

# Immersion Heater Selection for Cyclo® BBB

## Purpose:

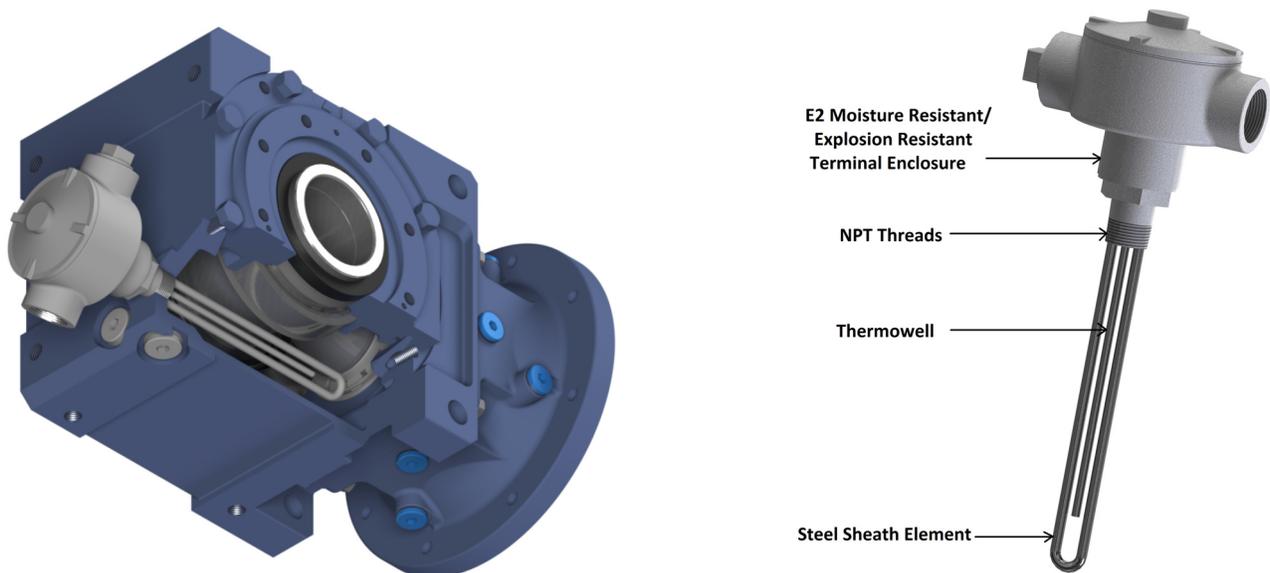
Identify and select immersion (internal) type heating devices for all sizes of oil lubricated Cyclo® BBB4 units.

## Principle of Operation:

Immersion heaters are designed for direct contact heating of gearbox lubricants. Using heaters, the lubricant temperature can be maintained within the operating range to achieve proper viscosity. This would enable oil lubricated Cyclo® BBB4 units to successfully operate in severe outdoor environment (down to  $-20^{\circ}\text{F}$ ) as well as freezers (down to  $-40^{\circ}\text{F}$ ).

## Heater Type:

Considering the industrial application, **Chromalox® ARMTO** heater model is specified for Cyclo® BBB4 reducers. ARMTO model is an immersion heater with steel screw plug, an integrated thermostat, 250 – 1000 Watt capacity, 120V/240V, single phase, E2 moisture/explosion resistant terminal enclosure and steel sheath element(s).



**Figure 1: Chromalox® ARMTO immersion heater in Y1 mounting position**

The following units are excluded from the scope of this document, because of the existence of two separate reservoirs in a unit (Y4 mounting) and/or space constraints.

Unit	Mounting Position	Size	Reason for Exclusion
Cyclo® BBB4	Y4	All	Multiple Oil Reservoirs
Cyclo® BBB4	Y5	4A	Space Constraints
Cyclo® BBB4	Y6	All	Standard Oil Level Too Low
Cyclo® BBB5	All	All	Space Constraints

**Table 1: Heater option is not available for these units**

The following changes need to be included while entering an order for Immersion heater-equipped BBB unit.

1. BBB model number: "S" letter for modification. (For example- LHYJS-4A105-Y1-207)
2. SSC Code: YBCO
3. Engineering Notes: Wattage (Table 2, Heater Capacity) and Voltage (120V or 240V) of the heater.

## Immersion Heater Selection for Cyclo® BBB (continued)

Heater Requirements		Heater Selection	
Unit	Required Heating (W)*	Chromalox Model	Heater Capacity (W)
4A	151	ARMTO-250E2T8	250
4B	234	ARMTO-250E2T8	250
4C	330	ARMTO-375E2T8	375
4D	493	ARMTO-105E2T8	500
4E	702	ARMTO-110E2T8	1000
4F	889	ARMTO-110E2T8	1000

**Table 2: Selected Chromalox heater models**  
(\* Please see Appendix I for Heat Energy requirement calculation)

### Time required to heat oil to proper viscosity:

BBB heater should be energized for sufficient time before the gearbox is put into operation, to ensure proper oil viscosity for effective splash lubrication. The heater selections are based on 3 hour start-up time and 67°F temperature difference (Appendix I), considering the worst case scenario. However, for any certain case, the start-up time can be calculated using formula:

$$T = \frac{W \cdot C_p \cdot \Delta T_{OIL}}{3,412 \cdot Q_T} \quad \text{-Equation I}$$

- $T$  = time, hours
- $W$  = weight of oil, lbs [gal x 7.5lbs/gal]
- $C_p$  = specific heat of lubricating oil [Btu/lb/°F] (Assume  $C_p = 0.43$  Btu/lb/°F for lubricating oils @50°F)
- $\Delta T_{OIL}$  = change in oil temp [ $T_{2FINAL} - T_{1START}$ ]
- $T_{1START}$  = min ambient temp
- $T_{2FINAL}$  = min oil temp for proper oil viscosity
- $Q_T$  = Heater Wattage (kW) of BBB heater (Refer Table 2; kW= Watt x 1000)

### Thermostat settings:

The heaters integrated thermostat (model code T8) has a temperature range of 0 °F to 127 °F. The thermostat should be set at the minimum temperature of ambient temperature range of a specific lubricant. For standard oil temperature ranges, please refer Table 22 from Cyclo®BBB4 O&M manual (13.604.60.002) or Table 5.39 from Cyclo® BBB4 Catalog (13.604.50.001).

*Example:* Mobil oil ISO VG220 is used in ambient temperature range of 86 °F - 122 °F. Therefore, the thermostat is to be set to turn off the heater at 86 °F (minimum temp of ambient temp range).

Installation Location/ external dimensions: In order to keep the heating element submerged in oil, the location of the immersion heater varies according to the mounting position of the reducer. Please refer Appendix II for locations and external dimensions of immersion heaters.

### Rework drawings/ BOMs:

Please refer Appendix III for rework drawing numbers and Bill of Materials (BOM). Note that this Appendix lists BOMs for BBB4 units with Taper Grip Bushings and 3.5 bevel ratios. All other output options are suitable for heaters and hollow keyed, solid shaft, shrink disc units will be processed on an 'as-ordered' basis.

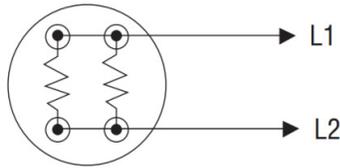
Also, BOMs include only 120 V heater option. 240 V option BOM will be created per requirement.

### Operating instructions:

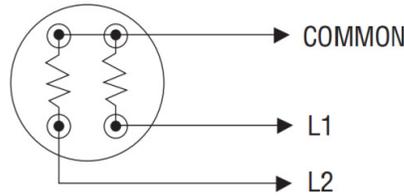
Please refer to Chromalox Installation and Operating Manual, for specific heater data. Heater is factory installed. Field installation is not available. Do not rework or replace heater without draining oil sump. Drywell or Glycol filled options are not available, due to internal space constraints.

# Immersion Heater Selection for Cyclo® BBB (continued)

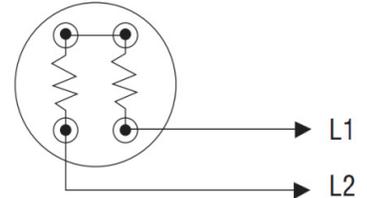
## Wiring Diagrams:



120-600 V, 1 ph, Parallel



120-600 V, 3ph, Parallel



120-600 V, 3 ph, Series

Figure 2:Wiring Diagrams

### BBB5 Immersion Heater:

There is no suitable internal option available for Cyclo® BBB5, due to limited available space inside compact housing. Heaters with integral thermostat and separate heater/thermostat options were investigated; however both options cannot be accommodated under standard oil level of Cyclo® BBB5 sizes.

### Reference:

- Chromalox Catalog (Version P0066-32)
- Cyclo® BBB4 catalog (13.604.50.001) and O&M manual (13.604.60.002)
- Paramax® heater EDOC1-09-003

## APPENDIX I: Heat Energy Requirement & Selection Criteria

These calculations consider the following assumptions:

1. The heater would change the oil temperature by 67 °F (from -40 °F to 27 °F, considering worst case).
2. Start-up time required is 3 hours.
3. Operating time considered is 1 hour.
4. Service factor (SF) 1.25 is used for the heater selection.

$$Q_s = \left( \frac{Q_o + Q_c}{T} + \frac{Q_{ls}}{2} \right) (SF) \quad \text{-Equation II}$$

where:

$Q_s$  = Heat required for start-up (kW)

$Q_o$  = Heat required to raise the oil temperature (kW) = (Oil weight x specific heat of oil x temp difference)/3412

$Q_c$  = Heat required to raise the housing temperature (kW) = (housing weight x specific heat of oil x temp difference)/3412

$Q_{ls}$  = Heat losses through housing surfaces = 0.6 x housing surface area x temperature difference

SF = Service factor

$$L_{LS} = L_{SO} + L_{SC} \quad \text{-Equation III}$$

where:

$L_{LS}$  = Heat energy required to maintain operation

$L_{SO}$  = Heat losses from oil surface (assumed to be zero)

$L_{SC}$  = Heat losses through surface of the housing

# Immersion Heater Selection for Cyclo<sup>®</sup> BBB (continued)

The size and rating of the installed heater is based on the larger of calculated results of Equation I OR II. Please Consult Factory for detailed calculations.

**Heater Selection Criteria:**

The heaters are selected based on the following criteria:

**Physical criteria-**

1. Availability of space inside the reducer to accommodate the heater.
2. Sufficient clearance between the heater and external features of the housing.
3. The heater to be completely submerged in the oil with standard oil quantity.

**Performance criteria-**

1. Maintain operational oil temperature in severe outdoor temperatures, ranging from 27 °F to -40 °F.
2. Corrosion resistance. Stainless steel sheath element with steel screw plug is selected.
3. 120V and 240V availability.
4. Moisture Resistant/Explosion Resistant Enclosure.

**APPENDIX- II: External dimensions**

Mounting Position	BBB SIZE	C	D	E	F	Figure
Y1	4A	153.1	176.8	30.2	60.3	
	4B	153.1	176.8	32	65	
	4C	153.1	176.8	55	80	
	4D	156.7	176.8	60	100	
	4E	152.6	176.8	60	100	
	4F	151.7	176.8	80	140	
Y2	4A	153.1	176.8	37.8	88	
	4B	153.1	176.8	38	95	
	4C	153.1	176.8	45	85	
	4D	152.6	176.8	55	110	
	4E	152.6	176.8	55	110	
	4F	151.7	176.8	70	94	
Y3	4A	153.1	176.8	37.5	70	
	4B	153.1	176.8	40	68	
	4C	153.1	176.8	55	80	
	4D	152.6	176.8	60	100	
	4E	152.6	176.8	60	100	
	4F	151.7	176.8	80	140	
Y5	4A	N/A	N/A	N/A	N/A	
	4B	153.1	176.8	38	95	
	4C	153.1	176.8	45	85	
	4D	151.7	176.8	55	110	
	4E	152.6	176.8	55	110	
	4F	151.7	176.8	70	94	

# Immersion Heater Selection for Cyclo® BBB (continued)

**APPENDIX III: Bill of Material for BBB4 units with Taper Grip Bushing & 3.5 bevel ratio**

Mounting Position	Sr. No.	BBB SIZE	BOM	Phantom BOM	Rework Drawing	Immersion Heater (Cromalox)		Rework Hole Size
						Article ID	Model #	
Y1	1	4A10	CP14279	SSCYBC0-4A10CBTGB-Y1	TDRR0347-1	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	2	4A11	CP14282	SSCYBC0-4A11CBTGB-Y1				
	3	4A12	CP14276	SSCYBC0-4A12CBTGB-Y1				
	4	4A14	CP14285	SSCYBC0-4A14CBTGB-Y1				
	5	4B12	CP14288	SSCYBC0-4B12CBTGB-Y1	TDRR0347-2	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	6	4B14	CP14292	SSCYBC0-4B14CBTGB-Y1				
	7	4B16	CP14296	SSCYBC0-4B16CBTGB-Y1				
	8	4C14	CP14300	SSCYBC0-4C14CBTGB-Y1	TDRR0347-3	CP10005	ARMTO-375E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	9	4C16	CP14304	SSCYBC0-4C16CBTGB-Y1				
	10	4C17	CP14308	SSCYBC0-4C17CBTGB-Y1				
	11	4D16	CP14312	SSCYBC0-4D16CBTGB-Y1	TDRR0347-4	CP11794	ARMTO-105E2T8	**Dia. 44.05 THRU 1.5"-11.5 NPT
	12	4D17	CP14316	SSCYBC0-4D17CBTGB-Y1				
	13	4D18	CP14320	SSCYBC0-4D18EBTGB-Y1				
	14	4D18	CP14321	SSCYBC0-4D18CBTGB-Y1				
	15	4E17	CP14328	SSCYBC0-4E17CBTGB-Y1	TDRR0347-5	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	16	4E18	CP14332	SSCYBC0-4E18EBTGB-Y1				
	17	4E18	CP14333	SSCYBC0-4E18CBTGB-Y1				
	18	4E19	CP14341	SSCYBC0-4E19EBTGB-Y1				
	19	4E19	CP14342	SSCYBC0-4E19CBTGB-Y1				
	20	4F18	CP14349	SSCYBC0-4F18EBTGB-Y1	TDRR0347-6	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	21	4F18	CP14350	SSCYBC0-4F18CBTGB-Y1				
	22	4F19	CP14357	SSCYBC0-4F19EBTGB-Y1				
	23	4F19	CP14358	SSCYBC0-4F19CBTGB-Y1				
Y2	24	4A10	CP14280	SSCYBC0-4A10CBTGB-Y2	TDRR0351-1	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	25	4A11	CP14283	SSCYBC0-4A11CBTGB-Y2				
	26	4A12	CP14277	SSCYBC0-4A12CBTGB-Y2				
	27	4A14	CP14286	SSCYBC0-4A14CBTGB-Y2				
	28	4B12	CP14289	SSCYBC0-4B12CBTGB-Y2	TDRR0351-2	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	29	4B14	CP14293	SSCYBC0-4B14CBTGB-Y2				
	30	4B16	CP14297	SSCYBC0-4B16CBTGB-Y2				
	31	4C14	CP14301	SSCYBC0-4C14CBTGB-Y2	TDRR0351-3	CP10005	ARMTO-375E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	32	4C16	CP14305	SSCYBC0-4C16CBTGB-Y2				
	33	4C17	CP14309	SSCYBC0-4C17CBTGB-Y2				
	34	4D16	CP14313	SSCYBC0-4D16CBTGB-Y2	TDRR0351-4	CP11794	ARMTO-105E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	35	4D17	CP14317	SSCYBC0-4D17CBTGB-Y2				
	36	4D18	CP14322	SSCYBC0-4D18EBTGB-Y2				
	37	4D18	CP14323	SSCYBC0-4D18CBTGB-Y2				
38	4E17	CP14329	SSCYBC0-4E17CBTGB-Y2	TDRR0351-5	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT	
39	4E18	CP14334	SSCYBC0-4E18EBTGB-Y2					
40	4E18	CP14335	SSCYBC0-4E18CBTGB-Y2					
41	4E19	CP14343	SSCYBC0-4E19EBTGB-Y2					
42	4E19	CP14344	SSCYBC0-4E19CBTGB-Y2					
43	4F18	CP14351	SSCYBC0-4F18EBTGB-Y2	TDRR0351-6	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT	
45	4F18	CP14352	SSCYBC0-4F18CBTGB-Y2					
46	4F19	CP14359	SSCYBC0-4F19EBTGB-Y2					
47	4F19	CP14360	SSCYBC0-4F19CBTGB-Y2					

\*\* Heaters for 4D sizes will be assembled with 1-1/2" x 1-1/4" NPT bushing, in Y1 mounting position.

# Immersion Heater Selection for Cyclo® BBB (continued)

## APPENDIX III: Bill of Material for BBB4 units with Taper Grip Bushing & 3.5 bevel ratio (Continued)

Mounting Position	Sr. No.	BBB SIZE	BOM	Phantom BOM	Rework Drawing	Immersion Heater (Cromalox)		Rework Hole Size
						Article ID	Model #	
Y3	48	4A10	CP14281	SSCYBC0-4A10CBTGB-Y3	TDRR0352-1	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	49	4A11	CP14284	SSCYBC0-4A11CBTGB-Y3				
	50	4A12	CP14278	SSCYBC0-4A12CBTGB-Y3				
	51	4A14	CP14287	SSCYBC0-4A14CBTGB-Y3				
	52	4B12	CP14290	SSCYBC0-4B12CBTGB-Y3	TDRR0352-2	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	53	4B14	CP14294	SSCYBC0-4B14CBTGB-Y3				
	54	4B16	CP14298	SSCYBC0-4B16CBTGB-Y3				
	55	4C14	CP14302	SSCYBC0-4C14CBTGB-Y3	TDRR0352-3	CP10005	ARMTO-375E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	56	4C16	CP14306	SSCYBC0-4C16CBTGB-Y3				
	57	4C17	CP14310	SSCYBC0-4C17CBTGB-Y3				
	58	4D16	CP14314	SSCYBC0-4D16CBTGB-Y3	TDRR0352-4	CP11794	ARMTO-105E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	59	4D17	CP14318	SSCYBC0-4D17CBTGB-Y3				
	60	4D18	CP14324	SSCYBC0-4D18EBTGB-Y3				
	61	4D18	CP14325	SSCYBC0-4D18CBTGB-Y3				
	62	4E17	CP14330	SSCYBC0-4E17CBTGB-Y3	TDRR0352-5	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	63	4E18	CP14336	SSCYBC0-4E18EBTGB-Y3				
	64	4E18	CP14337	SSCYBC0-4E18CBTGB-Y3				
	65	4E19	CP14345	SSCYBC0-4E19EBTGB-Y3				
	66	4E19	CP14346	SSCYBC0-4E19CBTGB-Y3	TDRR0352-6	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	67	4F18	CP14353	SSCYBC0-4F18EBTGB-Y3				
68	4F18	CP14354	SSCYBC0-4F18CBTGB-Y3					
69	4F19	CP14361	SSCYBC0-4F19EBTGB-Y3					
70	4F19	CP14362	SSCYBC0-4F19CBTGB-Y3					
Y5		4A	<b>NOT AVAILABLE</b>					
	71	4B12	CP14291	SSCYBC0-4B12CBTGB-Y5	TDRR0353-2	CP10019	ARMTO-250E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	72	4B14	CP14295	SSCYBC0-4B14CBTGB-Y5				
	73	4B16	CP14299	SSCYBC0-4B16CBTGB-Y5				
	74	4C14	CP14303	SSCYBC0-4C14CBTGB-Y5	TDRR0353-3	CP10005	ARMTO-375E2T8	Dia. 29.37 THRU 1"-11.5 NPT
	75	4C16	CP14307	SSCYBC0-4C16CBTGB-Y5				
	76	4C17	CP14311	SSCYBC0-4C17CBTGB-Y5				
	77	4D16	CP14315	SSCYBC0-4D16CBTGB-Y5	TDRR0353-4	CP11794	ARMTO-105E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	78	4D17	CP14319	SSCYBC0-4D17CBTGB-Y5				
	79	4D18	CP14326	SSCYBC0-4D18EBTGB-Y5				
	80	4D18	CP14327	SSCYBC0-4D18CBTGB-Y5				
	81	4E17	CP14331	SSCYBC0-4E17CBTGB-Y5	TDRR0353-5	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT
	82	4E18	CP14338	SSCYBC0-4E18EBTGB-Y5				
83	4E18	CP14339	SSCYBC0-4E18CBTGB-Y5					
84	4E19	CP14347	SSCYBC0-4E19EBTGB-Y5					
85	4E19	CP14348	SSCYBC0-4E19CBTGB-Y5	TDRR0353-6	CP13499	ARMTO-110E2T8	Dia. 38.1 THRU 1.25"-11.5 NPT	
86	4F18	CP14355	SSCYBC0-4F18EBTGB-Y5					
87	4F18	CP14356	SSCYBC0-4F18CBTGB-Y5					
88	4F19	CP14363	SSCYBC0-4F19EBTGB-Y5					
89	4F19	CP14364	SSCYBC0-4F19CBTGB-Y5					