Industrial and Mobile Coolers

ULAC, ULOC, ULDC, ULHC, OAW Series

Parker

ENGINEERING YOUR SUCCESS.

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In line with our policy of continuing product improvement, specifications and information contained in this catalog are subject to change.

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⚠ PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Overview

Machesney Park, Illinois
10711 N. Second Street, Machesney Park, IL 61115

Santa Fe Springs, California
14087 Borate Street, Santa Fe Springs, CA 90670

If you have questions about the information contained herein, please contact:

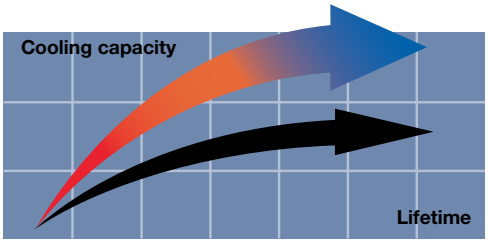
Cylinder and Accumulator Division
phone **815 636 4100**
parker.com/cylinder-accumulator

Oil Coolers

Parker is a global player specializing in innovative, efficient system solutions for temperature optimization and energy storage. All over the world, our products are working in the most diverse environments and applications.

Air-Oil Cooler Sizing Software (.exe)
Link

Choosing the right cooler requires precise system sizing. The most reliable way to size a cooler is with the aid of our calculation program. This program, together with precise evaluations from our experienced, skilled engineers, gives you the opportunity for more cooling per $ invested.



Overheating – an expensive problem
An underestimated cooling capacity produces a temperature that is too high. The consequences are poor lubricating properties, higher internal leakage, a higher risk of cavitation, damaged components, etc. Overheating leads to a significant drop in efficiency which can be detrimental to our environment.

Temperature optimization – a basic prerequisite for cost-efficient operation
Temperature balance in a hydraulic system occurs when the cooler can cool down the energy input that the system does not consume –

$$\mathbf{Power}_{loss} = \mathbf{Power}_{cool} = \mathbf{Power}_{in} - \mathbf{Power}_{used}$$

the system's lost energy. Temperature optimization occurs at the temperature at which the oil viscosity is maintained at recommended values. The correct working temperature produces a number of economic and environmental benefits:

- The hydraulic system's useful life is extended.
- The oil's useful life is extended.
- The hydraulic system's availability increases—more operating time and fewer shutdowns.
- Service and repair costs are reduced.
- High efficiency level maintained in continuous operation – the system's efficiency falls if the temperature exceeds the ideal working temperature.




Features

Air-Oil Coolers

Industrial Coolers

ULAC Series Cooler

- Single or Three-phase AC Fan Motor
  - NEMA 56C through 284T
  - ½ through 15 HP
- Cooling up to 425 HP @ Δ70˚F @ 250 gpm

ULOC Series Cooler

- Three-phase AC Pump & Fan Motor
  - 50/60 hz
  - 1 through 5 HP
- Flow rates up to 25 gpm
- Cooling up to 60HP @ Δ70˚F @ 25 gpm

Mobile Coolers

ULDC Series Cooler

- 12V or 24V DC Motor (SPAL)
- Cooling up to 40 HP @ Δ70˚F @ 80 gpm
- Optional integrated partial bypass
- Optional integrated thermoswitch

ULHC Series Cooler

- Hydraulic motor displacement ranges from 8cc to 28cc
- Cooling up to 185 HP @ Δ70˚F @ 120 gpm @ 1000 rpm
- Optional integrated partial bypass valve
- Optional integrated thermoswitch

Water-Oil Coolers

OAW Brazed Plate Cooler Series

- Cooling up to 275 hp @ 120 gpm @ Δ60˚F
  - higher cooling capacities available upon request
- Optional mounting clamps available
- SAE O-ring connections come standard

Cooler Sizing Form

Essential Cooler Sizing Parameters

Please read carefully and complete the following. the items in BOLD are the minimum requirements to properly size a cooler for your application. Fill out and email the form to cad.accumulator@support.parker.com

Name		Company	
Title		Location	
Phone #		E-mail	

Required Heat Dissipation (hp)* _____ **Max Ambient Temperature (◦F)** _____

Oil Flow Rate (gpm) _____ **Max Inlet Oil Temperature (◦F)** _____

Oil Type and Viscosity _____

Max Oil Pressure Drop (psi) _____ Max Noise Decibel Level _____

Air Oil Coolers Only

Fan Motor (AC, DC, Hydraulic) _____

Include details on voltage, frequency, etc.

Options: Bypass (20/65psi) _____ Thermoswitch(100/120/140/160/175◦F) _____

Water Oil Coolers Only

Water Type (ie. Water-Glycol) _____

Water Flow Rate (gpm) _____ **Max Inlet Water Temperature (◦F)** _____

Max Water Pressure Drop (psi) _____

Special Requirements/Features _____

(ie. Explosion proof, Marine grade, Oil Filter, Air Filter, etc.)

* If Required Heat Dissipation is unknown then it can either be estimated by assuming 20-30% of the installed horsepower will be converted to heat load. However, the most accurate measure would be to calculate the heat load by recording the time the oil takes to get up to temperature with no cooler in the system. In order to calculate, the following info. is needed:

Initial Oil Temperature (◦F) _____ Final Oil Temperature (◦F) _____

Time Interval (minutes) _____ Total Oil Volume in System (gal) _____

Competitive Cross Reference Tool
crossref.parker.com

Cooler Sizing Form
parker.com/coolersizingform

ULAC with AC Motor

For Industrial use - cooling capacity up to 425 HP

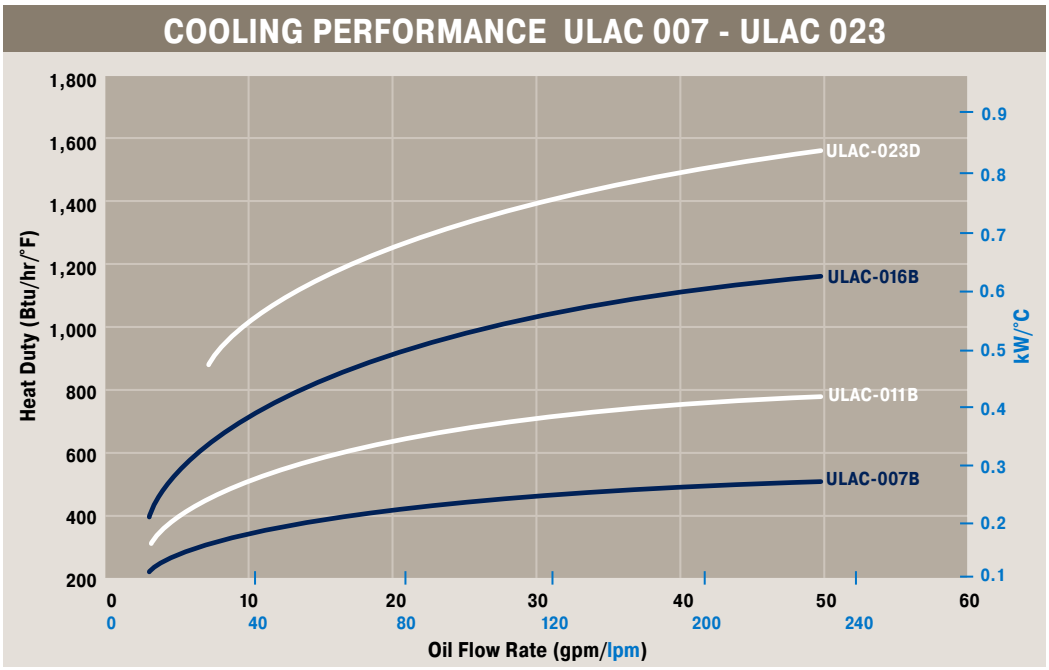
Product Features:

The ULAC oil cooler with AC motor is optimized for use in the industrial sector. Together with a wide range of accessories, the ULAC cooler is suitable for installation in most applications and environments.

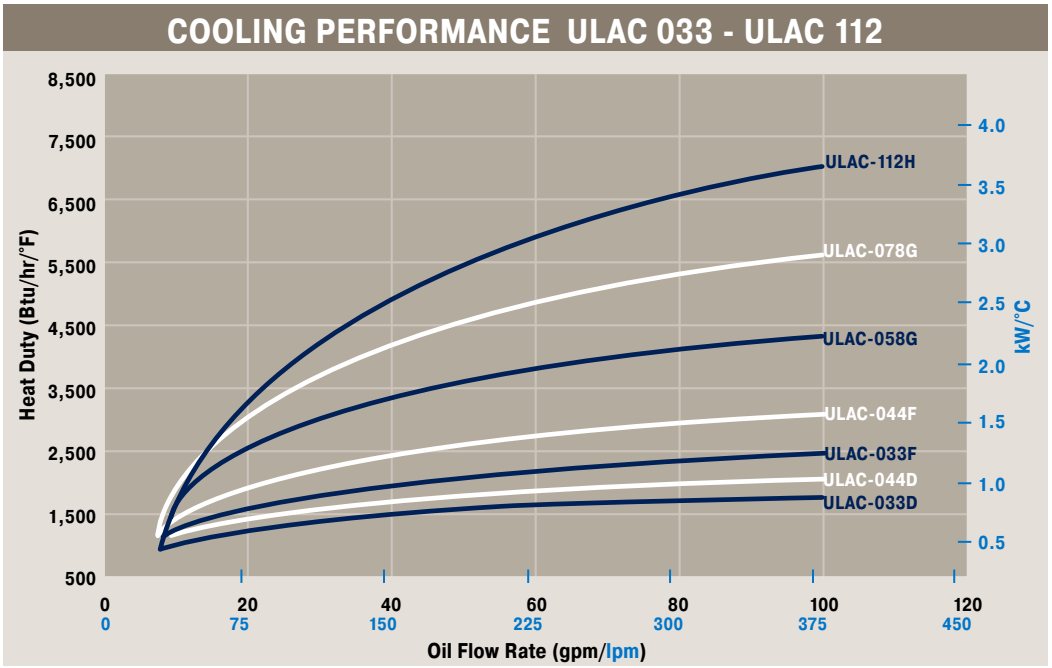
- **Optimized design with right choice of materials and components ensures a reliable and long lasting cooler with low service and maintenance costs.**
- **Compact design resulting in lighter weight unit yet with higher cooling capacity and lower pressure drop.**
- **Easy to maintain and easy to retrofit into many applications.**
- **AC motor – NEMA three phase motors are standard. Wide range of operating voltages and frequencies available.**
- **Cooler core with low pressure drop and high cooling capacity.**

ULAC Cooling Performance

The cooling capacity curves are based on an ETD (Entering Temperature Difference) of 1 °F. For example, inlet oil temperature of 140 °F and ambient air temperature of 70 °F yields a temperature difference of 70 °F. Multiply the number from the cooling graphs corresponding to the specific flow rate by the ETD for the particular application to get the total heat duty.



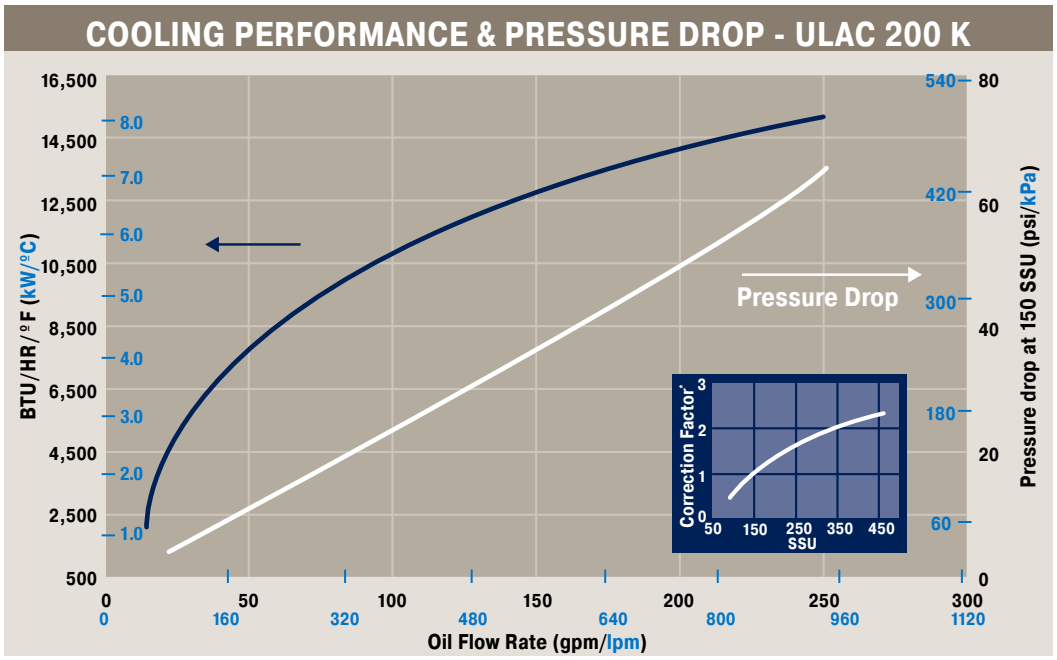
Cooling capacity tolerance ± 10%.



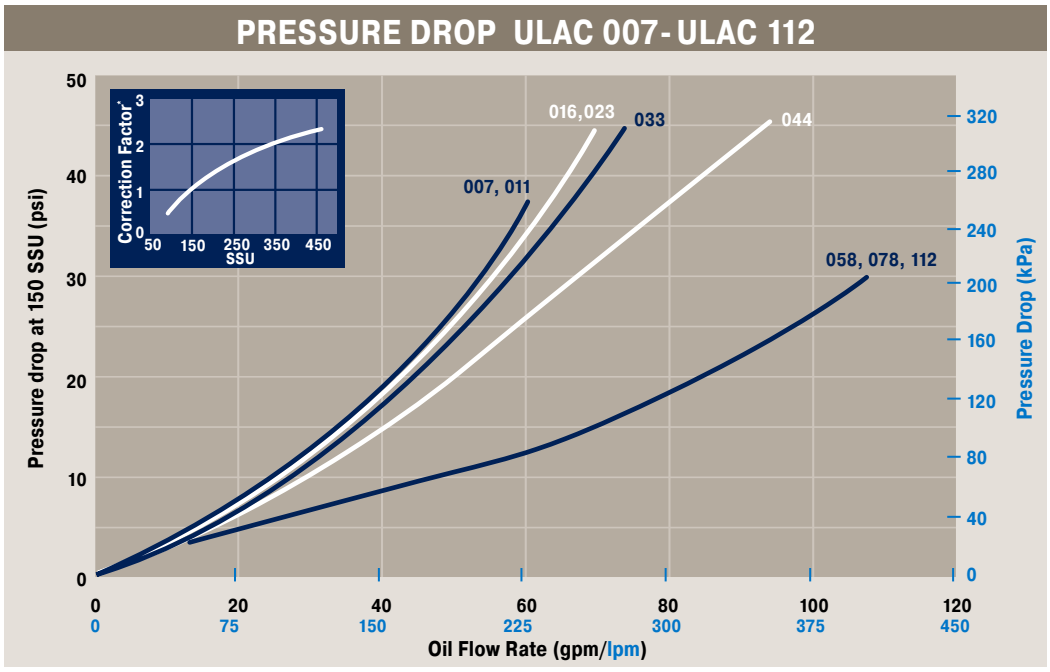
Cooling capacity tolerance ± 10%.

Helpful Equations
Unit Conversion: ____ [HP/(Max Oil Inlet Temp °F - Ambient Air Temp °F)] x 2547 = ____BTU/hr/°F
____kW/°C x 1897 = ____BTU/hr/°F
____GPM x 3.79 = ____ LPM
____PSI x 6.894 = ____ kPa

ULAC Cooling Performance

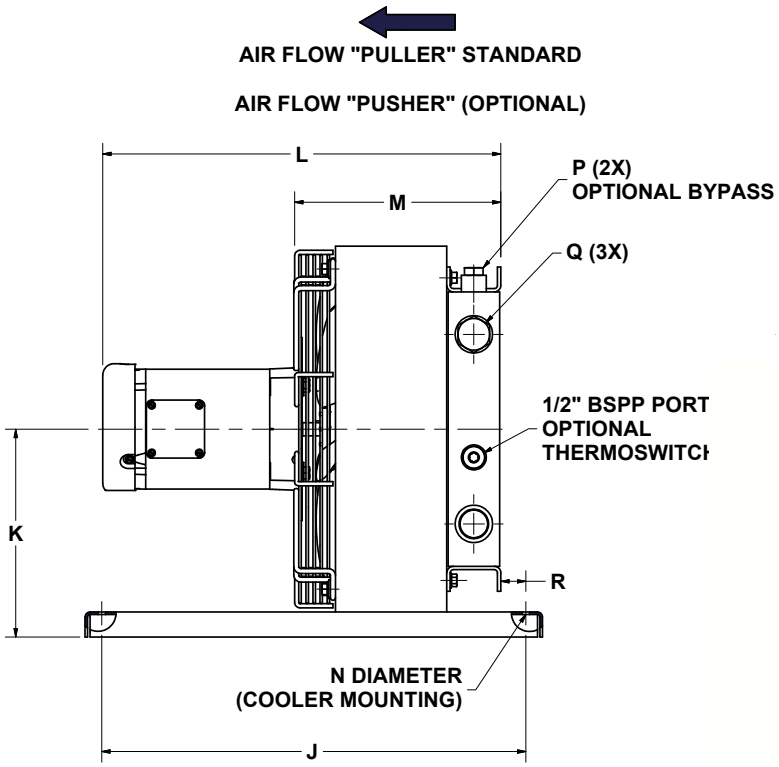


Cooling capacity tolerance ± 10%.



* Pressure Drop Correction Factor for other viscosities.

Helpful Equations
Unit Conversion: ____ [HP/(Max Oil Inlet Temp °F - Ambient Air Temp °F)] x 2547 = ____BTU/hr/°F
____kW/°C x 1897 = ____BTU/hr/°F
____GPM x 3.79 = ____ LPM
____PSI x 6.894 = ____ kPa

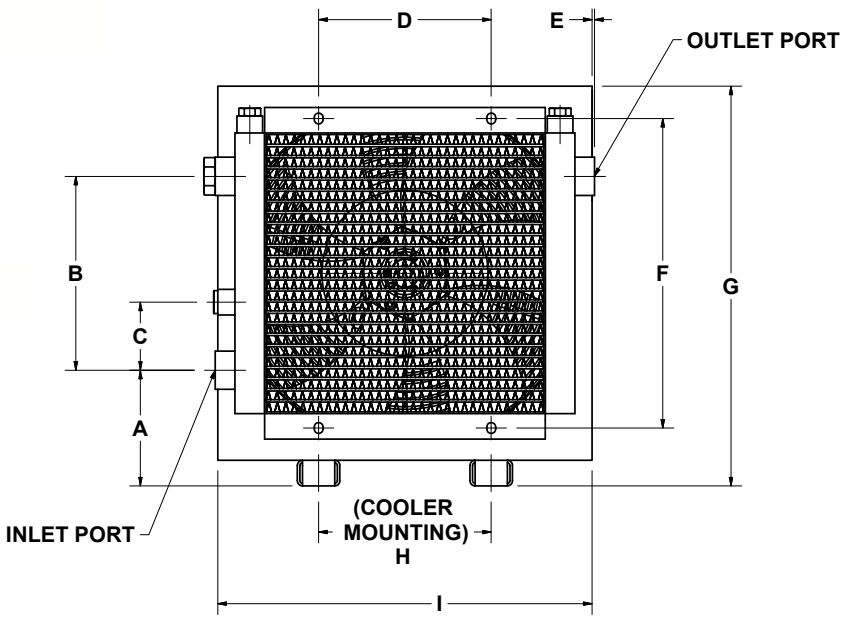


ULAC with Standard Removable Mounting Feet

ULAC Engineering Specifications

TYPE	Acoustic Pressure Level LpA dB(A) 3 Ft.*	No. Of Poles/ Capacity HP	Weight Lbs. (Approx.)	P SAE O-Ring	Q SAE O-Ring Boss	NEMA Motor Frame Size
ULAC 007B	69	4/0.5	33	½" (#8)	1" (#16)	56C
ULAC 011B	71	4/0.5	44	½" (#8)	1" (#16)	56C
ULAC 016B	74	4/0.5	53	½" (#8)	1" (#16)	56C
ULAC 023D	81	4/1	79	½" (#8)	1" (#16)	56C
ULAC 033D	82	4/1	115	½" (#8)	1¼" (#20)	56C
ULAC 033F	86	4/3	170	½" (#8)	1¼" (#20)	182T
ULAC 044D	83	4/1	143	½" (#8)	1¼" (#20)	56C
ULAC 044F	87	4/3	197	½" (#8)	1¼" (#20)	182T
ULAC 058G	90	4/5	264	¾" (#12)	1½" (#24)	184T
ULAC 078G	92	4/5	434	¾" (#12)	1½" (#24)	184T
ULAC 112H	96	4/7.5	542	¾" (#12)	1½" (#24)	213T
ULAC 200K	93	6/15	1,030	NA	CODE 61 SAE 2" FLANGE	284T

* Noise level tolerance ± 3 dB(A).



ULAC with Standard Removable Mounting Feet

ULAC Dimensions

TYPE	A	B	C	D	E	F	G	H	I	J	K	L	M	Nø	R
ULAC 007B	5.2	6.3	3.2	8.0	0.24	11.7	15.6	8.0	14.4	20.1	8.4	19.8	8.8	0.35	1.18
ULAC 011B	5.4	9.0	3.2	8.0	0.12	14.3	18.5	8.0	17.3	20.1	9.8	20.8	9.8	0.35	1.18
ULAC 016B	5.2	11.7	3.2	8.0	0.28	17.0	20.7	8.0	19.5	20.1	10.9	21.6	10.7	0.35	1.18
ULAC 023D	5.2	14.9	3.2	14.0	0.20	20.2	24.0	14.0	22.8	20.1	12.6	22.2	11.3	0.35	1.18
ULAC 033D	5.2	19.1	3.2	14.0	NA	24.5	28.4	14.0	27.2	20.1	14.8	23.1	12.5	0.35	1.18
ULAC 033F	5.2	19.1	3.2	14.0	NA	24.5	28.4	14.0	27.2	24.0	14.8	25.6	12.5	0.55	1.34
ULAC 044D	4.6	26.1	3.2	14.0	NA	31.5	34.1	14.0	27.2	20.1	17.6	24.1	13.3	0.35	1.18
ULAC 044F	4.6	26.1	3.2	14.0	NA	31.5	34.1	14.0	27.2	24.0	18.3	26.6	13.5	0.55	1.34
ULAC 058G	5.2	26.1	3.2	20.0	NA	31.5	35.4	20.0	34.2	24.0	18.3	29.9	15.2	0.55	0.40
ULAC 078G	5.2	32.3	3.9	26.8	NA	38.9	41.4	20.4	40.2	35.4	21.1	30.9	16.2	0.55	3.88
ULAC 112H	5.1	38.8	3.9	31.1	0.14	45.4	47.8	23.6	46.7	35.4	24.4	31.9	17.2	0.55	3.22
ULAC 200K	7.2	50.9	5.0	49.6	1.2	61.0	64.2	55.9	59.4	35.4	32.7	41.5	18.7	0.71	0.67

All dimensions listed above are in inches.
For dimensions not shown on this page, refer to previous page.

ULAC Motor Specifications

MOTOR HP	USED ON	MOTOR TYPE	Standard Motor	575V 60Hz Motor
1/2	ULAC-007B ULAC-011B ULAC-016B	Part Number	SM-.5-4-56C-DFM	SM-.5-4-56C-575V
		Voltage Frequency	190-220/380-415V 50Hz//230/460V 60Hz	575V 60Hz
1	ULAC-023D ULAC-033D ULAC-044D	Part Number	SM-1-4-56C-DFM	SM-1-4-56C-575V
		Voltage Frequency	190-220/380-415V 50Hz//230/460V 60Hz	575V 60Hz
3	ULAC-033F ULAC-044F	Part Number	EM-3-4-182T	ACM-3-4-182T-575V
		Voltage Frequency	190-220/380-415V 50Hz//230/460V 60Hz	576V 60Hz
5	ULAC-058G ULAC-078G	Part Number	EM-5-4-184T	ACM-5-4-184T-575V
		Voltage Frequency	190-220/380-415V 50Hz//230/460V 60Hz	575V 60Hz
7-1/2	ULAC-112H	Part Number	ACM-7.5-4-213T-DFM	ACM-7.5-4-213T-575V
		Voltage Frequency	380, 400, 415V 50Hz//230/460V 60Hz	576V 60Hz
15	ULAC-200K	Part Number	EM-15-6-284TC	EM-15-6-284TC-575V
		Voltage Frequency	380, 400, 415V 60Hz//230/460V 60Hz	576V 60Hz

Order Key for ULAC Oil Coolers

All positions must be filled in when ordering.

Series (1)	Model (2)	Motor (3)	Thermoswitch (4)	Core Bypass (5)
ULAC	- 007B	- M	000	SA

EXAMPLE: ULAC-007B-M000SA

1. OIL COOLER SERIES WITH AC MOTOR; ULAC

2. COOLER SIZE/MODEL

007B, 011B, 016B, 023D, 033F, 033D, 044F, 044D, 058G, 078G, 112H and 200K.

3. MOTOR TYPE

No motor	= W
Three-phase 380V 50Hz, 230/460V 60Hz	= M*
Three-phase 575V 60Hz	= Q
Single-phase 115/230V 60Hz	= R
Explosion proof, Division 1, Class 1 Group D, Class II Group F & G, T3C	= X**
Not listed, consult Accumulator and Cooler Division	= Z

*M-motor is standard. The performance at 50Hz will be reduced by approximately 10%. P and N motor types were replaced by M motor type
**Thermal switch not available with explosion proof motor option cooler.

4. THERMOSWITCH

No thermoswitch	= 000
100 °F (38 °C)	= 100
120 °F (49 °C)	= 120
140 °F (60 °C)	= 140
160 °F (71 °C)	= 160
175 °F (79 °C)	= 175

5. CORE BYPASS

No Bypass	= SW
20 psi External Hose Bypass (standard option)	= SA
65 psi External Hose Bypass (standard option)	= SB

Technical Specifications

FLUID COMBINATIONS

Mineral oil
Oil/water emulsion
Water glycol
Phosphate ester

COOLER CORE*

Maximum static working pressure	300 psi
Dynamic working pressure	200 psi**
Heat transfer tolerance	± 6 %
Maximum oil inlet temperature	250 °F

*Standard cores are single pass. Two pass cores and other options available upon request, please consult Accumulator and Cooler Division.
** Tested in accordance with ISO/DIS 10771-1

MATERIAL

Cooler core	Aluminum
Fan blades/hub	Glass fiber reinforced polypropylene/Aluminum
Fan housing	Steel
Fan Guard	Steel
Other parts	Steel

COOLING CAPACITY CURVES

The cooling capacity curves in this catalogue are created using oil type ISO VG 46 oil.

CONTACT PARKER FOR ADVICE ON

Oil temperatures > 250 °F
Oil viscosity > 100 cSt / 500 SSU @ 100 °C *
Aggressive environments
Environments with heavy airborne particulates
High-altitude locations

*See Viscosity Conversion Chart on page 41.

ADDITIONAL OPTIONS INCLUDE (SEE ACCESSORIES)

Separately Mounted Full Flow Thermal/Pressure Bypass Valve, Thermal Switch

Learn more online:

UL Series: Air-Oil Cooler Configurator
parker.com/air-oil-coolers
Competitive Cross Reference Tool
crossref.parker.com
UL Series: Air-Oil Cooler Sizing Software (.exe)
Link

The information in this brochure is subject to change without prior notice.

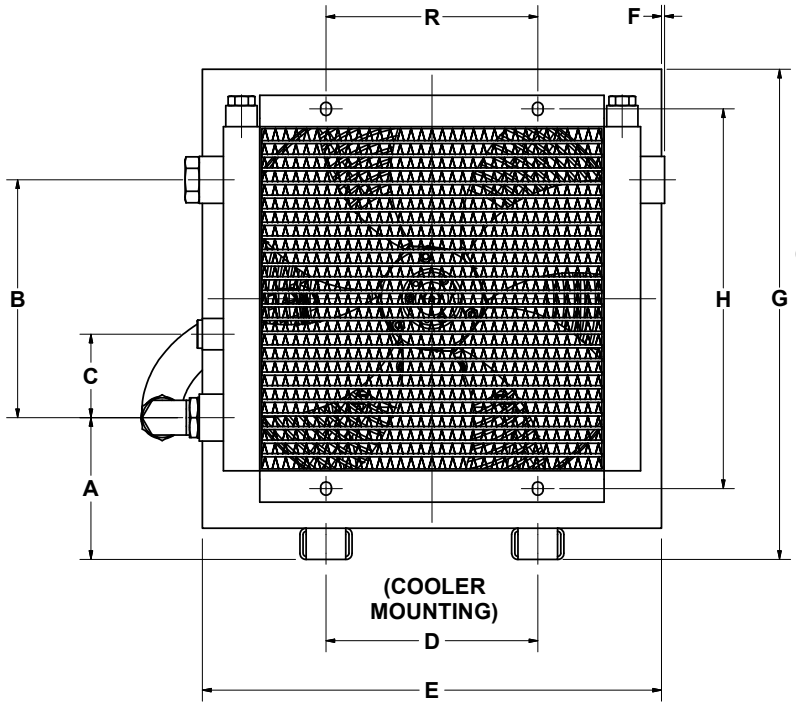
ULOC Cooling System

For Industrial use - cooling capacity up to 60 HP

Product Features:

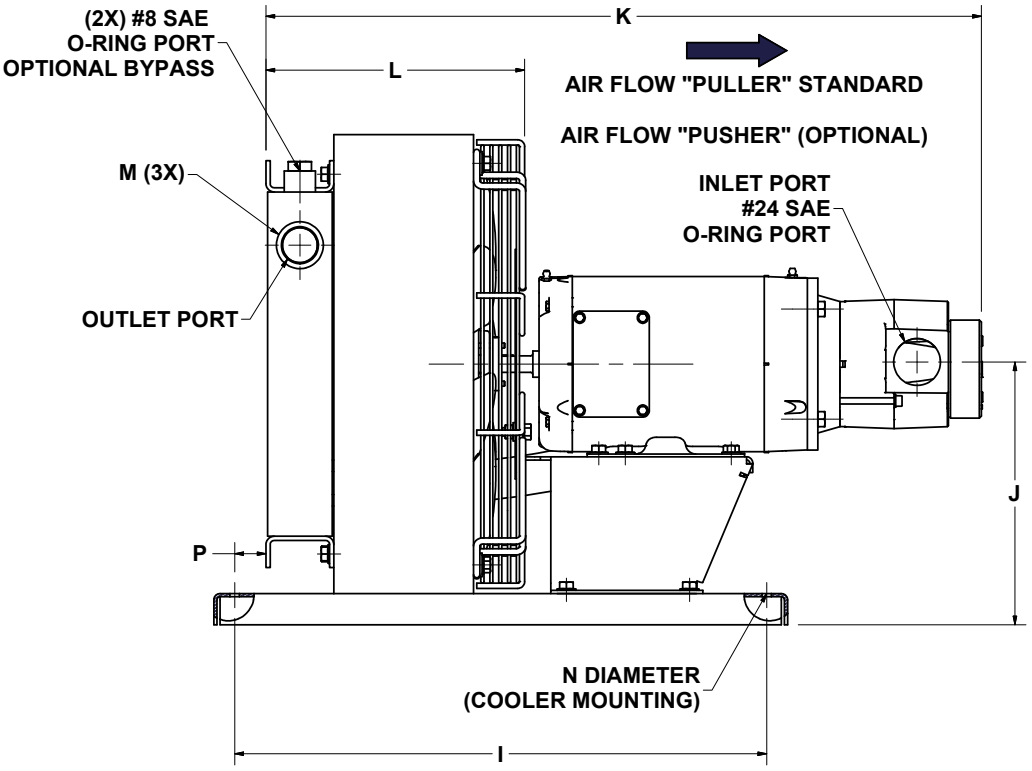
The ULOC cooling system with three-phase AC motor is optimized for use in the industrial sector. The system is supplied ready for installation. An integrated circulation pump makes it possible to cool and treat the oil in a separate circuit – offline cooling. Together with a wide range of accessories, this cooling system is suitable for installation in most applications and environments.

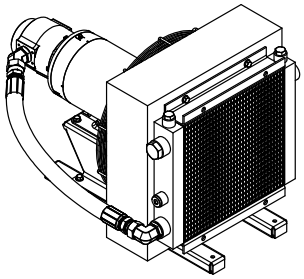
- **Optimized design with right choice of materials and components ensures a reliable and long lasting cooler with low service and maintenance costs.**
- **Integrated circulation pump produces an even flow with low pressure pulsations**
- **Easy to maintain and easy to retrofit into many applications.**
- **Compact design and low weight.**
- **Cooler core with low pressure drop and high cooling capacity.**



TYPE	Nom. Oil Flow Rate (gpm)	Cooling Capacity at 50 °F ETD (Btu/hr)	Cooling Capacity Btu/hr/°F	Acoustic Pressure Level LpA dB(A) 3 Ft.*	Motor HP / No. Of Poles	Motor
ULOC 007D - A	6.3	15,500	310	71	1/4	1-4-143TC
ULOC 007D - B	12.7	19,000	380	71	1/4	1-4-143TC
ULOC 007E - C	19.0	21,000	420	72	2/4	2-4-145TC
ULOC 007E - D	25.4	22,500	450	72	2/4	2-4-145TC
ULOC 011D - A	6.3	24,000	480	74	1/4	1-4-143TC
ULOC 011D - B	12.7	28,500	570	74	1/4	1-4-143TC
ULOC 011E - C	19.0	32,000	640	74	2/4	2-4-145TC
ULOC 011E - D	25.4	34,500	690	74	2/4	2-4-145TC
ULOC 016E - A	6.3	33,500	670	78	2/4	2-4-145TC
ULOC 016E - B	12.7	41,000	820	78	2/4	2-4-145TC
ULOC 016E - C	19.0	47,000	940	78	2/4	2-4-145TC
ULOC 016E - D	25.4	50,000	1,000	78	2/4	2-4-145TC
ULOC 023F - B	12.7	60,000	1,200	82	3/4	3-4-182TC
ULOC 023F - C	19.0	65,000	1,300	82	3/4	3-4-182TC
ULOC 023F - D	25.4	70,000	1,400	82	3/4	3-4-182TC
ULOC 033G - C	19.0	80,000	1,600	87	5/4	5-4-184TC
ULOC 033G - D	25.4	90,000	1,800	87	5/4	5-4-184TC
ULOC 044G - C	19.0	95,000	1,900	88	5/4	5-4-182TC
ULOC 044G - D	25.4	105,000	2,100	88	5/4	5-4-182TC

Electric motors specified are calculated for maximum working pressure 90 psi at 125 cSt and 50Hz, 60 psi at 125 cSt and 60Hz.
If you require higher pressure, please contact us for a choice of motors with a higher output.
* Noise level tolerance ± 3 dB(A).





ULOC

TYPE	A	B	C	D	E	F	G	H	I	J	K	L	M	N HOLE DIAMETER	P	R
ULOC 007D - A	5.2	6.3	3.1	8.0	14.4	0.2	15.6	11.7	20.1	8.4	26.1	8.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 007D - B	5.2	6.3	3.1	8.0	14.4	0.2	15.6	11.7	20.1	8.4	26.6	8.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 007E - C	5.2	6.3	3.1	8.0	14.4	0.2	15.6	11.7	20.1	8.4	27.1	8.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 007E - D	5.2	6.3	3.1	8.0	14.4	0.2	15.6	11.7	20.1	8.4	27.6	8.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 011D - A	5.4	9.0	3.1	8.0	17.3	0.1	18.5	14.3	20.1	9.9	27.0	9.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 011D - B	5.4	9.0	3.1	8.0	17.3	0.1	18.5	14.3	20.1	9.9	27.4	9.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 011E - C	5.4	9.0	3.1	8.0	17.3	0.1	18.5	14.3	20.1	9.9	28.0	9.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 011E - D	5.4	9.0	3.1	8.0	17.3	0.1	18.5	14.3	20.1	9.9	28.5	9.8	1" (#16 SAE)	0.35	1.2	8.0
ULOC 016E - A	5.1	11.7	3.1	8.0	19.5	0.3	20.7	17.0	20.1	11.0	27.7	10.6	1" (#16 SAE)	0.35	1.2	8.0
ULOC 016E - B	5.1	11.7	3.1	8.0	19.5	0.3	20.7	17.0	20.1	11.0	28.2	10.6	1" (#16 SAE)	0.35	1.2	8.0
ULOC 016E - C	5.1	11.7	3.1	8.0	19.5	0.3	20.7	17.0	20.1	11.0	28.8	10.6	1" (#16 SAE)	0.35	1.2	8.0
ULOC 016E - D	5.1	11.7	3.1	8.0	19.5	0.3	20.7	17.0	20.1	10.7	29.3	10.6	1" (#16 SAE)	0.35	1.2	8.0
ULOC 023F - B	5.2	14.9	3.1	14.0	22.8	0.2	24.0	20.2	24.0	12.4	30.7	11.2	1" (#16 SAE)	0.55	1.2	14.0
ULOC 023F - C	5.2	14.9	3.1	14.0	22.8	0.2	24.0	20.2	24.0	12.4	31.2	11.2	1" (#16 SAE)	0.55	1.2	14.0
ULOC 023F - D	5.2	14.9	3.1	14.0	22.8	0.2	24.0	20.2	24.0	12.4	31.7	11.2	1" (#16 SAE)	0.55	1.2	14.0
ULOC 033G - C	5.2	19.1	3.1	14.0	27.2	-	28.4	24.5	24.0	14.6	32.7	12.5	1¼" (#20 SAE)	0.55	1.3	14.0
ULOC 033G - D	5.2	19.1	3.1	14.0	27.2	-	28.4	24.5	24.0	14.9	33.2	12.5	1¼" (#20 SAE)	0.55	1.3	14.0
ULOC 044G - C	4.6	26.1	3.1	14.0	27.2	-	34.1	31.5	24.0	17.4	33.7	13.5	1¼" (#20 SAE)	0.55	1.3	14.0
ULOC 044G - D	4.6	26.1	3.1	14.0	27.2	-	34.1	31.5	24.0	17.4	33.9	13.5	1¼" (#20 SAE)	0.55	1.3	14.0

* Port on the inlet side of the pump is 1½" (#24) SAE O-ring Boss for all models.
For dimensions not shown on this page, refer to previous.
All dimensions listed above are in inches.

Order Key for ULOC Oil Coolers

All positions must be filled in when ordering.

Series (1)	Model (2)	Motor (3)	Pump Flow Rate (4)	Core Bypass (5)
ULOC	- 007D	- M	- A	- SA

EXAMPLE: ULOC-007D-M-A-SA

1. OIL COOLER SERIES OFFLINE, WITH PUMP; ULOC

2. COOLER SIZE/MODEL

007D, 007E, 011D, 011E, 016E, 023F, 033G, 044G

3. MOTOR TYPE

No motor	= W
Three phase, 380V 50Hz, 208-230/460V 60Hz	= M*
Three phase, 575V 60Hz	= Q
Not listed, consult Accumulator and Cooler Division	= Z
Performance at 50Hz will be reduced by approximately 15%	

4. PUMP FLOW RATE (GPM)

60 HZ	50 HZ	
6	5	= A
12	10	= B
19	15.8	= C
25	20.8	= D

5. CORE BYPASS*

No Bypass	= SW
20 psi External Hose Bypass (standard option)	= SA
65 psi External Hose Bypass (standard option)	= SB

* M is the standard, cores are single pass.

Technical Specifications

COOLER CORE

Maximum static working pressure	300 psi
Dynamic working pressure	200 psi*
Heat transfer tolerance	± 6 %
Maximum oil inlet temperature	210 °F

* Tested in accordance with ISO/DIS 10771-1

- ULOC is designed primarily for synthetic oils, vegetable oils and mineral oil type HL/HLP in accordance with DIN 51524. Maximum oil temperature 210 °F.
- Maximum negative pressure in the inlet line is 5 inches Hg with an oil-filled pump. Maximum pressure on the pump's suction side is 8 psi.
- Maximum working pressure for the pump is 150 psi.

Heat transfer tolerance	± 6 %

MATERIAL

Cooler core	Aluminum
Fan blades/hub	Glass fiber reinforced polypropylene/Aluminum
Fan housing	Steel
Fan guard	Steel
Pump housing	Aluminum
Other parts	Steel

CONTACT PARKER FOR ADVICE ON

Water-glycol that is < 60% glycol, Oil temperatures > 210 °F, Oil viscosity > 100 cSt /500 SSU*, Aggressive environments, Environments with heavy airborne particulates, High-altitude locations

*See page 41 for Viscosity Conversion Chart

ADDITIONAL OPTIONS INCLUDE

Separately Mounted Full Flow Thermal/Pressure Bypass Valve

Available options to include separately mounted full flow thermal/pressure bypass valve, thermal switch (see Accessories). Note: Thermal switch (sold separately) if used, should be installed in the hydraulic reservoir and not the cooler.

Learn more online: **UL Series: Air-Oil Cooler Sizing Software (.exe)**
Link

ULOC Motor Specifications

MOTOR HP	USED ON	MOTOR TYPE	Standard Motor	575V 60Hz
1	ULOC-007D ULOC-011D	Part Number	ACD-1-4-143TC	ACD-1-4-143TC-575V
		Voltage Frequency	190/380 50Hz//208-230/460 60Hz	575V 60Hz
2	ULOC-007E ULOC-011E ULOC-016E	Part Number	ACD-2-4-145TC	ACD-2-4-145TC-575V
		Voltage Frequency	190/380 50Hz//208-230/460V 60Hz	575V 60Hz
3	ULOC-023F	Part Number	ACD-3-4-182TC	ACD-3-4-182TC-575V
		Voltage Frequency	190/380 50Hz//208-230/460V 60Hz	575V 60Hz
5	ULOC-033G ULOC-044G	Part Number	ACD-5-4-184TC	ACD-5-4-184TC-575V
		Voltage Frequency	190/380 50Hz//208-230/460V 60Hz	575V 60Hz

The information in this brochure is subject to change without prior notice.

ULDC with DC Motor

For mobile use - cooling capacity up to 40 HP

Product Features:

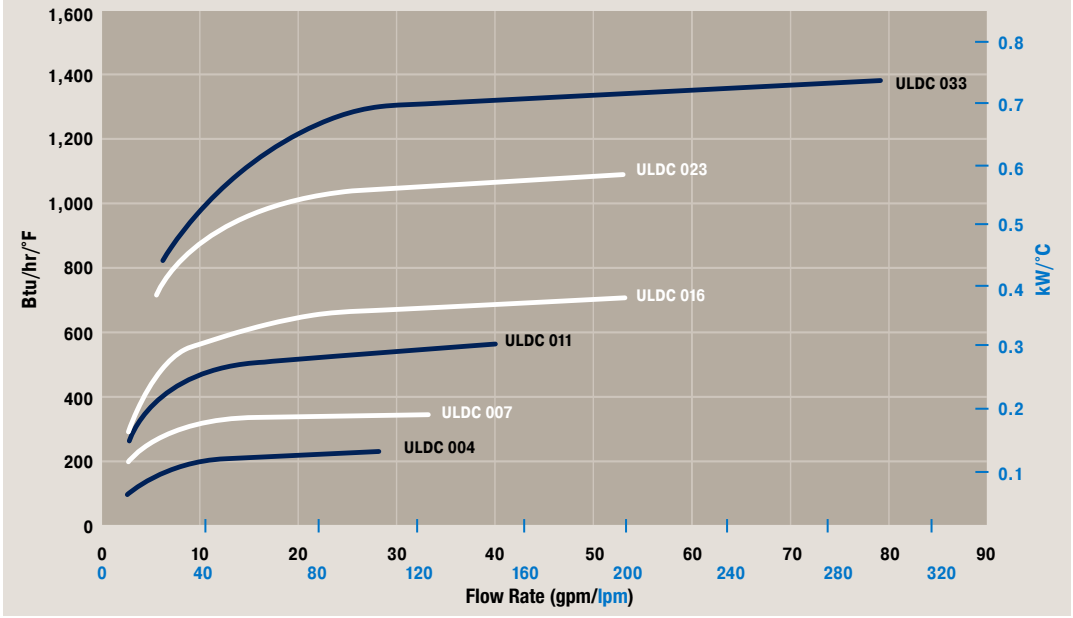
The ULDC oil cooler with 12V or 24V DC motor is optimized for use in the mobile industry. Together with a wide range of accessories, the ULDC cooler is suitable for installation in most applications and environments.

- **Optimized design with right choice of materials and components ensures a reliable and long lasting cooler with low service and maintenance costs.**
- **Compact design resulting in lighter weight unit yet with higher cooling capacity and lower pressure drop.**
- **Easy to maintain and easy to retrofit into many applications.**
- **DC motor 12V or 24V.**

ULDC Cooling Performance

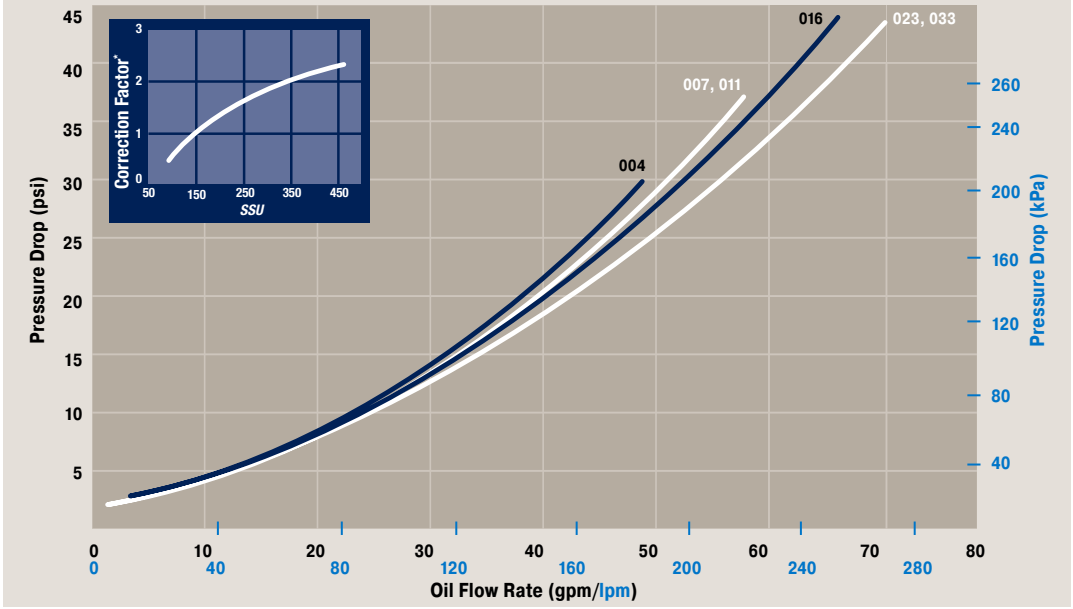
The cooling capacity curves are based on an ETD (Entering Temperature Difference) of 1 °F. For example, inlet oil temperature of 140 °F and ambient air temperature of 70 °F yields a temperature difference of 70 °F. Multiply the number from the cooling graphs corresponding to the specific flow rate by the ETD for the particular application to get the total heat duty.

COOLING PERFORMANCE ULDC 004 - ULDC 033



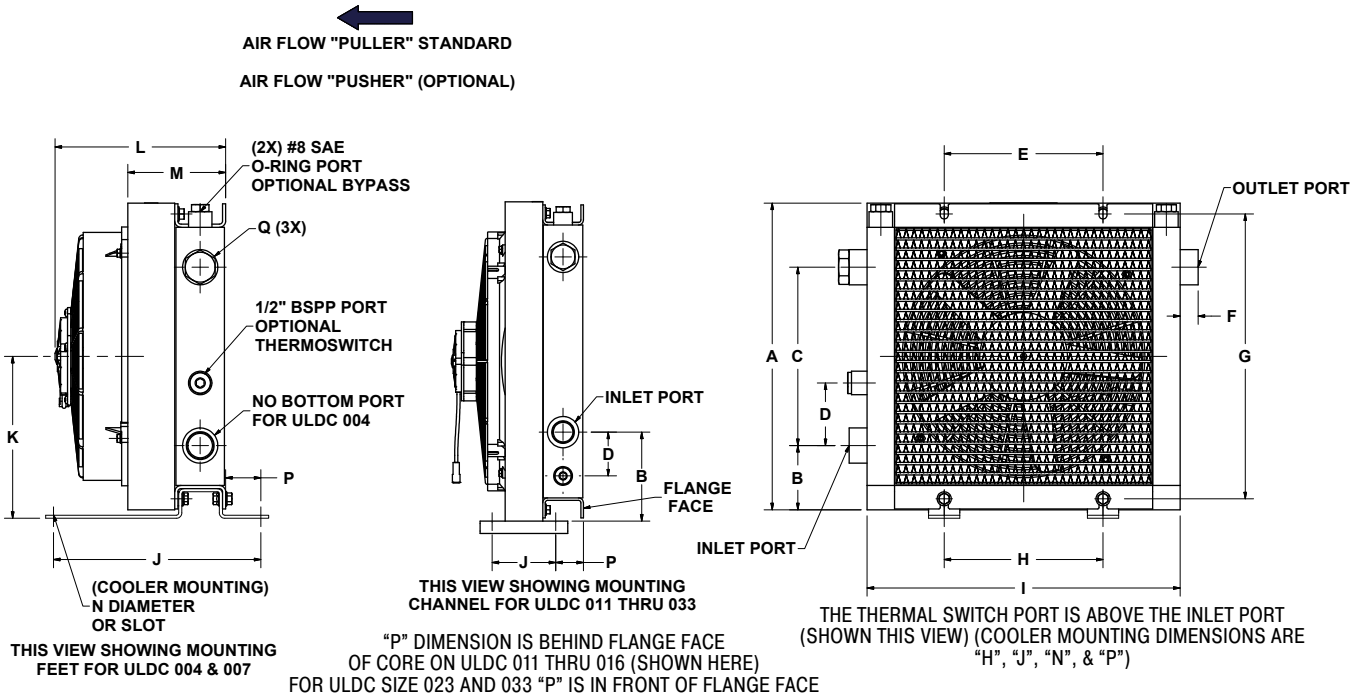
Cooling capacity tolerance ± 10%.

PRESSURE DROP



*** Pressure Drop Correction Factor for other viscosities.**

Helpful Equations
Unit Conversion: ____ [HP/(Max Oil Inlet Temp °F - Ambient Air Temp °F)] x 2547 = ____BTU/hr/°F
____kW/°C x 1897 = ____BTU/hr/°F
____GPM x 3.79 = ____ LPM
____PSI x 6.894 = ____ kPa



ULDC Cooler

Type	Weight lbs (Approx.)	Acoustic Pressure LpA dB(A) 3 Ft.*	Running Current (Amps.)** 12 Volts	24 Volts	Q SAE O-Ring Boss	Recommended Fuse 12V	24V
ULDC 004	13	68	7	4	1" (#16)	15	10
ULDC 007	20	71	13	6	1" (#16)	30	15
ULDC 011	26	75	20	12	1" (#16)	40	30
ULDC 016	33	75	20	12	1" (#16)	40	30
ULDC 023	55	75	20	12	1" (#16)	40	30
ULDC 033	66	75	20	12	1¼" (#20)	40	30

* Noise level tolerance ± 3 dB(A).
** ULDC-023 & ULDC-033 Cooler assemblies come with two fans each. The indicated running current is for one fan only.

Type	A	B	C	D	E	F	G	H	I	J	K	L	M	N Ø Hole Diameter or Slot Size	P	Q
ULDC 004	9.6	-	-	-	6.0	0.9	9.0	5.3	10.5	5.8	5.2	6.0	4.1	.35 x 0.55	0.6	1" (#16 SAE)
ULDC 007	13.0	3.3	6.3	3.1	8.0	0.9	11.7	8.0	13.0	10.4	6.8	6.7	4.1	0.35	1.8	1" (#16 SAE)
ULDC 011	15.4	3.2	9.0	3.1	8.0	0.9	14.3	14.2	15.7	4.0	8.5	8.6	4.9	0.35 x .79	1.8	1" (#16 SAE)
ULDC 016	18.2	3.3	11.7	3.1	8.0	0.9	17.0	16.4	18.3	4.0	9.9	8.6	4.9	0.35 x .79	1.8	1" (#16 SAE)
ULDC 023	24.2	4.7	14.9	3.1	14.0	0.9	20.2	14.0	24.2	11.4	7.9/17.9	8.6	4.9	.50	1.4	1" (#16 SAE)
ULDC 033	25.9	3.4	19.1	3.1	14.0	1.0	24.5	14.0	25.0	11.4	8.8/18.8	10.2	6.5	.50	1.4	1¼" (#20 SAE)

All dimensions listed above are in inches.
* Thermoswitch port is below inlet port.

Order Key for ULDC Oil Coolers

All positions must be filled in when ordering.

Series (1)	Model (2)	Motor (3)	Thermoswitch (4)	Core Bypass (5)
ULDC	- 004	- A	- 000	SW

EXAMPLE: ULDC-004-A-000SW

1. OIL COOLER SERIES WITH DC MOTOR; ULDC	
2. COOLER SIZE/MODEL	
004, 007, 011, 016, 023, 033	
3. MOTOR VOLTAGE	
12 V Puller (Standard)	= A
12 V Pusher (Optional)	= AP
24V Puller (Standard)	= B
24V Pusher (Optional)	= BP
4. THERMOSWITCH	
No thermoswitch	= 000
100 °F (38°C)	= 100
120 °F (49°C)	= 120
140 °F (60°C)	= 140
160 °F (71°C)	= 160
175 °F (79°C)	= 175
5. CORE BYPASS*	
No Bypass	= SW
20 psi External Hose Bypass	= SA
65 psi External Hose Bypass	= SB

* The standard cores are single pass. Two pass cores and other options available upon request, please consult Cylinder and Accumulator Division.
Core bypass not available for size -004 coolers. Available on sizes -007 and above.

Learn more online:

UL Series: Air-Oil Cooler Configurator
parker.com/air-oil-coolers
Competitive Cross Reference Tool
crossref.parker.com
UL Series: Air-Oil Cooler Sizing Software (.exe)
Link

Technical Specifications

FLUID COMBINATIONS	
Mineral oil	
Oil/water emulsion	
Water glycol	
Phosphate ester	
MATERIAL	
Cooler core	Aluminum
Fan blades/guard	Glass fiber reinforced polypropylene
Fan housing	Steel
Other parts	Steel
COOLER CORE	
Maximum static working pressure	300 psi
Dynamic working pressure	200 psi*
Heat transfer tolerance	± 6 %
Maximum oil inlet temperature	250 °F
* Tested in accordance with ISO/DIS 10771-1	
COOLING CAPACITY CURVES	
The cooling capacity curves in this catalogue are created using oil type ISO VG 46 oil.	
CONTACT PARKER FOR ADVICE ON	
Oil temperatures > 250 °F	
Oil viscosity > 100 cSt / 500 SSU*	
Aggressive environments	
Environments with heavy airborne particulates	
High-altitude locations	
*See Viscosity Conversion Chart on page 41	

FAN MOTOR CONNECTION		
AMP	180908-0	CONNECTOR
AMP	42460	TERMINAL
MATING CONNECTOR		
AMP	180907	CONNECTOR
AMP	42281	TERMINAL
Red = (+) Black = (-)		

ADDITIONAL OPTIONS INCLUDE
Separately Mounted Full Flow Thermal/Pressure Bypass Valve

Available options to include separately mounted full flow thermal/pressure bypass valve (see Accessories)

The information in this brochure is subject to change without prior notice.

ULHC with Hydraulic Motor

For mobile and industrial use - maximum cooling capacity up to 185 HP

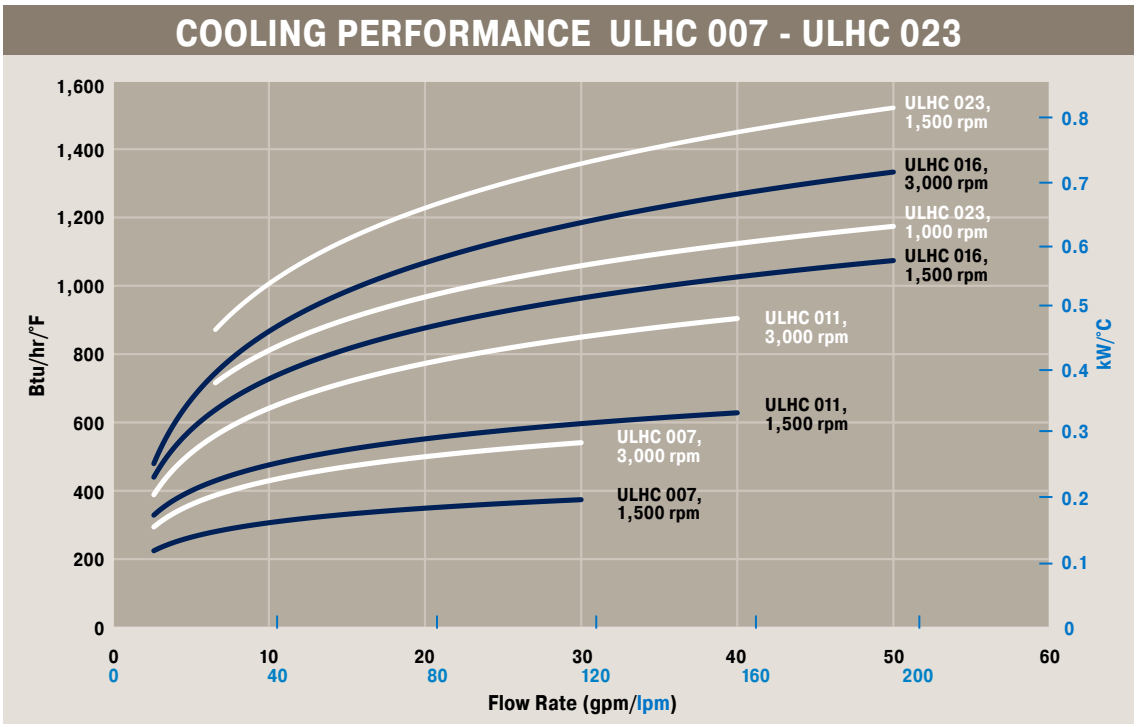
Product Features:

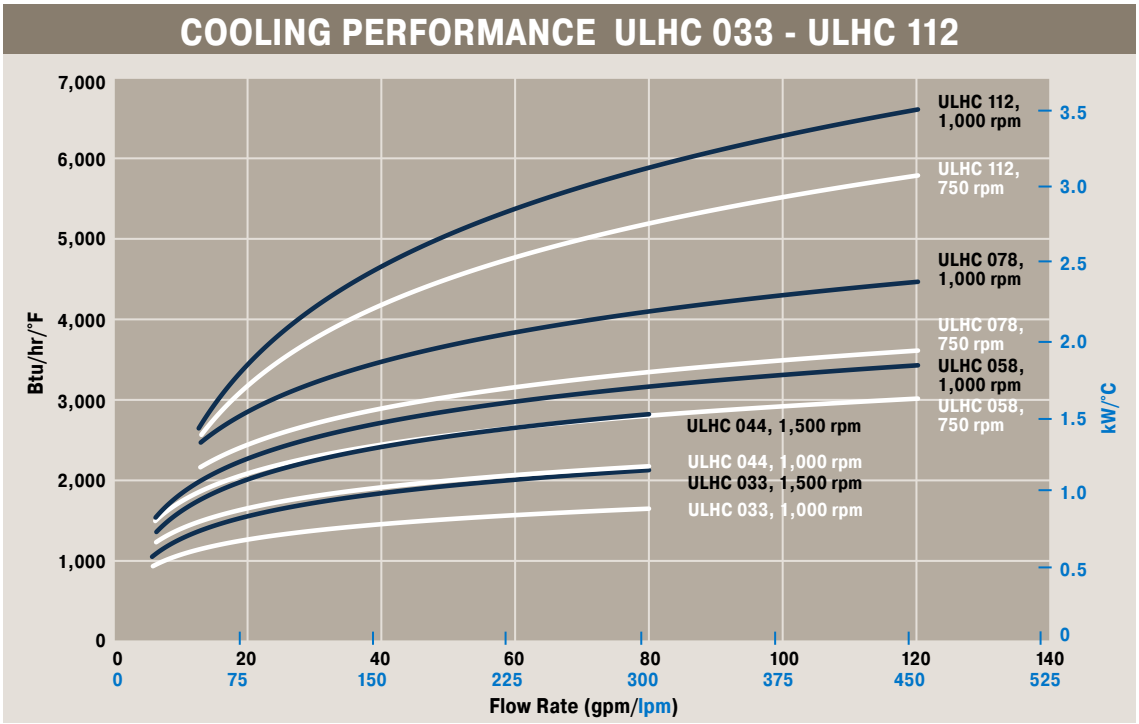
The ULHC oil cooler with hydraulic motor is optimized for use in the mobile and industrial sector. Together with a wide range of accessories, the ULHC cooler is suitable for installation in most applications and environments.

- **Optimized design with right choice of materials and components ensures a reliable and long lasting cooler with low service and maintenance costs.**
- **Compact design resulting in lighter weight unit yet with higher cooling capacity and lower pressure drop.**
- **Easy to maintain and easy to retrofit into many applications.**
- **Hydraulic motors with 8 cc/rev to 19 cc/rev. displacements**
- **Collar bearing for fan motor on larger models provides longer operating life.**
- **Cooler core with low pressure drop and high cooling capacity.**

ULHC Cooling Performance

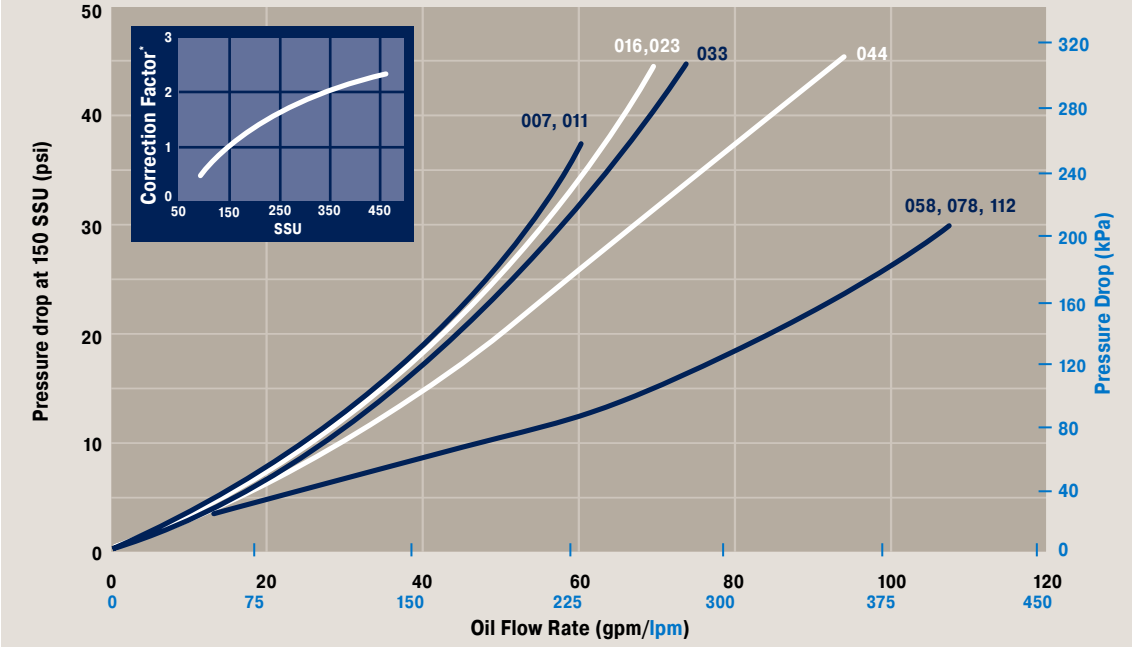
The cooling capacity curves are based on an ETD (Entering Temperature Difference) of 1 °F. For example, inlet oil temperature of 140 °F and ambient air temperature of 70 °F yields a temperature difference of 70 °F. Multiply the number from the cooling graphs corresponding to the specific flow rate by the ETD for the particular application to get the total heat duty.





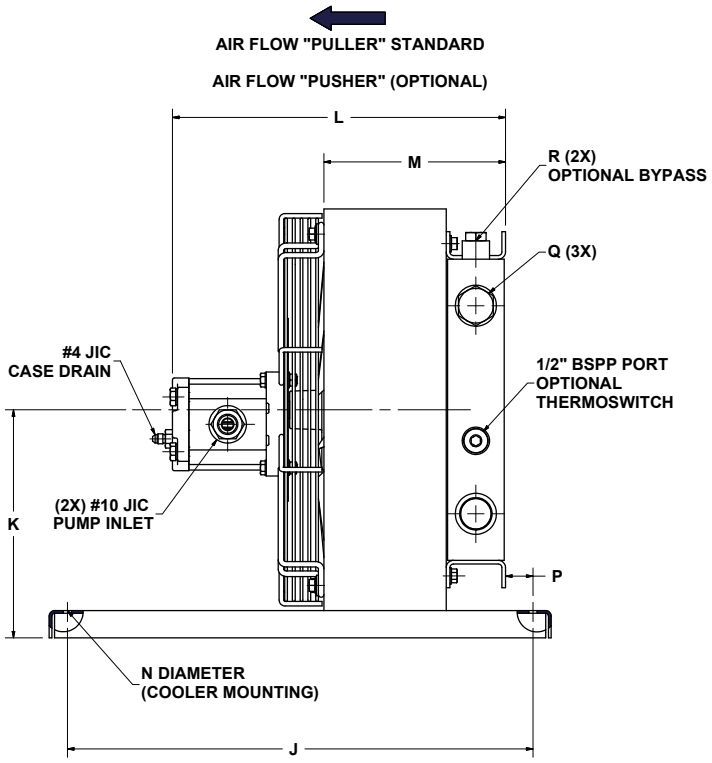
Helpful Equations
Unit Conversion: ___ [HP/(Max Oil Inlet Temp °F - Ambient Air Temp °F)] x 2547 = ____BTU/hr/°F
____kW/°C x 1897 = ____BTU/hr/°F
____GPM x 3.79 = ____ LPM
____PSI x 6.894 = ____ kPa

PRESSURE DROP



*** Pressure Drop Correction Factor for other viscosities.**

Helpful Equations
Unit Conversion: ____ [HP/(Max Oil Inlet Temp °F - Ambient Air Temp °F)] x 2547 = ____BTU/hr/°F
____kW/°C x 1897 = ____BTU/hr/°F
____GPM x 3.79 = ____ LPM
____PSI x 6.894 = ____ kPa

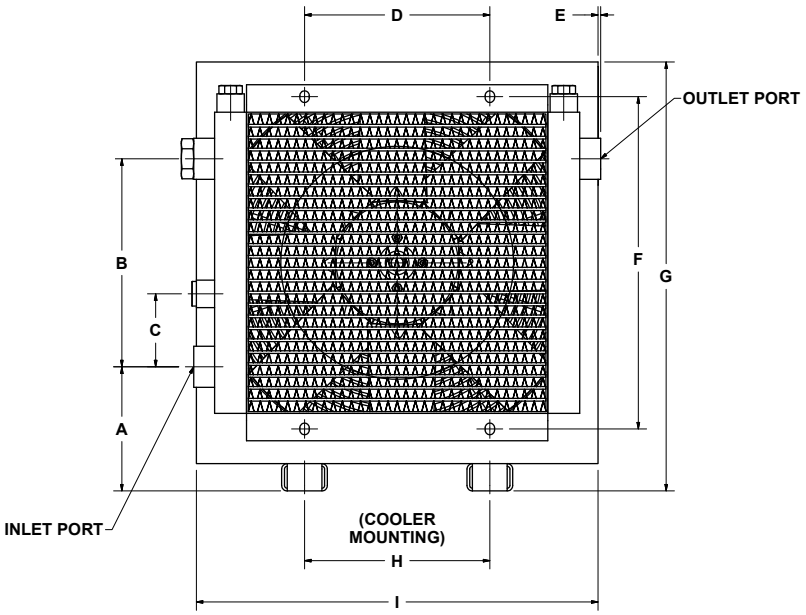


Type	Fan Speed rpm	Fan Power HP	Weight lbs. (Approx.)	Acoustic Pressure Level LpA dB(A) 3 Ft*	Max Allowable Fan Speed rpm
ULHC 007	1,500	0.13	22	62	3,500
	3,000	0.87	22	79	3,500
ULHC 011	1,500	0.27	33	67	3,500
	3,000	2.01	33	82	3,500
ULHC 016	1,500	0.13	40	60	3,500
	3,000	0.47	40	70	3,500
ULHC 023	1,000	0.20	66	64	2,840
	1,500	0.67	66	76	2,840
ULHC 033	1,000	0.87	88	75	2,350
	1,500	2.68	88	85	2,350
ULHC 044	1,000	0.94	123	77	2,350
	1,500	2.68	123	86	2,350
ULHC 058	750	1.01	170	75	1,850
	1,000	2.41	170	83	1,850
ULHC 078	750	0.94	245	81	1,690
	1,000	2.15	245	88	1,690
ULHC 112	750	2.28	276	86	1,440
	1,000	5.36	276	92	1,440

* Noise level tolerance ± 3 dB(A).

Motor	Displacement cc/rev	Max. Working Pressure psi
A	8	3,000
E	19	3,000

All dimensions listed above are in inches.



Type	A	B	C	D	E	F	G	H	I	J	K	L	M	P
ULHC 007	5.2	6.3	3.1	8.0	0.2	11.7	15.6	8.0	14.4	20.1	7.8	13.4	8.8	1.2
ULHC 011	5.4	9.0	3.1	8.0	0.1	14.3	11.7	18.5	17.3	20.1	9.2	14.4	9.8	1.2
ULHC 016	5.1	11.7	3.1	8.0	0.3	17.0	20.7	8.0	19.5	20.1	10.3	15.2	10.6	1.2
ULHC 023	5.2	14.9	3.1	14.0	0.2	20.2	24.0	14.0	22.8	20.1	12.0	15.8	11.2	1.2
ULHC 033	5.2	19.1	3.1	14.0	-	24.5	28.4	14.0	27.2	20.1	14.2	18.7	12.5	1.2
ULHC 044	4.6	26.1	3.1	14.0	-	31.5	34.1	14.0	27.2	20.1	17.0	19.7	13.5	1.2
ULHC 058	5.2	26.1	3.1	20.0	-	31.5	35.4	20.0	34.2	20.1	17.6	21.5	15.3	1.2
ULHC 078	5.1	32.3	3.9	26.8	-	38.9	41.4	20.4	40.2	24.0	20.7	22.5	16.2	0.8
ULHC 112	5.1	38.8	3.9	31.1	0.1	45.4	47.8	23.6	46.7	24.0	23.9	23.4	17.2	0.8

All dimensions listed above are in inches.

Type	N Hole Diameter	Q O-ring Boss	R O-ring	Motor Selection
ULHC 007	0.35	1" (#16 SAE)	½" (#8 SAE)	A or E
ULHC 011	0.35	1" (#16 SAE)	½" (#8 SAE)	A or E
ULHC 016	0.35	1" (#16 SAE)	½" (#8 SAE)	A or E
ULHC 023	0.35	1" (#16 SAE)	½" (#8 SAE)	A or E
ULHC 033	0.35	1¼" (#20 SAE)	½" (#8 SAE)	A or E
ULHC 044	0.35	1¼" (#20 SAE)	½" (#8 SAE)	A or E
ULHC 058	0.35	1½" (#24 SAE)	¾" (#12 SAE)	A or E
ULHC 078	0.55	1½" (#24 SAE)	¾" (#12 SAE)	E
ULHC 112	0.55	1½" (#24 SAE)	¾" (#12 SAE)	E

All dimensions listed above are in inches.
For dimensions not shown on this page, refer to previous.

Order Key for ULHC Oil Coolers

All positions must be filled in when ordering.

Series (1)	Model (2)	Motor (3)	Thermoswitch (4)	Core Bypass (5)
ULHC	- 023	- A	- 000	SA

EXAMPLE: ULHC-023-A-000SA

1. OIL COOLER SERIES WITH HC MOTOR; ULHC	
2. COOLER SIZE/MODEL	
007, 011, 016, 023, 033, 044, 058, 078 and 112	
3. HYDRAULIC MOTOR, DISPLACEMENT	
No hydraulic motor	= W
Displacement 8 cc/rev.	= A
Displacement 19 cc/rev.	= E
4. THERMO CONTACT	
No thermoswitch	= 000
100 °F (38°C)	= 100
120 °F (49°C)	= 120
140 °F (60°C)	= 140
160 °F (71°C)	= 160
175 °F (79°C)	= 175
5. CORE BYPASS*	
No Bypass	= SW
20 psi External Hose Bypass (standard option)	= SA
65 psi External Hose Bypass (standard option)	= SB

* M is the standard, cores are single pass. Two pass cores and other options available upon request, please consult Cylinder and Accumulator Division.

Technical Specifications

FLUID COMBINATIONS	
Mineral oil	
Oil/water emulsion	
Water glycol	
Phosphate ester	
MATERIAL	
Cooler core	Aluminum
Fan blades/housing	Glass fiber reinforced polypropylene/Aluminum
Fan housing	Steel
Fan guard	Steel
Other parts	Steel
COOLER CORE	
Maximum static working pressure	300 psi
Dynamic operating pressure	200 psi*
Heat transfer tolerance	± 6 %
Maximum oil inlet temperature	250 °F
* Tested in accordance with ISO/DIS 10771-1	
COOLING CAPACITY CURVES	
The cooling capacity curves in this catalogue are created using oil type ISO VG 46 oil.	
CONTACT PARKER FOR ADVICE ON	
Oil temperatures > 250 °F*	
Oil viscosity > 100 cSt / 500 SSU	
Aggressive environments	
Environments with heavy airborne particulates	
High-altitude locations	
*See Viscosity Conversion Chart on page 41.	
ADDITIONAL OPTIONS INCLUDE	
Separately Mounted Full Flow Thermal/Pressure Bypass Valve	

Available options to include separately mounted full flow thermal/pressure bypass valve (see Accessories)

Learn more online:

UL Series: Air-Oil Cooler Configurator
parker.com/air-oil-coolers
Competitive Cross Reference Tool
crossref.parker.com
UL Series: Air-Oil Cooler Sizing Software (.exe)
Link

The information in this brochure is subject to change without prior notice.

OAW Water-Oil Cooler

For industrial use

Product Features:

The OAW oil cooler is optimized for use in mobile and industrial markets. Together with a wide range of accessories, the OAW cooler is suitable for installation in most applications and environments.

- **Optimized design with right choice of materials and components ensures a reliable and long lasting cooler with low service and maintenance costs.**
- **Compact design for easy installation.**
- **Turbulent water flow prevents clogging and reduces maintenance.**
- **Low water consumption for economical operation.**
- **SAE O-ring connections for ease of assembly and leak-proof operation.**
- **For BSPP Ports (ISO-9) see PWO Cooler Catalog**
- **Maximum material efficiency with no “Dead Zone.”**

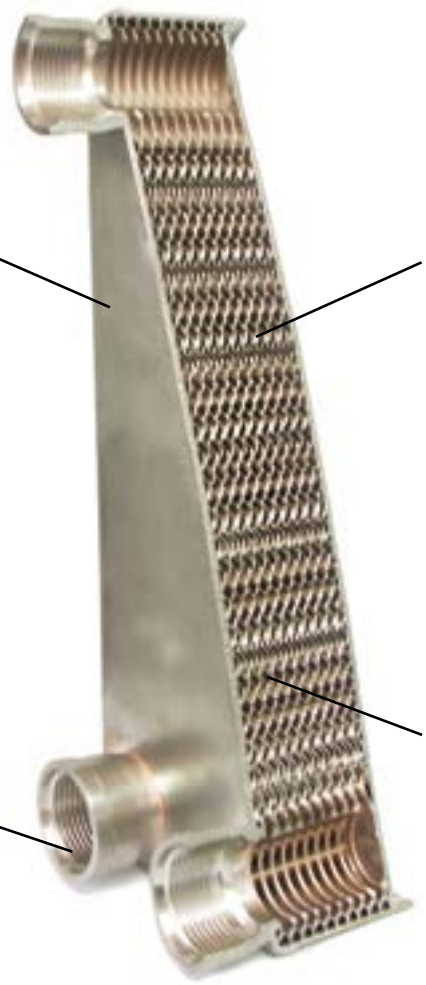
OAW Water-Oil Coolers

Our OAW coolers are designed for a maximum working pressure of 450 psi. The most standard application for the OAW cooler involves a cold-water circuit and a hot-oil circuit. Fluids are not limited to oil and water however; see the Fluid Compatibility section in the OAW product literature for more information. Inlets and outlets are clearly identified by the Accumulator and Cooler Division sticker affixed to the front of the unit. When in doubt, pour a liquid in one of the connections and note which connection it comes out of. This will be the inlet and outlet for one circuit (either oil or water). The other inlet should be located on the diagonal from the first inlet. Maximum cooling efficiency is achieved by cross flowing through the plates, the oil inlet and water inlet being located on a diagonal.

Extremely Compact:

85-90% reduction in volume and weight of a shell-and-tube heat exchanger of the same capacity.

- **LOW WATER CONSUMPTION**
- **ECONOMICAL OPERATION**
- **COMPACT**



Corrugated:

Plates made of 316 stainless steel brazed with pure copper.

TURBULENT WATER FLOW PREVENTS CLOGGING AND REDUCES MAINTENANCE

SMALLER SIZE MAKES IT EASY TO INSTALL

BROAD RANGE: SEVERAL MODELS IN-STOCK FOR IMMEDIATE DELIVERY

SAE O-Ring Connections:

Good for ease of assembly and leak proof operation.

Maximum Efficiency:

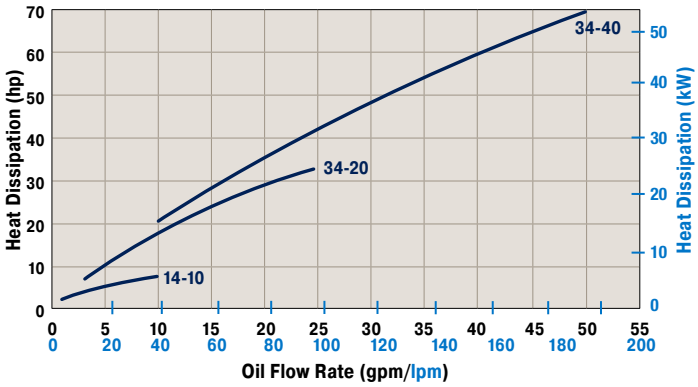
Maximum material efficiency. No “Dead Zone” because there is no need for gaskets.

OAW 14 & OAW 34

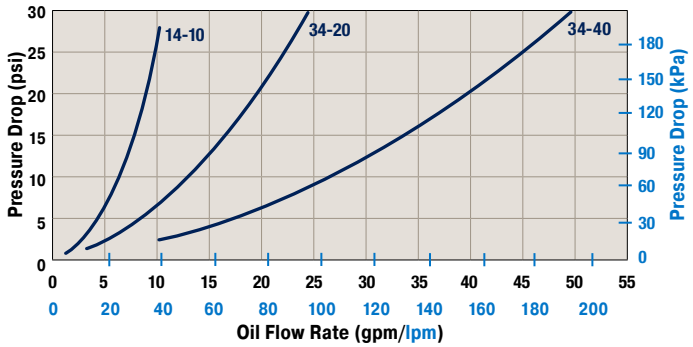
MODEL	Cooling Capacity (*hp)	Connection	A (inches)	Weight (lbs.)	Volume (in^3)
OAW 14-10-SG	2-7	5/8" SAE O-ring	-	1.4	15
OAW 34-20	6-33	1" SAE O-ring	2.3	9	74
OAW 34-40	20-69	1" SAE O-ring	4.1	15	149

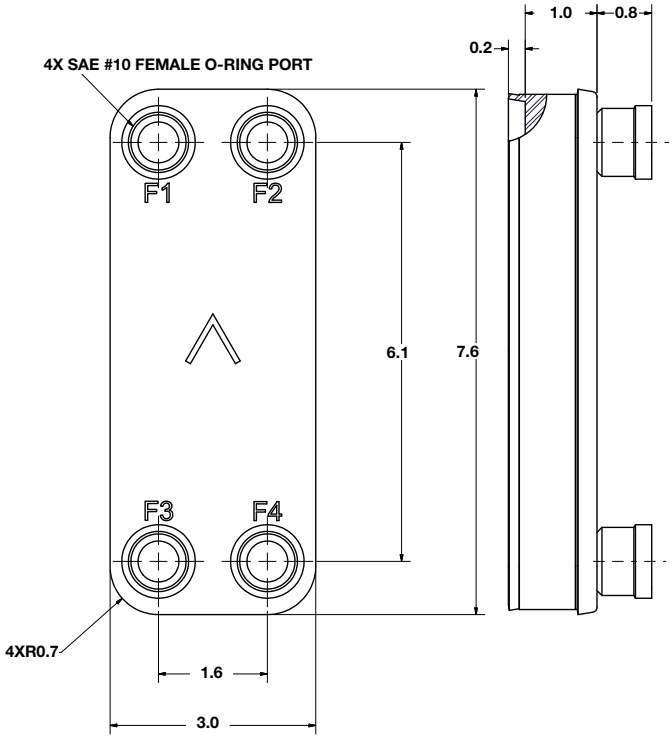
*Cooling capacity is calculated with the following conditions. For other flow conditions, type of fluids or temperatures, please see page 35 or consult Cylinder and Accumulator Division. Oil type – ISO VG 32 – Oil/water flow ratio – 2:1 – Oil inlet temperature – 140°F – Water inlet temperature – 80°F See page 45 for Viscosity Conversion chart.

OAW 14 & 34 COOLING CAPACITY

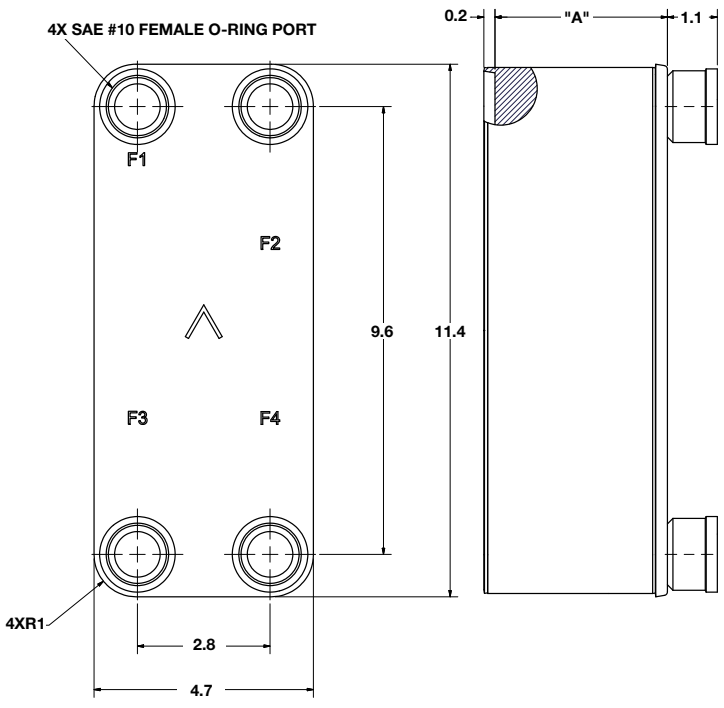


OAW 14 & 34 PRESSURE DROP





OAW 14



OAW 34

Helpful Equations
Horsepower equation: ____HP x 0.7457 = _____ kW
GPM to LPM equation: _____ GPM x 3.79 = _____ LPM
PSI to kPa equation: _____PSI x 6.894 = _____ kPa

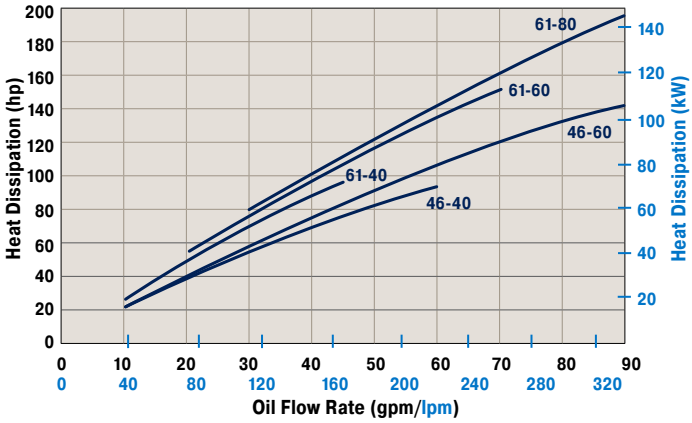
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

OAW 46 & OAW 61

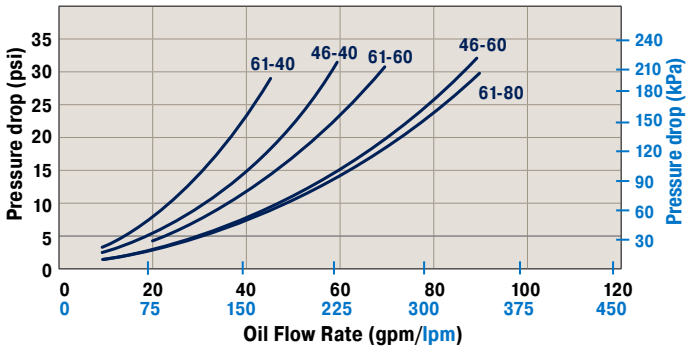
MODEL	Cooling Capacity (*hp)	Connection	A (inches)	Weight (lbs.)	Volume (in^3)
OAW 46-40	21-94	1¼" SAE O-ring	3.9	13	200
OAW 46-60	23-142	1¼" SAE O-ring	5.7	18	300
OAW 61-40	27-98	1¼" SAE O-ring	3.9	19	271
OAW 61-60	53-152	1¼" SAE O-ring	5.7	27	406
OAW 61-80	79-198	1¼" SAE O-ring	7.4	34	542

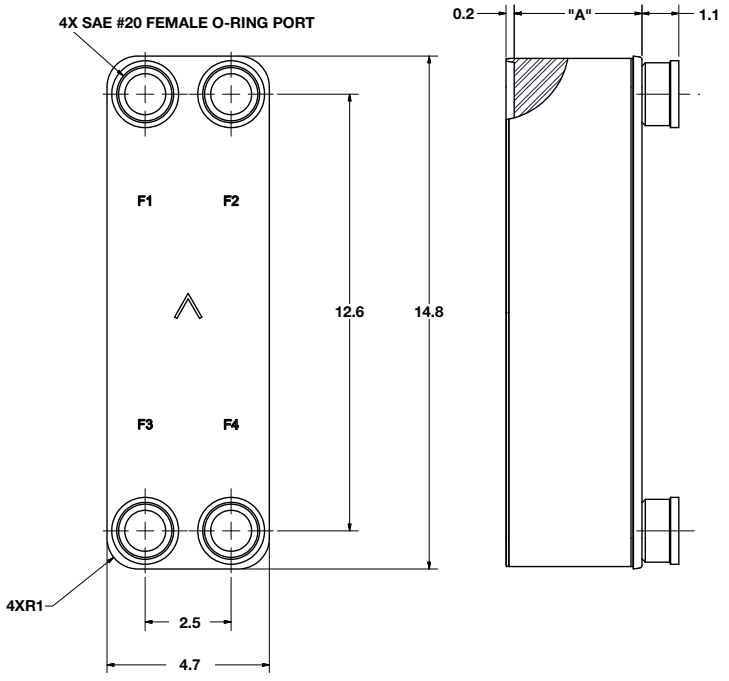
***Cooling capacity is calculated with the following conditions. For other flow conditions, type of fluids or temperatures, please see page 35 or consult Cylinder and Accumulator Division. Oil type – ISO VG 32 – Oil/water flow ratio – 2:1 – Oil inlet temperature – 140°F – Water inlet temperature – 80°F. See page 45 for Viscosity Conversion chart.**

OAW 46 & 61 COOLING CAPACITY

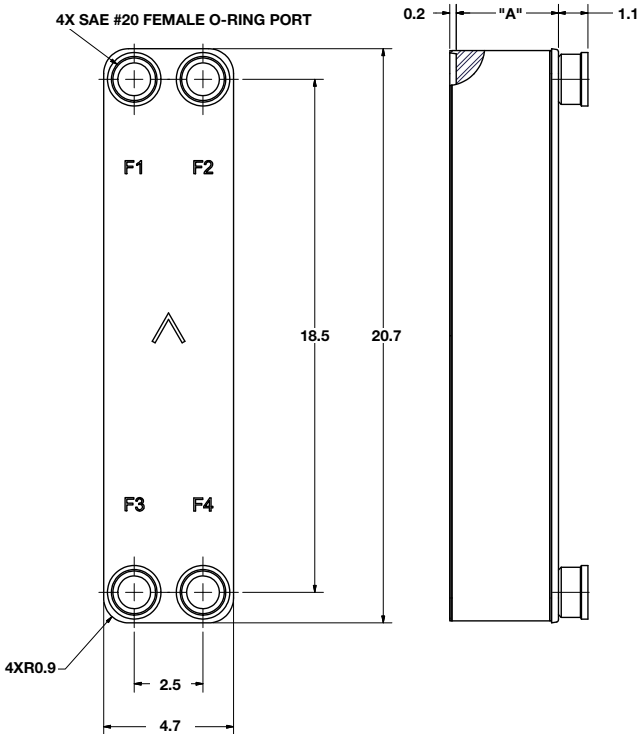


OAW 46 & 61 PRESSURE DROP





OAW 46



OAW 61

Helpful Equations
Horsepower equation: ____HP x 0.7457 = _____ kW
GPM to LPM equation: _____ GPM x 3.79 = _____ LPM
PSI to kPa equation: _____PSI x 6.894 = _____ kPa

⚠ PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

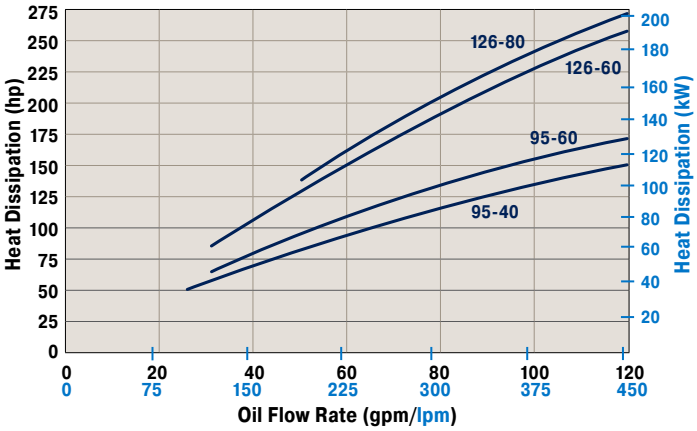
Parker Hannifin Corporation
Cylinder and Accumulator Division
Des Plaines, Illinois USA

OAW 95 & OAW 126

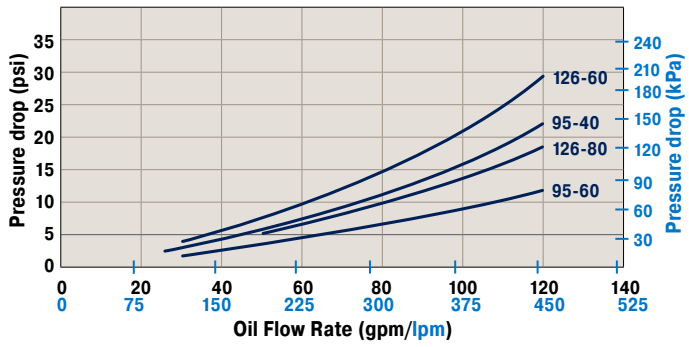
MODEL	Cooling Capacity (*hp)	Connection	A (inches)	Weight (lbs.)	Volume (in^3)
OAW 95-40	50-150	1½" SAE O-ring	4.1	44	427
OAW 95-60	63-171	1½" SAE O-ring	6.0	59	641
OAW 126-60	84-259	1½" SAE O-ring	6.1	79	856
OAW 126-80	138-274	1½" SAE O-ring	7.9	97	1142

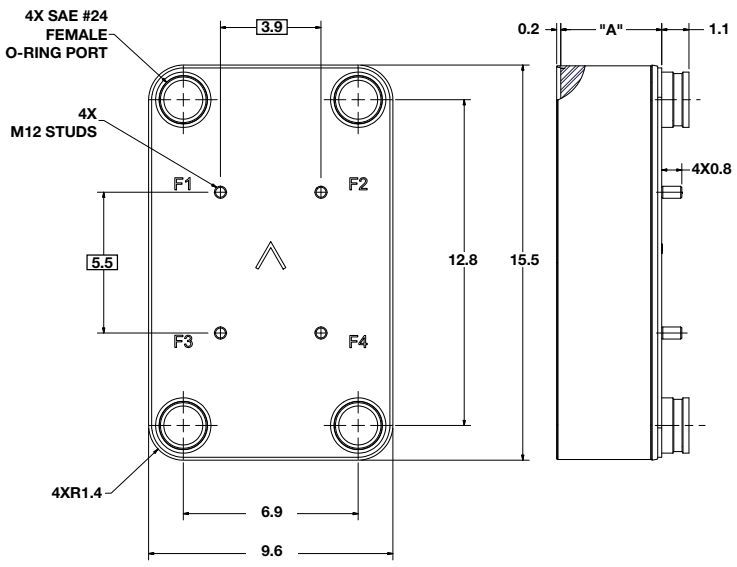
***Cooling capacity is calculated with the following conditions. For other flow conditions, type of fluids or temperatures, please see page 35 or consult Cylinder and Accumulator Division. Oil type – ISO VG 32 – Oil/water flow ratio – 2:1 – Oil inlet temperature – 140°F – Water inlet temperature – 80°F See page 45 for Viscosity Conversion chart.**

OAW 95 & 126 COOLING CAPACITY

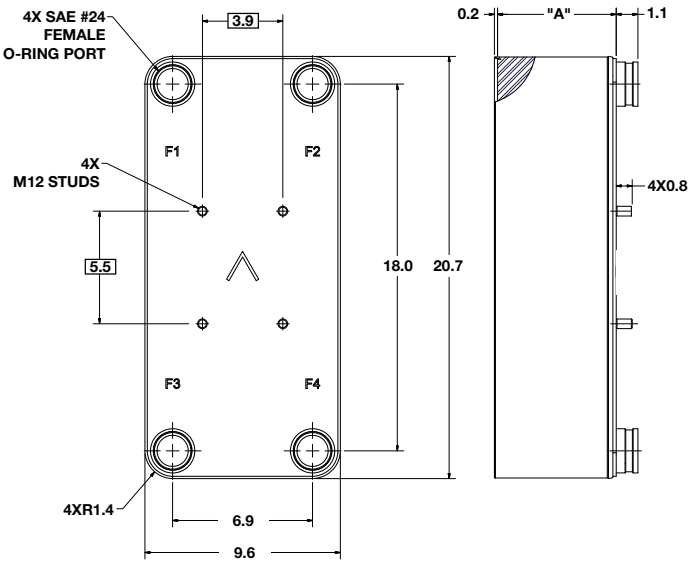


OAW 95 & 126 PRESSURE DROP





OAW 95



OAW 126

Helpful Equations
Horsepower equation: ____HP x 0.7457 = _____ kW
GPM to LPM equation: _____ GPM x 3.79 = _____ LPM
PSI to kPa equation: _____PSI x 6.894 = _____ kPa

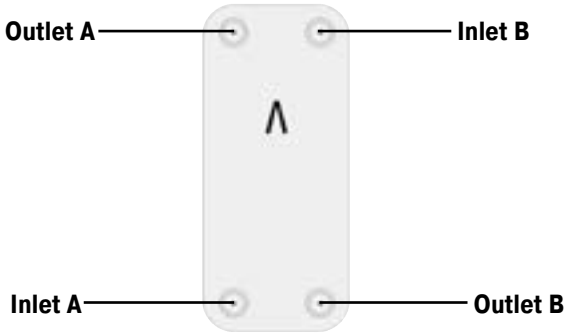
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

OAW Installation Guide

Installation Instructions for OAW Coolers

The OAW coolers are designed for a maximum working pressure of 450 psi. The most standard application for the OAW cooler involves a cold water circuit and a hot oil circuit. Fluids are not limited to oil and water however; for other types of fluid, please contact the factory.

Inlets and outlets are clearly identified by the Accumulator and Cooler Division sticker affixed to the front of the unit. When in doubt, pour a liquid in one of the connections and note which connection it comes out of. This will be the inlet and outlet for one circuit (either oil or water). The other inlet should be located on the diagonal from the first inlet.



Maximum cooling efficiency is achieved by cross flowing through the plates, the oil inlet and water inlet being located on a diagonal. Failure to have the cooler attached in this manner will lead to a decrease in efficiency.

The cooler may be mounted in any position. However, requirements for draining the circuits should be taken into consideration.

The OAW coolers must not be installed into a rigid frame. Use the Accumulator and Cooler Division purpose-made brackets (or “Armaflex” equivalent) to provide a “soft, elastic installation.” The OAW 95 and 126 series coolers come equipped with stud bolts to assist in mounting. However, these bolts alone should not be used to suspend the cooler. All tubing should be done in such a way as to minimize vibrations to the cooler. When installed on a return line, the cooler should be connected using flexible hoses.

When to Clean

Fouling occurs mainly on the water side of the cooler. Fouling can be detected by monitoring the inlet and outlet temperatures and/or the pressure drop across the cooler. Fouling will result in decreased heat transfer, producing temperature differences lower than specified.

Fouling also restricts the passages and thus causes an increase in velocity. This will produce an increase in the pressure drop across the cooler. When either the temperature difference or the pressure drop is significantly different from specified values, cleaning should be performed.

Methods of Cleaning

If cleaning the cooler is required, backflushing with water will remove most of the soft deposits. If fouling appears in the form of hard deposits, circulate a weak acid through the cooler in reverse direction to normal water flow. Use 5% phosphoric acid for infrequent cleanings. For more frequent cleaning, use 5% oxalic acid or similar weak organic acid. Afterwards, flush with a large quantity of water to remove all acid from the cooler before starting up the system again. Never wait until the cooler is completely clogged before cleaning!

Filters or Strainers

When there are particles in the fluid that could clog the cooler, filters or strainers should be used. Particles up to 1mm diameter will not cause any problems.

Fluid Compatibility

On the oil side, most synthetic and petroleum based fluids may be used. For aggressive oils, please contact Accumulator and Cooler Division for compatibility. On the water side, de-mineralized and untreated water may be used without concern. When water is chemically treated please contact Accumulator and Cooler Division for suitability. Sea water cannot be used in OAW coolers. For sea water applications, please contact Accumulator and Cooler Division on information on titanium coolers. Do not use ammonia in the OAW coolers.

OAW Installation Guide

Correction Factors for Other Oil Types, Temperatures and Flow Rates

All of the cooling curves are based on very specific conditions. These include using an ISO VG 32 oil, having an oil/water ratio of 2:1, and having an oil/water inlet difference of 60 °F. For other conditions, the following correction factors should be used.

Correction Factors for Other Oil Types

Cooling Capacity: Multiply the requested cooling capacity with the correction factor Kv.

Oil Pressure Drop: Multiply the pressure drop with the correction factor Kp.

Viscosity Class	Cooling Capacity Factor, Kv	Pressure Drop Factor, Kp
ISO VG 22	0.95	0.9
ISO VG 32	1.0	1.0
ISO VG 46	1.05	1.3
ISO VG 68	1.2	1.7
ISO VG 100	1.35	2.2
ISO VG 150	1.6	3.0
ISO VG 220	1.9	4.3

Table 1

Correction Factors for Other Inlet Temperature Differences

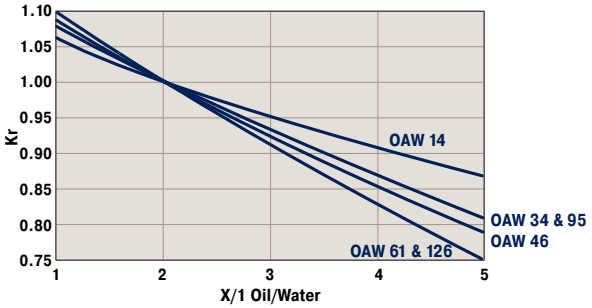
Cooling Capacity: For inlet temperature differences other than 60 °F, multiply the requested cooling capacity by the correction factor Kt.

ETD	30	40	50	60	70
Kt	1.87	1.43	1.17	1.0	0.88

Table 2

Correction Curves for Other Oil/Water Flow Ratios

Cooling Capacity: For all other oil/water flow ratios other than 2:1, divide the requested cooling capacity by the factor Kr obtained from the curves in Graph 3.



Graph 3

Sizing Example

Conditions:

Oil type:		ISO VG 68
Oil Flow:		40 gpm
Desired cooling capacity	Qr	40 hp
Oil temperature in	To	140 °F
Water temperature in	Tw	100 °F
Available water flow		10 gpm
Maximum Pressure Drop		30 psi

ETD = To - Tw = 140°F - 100°F = 40°F

The design cooling capacity (Qd) is the cooling capacity used when selecting a suitable cooler. Qd is calculated by multiplying Qr by the factors Kv and Kt (found in Tables 1 and 2 respectively) and then dividing by the Kr factor found from Graph 3.

$$Qd = \frac{Qr \times Kv \times Kt}{Kr} = \frac{40\ hp \times 1.2 \times 1.43}{0.82} = 83\ hp$$

According to the cooling capacity curves the minimum size cooler for these conditions is an OAW 61-40.

The oil pressure drop can be found from the pressure drop curve. It should be multiplied by the Pressure Drop Factor, Kp from Table 1.

DPoil = p x Kp = 23 psi x 1.7 = 39.1 psi.

In this case the pressure drop exceeds the maximum allowable. The next size cooler would be an: OAW 61-60

The pressure drop for this cooler would be:

DPoil = p x Kp = 12 psi x 1.7 = 20.4 psi.

Therefore the correct size cooler would be the OAW 61-60.

For assistance with calculations, please contact Cylinder and Accumulator Division.

Learn more online:

OAW Series: Brazed Plate Cooler Configurator
parker.com/oaw-coolers
Competitive Cross Reference Tool
crossref.parker.com
OAW Sizing (web app)
parker.com/OAWsizing

Parker Hannifin Corporation
Cylinder and Accumulator Division
Des Plaines, Illinois USA

Air-Cooler Accessories

Integrated Pressure-controlled Bypass Valve

Allows the oil to **partially** bypass the cooler core if the pressure drop is too high. Reduces the risk of the cooler bursting, e.g. in connection with cold starts and temporary peaks in pressure or flow. Available for single-pass or two-pass core design.

External Temperature/Pressure-controlled 3-way Bypass Valve

Allows the oil to **fully** bypass the cooler core if the pressure is too high or the oil temperature is too low. Reduces the risk of the cooler bursting, e.g. in connection with cold starts and temporary peaks in pressure or flow.

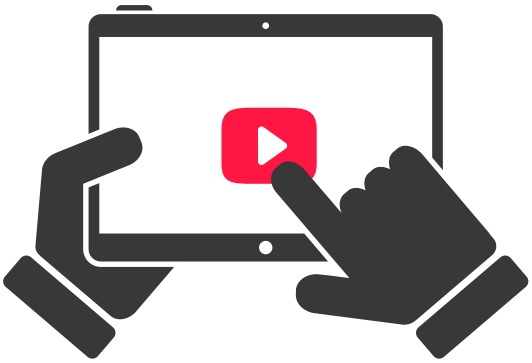
ThermoSwitch

Temperature sensor with a fixed set point that automatically switches the fan motor on and off, thereby reducing the energy usage.

UL Series: Air-Oil Coolers
parker.com/air-oil-coolers

UL Series: Air-Oil Cooler Sizing Software (.exe)
Link

All the Latest Information



Be sure to keep up with all the latest product updates and up to date information by calling the division to find out new cooler promotions and educational webinars.

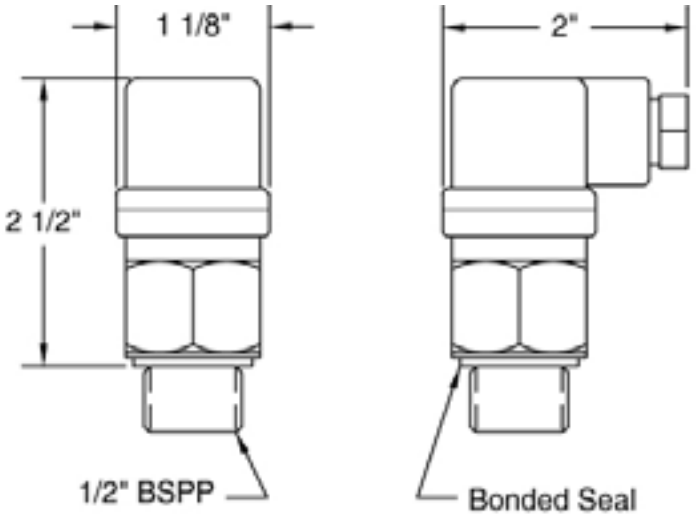
Cylinder and Accumulator Division
phone 815 636 4100
parker.com/cylinder-accumulator

Clamps for OAW and PWO Brazed Plate Coolers

Part Number	Description
A2130002	Clamp for OAW 14, PWO B5
A2130022	Clamp for OAW 34, PWO B10 and B12
A2130052	Clamp for OAW 46, PWO B16
A2130062	Clamp for OAW 61, PWO B25
A2130082	Clamp for OAW 95, PWO B35
A2130102	Clamp for OAW 126, PWO B45*

* Two clamps are required for OAW 126 & PWO B45

ThermoSwitch



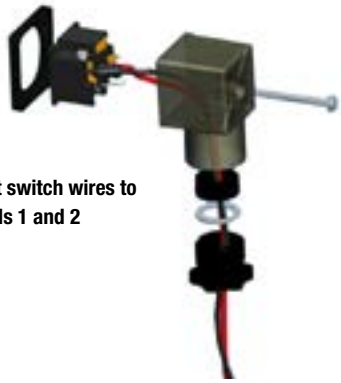
To ensure the best possible temperature control and working conditions of a hydraulic system, a thermoswitch should be installed to control the motor (AC or DC) on an air-oil cooler. The thermoswitches can also be used to give alarm signals for excessive fluid temperatures.

Part Number	Closing Temperature	Opening Temperature
ATS-GF-C100	100°F ± 9°F	80°F ± 9°F
ATS-GF-C120	117°F ± 9°F	97°F ± 9°F
ATS-GF-C140	140°F ± 9°F	120°F ± 9°F
ATS-GF-C160	158°F ± 9°F	138°F ± 9°F
ATS-GF-C175	176°F ± 9°F	156°F ± 9°F

Thermoswitches are normally open (NO)
IP65 protection; PG09 Plug Connector

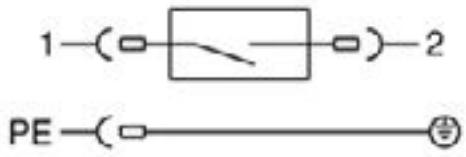
Voltage	12V DC	24V DC	240V AC
Amps (Max.)	10A	5A	10A

Wire connection diagram to DIN connector



Connect switch wires to terminals 1 and 2

Electrical Circuit



NOTE: Thermoswitch must be installed in the hydraulic reservoir when used with a ULOC cooler.

Thermal Bypass Valves - TH Series

Maintain Optimum Fluid Temperature

Parker's thermal bypass valve will modulate fluid temperature by shifting return line flow through the cooler, or bypassing it directly to the reservoir.

Additionally, an integral pressure relief function automatically releases excess pressure to the reservoir if the cooler becomes restricted, and the inlet pressure becomes excessive. Relief crack pressure settings range from 5 to 85 PSI.

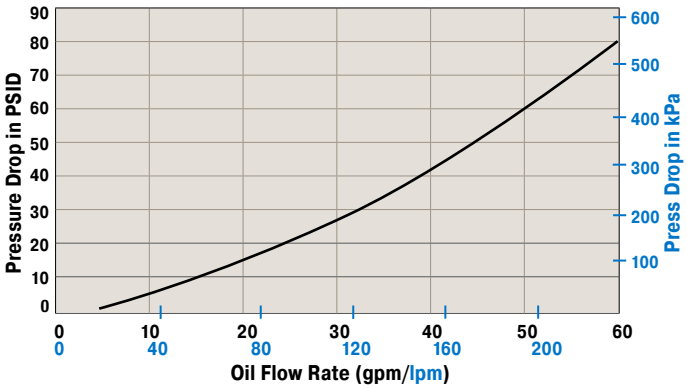
These lightweight, aluminum valves are ideal for hydrostatic drive circuits requiring fast warm-up, controlled fluid temperatures, and low return line back pressure.

Features

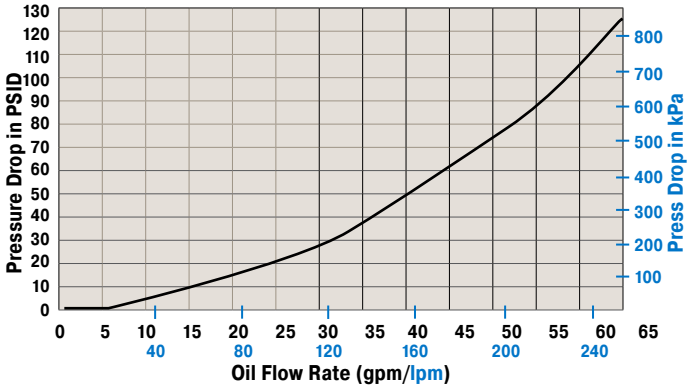
- Lightweight, corrosion-resistant aluminum housing.
- Available in five shift temperatures.
- Integral relief valve to dump excessive inlet pressures to the reservoir.
- 250 PSI maximum operating pressure.
- Up to 60 GPM flow rates.

Flow Data Pressure Drop (Mobil DTE 26 oil)

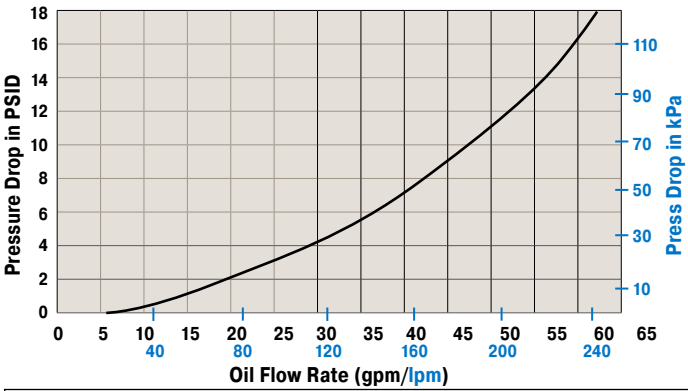
Inlet Port through Tank Port @ 100 °F (300 SUS)



Inlet Port over Integral Relief Port @ 170 °F (78 SUS Oil)



Inlet Port through Cooler Port @ 145 °F (110 SUS Oil)



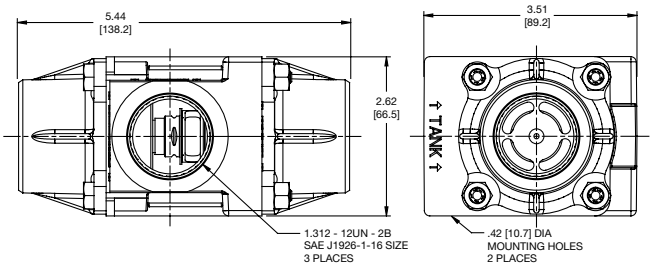
Helpful Equations
GPM to LPM equation: ____ GPM x 3.79 = ____ LPM
PSI to kPa equation: ____PSI x 6.894 = ____ kPa

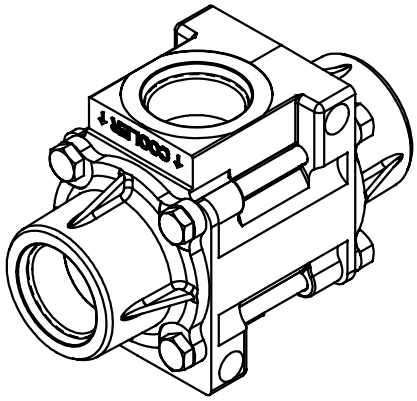
⚠PROP 65 WARNING **WARNING:** This product can expose you to chemicals including Lead and Lead Compounds which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Thermal Bypass Valves - TH Series

TH Series Specifications	
Size	1 inch
Weight	2.00 lbs
Std Shift Temperatures	100 °F (38 °C), 120 °F (49 °C), 140 °F (60 °C), 160 °F (71 °C), 180 °F (82 °C)
Full Shift Temperature (cooler port open)	Shift Temperature plus 25 °F
Proof Pressure	300 PSI (21 bar)
Minimum Burst Pressure	Up to full shift temperature: 325 PSI (22 bar) Above full shift temperature: 600 PSI (41 bar)
Operating Temperature	Min: -30 °F Max: Shift temperature plus 75 °F
Max Flow Rate	60 GPM (227 l/m)

Dimensions





Ordering Information

T H - 1 0 0 0 - 1 6 F O - * *

VALVE SERIES:
Thermal Bypass

VALVE SIZE:
1000 = 1 inch

CRACK PRESSURE/TEMPERATURE CODE:
(see table)

PORT SIZE & STYLE:
16FO = 1 inch SAE O-Ring Boss (1.312 -12UN-2B thread)

Shift Temperature	Crack Pressure PSI																
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
100 °F (38 °C)	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
120 °F (49 °C)	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
140 °F (60 °C)	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
160 °F (71 °C)	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
180 °F (82 °C)	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97

FAQ

What is a thermoswitch and how does it work?
A thermoswitch is a temperature sensor that can be installed into a cooling circuit. This can be either in the cooler core or upstream of the cooler core inlet. The thermoswitch senses the fluid temperature and at a preset temperature, sends a electrical signal to the fan-motor controller or relay. This signal then is used to turn the motor on and off.

What are the benefits of having a thermoswitch in a cooler?
The thermoswitch can reduce power consumed by the fan motor, thus making the cooling circuit more energy efficient.

What is an Integrated Pressure-controlled Bypass Valve and how does it work?
This is a pressure bypass valve that senses the pressure difference between the inlet and outlet ports of the core. When the pressure differential reaches the valve setting, it opens, allowing a portion of the inlet flow to bypass the core. This is a spring operated poppet valve.

What are the benefits of having an Integrated Pressure-controlled Bypass Valve ?
When the fluid media is at a low temperature, it can be highly viscous and cause increased pressure in the system. Having a bypass valve installed will reduce the pressure by allowing the media to heat up quicker and prevent damage. This is extremely important during cold weather machine startups.

What is the difference between an external (TH Series) Bypass Valve and the Pressure Bypass Valve that is installed on the cooler?
The Integrated Pressure-controlled Bypass Valve only diverts some of the flow around the cooler core and is activated by pressure differential only. The External Temperature-controlled 3-way Bypass Valve (TH Series) diverts full flow away from the core and can be activated by both temperature and pressure. The External Temperature-controlled 3-way Bypass Valve (TH Series) is typically installed upstream of the core inlet and can divert all flow away from the core.

What are the advantages of a bar & plate over a tube & fin core design?
The Bar & Plate is a more robust design and provides better protection against tube damage by external objects.

What is a turbulator (hot fin)?
This is an internal fin that helps to mix the cooling media which improves heat transfer.

When do I use a Brazed Plate Cooler vs a Shell & Tube?
You must consider flow rates of each fluid being used, envelope restrictions, maximum pressure drop allowance, cost, and material capability when determining which water-oil cooler is right for you. You can fill out the cooler sizing form @ parker.com/coolersizingform, submit it, and Parker ACD can size each type for you.

What is the minimum clearance when mounting an air-oil cooler?
The minimum clearance when mounting an air-oil cooler is 1/2 the fan diameter both in front and back of the cooler.

What is Heat Load?
Heat Load is the amount of energy a system creates. Cooling Capacity is the amount of energy that can be removed from the system by the cooler.

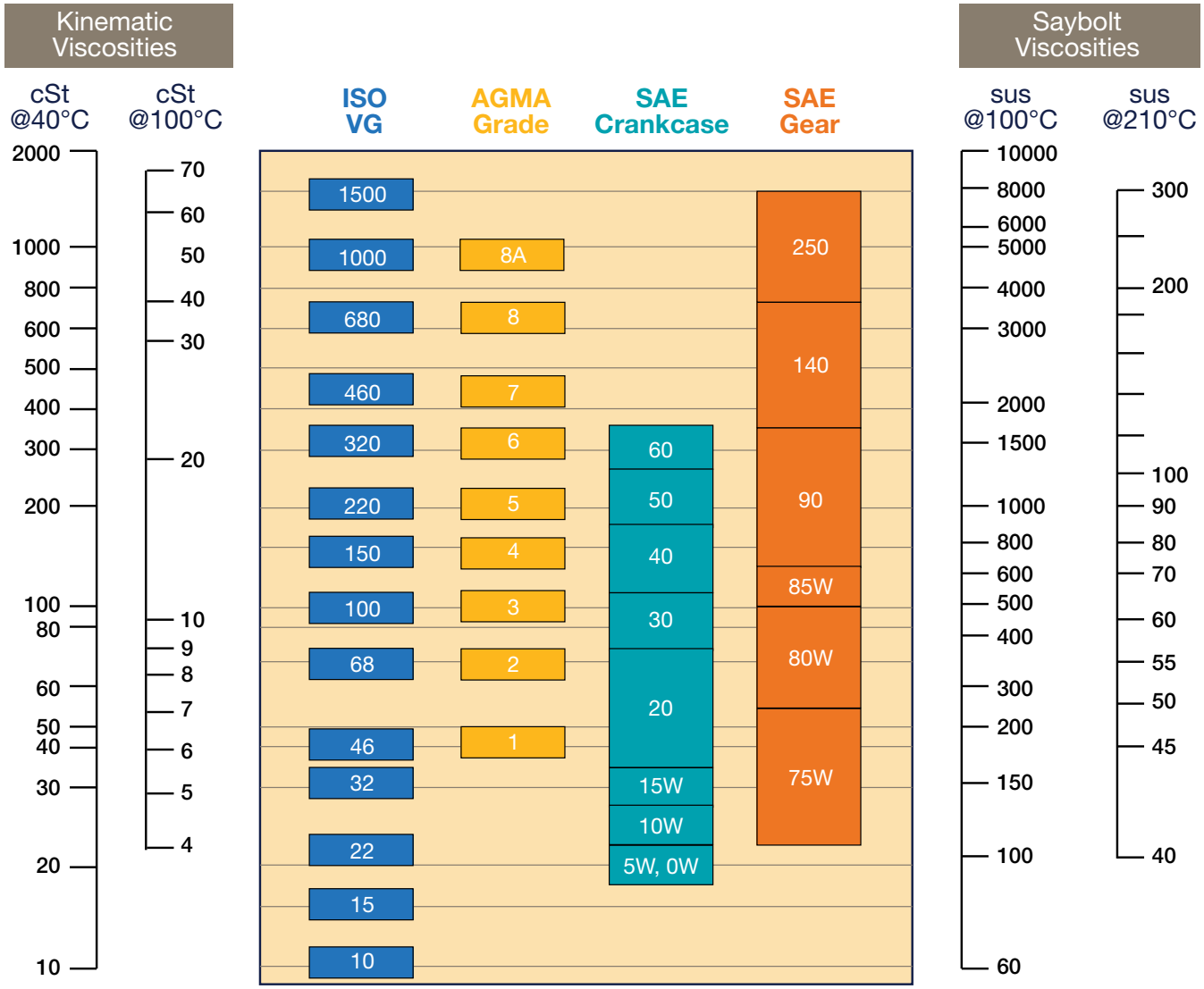
Why is heat load important?
If the Heat Load exceeds the cooling capacity of the cooler, then the system will overheat.

What is the difference between temperature and heat load?
Temperature is measured in °F and Heat Load (HP, kW, BTU/Hr) is measured by power.

How do I plumb my cooler?
Follow the installation instructions found here: Parker.com/cylinder-accumulator

What is a 2-pass (dual pass) cooler and when should I use it? What are the advantages and disadvantages to using a 2-pass cooler?
A 2-pass cooler has a core that makes the fluid being cooled pass through the core twice, instead of just once. This will increase the velocity of the fluid being cooled is in the core, thus increasing the cooling capacity of the cooler. When the fluid goes through the core twice, the speed of the fluid being cooled increases thus increasing the pressure drop across the core by four times that of a 1-pass (single pass) cooler. So you get more cooling capacity but at the cost of higher pressure drop.

Viscosity Conversion Chart



Basic Hydraulic Formulas

Torque and Horsepower Relationships:

Torque (ft lbs) = horsepower (hp) x 5,252 / speed (rpm)

Horsepower (hp) = torque (ft lbs) x speed (rpm) / 5,252

Speed (rpm) = horsepower (hp) x 5,252 / torque (ft lbs)

Piston Cylinder Area (in^2) = diameter squared x .7854
(Can also use 3.1416 x radius squared (ins))

Piston Rod End (annulus end) Area (in^2) = piston cylinder area (in^2) - rod area (in^2)

Cylinder Force (lbs) = pressure (psi) x area (in^2)

Cylinder Speed (ft/min) = 19.25 x flow rate (gpm) / area (in^2)
(Divide by 60 to convert speed to ft/sec)

Cylinder Speed (in/min) = flow rate (cu ins/min) / area (in^2)
(Note that 1 US gallon = 231 cu ins)

Cylinder Time (secs) = area (in^2) x cylinder stroke (ins) x .26 / flow rate (gpm)

Cylinder Flow Rate (gpm) = 12 x 60 x cylinder speed (ft/sec) x area (in^2) / 231

Cylinder Volume Capacity (gals) = cylinder area (in^2) x cylinder stroke (ins) / 231

Basic Hydraulic Motor Calculations:

Motor Torque (in lbs) = pressure (psi) x motor displacement (cu ins/rev) / 6.28
(Can also use horsepower (hp) x 63,025 / speed (rpm))

Motor Speed (rpm) = 231 x flow rate (gpm) / motor displacement (cu ins/rev)

Motor Horsepower (hp) = torque (in lbs) x motor speed (rpm) / 63,025

Motor Flow Rate (gpm) = motor speed (rpm) x motor displacement (cu ins/rev) / 231

Motor Displacement (cu ins/rev) = torque (in lbs) x 6.28 / pressure (psi)

Basic Pump Calculations:

Pump Outlet Flow (gpm) = pump speed (rpm) x pump displacement (cu ins/rev) / 231

Pump Speed (rpm) = 231 x pump flow rate (gpm) / pump displacement (cu ins/rev)

Pump Horsepower (hp) = flow rate (gpm) x pressure (psi) / 1,714 x pump efficiency factor (Can also use horsepower (hp) = torque (in lbs) x pump speed (rpm) / 63,025)

Pump Torque (in lbs) = pressure (psi) x pump displacement (cu ins/rev) / 6.28
(Can also use horsepower (hp) x 63,025 / pump displacement (cu ins/rev)

Heat Generation Formulas: Converting heat into other units

1 hp = 2,545 BTU/hr = 42.4 BTU/min = 33,000 ft. lbs./min = 746 watts

Horsepower (hp) = pressure (psi) x flow (gpm) / 1714 -or- BTU/hr = 1½ x psi x gpm

1 BTU/hr = .0167 BTU/min = .00039 hp

Example: 10 gpm flow across a pressure reducing valve with a 300 psi drop = 1.75 hp of heat generated

1.75 hp of heat = 4,453 BTU/hr = 105 BTU/min = 57,750 ft. lbs./min = 1,305 watts

- Most of this heat will be carried back to the reservoir.

Pressure, Force and Horsepower Relationships:

Pressure (psi) = force (lbs) / area (in^2)
Force (lbs) = area (in^2) x pressure (psi)
Area (in^2) = force (lbs) / pressure (psi)

Fluid Power Horsepower:

Fluid Power Horsepower (hp) = pressure (psi) x pump flow (gpm) / 1,714

General cooling capacity of a steel reservoir:

HP (heat) = .001 x TD x A

- TD = temperature difference of the oil in the reservoir and the surrounding ambient air
- A = entire surface area of the reservoir in square feet (including the bottom if elevated)

Commonly Used Fluid Power Equivalents:

One US gallon equals:

231 cubic inches
3.785 liters (1 liter = .2642 US gals)
4 quarts or 8 pints
128 ounces liquid
133.37 ounces weight
8.3356 pounds weight

One horsepower equals:

33,000 ft lbs per minute
550 ft lbs per sec
42.4 BTU per min
2,545 BTU per hour
746 watts
0.746 kw

One psi equals:

.0689 bar (1 bar = 14.504 psi)
6.895 kilopascal
2.0416 hg (inches of mercury)
27.71" water

One atmosphere equals:

14.696 psi
1.013 bar
29.921 hg (inches of mercury)

Basic Hydraulic Formulas

General Information and "Rules of Thumb":

Estimating pump drive horsepower: 1 hp of input drive for each
1 gpm at 1,500 psi pump output

Horsepower when idling a pump: an idle and unloaded pump will require about 5% of its full rate hp

Reservoir capacity (GALS) = length (IN) x width (IN) x height (IN) / 231

Oil compressibility: 1/2 % approximate volume reduction for every 1,000 psi of pressure

Water compressibility: 1/3 % approximate volume reduction for every 1,000 psi of pressure

Wattage to heat hydraulic oil: each .74 watt will raise the temperature of 1 gallon of oil by 1°F per hour

Guidelines for Flow Velocity in Hydraulic Lines:

2 to 4 ft/sec = suction lines

10 to 15 ft/sec = pressure lines up to 500 psi

15 to 20 ft/sec = pressure lines 500 – 3,000 psi

25 ft/sec = pressure lines over 3,000 psi

4 ft/sec = any oil lines in air-over-oil systems

Velocity of Oil Flow in a Pipe: velocity (ft/sec) = flow (gpm) x .3208 / inside area of the pipe (sq in)

Area (sq in) = $\pi \times r^2$ where π (pi) = 3.1416 and r = radius in inches squared

Area (sq in) = $\pi \times d^2 / 4$ where π (pi) = 3.1416 and d = diameter in inches

Circumference (in) = $2 \times \pi \times r$ where π (pi) = 3.1416 and r is radius in inches

Circumference (in) = $\pi \times d$ where π (pi) = 3.1416 and d = diameter in inches

Gas Laws for Accumulator Sizing

Where "P" = psia (absolute) = psig (gauge pressure) + 14.7 psi

Pressure or Volume: original pressure x original volume = final pressure x final volume

$P_1V_1 = P_2V_2$ (Isothermic) (with constant "T" temperature)

Pressure or Temperature: original pressure x final temperature = final pressure x original temperature

$P_1T_2 = P_2T_1$ (Isochoric) (with constant "V" volume)

Volume or Temperature: original volume x final temperature = final volume x original temperature

$V_1T_2 = V_2T_1$ (Isobaric) (with constant "P" volume)

Pressure or Volume with Temperature Change Due to Heat of Compression:

Original pressure x original volume^n = final pressure x final volume^n

$P_1 V_1^n = P_2V_2^n$

For Nitrogen the Exponent

"n" = 1.4 For full adiabotic conditions i.e., the "Full Heating" theoretical condition

"n" = 1.3 For rapid cycling (most heating normally experienced)

"n" = 1.1 For "normal" cycling

"n" = 1.0 Where gas time to return normal temp. before discharge or recharge

Offer of Sale

The items described in this document and other documents and descriptions provided by Parker Hannifin Corporation, its subsidiaries and its authorized distributors ("Seller") are hereby offered for sale at prices to be established by Seller. This offer and its acceptance by any customer ("Buyer") shall be governed by all of the following Terms and Conditions. Buyer's order for any item described in its document, when communicated to Seller verbally, or in writing, shall constitute acceptance of this offer. All goods, services or work described will be referred to as "Products".

1. Terms. All sales of Products by Seller will be governed by, and are expressly conditioned upon Buyer's assent to, these Terms. These Terms are incorporated into any Quote provided by Seller to Buyer. Buyer's order for any Products whether communicated to Seller verbally, in writing, by electronic data interface or other electronic commerce, shall constitute acceptance of these Terms. Seller objects to any contrary or additional terms or conditions of Buyer. Reference in Seller's order acknowledgement to Buyer's purchase order or purchase order number shall in no way constitute an acceptance of any of Buyer's terms or conditions of purchase. Any Quote made by Seller to Buyer shall be considered a firm and definite offer and shall not be deemed to be otherwise despite any language on the face of the Quote. Seller reserves all rights to accept or reject any purported acceptance by Buyer to Seller's Quote if such purported acceptance attempts to vary the terms of the Quote. If Seller ships Products after Buyer issues an acceptance to the Quote, any additional or different terms proposed by Buyer will not become part of the parties' business relationship unless agreed to in a writing that is signed by an authorized representative of Seller, excluding email correspondence. If the transaction proceeds without such agreement on the part of Seller, the business relationship will be governed solely by these Terms and the specific terms in Seller's Quote.

2. Price; Payment. The Products set forth in the Quote are offered for sale at the prices indicated in the Quote. Unless otherwise specifically stated in the Quote, prices are valid for thirty (30) days and do not include any sales, use, or other taxes or duties. Seller reserves the right to modify prices for any reason and at any time by giving ten (10) days prior written notice. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2020). All sales are contingent upon credit approval and full payment for all purchases is due thirty (30) days from the date of invoice (or such date as may be specified in the Quote). Under any circumstances, Buyer may not withhold or suspend payment of any amounts due and payable as a deduction, set-off or recoupment of any amount, claim or dispute with Seller. Unpaid invoices beyond the specified payment date incur interest at the rate of 1.5% per month or the maximum allowable rate under applicable law. Seller reserves the right to require advance payment or provision of securities for first and subsequent deliveries if there is any doubt, in Seller's sole determination, regarding the Buyer's creditworthiness or for other business reasons. If the requested advance payment or securities are not provided to Seller's satisfaction, Seller reserves the right to suspend performance or reject the purchase order, in whole or in part, without prejudice to Seller's other rights or remedies, including the right to full compensation. Seller may revoke or shorten any payment periods previously granted in Seller's sole determination. The rights and remedies herein reserved to Seller are cumulative and in addition to any other or further rights and remedies available at law or in equity. No waiver by Seller of any breach by Buyer of any provision of these terms will constitute a waiver by Seller of any other breach of such provision.

3. Shipment; Delivery; Title and Risk of Loss. All delivery dates are approximate, and Seller is not responsible for damages or additional costs resulting from any delay. All deliveries are subject to our ability to procure materials from our suppliers. Regardless of the manner of shipment, delivery occurs and title and risk of loss or damage pass to Buyer, upon placement of the Products with the carrier at Seller's facility. Unless otherwise agreed prior to shipment and for domestic delivery locations only, Seller will select and arrange, at Buyer's sole expense, the carrier and means of delivery. When Seller selects and arranges the carrier and means of delivery, freight and insurance costs for shipment to the designated delivery location will be prepaid by Seller and added as a separate line item to the invoice. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions. Buyer shall not return or repackage any Products without the prior written authorization from Seller, and any return shall be at the sole cost and expense of Buyer.

4. Warranty. The warranty for the Products is as follows: (i) Goods are warranted against defects in material or workmanship for a period of eighteen (18) months from the date of delivery or 2,000 hours of use, whichever occurs first; (ii) Services shall be performed in accordance with generally accepted practices and using the degree of care and skill that is ordinarily exercised and customary in the field to which the Services pertain and are warranted for a period of six (6) months from the date of completion of the Services; and (iii) Software is only warranted to perform in accordance with applicable specifications provided by Seller to Buyer for ninety (90) days from the date of delivery or, when downloaded by a Buyer or end-user, from the date of the initial download. All prices are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **EXEMPTION CLAUSE; DISCLAIMER OF WARRANTY, CONDITIONS, REPRESENTATIONS: THIS WARRANTY IS THE SOLE AND ENTIRE WARRANTY, CONDITION, AND REPRESENTATION, PERTAINING TO PRODUCTS. SELLER DISCLAIMS ALL OTHER WARRANTIES, CONDITIONS, AND REPRESENTATIONS, WHETHER STATUTORY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THOSE RELATING TO DESIGN, NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE SOFTWARE IS ERROR-FREE OR FAULT-TOLERANT, OR THAT BUYER'S USE THEREOF WILL BE SECURE OR UNINTERRUPTED, UNLESS OTHERWISE AUTHORIZED IN WRITING BY SELLER, THE SOFTWARE SHALL NOT BE USED IN CONNECTION WITH HAZARDOUS OR HIGH-RISK ACTIVITIES OR ENVIRONMENTS. EXCEPT AS EXPRESSLY STATED HEREIN, ALL PRODUCTS ARE PROVIDED "AS IS".**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon receipt. No claims for shortages will be allowed unless reported to Seller within ten (10) days of delivery. Buyer shall notify Seller of any alleged breach of warranty within thirty (30) days after the date the non-conformance is or should have been discovered by Buyer. Any claim or action against Seller based upon breach of contract or any other theory, including tort, negligence, or otherwise must be commenced within twelve (12) months from the date of the alleged breach or other alleged event, without regard to the date of discovery.

6. LIMITATION OF LIABILITY. IN THE EVENT OF A BREACH OF WARRANTY, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE THE NON-CONFORMING PRODUCTS, RE-PERFORM THE SERVICES, OR REFUND THE PURCHASE PRICE PAID WITHIN A REASONABLE PERIOD OF TIME. IN NO EVENT IS SELLER LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING ANY LOSS OF REVENUE OR PROFITS, WHETHER BASED IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE PAID FOR THE PRODUCTS.

7. Confidential Information. Buyer acknowledges and agrees that Confidential Information has been and will be received in confidence and will remain the property of Seller. Buyer further agrees that it will not use Seller's Confidential Information for any purpose other than for the benefit of Seller and shall return all such Confidential Information to Seller within thirty (30) days upon request.

8. Loss to Buyer's Property. Buyer's Property will be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer ordering the Products manufactured using Buyer's Property. Also, Seller shall not be responsible for any loss or damage to Buyer's Property while it is in Seller's possession or control.

9. Special Tooling. Seller may impose a tooling charge for any Special Tooling. Special Tooling shall be and remain Seller's property. In no event will Buyer acquire any interest in the Special Tooling, even if such Special Tooling has been specially converted or adapted for manufacture of Goods for Buyer and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller has the right to alter, discard or otherwise dispose of any Special Tooling or other property owned by Seller in its sole determination at any time.

10. Security Interest. To secure payment of all sums due from Buyer, Seller retains a security interest in all Products delivered to Buyer and, Buyer's acceptance of these Terms is deemed to be a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect Seller's security interest.

11. User Responsibility. Buyer, through its own analysis and testing, is solely responsible for making the final selection of the Products and assuring that all performance, endurance, maintenance, safety and warning requirements of the application of the Products are met. Buyer must analyze all aspects of the application and follow applicable industry standards, specifications, and any technical information provided with the Quote or the Products, such as Seller's instructions, guides and specifications. If Seller provides options of or for Products based upon data or specifications provided by Buyer, Buyer is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products. In the event Buyer is not the end-user of the Products, Buyer will ensure such end-user complies with this paragraph.

12. Use of Products, Indemnity by Buyer. Buyer shall comply with all instructions, guides and specifications provided by Seller with the Quote or the Products. If Buyer uses or resells the Products in any way prohibited by Seller's instructions, guides or specifications, or Buyer otherwise fails to comply with Seller's instructions, guides and specifications, Buyer acknowledges that any such use, resale, or non-compliance is at Buyer's sole risk. Further, Buyer shall indemnify, defend, and hold Seller harmless from any losses, claims, liabilities, damages, lawsuits, judgments and costs (including attorney fees and defense costs), whether for personal injury, property damage, intellectual property infringement or any other claim, arising out of or in connection with: (a) improper selection, design, specification, application, or any misuse of Products; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of Buyer's Property; (d) damage to the Products from an external cause, repair or attempted repair by anyone other than Seller, failure to follow instructions, guides and specifications provided by Seller, use with goods not provided by Seller, or opening, modifying, deconstructing, tampering with or repackaging the Products; or (e) Buyer's failure to comply with these Terms, including any legal or administrative proceedings, collection efforts, or other actions arising from or relating to such failure to comply. Seller shall not indemnify Buyer under any circumstance except as otherwise provided in these Terms.

13. Cancellations and Changes. Buyer may not cancel or modify, including but not limited to movement of delivery dates for the Products, any order for any reason except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage and any additional expense. Seller, at any time, may change features, specifications, designs and availability of Products.

14. Assignment. Buyer may not assign its rights or obligations without the prior written consent of Seller.

15. Force Majeure. Seller is not liable for delay or failure to perform any of its obligations by reason of any events or circumstances beyond its reasonable control. Such circumstances include without limitation: accidents, labor disputes or stoppages, government acts or orders, acts of nature, pandemics, epidemics, other widespread illness, or public health emergency, cyber related disruptions, cyber-attacks, ransomware sabotage, delays or failures in delivery from carriers or suppliers, shortages of materials, sudden increases in the price of raw material or components, shutdowns or slowdowns affecting the supply of raw materials or components, or the transportation thereof, oil shortages or oil price increases, energy crisis, energy or fuel interruption, war (whether declared or not) or the serious threat of same, riots, rebellions, acts of terrorism, embargoes, fire or any reason whether similar to the foregoing or otherwise. Seller will resume performance as soon as practicable after the event of force majeure has been removed. All delivery dates affected by an event of force majeure shall be tolled for the duration of such event of force majeure and rescheduled for mutually agreed dates as soon as practicable after the event of force majeure ceases to exist. The right to allocate capacity is in the Seller's sole discretion. An event of force majeure shall not include financial distress, insolvency, bankruptcy, or other similar conditions affecting one of the parties, affiliates and/or sub¬contractors. An event of force majeure in the meaning of these Terms means any circumstances beyond Seller's control that permanently or temporarily hinders performance, even where that circumstance was already foreseen. Buyer shall not be entitled to cancel any orders following its claim of an event of force majeure.

16. Waiver and Severability. Failure to enforce any provision of these Terms will not invalidate that provision; nor will any such failure prejudice either party's right to enforce that provision in the future. Invalidation of any provision of these Terms shall not invalidate any other provision herein and, the remaining provisions will remain in full force and effect.

17. Duration. Unless otherwise stated in the Quote, any agreement governed by or arising from these Terms shall: (a) be for an initial duration of one (1) year; and (b) shall automatically renew for successive one-year terms unless terminated by Buyer with at least 180-days written notice to Seller or if Seller terminates the agreement pursuant to Section 19 of these Terms.

18. Termination. Seller may, without liability to Buyer, terminate any agreement governed by or arising from these Terms for any reason and at any time by giving Buyer thirty (30) days prior written notice. Seller may immediately terminate, in writing, if Buyer: (a) breaches any provision of these Terms, (b) becomes or is deemed insolvent, (c) appoints or has appointed a trustee, receiver or custodian for all or any part of Buyer's property,(d) files a petition for relief in bankruptcy on its own behalf, or one is filed against Buyer by a third party, (e) makes an assignment for the benefit of creditors; or (f) dissolves its business or liquidates all or a majority of its assets.

19. Ownership of Rights. Buyer agrees that (a) Seller (and/or its affiliates) owns or is the valid licensee of Seller's IP and (b) the furnishing of information, related documents or other materials by Seller to Buyer does not grant or transfer any ownership interest or license in or to Seller's IP to Buyer, unless expressly agreed in writing. Without limiting the foregoing, Seller retains ownership of all Software supplied to Buyer. In no event shall Buyer obtain any greater right in and to the Software than a right in a license limited to the use thereof and subject to compliance with any other terms provided with the Software. Buyer further agrees that it will not, directly or through intermediaries, reverse engineer, decompile, or disassemble any Software (including firmware) comprising or contained within a Product, except and only to the extent that such activity may be expressly permitted, either by applicable law or, in the case of open source software, the applicable open source license.

20. Indemnity for Infringement of Intellectual Property Rights. Seller is not liable for infringement of any Intellectual Property Rights except as provided in this Section. Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on a third-party claim that one or more of the Products infringes the Intellectual Property Rights of a third party in the country of delivery of the Products by Seller to Buyer. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of any such claim, and Seller having sole control over the defense of the claim including all negotiations for settlement or compromise. If one or more Products is subject to such a claim, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Products, replace or modify the Products to render them non-infringing, or offer to accept return of the Products and refund the purchase price less a reasonable allowance for depreciation. Seller has no obligation or liability for any claim of infringement: (i) arising from information provided by Buyer (including Seller's use of Buyer's Property); or (ii) directed to any Products for which the designs are specified in whole or part by Buyer; or (iii) resulting from the modification, combination or use in a system of any Products. The foregoing provisions of this Section constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for claims of infringement of Intellectual Property Rights.

21. Governing Law. These Terms, the terms of any Quote, and the sale and delivery of all Products are deemed to have taken place in, and shall be governed and construed in accordance with, the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to the sale and delivery of the Products.

22. Entire Agreement. These Terms, along with the terms set forth in the Quote, forms the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale and purchase. In the event of a conflict between any term set forth in the Quote and these Terms, the terms set forth in the Quote shall prevail. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter shall have no effect. No modification to these Terms will be binding on Seller unless agreed to in a writing that is signed by an authorized representative of Seller, excluding email correspondence, 'clickwrap' or other purported electronic assent to different or additional terms. Sections 2-25 of these Terms shall survive termination or cancellation of any agreement governed by or arising from these Terms.

23. No 'Wrap' Agreements/No Authority to Bind. Seller's clicking any buttons or any similar action, such as clicking "I Agree" or "Confirm," to utilize Buyer's software or webpage for the placement of orders, is NOT an agreement to Buyer's Terms and Conditions. NO EMPLOYEE, AGENT OR REPRESENTATIVE OF SELLER HAS THE AUTHORITY TO BIND SELLER BY THE ACT OF CLICKING ANY BUTTON OR SIMILAR ACTION ON BUYER'S WEBSITE OR PORTAL.

24. Compliance with Laws. Buyer agrees to comply with all applicable laws, regulations, and industry and professional standards, including those of the United States of America, and the country or countries in which Buyer may operate, including without limitation the U.S. Foreign Corrupt Practices Act ("FCPA"), the U.S. Anti-Kickback Act ("Anti-Kickback Act"), U.S. and E.U. export control and sanctions laws ("Export Laws"), the U.S. Food Drug and Cosmetic Act ("FDCA"), and the rules and regulations promulgated by the U.S. Food and Drug Administration ("FDA"), each as currently amended. Buyer agrees to indemnify, defend, and hold harmless Seller from the consequences of any violation of such laws, regulations and standards by Buyer, its employees or agents. Buyer represents that it is familiar with all applicable provisions of the FCPA, the Anti-Kickback Act, Export Laws, the FDCA and the FDA and certifies that Buyer will adhere to the requirements thereof and not take any action that would make Seller violate such requirements. Buyer represents and agrees that Buyer will not make any payment or give anything of value, directly or indirectly, to any governmental official, foreign political party or official thereof, candidate for foreign political office, or commercial entity or person, for any improper purpose, including the purpose of influencing such person to purchase Products or otherwise benefit the business of Seller. Buyer further represents and agrees that it will not receive, use, service, transfer or ship any Products from Seller in a manner or for a purpose that violates Export Laws or would cause Seller to be in violation of Export Laws. Buyer agrees to promptly and reliably provide Seller all requested information or documents, including end-user statements and other written assurances, concerning Buyer's ongoing compliance with Export Law. 9/22

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3/25 / Catalog HY10-1700

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