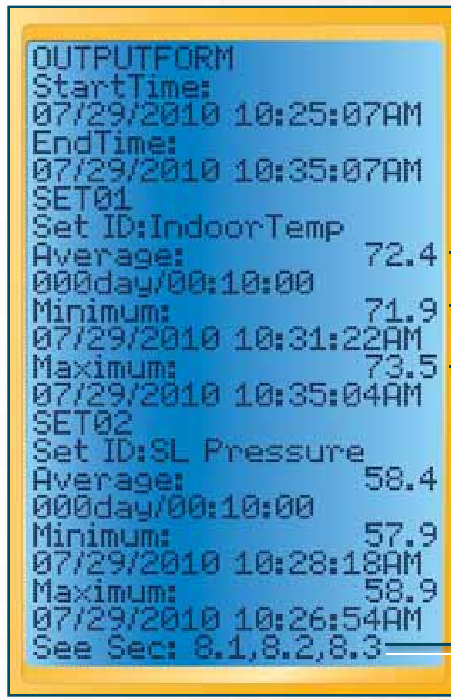
1. **StartTime:** The time when logging began.

2. **EndTime:** The time when the logging ended.

3. **Average:** Each data set has a calculated average over the entire set.

4. **Minimum:** Each data set has a minimum, time-stamped measurement.

5. **Maximum:** Each data set has a maximum, time-stamped measurement.



Average measurement of IndoorTemp with duration (Span) shown below.

Minimum and Maximum measurements during the 10 minute span with each time stamp shown below.

Here are the sections of the manual with more info on the Data Logger switch positions.

Data logger OUTPUT FORM.

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Setup Switch Position

Com with PC

Highlight Com with PC and press enter to upload and download tests to and from a PC. See HVAC Guide Software Manual for detailed information.

Memory Management

From the Setup Switch Position you can delete a single test, entire customer file, Grant info, data logs or all data. You can also check how much memory is left using the Check Memory Status.

Setup switch position display.

Power Savings

Sleep Mode: Set the HG3 to go into sleep mode after a desired amount of time. Sleep mode turns off the display while leaving all other functions running to save battery life. Press any button to come out of Sleep mode. Default for sleep mode is 15 Minutes.

Auto Power Off: Turn on Auto Power Off to save battery life. This is useful if the HG3 gets accidently left on. Auto power off is automatically disabled during data logging tests. You can set the time for Auto Power Off. Default for Auto Power off is 30 minutes.

Version (about)

You can check the version of your Firmware by highlighting Version(about) and pressing Enter. Keep your Firmware up to date by downloading the latest version from www.fieldpiece.com/downloads.

Time/ Time Setup

The internal clock is used to time stamp each saved test. The time cannot be altered once data is taken. The time is shown at the bottom of most INPUT FORMs.

- Rotate the dial to the SETUP.
- Scroll to Time Setup and Press ENTER.
- Press Enter to Change the time.
- LEFT and RIGHT arrows cycle through month, day, year, military clock, and minutes.
- UP and DOWN arrows adjusts.
- Press ENTER to set time.
- Press INPUT to get you back to the main SETUP screen.

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Advanced Operations

Units

On every INPUT FORM there is a "Units" line. The default is English units. Metric units can be used by pressing the RIGHT arrow when "Units" is highlighted. Scroll UP or DOWN to toggle between English and Metric units. Press ENTER to lock in your selection. The HVAC Guide will convert any measurement you have taken when units are changed mid test. The units change is universal throughout all switch positions.

Saving Data

Press the SAVE button and press ENTER while Yes is highlighted when in an INPUT FORM to save test data. Test data is saved along with Customer ID and a time stamp. You will be prompted to input a Customer ID before saving.

Recalling Saved Tests

While in the desired test, press the RECALL button to access previously saved test data. Highlight the Customer ID from the list, and press ENTER, and then highlight the date and time of the test you wish to recall, and press ENTER again. The INPUT FORM for that switch position will then be populated with the previous test's data. No Outputs are saved on the HVAC Guide, they are simply recalculated from the saved inputs.

Contrast Adjustment

To adjust the contrast level of the display hold the BACKLIGHT button until the Contrast Adjustment Screen shows. Press UP and DOWN arrows to adjust, and ENTER to set.

Clearing a Single Input or INPUT FORM

Press CLEAR when an input is highlighted to erase a single input. Hold the CLEAR button for three seconds and select Yes to clear an entire INPUT FORM.

Features

Dot matrix display mode (128 x 64 dot)
Scrolling display
Mini USB to USB
Plug for use with an AC/DC adapter for prolonged data logging
Wireless transmitter and receiver
Input types: drop down menu, signal (automatic) input, wireless (HG3 when used with a compatible transmitter ET2W and EH4W) manual input
Display contrast adjustment
Firmware updates through PC software
PC compatible
Output reports in Microsoft Excel™ format (.xls)
Blue Backlight
Test Data Diagnosis:

- Target Evaporator Exit Temperature
- Superheat Analysis
- Subcooling Analysis
- Combustion Analysis
- CheckMe!® Analysis
- Data Logger
- Display
- CFM
- Service Light

Data Record:

- Customer ID/Time
- Time (Date/Time Setting)
- Accessing Saved Tests
- Clear Saved Data

What's Included

- HG3 Body
- ATH4 Accessory Head
- ET2W Wireless Transmitter
- ATA1 - Dry Bulb Thermocouple
- ATWB1 - Wet Bulb Thermocouple
- ANC8 - Nylon Carrying Case
- Software
- Mini USB-USB Cable

Specifications

- Display: 21 characters X 8 rows
- Low battery indication: " " is displayed when the battery voltage drops below the operating level. To prevent data corruption wait until "Power Off" is cleared from the display before removing batteries. Battery: AA x 6.
- Operating environment: 0°C (32°F) to 50°C (122°F) at <70% R.H.
- Storage temperature: -20°C (-4°F) to 60°C (140°F) to 80% R.H. with battery removed from meter.
- Dimensions: 210mm (8.27in) (H) x 80mm (3.15in) (W) x 30mm (1.18in) (D)
- Weight: approx. 400g (0.88lb) including battery.
- DC Ranges: 500mVDC, 5VDC
- DC Accuracy: ±(0.5%rdg+2dgts)
- AC Range: 500mVAC (model HG2 & HG3)
- AC Accuracy: ±(0.8%rdg+6dgts) (model HG2 & HG3)
- Input protection: Max. 30VDC/24VAC (Use Accessory Heads Only)
- Resolution: 0.1mV = 1 count on 500mV range; 1mV=1 count of 5V range.
- Wireless Range: Approximately 100 feet

Limited Warranty

This meter is warranted against defects in material or workmanship for one year from date of purchase. Fieldpiece will replace or repair the defective unit, at its option, subject to verification of the defect.

This warranty does not apply to defects resulting from abuse, neglect, accident, unauthorized repair, alteration, or unreasonable use of the instrument.

Any implied warranties arising from the sale of a Fieldpiece product, including but not limited to implied warranties of merchantability and fitness for a particular purpose, are limited to the above. Fieldpiece shall not be liable for loss of use of the instrument or other incidental or consequential damages, expenses, or economic loss, or for any claim of such damage, expenses, or economic loss. State laws vary. The above limitations or exclusions may not apply to you.

Obtaining Service

Prior to sending the meter in for repair, try taking the batteries out and reinstalling them or replacing them. Send the meter freight prepaid to Fieldpiece Instruments. For warranty service, send proof of date and location of purchase. For out-of-warranty service, call Fieldpiece for a quote. The meter will be repaired or replaced, at the option of Fieldpiece, and returned via same shipping service (speed) as shipped to Fieldpiece.

For help with the CheckMe!® switch position, contact Proctor Engineering:

Proctor Engineering
Phone: (415) 451-2480
Fax: (415) 451-2491
418 Mission Avenue
San Rafael, CA 94901

For help with the PC Software, or general How to Use questions as well as Warranty Repair Issues contact Fieldpiece Instruments. www.fieldpiece.com.

Appendix

CheckMe! Diagnostics

5.4 Indoor Coil Airflow Diagnosis

5.401 Airflow OK: The indoor coil airflow was directly measured using the TrueFlow® grid and is OK.

5.402 Probable OK airflow: The indoor coil airflow was tested by an indirect means (temperature split) and is probably OK.

5.403 Airflow unknown, check airflow: The measurements are insufficient to diagnose the indoor coil airflow. Either measure the Return Plenum Dry Bulb, Wet Bulb and Supply Plenum Dry Bulb or use a TrueFlow® Plate.

5.404 Low airflow, increase airflow until actual temp split matches target temp split. Actual temp split is __°F and target temp split __°F: The indoor coil airflow is low based on the temperature split. Check the filter and coil, inspect for any restrictions and blockages. Make sure all registers are open. If the airflow remains low, consider increased blower speed and duct system modifications. Supply and return plenum static pressures can be used to diagnose the causes of low airflow.

5.405 Low airflow, increase airflow: The indoor coil airflow was directly measured using the TrueFlow® grid and is low. Check the filter and coil, inspect for any restrictions and blockages. Make sure all registers are open. If the airflow remains low after a retest, consider increased blower speed and duct system modifications. Supply and return plenum static pressures can be used to diagnose the causes of low airflow.

5.406 Low capacity or possible high airflow, measure airflow directly: The temperature split is low. This usually means that the capacity of the system has been reduced due to incorrect refrigerant charge. Higher than expected airflow is rare, but does occur occasionally. Measuring the airflow directly would identify if high airflow is the cause of the low temperature split.

5.407 High airflow, possibly reduce airflow: The indoor coil airflow was directly measured using the TrueFlow® grid and is higher than expected. Consider reducing the airflow particularly if the unit is in a damp climate. In heat pumps high airflow causes uncomfortably low delivery temperatures.

5.408 Possible plenum temperature measurement error, retake plenum temperatures: The reported wet and dry bulb temperature readings from the return and supply plenums are unlikely. Retake the measurements in the INPUT FORM. See Return DB and Return WB sections for detailed instructions on how to take these measurements properly.

5.5 Refrigerant Charge Diagnosis

5.501 Charge OK: Refrigerant charge was tested using the appropriate method, and it is OK.

5.502 Possible OK charge: The primary indicator of refrigerant charge (subcooling for TXV/EXV or superheat for non-TXV) indicates the refrigerant level was OK. However, a secondary indicator reduces the confidence in that diagnosis. Check out any other potential problems indicated.

5.503 Charge unknown, check charge: The measurements are insufficient to diagnose the refrigerant charge. For best results return to the INPUT FORM by pressing the INPUT button and fill out the INPUT FORM completely before pressing the OUTPUT button again.

5.504 Possible undercharge, possibly add refrigerant: Try fixing other conditions first and retesting but if this diagnosis persists the system may be undercharged, if no other conditions are triggered, consider adding refrigerant to correct. The amount of refrigerant to add will vary based on the size of the system and the difference between Target and

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Actual superheat/subcooling.

5.506 Undercharged, add refrigerant until actual superheat reaches target superheat. Your actual superheat is __°F and your target superheat is __°F: This fixed metering device system is low on refrigerant. Add refrigerant until the actual superheat is within ±5°F (Grant = None) of the target superheat. The closer the actual superheat is to the target superheat, the better.

5.507 Undercharged, add refrigerant to obtain 6°F of superheat: This fixed metering device system is low on refrigerant. Since the test conditions are hot outside, dry inside, or both, the exact target superheat cannot be determined. Because the actual superheat is greater than 6°F the unit is undercharged. Add refrigerant until the superheat is 6°F.

5.508 Charge unknown, raise indoor temperature to obtain a target superheat ≥ 5°F and retest: Since the test conditions are hot outside, dry inside, or both, the exact target superheat cannot be determined. This fixed metering device system may be correctly charged or overcharged. It may be possible to open windows or run the furnace to change the indoor conditions enough to obtain a target superheat upon a retest.

5.509 Possible overcharge, possibly remove refrigerant: Try fixing other conditions first and retesting, but if this diagnosis persists, the system may be overcharged. If no other conditions are triggered, consider recovering refrigerant to correct. The amount of refrigerant to recover will vary based on the size of the system and the difference between Target and Actual superheat/subcooling.

5.510 Overcharged, recover refrigerant until actual superheat reaches target superheat. Your actual superheat is _°F and your target superheat is _°F: There is too much refrigerant in this non-TXV system. Remove refrigerant until the superheat is within ±5°F of the target superheat. The closer the superheat is to the target, the better.

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5.511 Overcharged, recover refrigerant until actual subcooling reaches target subcooling. Actual subcooling is _°F and target subcooling is _°F: There is too much refrigerant in this TXV/EXV system. Remove refrigerant until the actual subcooling is within ±3°F (Grant = None) of the target subcooling. The closer the actual subcooling is to the target subcooling, the better.

5.512 Undercharged, add refrigerant until actual subcooling reaches target subcooling. Your actual subcooling is _°F and your target subcooling is _°F: This TXV/EXV system is low on refrigerant. Add refrigerant until the subcooling is within ±3°F (Grant = None) of the target subcooling. The closer the actual subcooling is to the target subcooling, the better.

5.6 Refrigerant Lines and Metering Devices Diagnosis

Refrigerant line restrictions, incorrect orifice sizes, and TXVs improperly installed are common. Any of these problems can lead to premature compressor failure.

If there are restrictions in the refrigerant lines (pinches, dirty filter driers), the charge measurements will provide contradictory information; and getting proper performance will not be possible. Similarly if the orifice of the metering device is too small or partially blocked by foreign material in the refrigerant (such as chips and flakes from improper brazing techniques), the unit will not perform to specifications.

If a fixed orifice is too large (not matched to the inside coil), the refrigerant will not meter properly, contradictory measurements will be obtained.

A thermostatic expansion valve (TXV) only works when the sensing bulb is in solid contact with the suction line and only senses the temperature of the suction line. Therefore, it must be well insulated from surrounding air. The TXV is designed to maintain a constant superheat.

5.601 Possible oversized metering orifice, consult manufacturer's specifications: The metering orifice is suspected of letting

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too much refrigerant through. Check that the orifice is sized properly. Find the metering device part number and obtain the orifice size from the manufacturer or distributor and verify the size is appropriate for the air conditioner.

5.602 Probable oversized metering orifice, consult manufacturer's specifications: The metering orifice lets too much refrigerant through. Check that the orifice is sized properly. Find the metering device part number and obtain the orifice size from the manufacturer or distributor and verify the size is appropriate for the air conditioner.

5.603 Check TXV to ensure proper functioning: This TXV is not maintaining proper superheat. Check that the TXV bulb is adjusted properly and in continuous contact with the suction line and well insulated from the surrounding air.

5.604 Possible liquid line restriction, check liquid line: Make sure the service shut-off valves are open. Check the liquid line for kinks, tight bends or sections that may have been stepped on or crushed. Check for a large temperature difference between the liquid line at the compressor and at the metering device.

5.7 Condenser Coil Performance Diagnosis

5.701 Condenser airflow OK: The condenser airflow and capacity indications are OK.

5.702 Condenser approach unknown, check condenser approach: Liquid line temperature and liquid line pressure measurements need to be taken for the condenser approach. These measurements give indications of the performance of the air conditioner including diagnoses of compressor problems, low capacity, and low condenser airflow.

5.703 Low condenser airflow, clean condenser, check condenser fan: There is insufficient airflow going across the condenser for the needed heat transfer. Check that the condenser coils and fins are clean, aligned and free of nearby obstructions. Check the fan motor bearings to ensure that the fan is rotating freely.

5.8 Outdoor Unit Amp Draw Diagnosis

5.801 Outdoor amp draw OK: The outdoor unit is running at the proper amperage for the current conditions.

5.802 Condensing unit amps unknown, check condensing unit amps: The outdoor unit amp draw was not measured.

5.803 High outdoor amp draw, probable excessive compressor friction: Check other possible causes of high amp draw (low condenser airflow and refrigerant overcharge) before condemning the compressor. Check that condenser coils and fins are clean, aligned, and free of nearby obstructions.

5.804 Low outdoor amp draw, possible compressor valve or motor problem: Check the refrigerant charge before condemning the compressor.

5.9 Cooling Capacity Diagnosis

The heat rejection at the outside unit is another measurement that gives indication of the health of the compressor as well as other potential problems.

5.902 Low capacity: This unit is operating under its expected capacity. Check the refrigerant charge, repair if needed, and retest.

5.903 Low capacity, check compressor amps and coil saturation temperatures: Full diagnosis of this situation requires a complete set of data including compressor amps, high and low side pressures, and liquid and suction line temperatures.

5.10 Heat Pump in Heating Diagnosis

5.1001 Heating Capacity OK: The heat pump is delivering the proper heating.

5.1002 Capacity unknown, check capacity: The TrueFlow® inputs, outdoor unit entering temp, return plenum temperature, and supply plenum temperature need to be measured before determining capacity.

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5.1003 Low capacity, defrost outside coil or adjust charge and retest: Verify that the outside coil is not frosted or iced. Frost reduces the capacity of the heat pump. If the unit is not frosted, adjust the refrigerant charge per the manufacturer's specification.

5.1004 High temp split, make sure strip heat is NOT on, recheck airflow if necessary: Check amperage to the electric strip heaters to verify they are turned off.

Accessory Head Descriptions

AAV3: Air velocity (Ft/min, M/s, MPH, KM/hr) and temperature (°F, °C). Switch Positions: CFM, Display, and Data logger.
ACH4: Amps (AAC). Switch positions: CheckMe!, Data logger and Display.
ACM3: Carbon Monoxide (CO). Switch positions: Combustion, Data logger and Display.
ADMN2 and **AMN2:** Static pressure in Water Column (WC) and millibar (mBar). Switch positions: Data logger and Display.
AOX2: Oxygen (%O2), Carbon Dioxide (%CO2), Excess Air (EA%) and Temp (°F, °C).
ARH4: Thermistor only measures %RH and °F. The wet bulb and dew point are calculated from those measurements. Switch positions: target evap exit temperature, superheat, subcooling, CheckMe!, data logger and display.
ASX14: Pressure (psig, kPa), line temperature (°F, °C). Switch Positions: Superheat, Subcooling, CheckMe!, Data Logger and Display.
ATH4: Temperature with thermocouples (includes wet bulb and dry bulb thermocouples). Accepts any K-Type thermocouples.
ATIR3: Infrared temperature measurement with laser (°F, °C). Switch Positions: Data logger and display.
AUA2: Milliamps (mA) and microamps(µA) AC and DC. Switch positions: Data logger and Display.
AVH1: Volts (V) AC and DC. Switch positions: Data logger and display.

K-Type Thermocouples

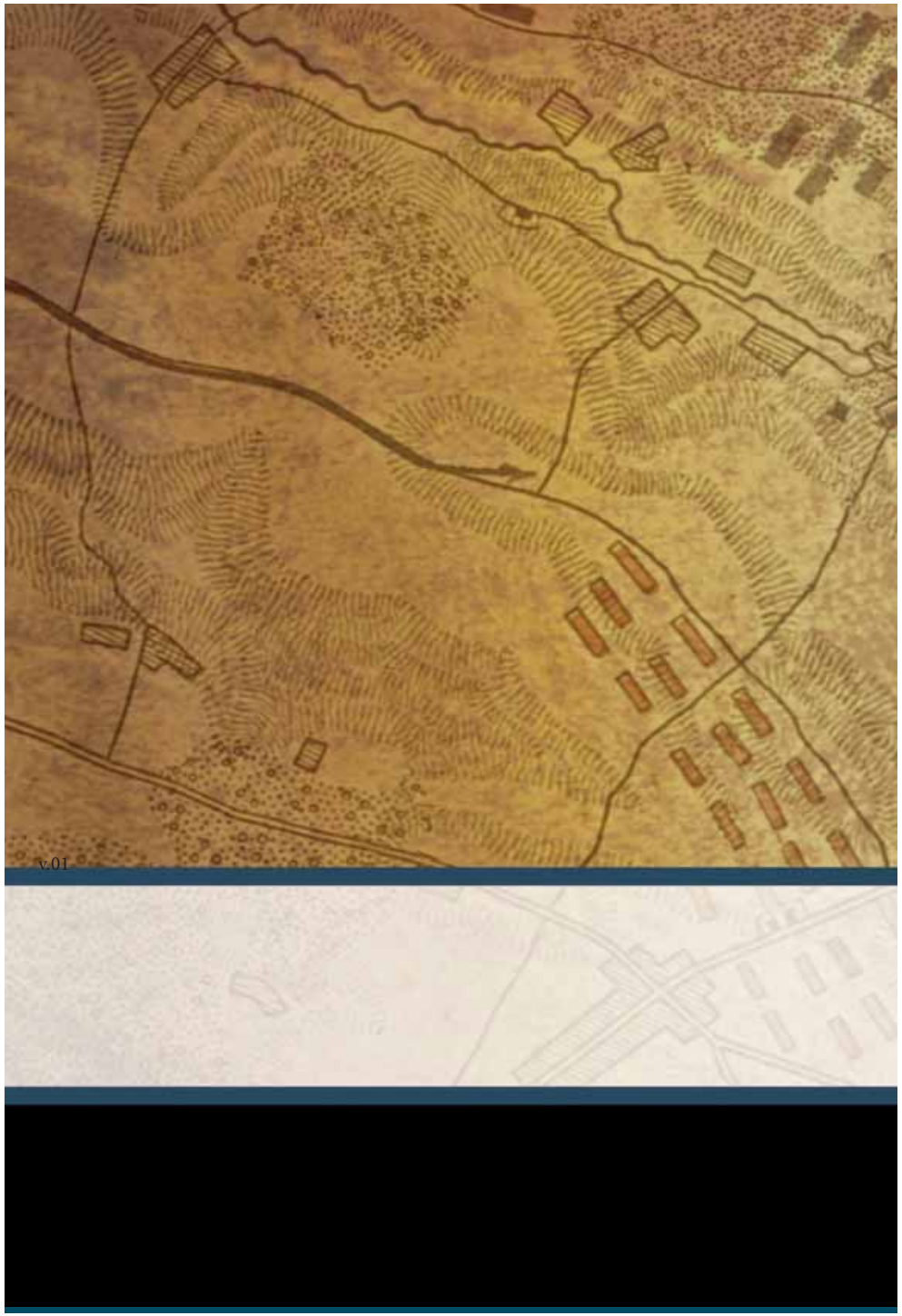
ATA1: Dry bulb air temperature with a clip.
ATB1: Dry bulb air temperature.
ATBF1: Dry bulb air temperature up to 900°F
ATC1: Pipe Clamp thermocouple (3/8" to 1 3/8").
ATC1R: Pipe clamp thermocouples. (1/8" to 3/4").
ATR1: Dry bulb air temperature with 4.5" piercing probe.
ATWB1: Wet bulb air temperature with clip.

Refrigerants

R-22, R-410A, R-134A, R-404A, R-407C, R-409C, R-408A, R-507A, R-414B (Hotshot), R-422C (Oneshot), R-422B (NU22B), R-12, R-416A, R-422D, R-38A (MO99), R-407A, R-123, R-502, R-401A (MP39), R-402A, R-11, R-500, R-503, R-401B, R-402B, R-406A, R-417A, R-420A, R-421A, R-421B, R-422A, R-424A, R-434A (RS-45), R-13, R-23, R-113, R-114, R-124, R-125.

Disclaimer

Neither this book nor the HVAC Guide makes you an expert in HVAC. The purpose of the HVAC Guide and this manual is to help you take the necessary tests to optimize an air conditioner easier and to refresh your memory on how to perform those tests. This book and the HVAC Guide by no means replace experience or completion of an HVAC program from a qualified school.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