

Long Line Applications Guideline

R-410A Split Systems

Single-Stage and Two-Stage

TABLE OF CONTENTS

A. Safety Considerations	2
B. Definitions	2
C. Introduction	3
D. General Limitations	3 – 4
E. Interconnecting Tubing and Fitting Losses	4 – 5
F. Metering Device — Cooling	5
G. Piston Sizing — Heat Pump Heating Mode	5
H. Liquid Line Solenoid Valve — Heat Pump Heating Mode	5
I. Charging Information	5 – 13
J. General Requirements (Check List)	13 – 14
K. R-410A Quick Reference Guide	15

INDEX OF TABLES

Table 1	Long Line Accessory Requirements	4
Table 2	Fitting Losses in Equivalent Feet	5
Table 3	R-410A Air Conditioner Cooling Capacity Loss for Various Line Lengths & Tube Diameters – Single-Stage ...	6
Table 4	R-410A Air Conditioner Cooling Capacity Loss for Various Line Lengths & Tube Diameters – Two-Stage	7
Table 5	R-410A Heat Pump Cooling Capacity Loss for Various Line Lengths & Tube Diameters – Single-Stage	7
Table 6	R-410A Heat Pump Cooling Capacity Loss for Various Line Lengths & Tube Diameters – Two-Stage	8
Table 7	Refrigerant Charge Adjustment	8
Table 8	Maximum Total Equivalent Length; Equal Level or Outdoor Unit Below Indoor Unit	9
Table 9	R-410A Refrigerant Long Line Description – Outdoor and Indoor on Same Level	9
Table 10	Maximum Total Equivalent Length; Outdoor Unit Below Indoor Unit	10
Table 11	R-410A Refrigerant Long Line Description – Outdoor Unit Below Indoor Unit	10
Table 12	HP Outdoor Piston Change — Outdoor Unit Below Indoor Unit	11
Table 13	Maximum Total Equivalent Length; Outdoor Unit Above Indoor Unit	12
Table 14	R-410A Refrigerant Long Line Description – Outdoor Unit Above Indoor Unit	12
Table 15	HP Outdoor Piston Change — Outdoor Unit Above Indoor Unit	13
Table 16	Common HP Piston Sizes Available Through FAST	14


INDEX OF FIGURES

Figure 1	Tube Bend Losses	5
Figure 2	R-410A Equal Level Applications	9
Figure 3	R-410A Outdoor Unit Below Indoor Unit	10
Figure 4	R-410A Outdoor Unit Above Indoor Unit	12

A. Safety Considerations

Only trained service technicians familiar with standard service instructions and training materials should attempt installation, service, and repair of these units. Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause death, personal injury, or property damage. Consult a qualified installer, service agency, or your distributor or branch for information or assistance. The qualified installer or agency must use factory--authorized kits or accessories when modifying this product. Refer to the individual instructions packaged with the kits or accessories when installing.

Follow all safety codes. Wear safety glasses, protective clothing, and work gloves. Use quenching cloth for brazing operations. Have fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit. Consult local building codes and National Electrical Code (NEC) for special requirements.

Recognize safety information. This is the safety-alert symbol . When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury. Understand these signal words; DANGER, WARNING, and CAUTION. These words are used with the safety-alert symbol. DANGER identifies the most serious hazards which **will** result in severe personal injury or death. WARNING signifies hazards which **could** result in personal injury or death. CAUTION is used to identify unsafe practices which **may** result in minor personal injury or product and property damage. NOTE is used to highlight suggestions which **will** result in enhanced installation, reliability, or operation.

WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death.

All equipment should be installed in accordance with accepted practices and unit Installation Instructions, and in compliance with all national and local codes. Power should be turned off when servicing or repairing electrical components. Extreme caution should be observed when troubleshooting electrical components with power on. Observe all warning notices posted on equipment and in instructions or manuals.

WARNING

EXPLOSION AND PERSONAL SAFETY HAZARD

Failure to follow this warning could result in personal injury, equipment damage or improper operation.

Refrigeration systems contain refrigerant under pressure. R-410A refrigerant systems operate at higher pressure than standard R-22 systems. Use only service equipment and components rated for R-410A refrigerant. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operations, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

Refrigeration systems contain refrigerant under pressure. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operations, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

B. Definitions

This Guideline covers **all** residential split system air conditioner and heat pump products using R-410A refrigerant **including two-stage models**.

C. Introduction

An application is considered Long Line, when the refrigerant level in the system requires the use of accessories to maintain acceptable refrigerant management for systems reliability. See Table 1 for required accessories. Defining a system as long line depends on the liquid line diameter, actual length of the tubing, and vertical separation between the indoor and outdoor units.

For Air Conditioner systems, the chart below shows when an application is considered Long Line.

AC with R-410A Refrigerant Long Line Description ft (m) Beyond these lengths, long line accessories are required			
Liquid Line Size	Units On Same Level	Outdoor Below Indoor	Outdoor Above Indoor
1/4	No accessories needed within allowed lengths	No accessories needed within allowed lengths	175 (53.3)
5/16	120 (36.6)	50 (15.2) vertical or 120 (36.6) total	120 (36.6)
3/8	80 (24.4)	35 (10.7) vertical or 80 (24.4) total	80 (24.4)

For Heat Pump systems, the chart below shows when an application is considered Long Line.

HP WITH R-410A REFRIGERANT LONG LINE DESCRIPTION ft (m) Beyond these lengths, long line accessories are required			
Liquid Line Size	Units On Same Level	Outdoor Below Indoor	Outdoor Above Indoor
3/8	80 (24.4)	20 (6.1) vertical or 80 (24.4) total	80 (24.4)

Long line applications are clearly defined in this Guideline, and must be treated differently from standard systems. A long line system requires special consideration for the following reasons:

- Additional refrigerant charge
- Refrigerant migration control
- Oil return concerns
- Capacity losses
- Metering device adjustments

Longer line sets require additional refrigerant charge that must be managed throughout the entire range of possible ambient conditions. Off-cycle refrigerant migration that results in excess refrigerant in the compressor at start up, or condensed liquid refrigerant in the suction line at start up must be avoided for compressor reliability. Follow all accessory requirements in this Guideline to control off-cycle refrigerant migration (see Table 1).

Another concern is proper line set sizing and construction to control oil return to the compressor, and minimize capacity losses. In residential applications, proper suction line sizing is critical to achieve adequate oil return, and maintain expected system performance. Oil return in heating mode is different from cooling mode thus, in some cases, heat pumps have additional line set limitations from air conditioning units. Table 3, Table 4, Table 5, and Table 6 in this guideline can be used to properly size suction lines. Follow all suction line sizing recommendations to ensure system performance and adequate oil return for compressor lubrication.

The third concern is refrigerant metering. Elevation changes affect pressure drop in refrigerant lines. These effects must be considered when sizing liquid lines and orifice-metering devices. Since all current products utilize a TXV for cooling mode metering, piston sizing is only a concern for heat pump heating operation. Follow piston change recommendations in this Guideline for proper heat pump heating operation (see Table 12 and Table 15).

Since the last revision of this guideline, testing has been done to determine limitations for the application of 1/4 and 5/16 inch liquid lines in cooling only systems. The limiting factor when sizing liquid lines is pressure drop. Equivalent length and vertical separation both contribute to the pressure drop in a liquid line. The liquid line sizing charts in this guideline have been developed based on a TXV metering device on the indoor coil. Staying within these guidelines and charging to a minimum of 10°F (5.6°C) subcooling will ensure a column of liquid is present at the TXV. There are no capacity or efficiency changes to the system performance when staying within these guidelines.

NOTE: When an application is “Long Line” the accessories shown in Table 1 are required.

D. General Limitations

Liquid Lines – AC Only

Liquid line diameters of 1/4” and 5/16” and 3/8” are allowed for cooling only systems and limitations are provided. Using smaller liquid lines affects the maximum allowable equivalent length and when the application qualifies as long line. Elevation changes between the indoor and outdoor units also affect allowable equivalent lengths. See Table 8, Table 10, and Table 13 to properly size liquid lines.

NOTE: Using 1/4 and 5/16” liquid lines within the limits provided, result in no capacity or efficiency changes to the system.

Liquid Lines – Heat Pump

Liquid line sizing for heat pumps is currently limited to 3/8”. Future updates are planned to include alternate liquid line sizing for heat pump applications. Check HVAC Partners for updates.

Suction Lines

Use Table 3 through Table 6 to properly size suction lines. Acceptable suction line sizes are shown for each size and type system. Air conditioners and heat pumps have separate charts due to oil return needs for heat pumps in heating mode.

Table 1	Long Line Accessory Requirements					
Accessory	Outdoor Unit Above		Outdoor Unit Below		Equal Level	
	AC	HP	AC	HP	AC	HP
Liquid Line Solenoid (outdoor)	No	YES	No	YES	No	YES
TXV (indoor)	YES	YES	YES	YES	YES	YES
Crankcase Heater (factory installed on some models)	YES	YES	YES	YES	YES	YES
Start Capacitor & Relay	YES	YES	YES	YES	YES	YES
Piston Change (Heat Pump Outdoor)	n/a	YES (see Table 15)	n/a	YES (see Table 12)	n/a	No
Inverted Trap (Vapor Line)	n/a	n/a	YES (See Figure 3)	YES (See Figure 3)	n/a	n/a
Standard Trap(s) (Vapor Line)	No	No	No	No	No	No

CAUTION

COMPONENT FAILURE HAZARD

Failure to follow this caution may result in unit component failure.

For proper oil return and minimizing capacity losses, only use vapor line sizes listed in Table 3 through Table 6.

E. Interconnecting Tubing and Fitting Losses

Choosing the proper tubing diameters is critical for reliable long line applications. For proper suction line sizing, see Table 3 through Table 6. These charts show all acceptable suction line diameters and related performance data based on total equivalent length. See Table 8, Table 10, and Table 13 for the allowable liquid tubing diameters for both single-stage and two-stage.

Refrigerant tubing must be measured both in terms of actual length and equivalent length. Use actual length for limitations and refrigerant charge calculation. The maximum liquid line length will vary depending on diameter and elevation change between indoor and outdoor units. Equivalent length takes into account pressure losses from both tubing length and losses due to fittings and accessories, such as elbows, liquid line solenoid and filter drier. Losses from fittings are expressed in equivalent length, meaning the length of straight tubing that would have the same pressure loss as the fitting. See Table 2 for equivalent lengths of commonly used fittings and accessories; maximum equivalent length allowed is up to 250 ft (76.2 m). See Table 8, Table 10, and Table 13 for maximum total equivalent length.

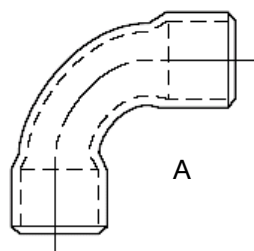
Calculate total equivalent length by adding linear (actual) length of the tubing required and the equivalent length of all elbows and accessories used. See Table 3 through Table 6 to determine capacity loss of the system due to equivalent length losses and subtract them from the published system capacity for the particular outdoor/indoor unit combination. This data is found in the outdoor unit Product Data.

Example: A 4-ton system using 7/8 in. diameter line set has a total tubing length of 165 ft. The tubing configuration uses four standard 90° elbows and two 90° long-radius elbows. Checking Table 2, the total equivalent length is calculated as:

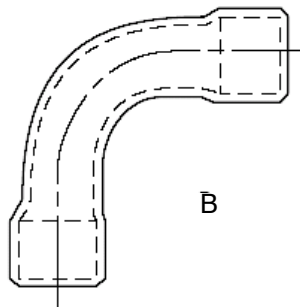
165 ft straight tubing + (four standard 90° elbows x 2 ft) + (two long-radius 90° elbows x 1.4 ft) = 165 ft. + 8 ft + 2.8 ft = 175.8 ft total equivalent length.

Figure 1

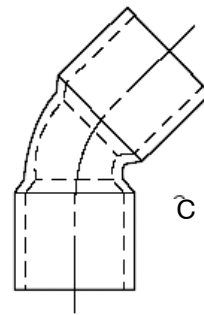
Tube Bend Losses



90° STANDARD



90° LONG RADIUS



45° STANDARD

A01058

Table 2 Tube Size O.D. (In.)	Fitting Losses in Equivalent Feet Fitting– Reference Diagram in Figure 1		
	90° Std (A)	90° Long-Rad (B)	45° Std (C)
1/2	1.2	0.8	0.6
5/8	1.6	1.0	0.8
3/4	1.8	1.2	0.9
7/8	2.0	1.4	1.0
1–1/8	2.6	1.7	1.3
Liquid Line Solenoid	12		
Filter Drier	6		

F. Metering Device – Long line Cooling

In current equipment, all indoor units use a hard-shutoff TXV for metering in the cooling mode. This provides adequate refrigerant migration protection for all cooling applications.

G. Piston Sizing – Heat Pump Only

A piston (fixed orifice) is used for refrigerant metering in the heating mode. This fixed expansion device must be changed from the factory-supplied piston based on indoor/outdoor vertical separation and system capacity. For horizontal applications up to 200 ft (61 m) linear length and 250 ft (76 m) total equivalent length, no heating piston change is necessary.

When sizing the heating piston for installations where the outdoor unit is below the indoor unit, use Table 12. When outdoor unit is located above indoor unit, use Table 15.

Example: The factory supplied piston for a single-stage 3-ton heat pump is a number 57. A system is installed with 200 equivalent ft of line set. Approximately 60 ft (18.3 m) is horizontal and the outdoor unit is 140 ft (42.7 m) above the indoor unit. Table 12 shows the piston change to be +6. The new piston size is $57 + 6 = 63$. If a 63 is not produced, round up to the next larger available piston size.

On the same heat pump, if the outdoor unit was located 49 ft (14.9 m) below the indoor unit, Table 12 shows the piston change to be $57 - 2 = 55$. If a 55 piston is not produced, round up to the next available size.

H. Liquid Line Solenoid – Long Line Heat pump Heating

Since pistons do not provide off-cycle refrigerant migration protection in the heating mode, a liquid line solenoid is required for single-stage and two-stage heat pump long line applications. Bi-flow solenoid valves provide flow control protection only in the direction of the arrow molded into the valve. **The arrow must point toward the outdoor unit** for off-cycle refrigerant control in the heating mode. The arrow shows the direction of flow control. The solenoid should be installed within 2 ft. of the outdoor unit. The liquid line solenoid kit number for a heat pump is NASA001LS.

NOTE: Equivalent length of the liquid line solenoid should be added to the total equivalent length of the tubing. See Table 2.

I. Charging information

Use subcooling as the primary method for charging longline applications. Outdoor units are pre-charged for 15 ft (4.6 m) of 3/8 liquid line. When using different length diameter liquid lines, charge adjustments are required. See Table 7 for charge adjustments required. The charge adjustment will depend on the liquid line diameter used. See unit installation instructions for proper charging procedure.

For all long line applications, pressure drop and subcooling loss become a concern. In these applications, a **minimum of 10°F (5.6°C) of subcooling** is required for all liquid line diameters to ensure no refrigerant flashing occurs before the TXV metering device. Systems should be charged to 10° subcooling or the rating plate subcooling, whichever is greater.

The amount of factory-charge can be found on the unit rating plate or in the Product Data literature. Long line applications do not require additional oil charge.

VAPOR LINE SIZING AND COOLING CAPACITY LOSS

Acceptable vapor line diameters provide adequate oil return to the compressor while avoiding excessive capacity loss. The suction line diameters shown in Table 3 through Table 6 are acceptable for AC and HP systems with R-410A refrigerant:

Table 3		R-410A AIR CONDITIONER, Single-Stage Cooling Capacity Loss for Various Line Lengths & Tube Diameters											
Model Size	Liquid Line in.(mm)	Acceptable Vapor Line Sizes in. (mm)	Cooling Capacity Loss (%) at Total Equivalent Line Length, feet (m)										
			Standard Application			Long Line Application (Requires Accessories)							
			25' (7.6)	50' (15.2)	80' (24.4)	81' (24.7)	100' (30.5)	125' (38.1)	150' (45.7)	175' (53.3)	200' (61)	225' (68.6)	250' (76.2)
18	3/8 (10)	1/2 (13)	1	2	3	3	4	6	7	8	9	10	12
		5/8 (16)	0	0	1	1	1	1	2	2	3	3	3
		3/4 (19)	0	0	0	0	0	1	1	1	1	1	1
24		5/8 (16)	0	1	1	1	2	3	3	4	4	5	6
		3/4 (19)	0	0	0	0	0	1	1	1	1	1	2
		7/8 (22)	0	0	0	0	0	0	0	0	0	0	1
30		5/8 (16)	1	2	3	3	3	4	5	6	7	8	9
		3/4 (19)	0	0	1	1	1	1	2	2	2	3	3
		7/8 (22)	0	0	0	0	0	1	1	1	1	1	1
36		5/8 (16)	1	2	4	4	5	6	7	9	10	11	13
		3/4 (19)	0	0	1	1	1	2	2	3	3	4	4
		7/8 (22)	0	0	0	0	0	1	1	1	1	2	2
42		3/4 (19)	0	1	2	2	2	3	4	4	5	6	6
		7/8 (22)	0	0	1	1	1	1	2	2	2	3	3
		1-1/8 (29)	0	0	0	0	0	0	0	0	0	0	1
48/49		3/4 (19)	0	1	2	2	3	4	5	5	6	7	8
		7/8 (22)	0	0	1	1	1	2	2	2	3	3	4
		1-1/8 (29)	0	0	0	0	0	0	0	0	1	1	1
60/61		3/4 (19)	1	2	4	4	5	6	7	9	10	11	12
		7/8 (22)	0	1	2	2	2	3	4	4	5	5	6
		1-1/8(29)	0	0	0	0	1	1	1	1	1	1	2

* Applications are considered "Long Line" if the total equivalent tubing length exceeds 80 feet (24.4m) or there is more than 20 foot (6.1m) vertical separation between indoor and outdoor units. These applications require additional accessories and system modifications for reliable system operation.

Applications in shaded area may have height restrictions that limit allowable total equivalent length when outdoor unit is below indoor unit.

Table 4		R-410A AIR CONDITIONER, Two-Stage Cooling Capacity Loss for Various Line Lengths & Tube Diameters											
Model Size	Liquid Line in.(mm)	Acceptable Vapor Line Sizes in. (mm)	Cooling Capacity Loss (%) at Total Equivalent Line Length, feet (m)										
			Standard Application			Long Line Application (Requires Accessories)							
			25' (7.6)	50' (15.2)	80' (24.4)	81' (24.7)	100' (30.5)	125' (38.1)	150' (45.7)	175' (53.3)	200' (61)	225' (68.6)	250' (76.2)
24	3/8 (10)	5/8 (16)	0	1	1	1	2	3	3	4	4	5	6
		3/4 (19)	0	0	0	0	0	1	1	1	1	1	2
36		5/8 (16)	1	2	4	4	5	6	7	9	10	11	13
		3/4 (19)	0	0	1	1	1	2	2	3	3	4	4
48		7/8 (22)	0	0	0	0	0	1	1	1	1	2	2
		3/4 (19)	0	1	2	2	3	4	5	5	6	7	8
		7/8 (22)	0	0	1	1	1	2	2	2	3	3	4
60		3/4 (19)	1	2	4	4	5	6	7	9	10	11	12
		7/8(22)	0	1	2	2	2	3	4	4	5	5	6
		1-1/8 (29)	0	0	0	0	1	1	1	1	1	1	2

* Applications are considered "Long Line" if the total equivalent tubing length exceeds 80 feet (24.4m) or there is more than 20 foot (6.1m) vertical separation between indoor and outdoor units. These applications require additional accessories and system modifications for reliable system operation.

Applications in shaded area may have height restrictions that limit allowable total equivalent length when outdoor unit is below indoor unit.

Table 5		R-410A HEAT PUMP, Single-Stage Cooling Capacity Loss for Various Line Lengths & Tube Diameters											
Model Size	Liquid Line in.(mm)	Acceptable Vapor Line Sizes in. (mm)	Cooling Capacity Loss (%) at Total Equivalent Line Length, feet (m)										
			Standard Application			Long Line Application (Requires Accessories)							
			25' (7.6)	50' (15.2)	80' (24.4)	81' (24.7)	100' (30.5)	125' (38.1)	150' (45.7)	175' (53.3)	200' (61)	225' (68.6)	250' (76.2)
18/19	3/8 (10)	1/2 (13)	1	2	3	3	4	6	7	8	9	10	12
		5/8 (16)	0	0	1	1	1	1	2	2	3	3	3
24		5/8 (16)	0	1	1	1	2	3	3	4	4	5	6
		3/4 (19)	0	0	0	0	0	1	1	1	1	1	2
30		5/8 (16)	1	2	3	3	3	4	5	6	7	8	9
		3/4 (19)	0	0	1	1	1	1	2	2	2	3	3
		7/8 (22)	0	0	0	0	0	1	1	1	1	1	1
36/37		5/8 (16)	1	2	4	4	5	6	7	9	10	11	13
		3/4 (19)	0	0	1	1	1	2	2	3	3	4	4
		7/8 (22)	0	0	0	0	0	1	1	1	1	2	2
42		3/4 (19)	0	1	2	2	2	3	4	4	5	6	6
		7/8 (22)	0	0	1	1	1	1	2	2	2	3	3
48		3/4 (19)	0	1	2	2	3	4	5	5	6	7	8
		7/8 (22)	0	0	1	1	1	2	2	2	3	3	4
60/61		3/4 (19)	1	2	4	4	5	6	7	9	10	11	12
		7/8 (22)	0	1	2	2	2	3	4	4	5	5	6
		1-1/8 (29)	0	0	0	0	1	1	1	1	1	1	2

* Applications are considered "Long Line" if the total equivalent tubing length exceeds 80 feet (24.4m) or there is more than 20 foot (6.1m) vertical separation between indoor and outdoor units. These applications require additional accessories and system modifications for reliable system operation.

Applications in shaded area may have height restrictions that limit allowable total equivalent length when outdoor unit is below indoor unit.

Table 6		R-410A HEAT PUMP, Two-Stage Cooling Capacity Loss for Various Line Lengths & Tube Diameters											
Model Size	Liquid Line in.(mm)	Acceptable Vapor Line Sizes in. (mm)	Cooling Capacity Loss (%) at Total Equivalent Line Length, feet (m)										
			Standard Application			Long Line Application (Requires Accessories)							
			25' (7.6)	50' (15.2)	80' (24.4)	81' (24.7)	100' (30.5)	125' (38.1)	150' (45.7)	175' (53.3)	200' (61)	225' (68.6)	250' (76.2)
24	3/8 (10)	5/8 (16)	0	1	1	1	2	3	3	4	4	5	6
		3/4 (19)	0	1	1	1	1	1	1	2	2	2	2
36		5/8 (16)	1	2	4	4	5	6	7	9	10	11	13
		3/4 (19)	0	0	1	1	1	2	2	3	3	4	4
48		3/4 (19)	0	1	2	2	3	4	5	5	6	7	8
		7/8 (22)	0	0	1	1	1	2	2	2	3	3	4
60		3/4 (19)	1	2	4	4	5	6	7	9	10	11	12
		7/8 (22)	0	1	2	2	2	3	4	4	5	5	6
		1-1/8 (29)	0	0	0	--	--	--	--	--	--	--	--

(—) Dashes indicate insufficient oil return to the compressor in heating mode. Use smaller tube diameter.

* Applications are considered “Long Line” if the total equivalent tubing length exceeds 80 feet (24.4m) or there is more than 20 foot (6.1m) vertical separation between indoor and outdoor units. These applications require additional accessories and system modifications for reliable system operation.

Applications in shaded area may have height restrictions that limit allowable total equivalent length when outdoor unit is below indoor unit.

Table 7	Refrigerant Charge Adjustments
Liquid Line Size	R-410A Charge (oz/ft)
3/8	0.60 (Factory charge for lineset = 9 oz)
5/16	0.40
1/4	0.27

Units are factory-charged for 15 ft (4.6 m) of 3/8" lineset. Factory charge for 3/8 lineset is 9 oz. When using other length or diameter liquid lines, charge adjustments are required per chart above.

Charging Formula:

$[(\text{Lineset oz/ft} \times \text{total length}) - (\text{factory charge for lineset})] = \text{charge adjustment}$

Example 1: System has 15 ft of line set using existing 1/4" liquid line. What charge adjustment is required?

Formula: $.27 \text{ oz/ft} \times 15\text{ft} - (9 \text{ oz}) = (-4.95) \text{ oz.}$

Net result is to remove 4.95 oz of refrigerant from the system

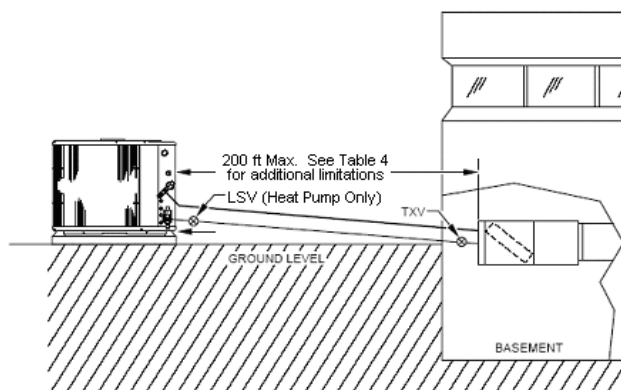
Example 2: System has 45 ft of existing 5/16" liquid line. What is the charge adjustment?

Formula: $(.40 \text{ oz/ft.} \times 45\text{ft}) - (9 \text{ oz.}) = 9 \text{ oz.}$

Net result is to add 9 oz of refrigerant to the system

Figure 2

R-410A Equal Level Applications



- A hard-shutoff TXV must be installed at indoor unit when application qualifies as long line. See Table 9.
- Hard Start Kit (start capacitor and relay) must be installed on outdoor unit when application qualifies as long line. See Table 9.
- A crankcase heater must be installed on compressor when the application qualifies as long line. See Table 9.
- Vapor line should slope towards indoor unit
- Maximum actual liquid line is up to 200 ft (61 m). See Table 8.
- Maximum total equivalent length is up to 250 ft (76.2 m). See Table 8.
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Heat pump only – Outdoor piston adjustment not required
- Use vapor line per Table 3 through Table 6.
- Use liquid lines per Table 8.

Table 8		Maximum Total Equivalent Length † Equal Level or Outdoor Unit Below Indoor Vertical Separation ft (m)									
Size	System Type	Liquid Line Diameter w/ TXV	0-5 (0-1.5)	6-10 (1.8-3.0)	11-20 (3.4-6.1)	21-30 (6.4-9.1)	31-40 (9.4-12.2)	41-50 (12.5-15.2)	51-60 (15.5-18.3)	61-70 (18.6-21.3)	71-80 (21.6-24.4)
18000	AC Only	1/4	150	150	125	100	100	75	--	--	--
	AC Only	5/16	250*	250*	250*	250*	250*	250*	250*	225*	150
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
24000	AC Only	1/4	75	75	75	50	50	--	--	--	--
	AC Only	5/16	250*	250*	250*	250*	250*	225*	175	125	100
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
30000	AC Only	1/4	30	--	--	--	--	--	--	--	--
	AC Only	5/16	175	225*	200	175	125	100	75	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
36000	AC Only	5/16	175	150	150	100	100	100	75	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
42000	AC Only	5/16	125	100	100	75	75	50	--	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	150
48000	AC/HP	3/8	250*	250*	250*	250*	250*	250*	230	160	--
60000	AC/HP	3/8	250*	250*	250*	225*	190	150	110	--	--

* Maximum actual length not to exceed 200 ft (61 m)

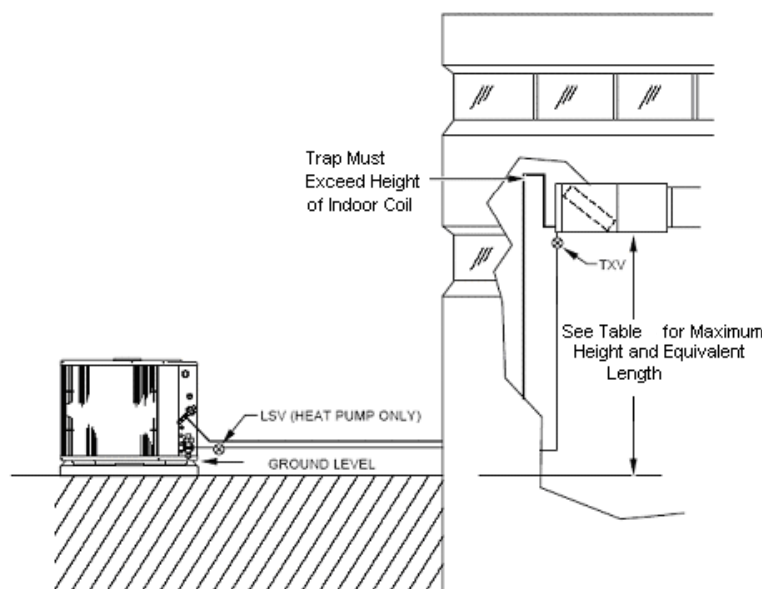
† Total equivalent length accounts for losses due to elbows or fitting. See the Table 2 for details.

-- = outside acceptable range

Table 9		AC / HP with R-410A Refrigerant Long Line Description ft (m) Beyond these lengths, long line accessories are required	
AC	AC Liquid Line Size		Units On Same Level
	1/4		No accessories needed within allowed lengths
	5/16		120 (36.6)
	3/8		80 (24.4)
HP	HP Liquid Line Size		Units On Same Level
	3/8		80 (24.4)

Figure 3

R-410A Outdoor Unit Below Indoor Unit



- Unit must be charged to 10° subcooling or nameplate subcooling, whichever is greater.
- A hard-shutoff TXV must be installed at indoor unit when application qualifies as long line. See Table 11.
- A crankcase heater must be installed on compressor when the application qualifies as long line. See Table 11.
- Hard Start Kit (start capacitor and relay) must be installed in outdoor unit when the application qualifies as long line. See Table 11.
- An inverted vapor-line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil.
- Maximum actual liquid line length is up to 200 ft (61 m) See Table 10 for maximum total equivalent length.
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Heat pump only – Adjust outdoor piston per Table 12.
- Use vapor line per Table 3 through Table 6.
- Use liquid lines per Table 10.

Table 10 Maximum Total Equivalent Length† Outdoor Unit Below Indoor Unit, Vertical Separation ft (m)											
Size	System Type	Liquid Line Diameter w/ TXV	0-5 (0-1.5)	6-10 (1.8-3.0)	11-20 (3.4-6.1)	21-30 (6.4-9.1)	31-40 (9.4-12.2)	41-50 (12.5-15.2)	51-60 (15.5-18.3)	61-70 (18.6-21.3)	71-80 (21.6-24.4)
18000	AC Only	1/4	150	150	125	100	100	75	--	--	--
	AC Only	5/16	250*	250*	250*	250*	250*	250*	250*	225*	150
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
24000	AC Only	1/4	75	75	75	50	50	--	--	--	--
	AC Only	5/16	250*	250*	250*	250*	250*	225*	175	125	100
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
30000	AC Only	1/4	30	--	--	--	--	--	--	--	--
	AC Only	5/16	175	225*	200	175	125	100	75	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
36000	AC Only	5/16	175	150	150	100	100	100	75	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	250*
42000	AC Only	5/16	125	100	100	75	75	50	--	--	--
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*	150
48000	AC/HP	3/8	250*	250*	250*	250*	250*	250*	230	160	--
60000	AC/HP	3/8	250*	250*	250*	225*	190	150	110	--	--

* Maximum actual length not to exceed 200 ft (61 m)

† Total equivalent length accounts for losses due to elbows or fitting. See the Table 2 for details.

-- = outside acceptable range

Table 11 AC / HP with R-410A Refrigerant Long Line Description ft (m) Beyond these lengths, long line accessories are required		
AC	AC Liquid Line Size	
	Outdoor Below Indoor	
	1/4	No accessories needed within allowed lengths
	5/16	50 (15.2) vertical or 120 (36.6) total
HP	3/8	35 (10.7) vertical or 80 (24.4) total
	HP Liquid Line Size	
	Outdoor Below Indoor	
HP	3/8	20 (6.1) vertical or 80 (24.4) total

Table 12	R-410A Refrigerant Heat Pump Outdoor Piston Change – Outdoor Unit BELOW Indoor Unit Vertical Separation ft (m)						
Btuh	0–19 (0–5.8)	20–29 (6.1–8.8)	30–39 (9.1–11.9)	40–49 (12.2–14.9)	50–59 (15.2–18.0)	60–69 (18.3–21.0)	70–80 (21.3–24.4)
18,000	0	–1	–1	–2	–2	–2	–2
24,000	0	–1	–1	–2	–2	–3	–3
30,000	0	–1	–1	–2	–2	–3	–3
36,000	0	–1	–2	–2	–2	–3	–3
42,000	0	–1	–2	–2	–3	–3	–4
48,000	0	–1	–2	–2	–3	–3	—
60,000	0	–1	–2	–3	–3	—	—

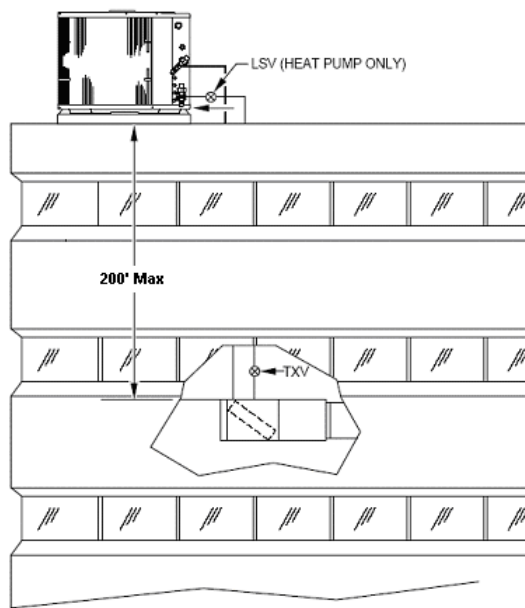
NOTE: (—) Indicates vertical separation exceeds allowable limits.

Example 1: On a 4 ton system the outdoor unit is 60 ft (18.3 m) below the indoor unit. This is acceptable only if the total equivalent length is 230 ft (70.1 m) or less. The heating piston must be re-sized –3.

Example 2: On a 3-ton system the outdoor unit is 80 ft (24.4 m) below the indoor unit. This is acceptable up to 250 ft (76.2 m) total equivalent length. The heating piston must be re-sized –3.

Figure 4

R-410A Outdoor Unit Above Indoor Unit



A98328

- A hard-shutoff TXV must be installed at indoor unit when the application qualifies as long line. See Table 14.
- A crankcase heater must be installed on compressor when the application qualifies as long line. See Table 14.
- Hard Start Kit (start capacitor and relay) must be installed in outdoor unit when the application qualifies as long line. See Table 14.
- Heat pump only – Heating piston must be changed as shown in Table 15.
- Maximum actual liquid line length is up to 200 ft (61 m). See Table 13.
- Maximum total equivalent length is up to 250 ft (61 m). See Table 13.
- Heat pump only – Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.
- Use vapor line sizes per Table 3 through Table 6.
- Use liquid lines per Table 13.
- Vapor line traps are not required.

R-410A Refrigerant Maximum Total Equivalent Length Outdoor Unit ABOVE Indoor Unit										
Vertical Separation ft (m)										
Size	System Type	Liquid Line Diameter	25 (7.6)	26-50 (7.9-15.2)	51-75 (15.5-22.9)	76-100 (23.2-30.5)	101-125 (30.8-38.1)	126-150 (38.4-45.7)	151-175 (46.0-53.3)	176-200 (53.6-61.0)
18000	AC Only	1/4	175	250*	250*	250*	250*	250*	250*	250*
	AC Only	5/16	250*	250*	250*	250*	250*	250*	250*	250*
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
24000	AC Only	1/4	100	125	175	200	225*	250*	250*	250*
	AC Only	5/16	250*	250*	250*	250*	250*	250*	250*	250*
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
30000	AC Only	1/4	30	--	--	--	--	--	--	--
	AC Only	5/16	250*	250*	250*	250*	250*	250*	250*	250*
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
36000	AC Only	5/16	225*	250*	250*	250*	250*	250*	250*	250*
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
42000	AC Only	5/16	175	200	250*	250*	250*	250*	250*	250*
	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
48000	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*
60000	AC/HP	3/8	250*	250*	250*	250*	250*	250*	250*	250*

*Maximum Actual Length Not to Exceed 200ft (61 m)

AC / HP with R-410A Refrigerant Long Line Description ft (m)		
Beyond these lengths, long line accessories are required		
AC	AC Liquid Line Size	Outdoor Above Indoor
AC	1/4	175 (53.3)
	5/16	120 (36.6)
	3/8	80 (24.4)
HP	AC Liquid Line Size	Outdoor Above Indoor
	3/8	80 (24.4)

Table 15	Heat Pump Outdoor Piston Change – Outdoor Unit ABOVE Indoor Unit							
	Vertical Separation ft (m)							
Btuh	20–25 (6.1–7.6)	26–50 (7.9–15.2)	51–75 (15.5–22.9)	76–100 (23.2–30.5)	101–125 (30.8–38.1)	126–150 (38.4–45.7)	151–175 (46.0–53.3)	176–200 (53.6–61.0)
18,000	+1	+1	+2	+3	+3	+4	+5	+6
24,000	+1	+1	+2	+3	+4	+5	+6	+7
30,000	+1	+2	+2	+4	+5	+6	+8	+9
36,000	+1	+2	+2	+4	+5	+6	+8	+9
42,000	+1	+2	+3	+4	+5	+7	+8	+10
48,000	+1	+2	+3	+4	+5	+7	+9	+10
60,000	+1	+2	+3	+5	+6	+8	+10	+12

J. General Requirements (Checklist)

All Long Line Applications

- Hard-shutoff TXV must be installed at indoor unit.
- Hard Start Kit (start capacitor and relay) must be installed on outdoor unit.
- Crankcase heater must be installed on compressor.
- Use liquid line per Table 8, Table 10, and Table 13.
- Use only vapor line sizes listed in Table 3 through Table 6.
- Adjust charge per Table 7.
- Charge system to 10° subcooling or rating plate subcooling, whichever is greater.

Heat Pumps Only

- Bi-flow liquid line solenoid must be installed within 2 ft (0.61 m) of outdoor unit with arrow pointing towards outdoor unit.

Equal-level Outdoor/Indoor unit

- Outdoor unit and indoor unit must be within +/- 20 ft (6.1 m) vertical separation.
- Vapor line should slope towards indoor unit.

Heat Pumps Only

- No outdoor piston adjustment required with less than 20 ft (6.1 m) vertical separation.

Outdoor unit BELOW indoor unit

- See Table 9, Table 11, and Table 14 for longline thresholds.
- An inverted vapor-line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil. See Figure 3.
- Vertical separation and line set equivalent length must not exceed requirements listed in Table 8, Table 10, and Table 13.

Heat Pumps Only

- Adjust outdoor piston per Table 12.

Outdoor unit ABOVE indoor unit

- Maximum vertical separation is 200 ft (61 m)
- Maximum actual line length is 200 ft (61 m)
- Maximum total equivalent length is 250 ft (76.2 m). See Table 13.
- Vapor line traps are not required.

Heat Pumps Only

- Adjust outdoor piston per Table 15.

Table 16	Common HP Pistons Available through FAST
Size	FAST Part Number
.040	1173990
.042	1173634
.046	1173650
.049	1173868
.052	1174060
.055	1173655
.057	1173658
.059	1173871
.061	1173663
.063	1174003
.065	1173873
.067	1173867
.070	1173869
.073	1174017
.076	1173673
.078	1174094
.082	1173870
.086	1173872
.104	1173532

K. R-410A Quick Reference Guide

- R-410A refrigerant operates at 50% – 70% higher pressures than R-22. Be sure that servicing equipment and replacement components are designed to operate with R-410A.
- R-410A refrigerant cylinders are rose colored.
- Recovery cylinder service pressure rating must be 400 psig, DOT 4BA400 or DOT BW400.
- R-410A systems should be charged with liquid refrigerant. Use a commercial type metering device in the manifold hose.
- Manifold sets should be 750 psig high-side and 200 psig low-side with 520 psig low-side retard.
- Use hoses with 750 psig service pressure rating.
- Leak detectors should be designed to detect HFC refrigerant.
- R-410A, as with other HFC refrigerants, is only compatible with POE oils.
- Vacuum pumps will not remove moisture from oil.
- Do not use liquid line filter-driers with rated working pressures less than 600 psig.
- Do not install a suction line filter-drier in liquid line.
- POE oils absorb moisture rapidly. Do not expose oil to atmosphere.
- POE oils may cause damage to certain plastics and roofing materials.
- Wrap all filter-driers and service valves with wet cloth when brazing.
- A liquid line filter-drier is required on every unit.
- Do not use with an R-22 TXV.
- If indoor unit is equipped with an R-22 TXV, it must be changed to an R-410A TXV.
- Never open system to atmosphere while it is under a vacuum.
- When system must be opened for service, break vacuum with dry nitrogen and replace all filter-driers.
- Do not vent R-410A into the atmosphere.
- Do not use capillary tube indoor coils.
- Observe all **WARNINGS**, **CAUTIONS**, **NOTES**, and **bold** text.