SIEMENS SINUMERIK 840D CONTROL

MAINTENANCE MANUAL

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1.0 SPECIFICATIONS

This section provides dimensions/specifications of machines (VMCs 2216, 3016, 4020, 6030, 8030, 3020, 4525, and 6535). Dimensions represent in inches and millimeters.

1.1 ILLUSTRATIONS & DATA FOR ALL VMC MODELS

1.1.1 VMC 2216

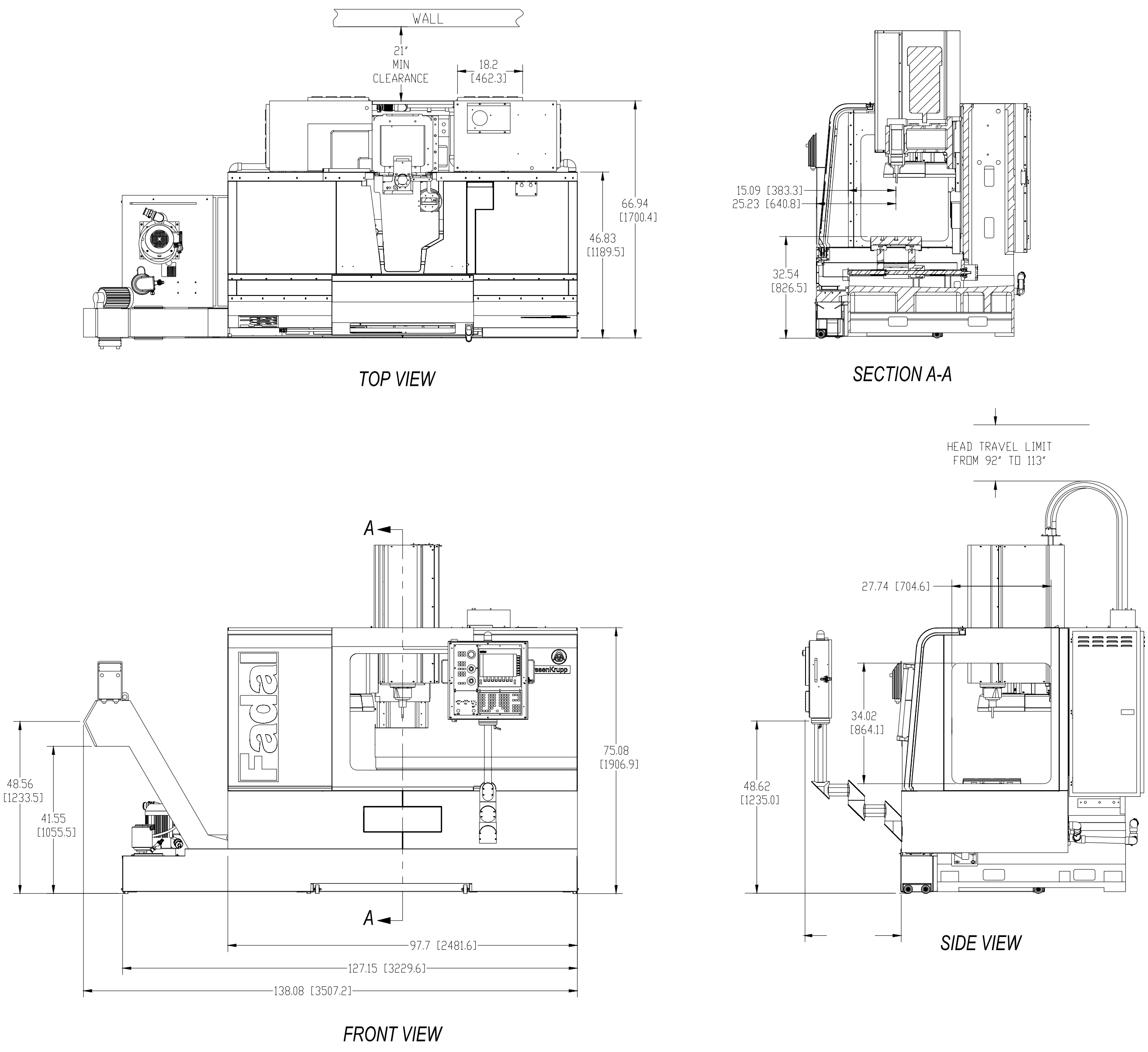


Figure 1-1: VMC 2216

> *NOTE*
> Dimensions represented in inches and [millimeters].

Table 1-1: VMC 2216 Specifications

2216 SPECIFICATIONS	2216 STANDARD	2216 METRIC
Table Size	39" x 16"	750 mm x 406 mm
Floor to Table	31"	787 mm
T-Slots (No. x Width x Span)	3 x .708" x 4.33"	3 x 18 mm x 110 mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%) mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min. (X,Y) 17.7 m/min (Z)
Max. Weight on Table	2,006 lbs.	991 kg.
Axis Drive Motor (X/Y/Z)*	AC, 3,800 lbs	AC, 16.900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	22"	559 mm
Cross (Y Axis)	16"	406 mm
Vertical (Z Axis)	20" (28" Opt.)	508 mm (711 mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102 mm-610 mm (102 mm-813 mm)
Spindle Center to Column Ways	16"	406 mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (HT)	220 Nm/300 Nm
Accuracy, Axis Positioning	± .0002"	.0050 mm
Accuracy, Axis Repeatability	± .0001"	.0025 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21,(opt 20, 1.9 sec. dual arm)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76mm (114 mm w/o adjacent tools)
Max. Tool Length	15"	381
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	98" W x 67" D (w/o chip conveyor or 21” wall clearance)	2481.6 mm W x 1700.4 mm D (w/o chip conveyor or 21” wall clearance)
Machine Maximum Height	113"	2870.2 mm
Machine Weight	8,600 lbs. (w/o chip conveyor)	3900.9 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30amp 480 VAC, 40 amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	X-dual, Y-single, Z 20”-single	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.2 VMC 3016

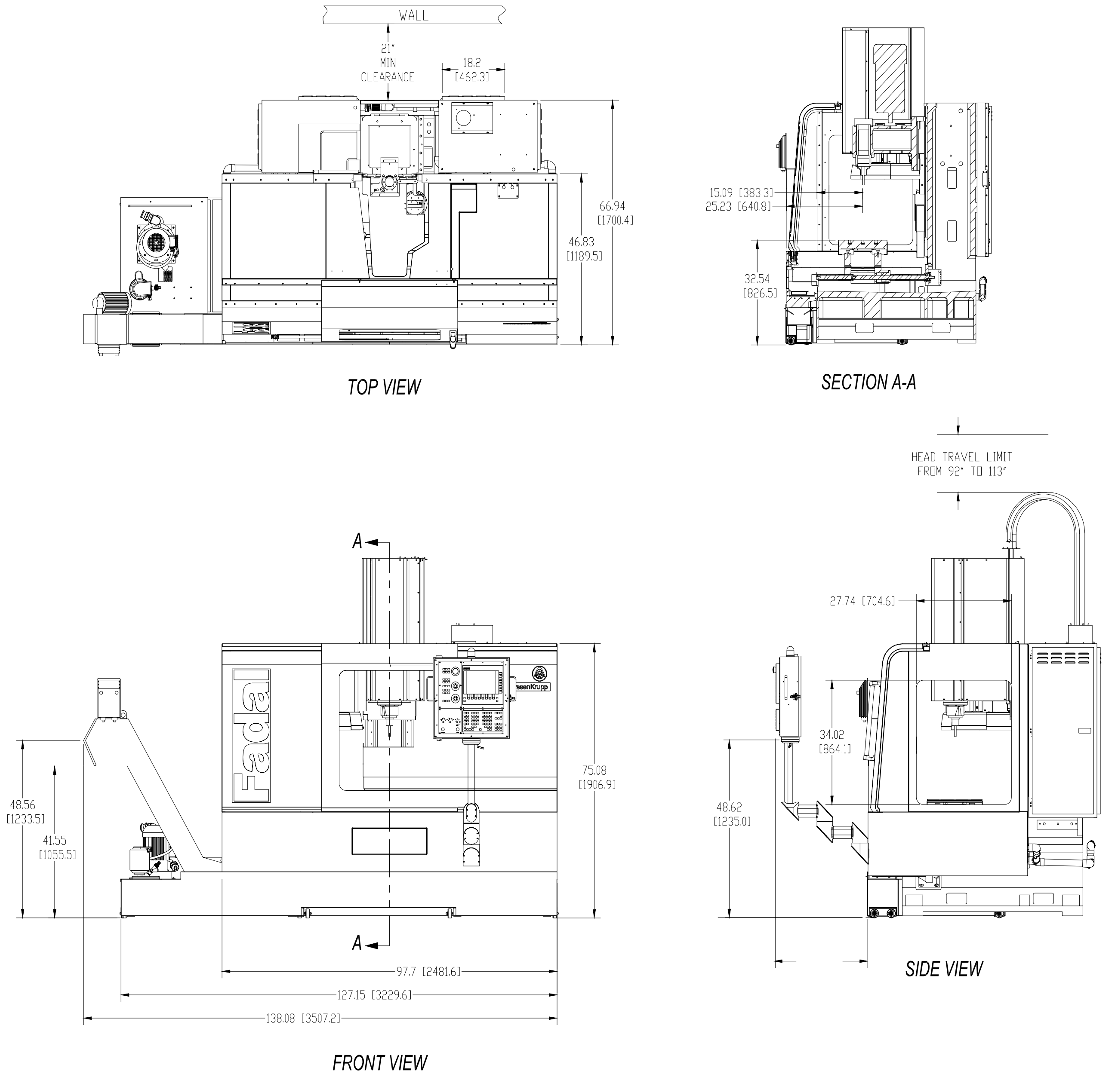


Figure 1-2: VMC 3016

> *NOTE*
> Dimensions represented in inches and [millimeters].

Table 1-2: VMC 3016 Specifications

3016 SPECIFICATIONS	3016 STANDARD	3016 METRIC
Table Size	39" x 16"	750 mm x 406 mm
Floor to Table	31"	787 mm
T-Slots (No. x Width x Span)	3 x .708" x 4.33"	3 x 18 mm x 110 mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%) mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min. (X,Y) 17.7 m/min (Z)
Max. Weight on Table	2,736 lbs.	1,241 kg.
Axis Drive Motor (X/Y/Z)	AC, 3,800 lbs peak thrust	AC, 16.900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	30"	762 mm
Cross (Y Axis)	16"	406 mm
Vertical (Z Axis)	20" (28" Opt.)	508 mm (711 mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102 mm-610 mm (102 mm-813 mm)
Spindle Center to Column Ways	16"	406 mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Torque	160 ft-lbs, 220 ft-lbs (HT)	220 Nm/300 Nm
Accuracy, Axis Positioning	± .0002"	.0050 mm
Accuracy, Axis Repeatability	± .0001"	.0025 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76 mm (114 mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	98" W x 67" D (w/o chip conveyor or 21" wall clearance)	2481.6 mm W x 1700.4 mm D (w/o chip conveyor or 21" wall clearance)
Machine Maximum Height	113"	2870.2 mm
Machine Weight	8,600 lbs. (w/o chip conveyor)	3900.9 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30amp 480 VAC, 40 amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	X-dual, Y-single, Z 20"-single	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.3 VMC 4020

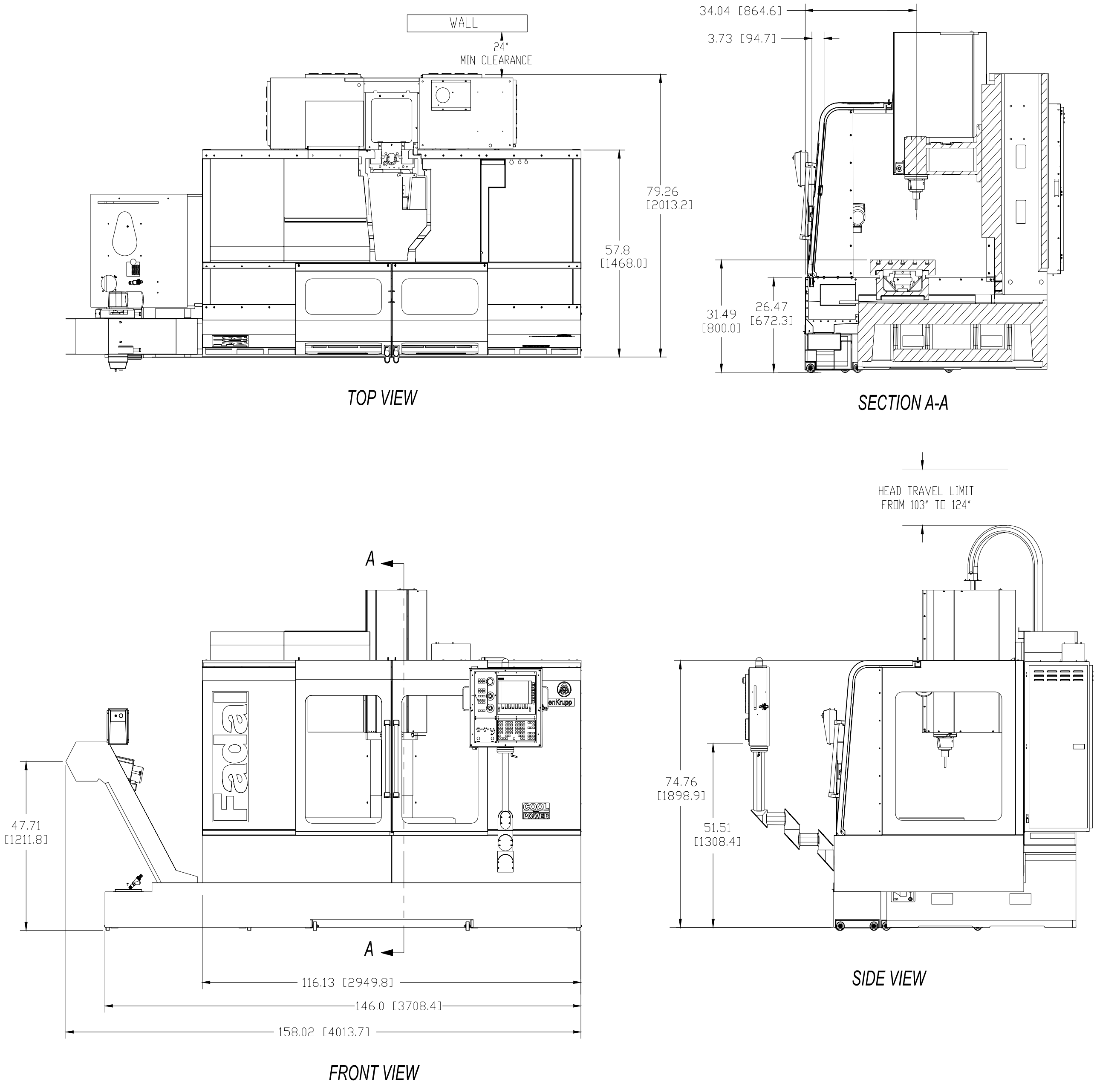


Figure 1-3: VMC 4020

> *NOTE*
> Dimensions represented in inches and [millimeters].

Table 1-3: VMC 4020 Specifications

4020 SPECIFICATIONS	4020 STANDARD	4020 METRIC
Table Size	48" x 20"	1,219mm x 508 mm
Floor to Table	32"	813 mm
T-Slots (No. x Width x Span)	5 x .708" x 3.74"	5 x18 mm x 95 mm
Cutting Feed Rate	.01-400 ipm (600 @ 150%)	.25-10,160 (15,240 at 150%) mm/min.
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	22.8 m/min (X,Y,Z)
Max. Weight on Table	3,641 lbs.	1,652 kg.
Axis Drive Motor (X/Y/Z)	AC, 3,800 lbs peak thrust	AC, 16,900 N* thrust
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	40"	1,016 mm
Cross (Y Axis)	20"	508 mm
Vertical (Z Axis)	20" (28" Opt.)	508 mm (711 mm Opt.)
Spindle Nose to Table	4"-24" (4"-32" Opt.)	102 mm-610 mm (102 mm-813 mm)
Spindle Center to Column Ways	20"	406 mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor-Automatic 2 Speed Vector	30 HP*, 22.4KW	
Torque	160 ft-lbs, 220 ft-lbs (Opt.)	220 Nm/300Nm/378Nm
Accuracy, Axis Positioning	± .0002"	.0050 mm
Accuracy, Axis Repeatability	± .0001"	.0025 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.) (24 opt 1.9 sec. dual arm)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (6" w/o adjacent tools)	76 mm (114 mm w/o adjacent tools)
Max. Tool Length	15"	381 mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	116" W x 80" D (w/o chip conveyor or 21" wall clearance)	2949.8 mm W x 2013.2 mm D (w/o chip conveyor or 21" wall clearance)
Machine Maximum Height	124"	3149.6 mm
Machine Weight	10,800 lbs. (w/o chip conveyor)	4898.8 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	X-dual, Y-single, Z 20"-single	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.4 VMC 6030

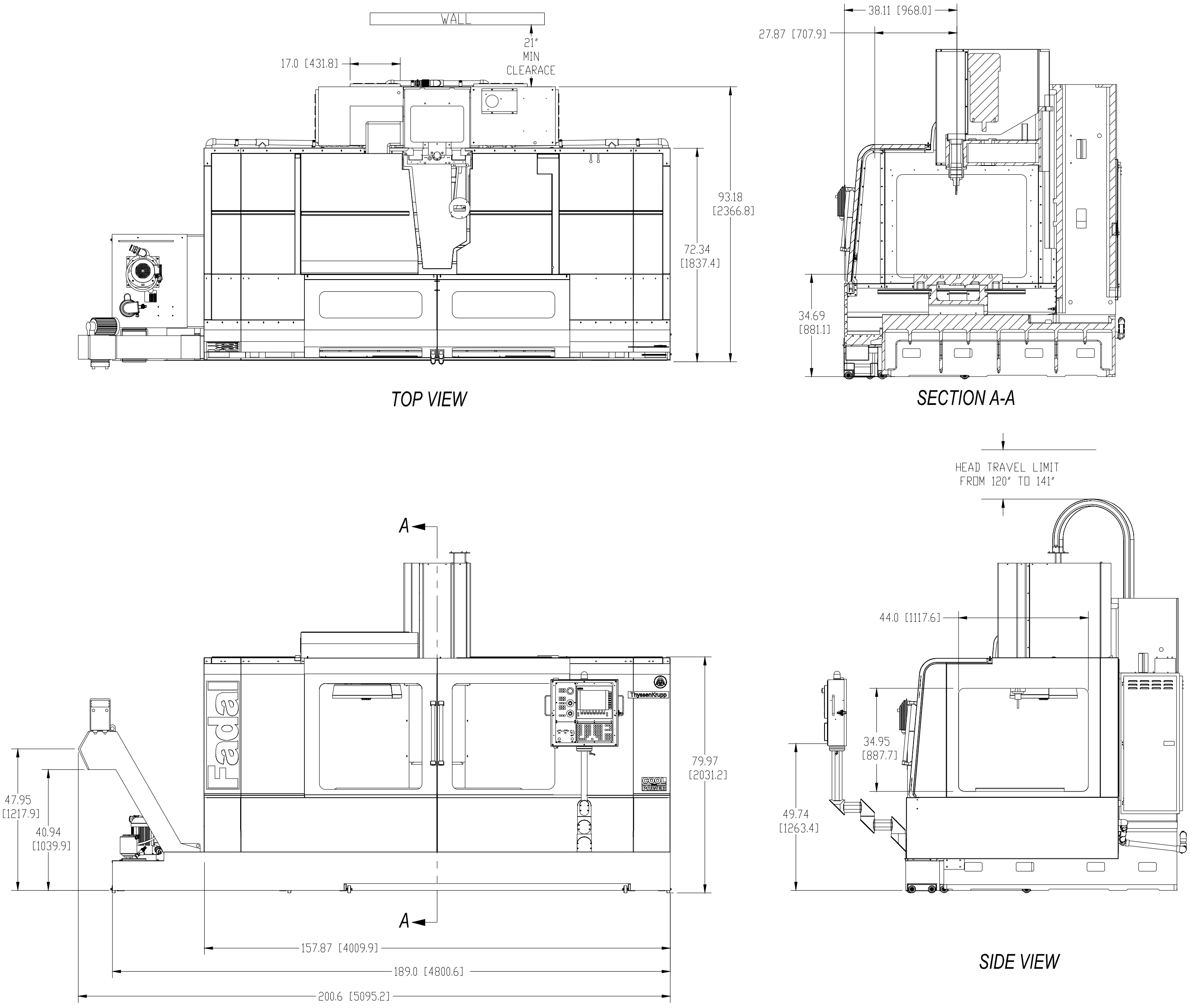


Figure 1-4: VMC 6030

> *NOTE*
> Dimensions represented in inches & [millimeters].

Table 1-4: VMC 6030 Specifications

6030 SPECIFICATIONS	6030 STANDARD	6030 METRIC
Table Size	62.5 x 30"	1,588mm x 762 mm
Floor to Table	36"	914 mm
T-Slots (No. x Width x Span)	5 x .708" x 5.512"	5 x 18 mm x 140 mm
Cutting Feed Rate	.01-250 ipm (375 @ 150%)	.25-6,350 (9,525 at 150%) mm/min.
Rapid Feed Rate (X/Y/Z)	400 ipm (X/Y/Z)	10.1 m/min (X,Y,Z)
Max. Weight on Table	4,120 lbs.	1,869 kg.
Axis Drive Motor (X/Y/Z)	AC, 5,000 lbs peak thrust	AC, 22,420 N* thrust
Ball Screw Size	1.75" Dia. (X/Y) 1.50" Dia. (Z)	44.45 mm Dia (X,Y) 38.1 mm Dia. (Z)
Longitudinal (X Axis)	60"	1,524 mm
Cross (Y Axis)	30"	762 mm
Vertical (Z Axis)	30"	762 mm
Spindle Nose to Table	5.5"-35.5"	140 mm-902 mm
Spindle Center to Column Ways	16"	406 mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor-Automatic 2 Speed Vector	30 HP*, 22.4KW	
Torque	160 ft.-lbs, 220 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .0004"	.0076 mm
Accuracy, Axis Repeatability	± .0002"	.0038 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.) (24 opt 1.9 sec. dual arm)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76 mm (114 mm w/o adjacent tools)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	158" W x 93" D (w/o chip conveyor and 21" wall clearance)	4009.9 mm x 2366.8 mm D (w/o chip conveyor and 21" wall clearance)
Machine Maximum Height	141"	3581.4 mm
Machine Weight	17,300 lbs. (w/o chip conveyor)	7847.1 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrew (Y)	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.5 VMC 8030

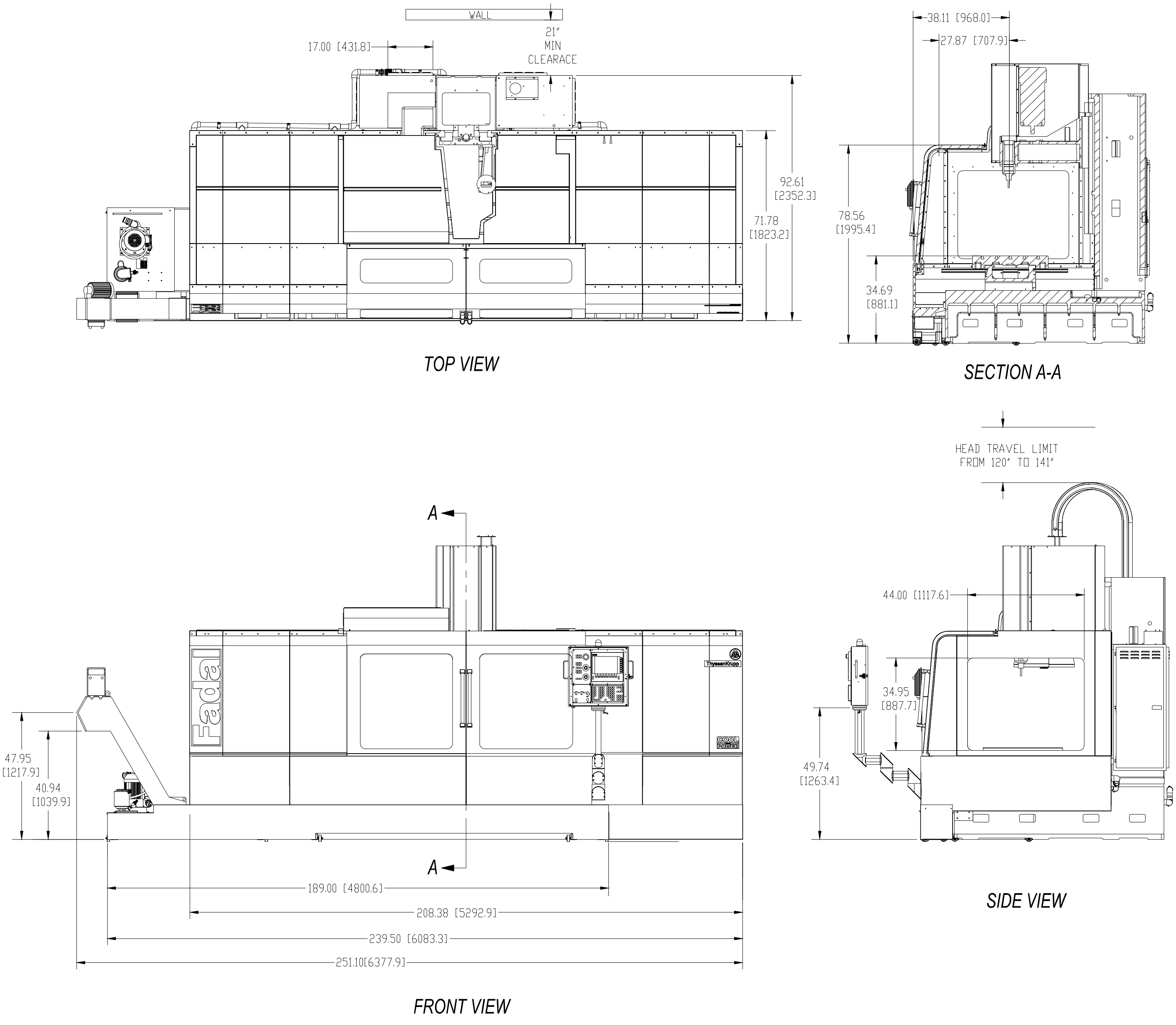


Figure 1-5: VMC 8030

> *NOTE*
> Dimensions represented in inches & [millimeters].

Table 1-5: VMC 8030 Specifications

8030 SPECIFICATIONS	8030 STANDARD	8030 METRIC
Table Size	82.5" x 30"	2,096 mm x 762 mm
Floor to Table	36"	914 mm
T-Slots (No. x Width x Span)	5 x .708" x 5.512"	5 x 18 mm x 140 mm
Cutting Feed Rate	.01-250 ipm (3765 @ 150%)	.25-6,350 (9,525 at 150%)mm/min.
Rapid Feed Rate (X/Y/Z)	400 ipm (X/Y/Z)	10.1 m/min (X,Y,Z)
Max. Weight on Table	3,751 lbs.	1,701 kg.
Axis Drive Motor (X/Y/Z)	AC, 5,000 lbs peak thrust	AC, 22,420 N* thrust
Ball Screw Size	1.75" Dia. (X/Y) 1.50" Dia. (Z)	44.45 mm Dia (X,Y) 38.1 mm Dia. (Z)
Longitudinal (X Axis)	80"	2,032 mm
Cross (Y Axis)	30"	762 mm
Vertical (Z Axis)	30"	76 2mm
Spindle Nose to Table	5.5"-35.5"	140 mm-902 mm
Spindle Center to Column Ways	16"	406 mm
Main Motor - Automatic 2 Speed Vector	15 HP*, 11.2 KW	
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor-Automatic 2 Speed Vector	30 HP*, 22.4 KW	
Torque	160 ft-lbs, 220 ft-lbs (Opt.)	300 Nm/375 Nm
Accuracy, Axis Positioning	± .0004"	.0076 mm
Accuracy, Axis Repeatability	± .0002"	.0038 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	21 (30 Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	6"	152 mm
Max. Tool Length	15"	381
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	208" W x 93" D (w/o chip conveyor and 21” wall clearance)	5292.9 mm W x 2352.3 mm D (w/o chip conveyor and 21” wall clearance)
Machine Maximum Height	141"	3481.4 mm
Machine Weight	18,300 lbs. (w/o chip conveyor)	8300.7 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrew (Y)	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.6 VMC 3020

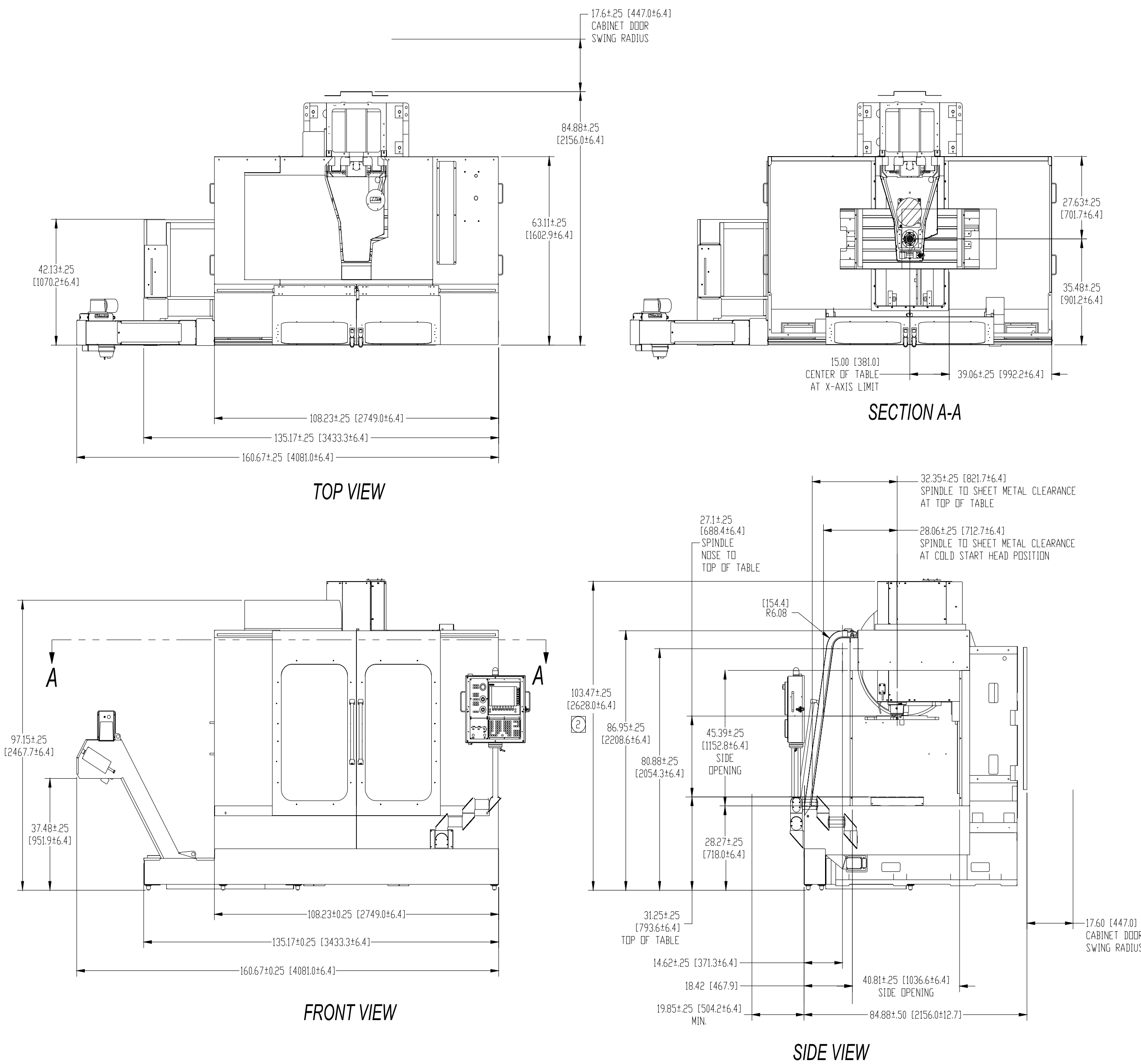


Figure 1-6: VMC 3020

> *NOTE*
> Table and head shown at cold start position. Top of head cover at cold start position. Add 18” for max operating height. Subtract 2” for install height.
> Dimensions represented in inches & [millimeters].

Table 1-6: VMC 3020 Specifications

3020 SPECIFICATIONS	3020 STANDARD	3020 METRIC
Table Size	40.5" x 20"	1,029 mm x 508 mm
Floor to Table	31"	787 mm
T-Slots (No. x Width x Span)	5 x .708" x 3.74"	5 x 18 mm x 95 mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	30"	762 mm
Cross (Y Axis)	20"	508 mm
Vertical (Z Axis)	24" (32" Opt.)	508 mm (610 mm)
Spindle Nose to Table	4"-28" (36" Opt.)	102 mm-61 0mm-(711 mm Opt.)
Spindle Center to Column Ways	22.875"	581 mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor-Automatic 2 Speed Vector	30 HP*, 22.4KW	
Torque	160 ft-lbs, 290 ft-lbs (Opt.)	300 Nm/375 Nm
Accuracy, Axis Positioning	± .0002"	±.004 mm
Accuracy, Axis Repeatability	± .0001"	±.0015 mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	24T 1.9sec. Dual Arm	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	3" (4.5" w/o adjacent tools)	76.2 mm (114.3 mm)
Max. Tool Length	15"	381 mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	108" W x 85" D (w/o chip conveyor or 21" wall clearance)	2749 mm W x 2156 mm D (w/o chip con-veyor or 21" wall clearance)
Machine Maximum Height	122" (130" with 22.5 HP Opt.)	3098.8 mm (3302 mm with 22.5hp. Opt)
Machine Weight	12,700 lbs. (w/o chip conveyor)	5760.6 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.1.7 VMC 4525

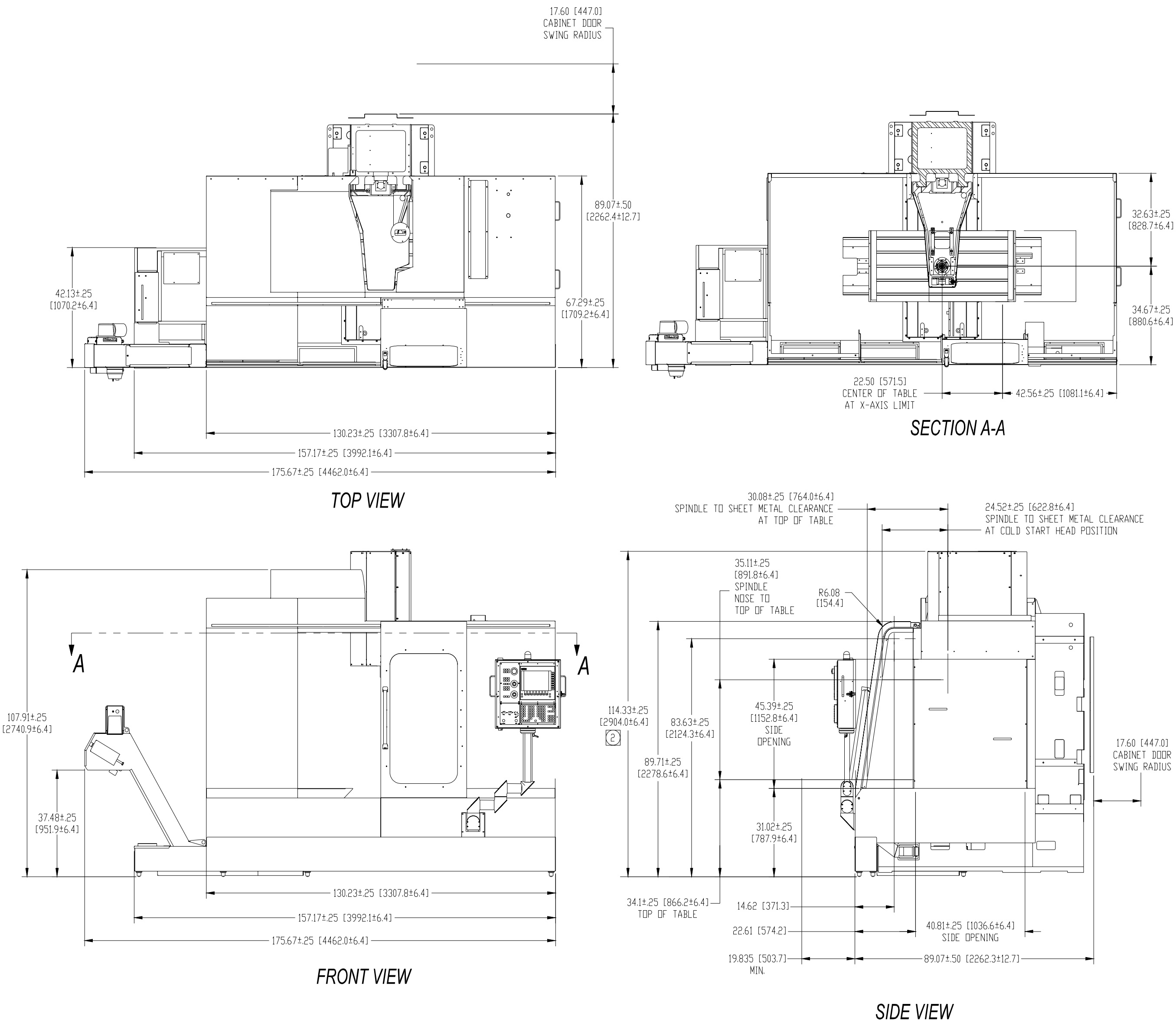


Figure 1-7: VMC 4525

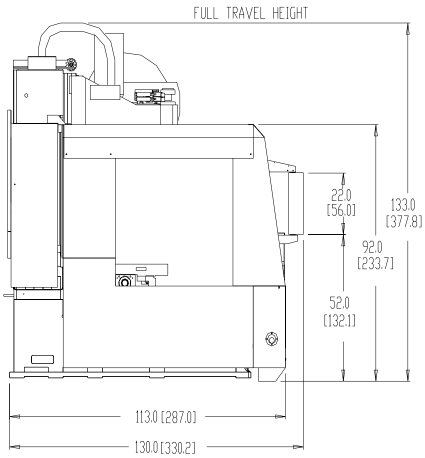
> *NOTE*
> Table and head shown at cold start position. Top of head cover at cold start position. Add 18” for max operating height. Subtract 2” for install height.
> Dimensions represented in inches & [millimeters].

Table 1-7: VMC 4525 Specifications

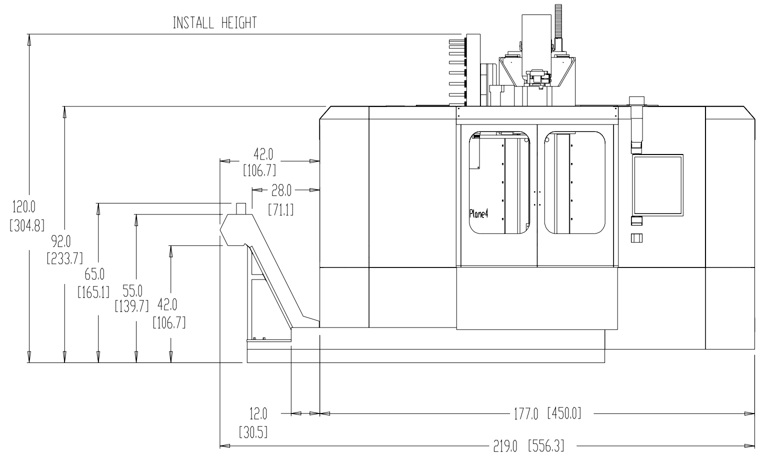
4525 SPECIFICATIONS	4525 STANDARD	4525 METRIC
Table Size	53.5" x 25"	1,359mm x 635mm
Floor to Table	31"	787mm
T-Slots (No. x Width x Span)	5 x .708" x 4.92"	5 x 18mm x 125mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg.
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	40mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	45"	1,143 mm
Cross (Y Axis)	25"	635mm
Vertical (Z Axis)	24"	610
Spindle Nose to Table	4"-24"	102mm-610mm
Spindle Center to Column Ways	27.87"	708mm
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor - Automatic 2 Speed Vector	30 HP*, 22.4 KW	
Torque	220 ft-lbs, 270 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .00016"	±.004mm
Accuracy, Axis Repeatability	± .00006"	±.0015mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40	
ATC, Number of Tools	1.9 sec dual arm / 24 tools	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	4" (4.5" w/o adjacent tools)	101.6mm (114.3mm)
Max. Tool Length	15"	381mm
Max. Tool Weight	15 lbs.	6.8 kg
Machine Width and Depth	131" W x 90" D (w/o chip conveyor or 21" wall clearance)	3307.8 mm W x 2262.4 mm D (w/o chip conveyor or 21" wall clearance)
Machine Maximum Height	133"	3378.2 mm
Machine Weight	13,900 lbs. (w/o chip conveyor)	6304.9 kg (w/o chip conveyor)
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Cool Power System	Spindle, Headstock, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

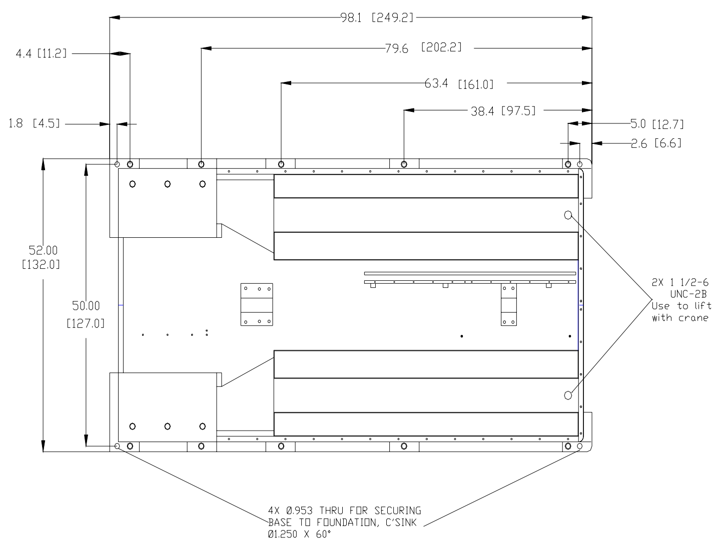
1.1.8 VMC 6535



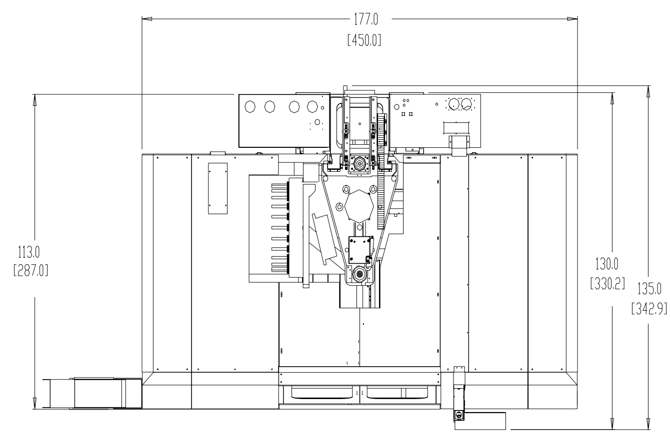
SIDE VIEW



FRONT VIEW



TOP VIEW - BASE



TOP VIEW

Figure 1-8: VMC 6535

> *NOTE*
> Dimensions represented in inches & [millimeters].

Table 1-8: VMC 6535 Specifications

6535 SPECIFICATIONS	6535 STANDARD	6535 METRIC
Table Size	74.8" x 26.5"	1,899mm x 673.1mm
Floor to Table	40.3"	1024mm
T-Slots (No. x Width x Span)	5 x .708" x 4.92"	5 x 18mm x 125mm
Cutting Feed Rate	.01-400 ipm (600 ipm @ 150%)	.25-10,160 (15,240 at 150%)
Rapid Feed Rate (X/Y/Z)	900 ipm (X/Y) 700 ipm (Z)	30.5(X,Y) 17.8(Z) m/min
Max. Weight on Table	4,250 lbs.	1,928 kg.
Axis Drive Motor (X/Y/Z)	AC 3,800 lbs peak thrust	AC, 16,903 N*thrust.
Ball Screw Size	62.2mm Dia. (X/Y/Z)	
Longitudinal (X Axis)	65"	1,651mm
Cross (Y Axis)	35"	889mm
Vertical (Z Axis)	34"	864mm
Spindle Nose to Table	5"-39"	127mm-991mm
Spindle Center to Column Ways	37.4"	950mm
Opt. HT Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. VHT Motor - Automatic 2 Speed Vector	30 HP*, 22.4 KW	
Torque	220 ft-lbs, 270 ft-lbs (Opt.)	300 Nm/375Nm
Accuracy, Axis Positioning	± .00016"	±.004mm
Accuracy, Axis Repeatability	± .00006"	±.0015mm
Glass Scales (X/Y/Z)	Optional	
Spindle Speed	10-10,000 rpm (15,000 Opt.),(7,500, 50 tpr.Opt.)	
Spindle Orientation	Electromechanical	
Spindle Taper	No. 40 (50 Opt.)	
ATC, Number of Tools	1.9 sec dual arm / 24, 62 tools (32, 40 50,tpr. Opt.)	
ATC, Tool Selection	Random, Bi-directional	
Max. Tool Diameter	Ø9.85”	Ø250mm
Max. Tool Length	15.75"	400mm
Max. Tool Weight	40 lbs.	18 kg
Machine Width and Depth	219" W x130" D	5.56m W x 3.3m D
Machine Maximum Height	133"	3.4m
Machine Weight	29,000 lbs.	6,169 kg
Air Pressure Reqs. (Momentary)	120 psi, 15 scfm	5.5 Bar
Power Reqs. (3-phase)	30 amps 480VAC, 40amps, 480VAC, 70amps 480VAC	
Power Reqs. (3-phase) 50 taper	70 amps, 480 VAC	
Cool Power System	Spindle, Ballscrews	
Ball Screw Supports (X/Y/Z)	dual	
No. of Ground Boxways per Axis (X/Y/Z)	2	

*Rated Peak Value

1.2 FADAL BOLT TORQUE SPECIFICATIONS

Table 1-9: Fadal Bolt Torque Specifications

COMPONENT	MODEL	LOCATION	BOLT SIZE	TORQUE	UNIT
COLUMN	ALL	COLUMN TO BASE	5/8"-11 X X.50 HHB	175	FT-LBS
COLUMN	ALL	COUPLER SET SCREW	1/4"-20 X 0.50 SHSS	70	IN-LBS
COLUMN	ALL	Z B/S MOUNT IN BACK	3/8"-16 X X.XX HHB	45	FT-LBS
COLUMN	ALL	Z B/S MOUNT IN FRONT	1/2"-13 X 2.XX HHB	75	FT-LBS
COLUMN	ALL	Z B/S NUT	5/16"-18 X 1.25 HHB	30	FT-LBS
COLUMN	ALL	Z MOTOR	3/8"-16 X 1.25 SHCS	40	FT-LBS
COLUMN	ALL	Z XT B/S BEARING MOUNT	5/16"-18 X 1.50 HHB	25	FT-LBS
COLUMN	ALL	Z XT B/S BEARING SUPPORT (60/8030)	3/8"-18 X X.XX HHB	40	FT-LBS
COLUMN	ALL	Z XT B/S SUPPORT ADAPTER	5/16"-18 X 1.50 SHCS	15	FT-LBS
HEAD	ALL	SPINDLE	3/8"-16 X 1.00 SHCS	45	FT-LBS
HEAD	ALL	SPINDLE RETAINING RING	3/8"-16 X 1.00 HHB	25	FT-LBS
HEAD	7.5K RPM	DRAWBAR PISTON	1/4"-20 X 2.00 HHB	15	FT-LBS
HEAD	7.5K RPM	ORIENTATION BRIDGE (7.5K)	3/8"-16 X 6.00 SHCS	45	FT-LBS
HEAD	10K RPM	BACK BELT GUIDE	1/2"-13 X 4.00 HHB	70	FT-LBS
HEAD	10K RPM	HYDRAULIC PISTON	1/4"-20 X 2.00 HHB	15	FT-LBS
HEAD	10K RPM	ORIENTATION BRIDGE (10K)	5/16"-18 X 6.00 HHB	30	FT-LBS
HEAD	10K RPM	SPINDLE MOTOR	1/2"-13 X X.XX HHB	65	FT-LBS
HEAD	10K RPM	SPINDLE MOTOR MOUNT	1/2"-13 X X.XX SHCS	70	FT-LBS
HEAD	10K RPM	VIBRATION MOUNTS	1/2"-13 X 0.75 SHCS	70	FT-LBS
HEAD	10K RPM	Z STRAP	3/8"-16 X 1.75 HHB	45	FT-LBS
X-Y AXIS	ALL	SADDLE STRAP	3/8"-16 X 1.75 HHB	45	FT-LBS
X-Y AXIS	ALL	TABLE STRAP	3/8"-16 X 0.75 HHB	45	FT-LBS
X-Y AXIS	ALL	X B/S NUT	5/16"-18 X 1.XX HHB	25	FT-LBS
X-Y AXIS	ALL	X-Y MOTOR	3/8"-16 X 1.XX SHSC	40	FT-LBS
X-Y AXIS	ALL	Y B/S NUT	5/16"-18 X 1.XX SHCS	30	FT-LBS
X-Y AXIS	60/8030	TABLE B/S BLOCK MOUNT (60/8030)	3/8"-16 X 3.50 SHCS	40	FT-LBS
X-Y AXIS	60/8030	X B/S SUPPORT MOUNT (60/8030)	1/2"-13 X 4.50 HHB	80	FT-LBS
X-Y AXIS	60/8030	X MOTOR MOUNT (60/8030)	1/2"-13 X 3.50 HHB	80	FT-LBS
X-Y AXIS	60/8030	Y MOTOR MOUNT (60/8030)	3/8"-16 X 1.50 HHB	40	FT-LBS
X-Y AXIS	22/30/4020	TABLE B/S BLOCK MOUNT (22/3016)	5/16"-18 X 2.75 SHCS	25	FT-LBS
X-Y AXIS	22/30/4020	X B/S SUPPORT MOUNT (22/30/4020)	3/8"-16 X 1.75 HHB	40	FT-LBS
X-Y AXIS	22/30/4020	X-Y MOTOR MOUNT (22/30/4020)	1/2"-13 X 3.XX HHB	80	FT-LBS

1.2.1 2216 & 3016
TABLE

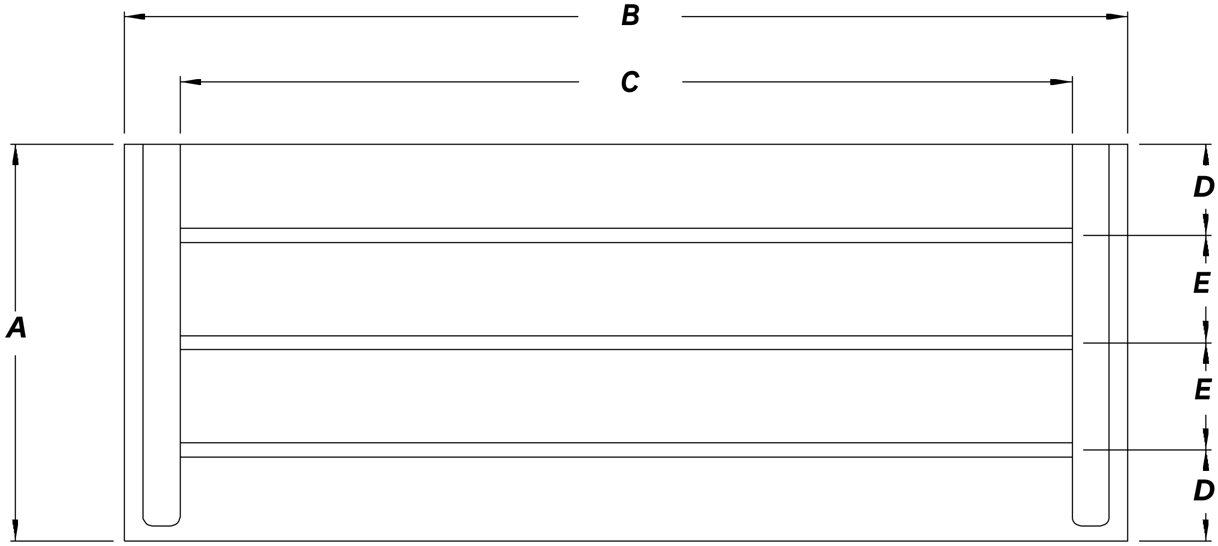


Figure 1-9: 2216 & 3016 Table

Table 1-10: 2216 & 3016 Table Dimensions

VMCS 2216 & 3016	
A	16.00" (406.4 mm)
B	40.50" (1028.7 mm)
C	36.00" (914.4 mm)
D	3.67" (93.22 mm)
E	4.33" (109.98 mm)

1.2.2 3020 & 4525 TABLE

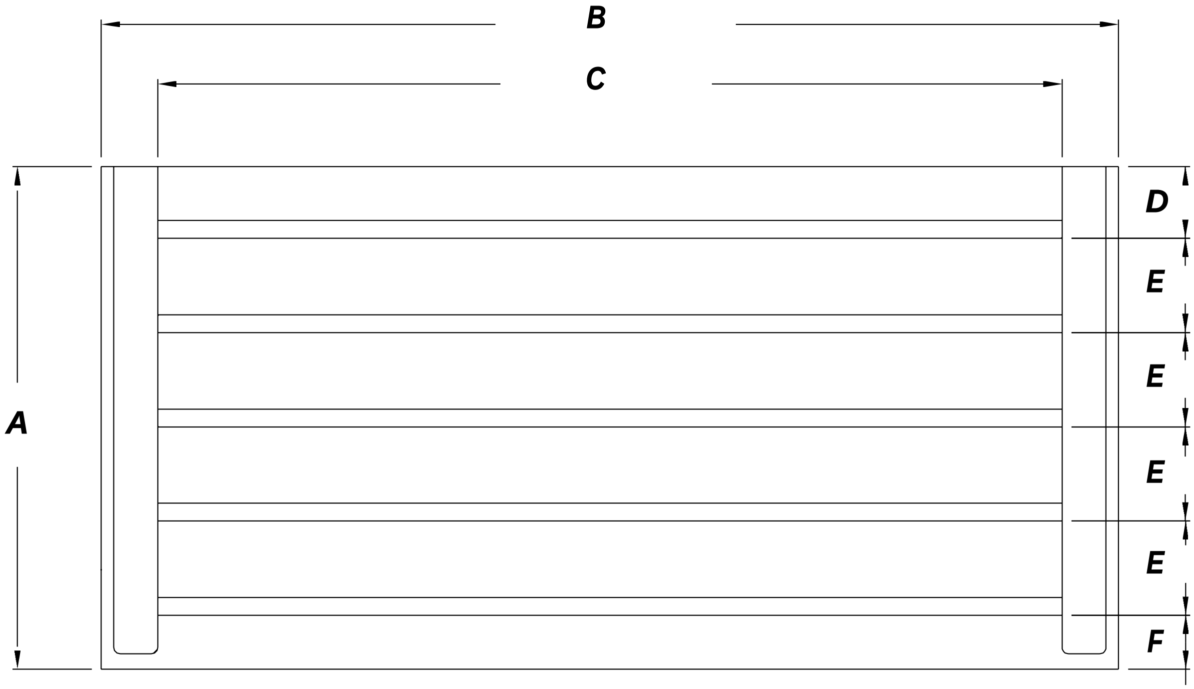


Figure 1-10: 3020 & 4525 Table

Table 1-11: 3020 & 4525 Table Dimensions

VMC 3020		VMC 4525	
A	20.00” (508 mm)	A	25.00” (635 mm)
B	41.75” (1060.45 mm)	B	54.76” (1390.90 mm)
C	36.00” (914.40 mm)	C	49.00” (1244.60 mm)
D	2.52” (64.0 mm)	D	2.658” (67.5mm)
E	3.74” (95.0 mm)	E	4.921” (124.99 mm)
F	2.52” (64.0 mm)	F	2.658” (67.5mm)

1.2.3 4020 TABLE

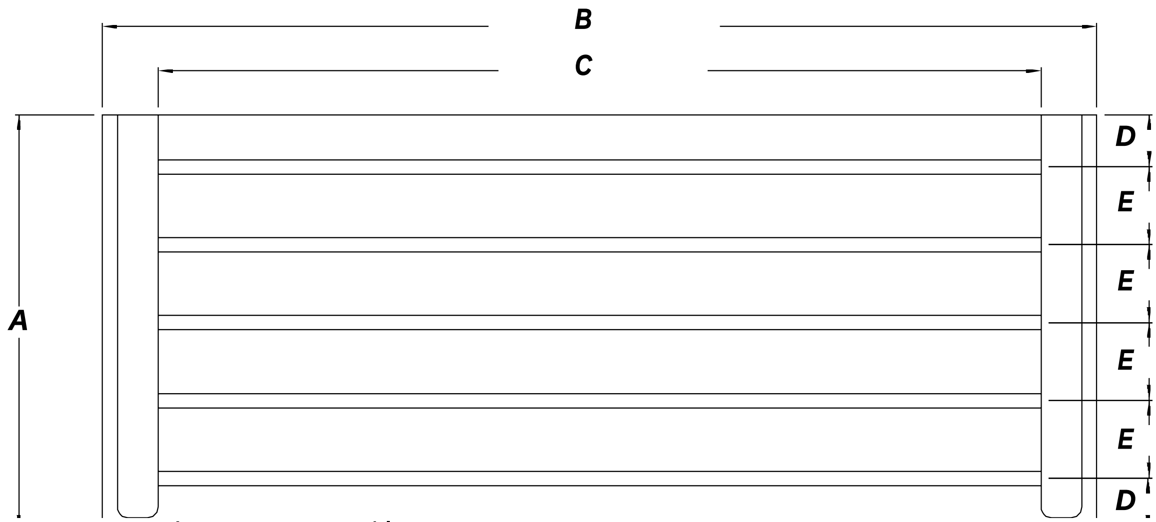


Figure 1-11: 4020 Table

Table 1-12: 4020 Table Dimensions

VMC 4020	
A	20.00” (508 mm)
B	49.00” (1244.66 mm)
C	43.50” (1104.9 mm)
D	2.52” (64 mm)
E	3.740” (95 mm)

1.2.4 6030 TABLE

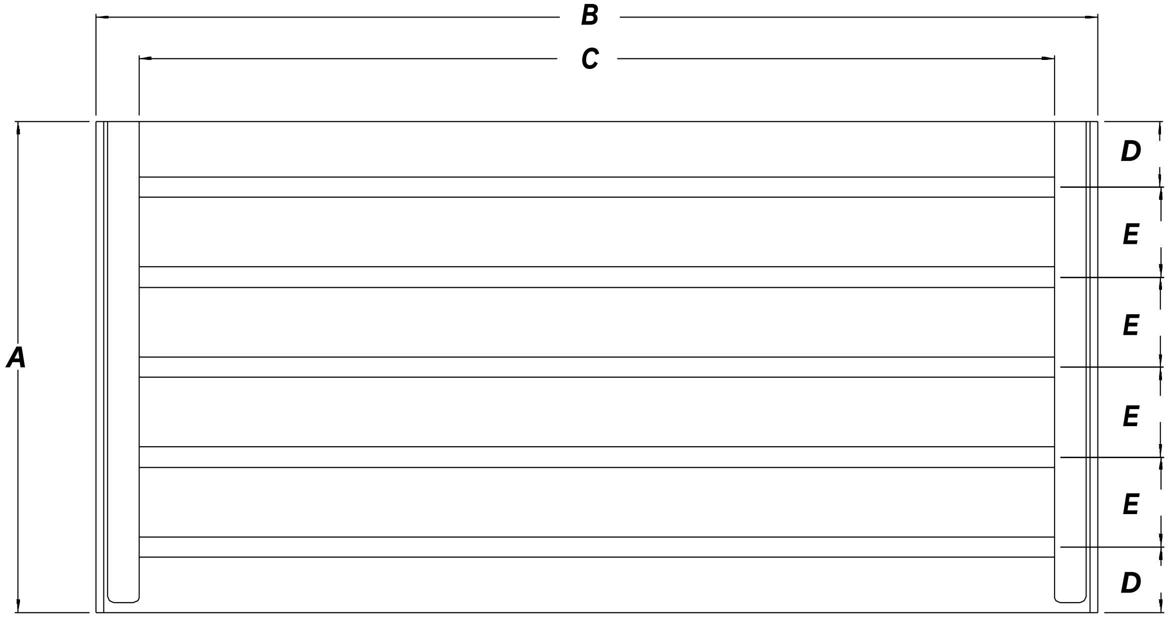


Figure 1-12: 6030 TABLE

Table 1-13: 6030 Table Dimensions

VMC 6030	
A	30.00” (762 mm)
B	63.50” (1612.9 mm)
C	58.00” (1473.2 mm)
D	3.976” (101 mm)
E	5.512” (140 mm)

1.2.5 8030 TABLE

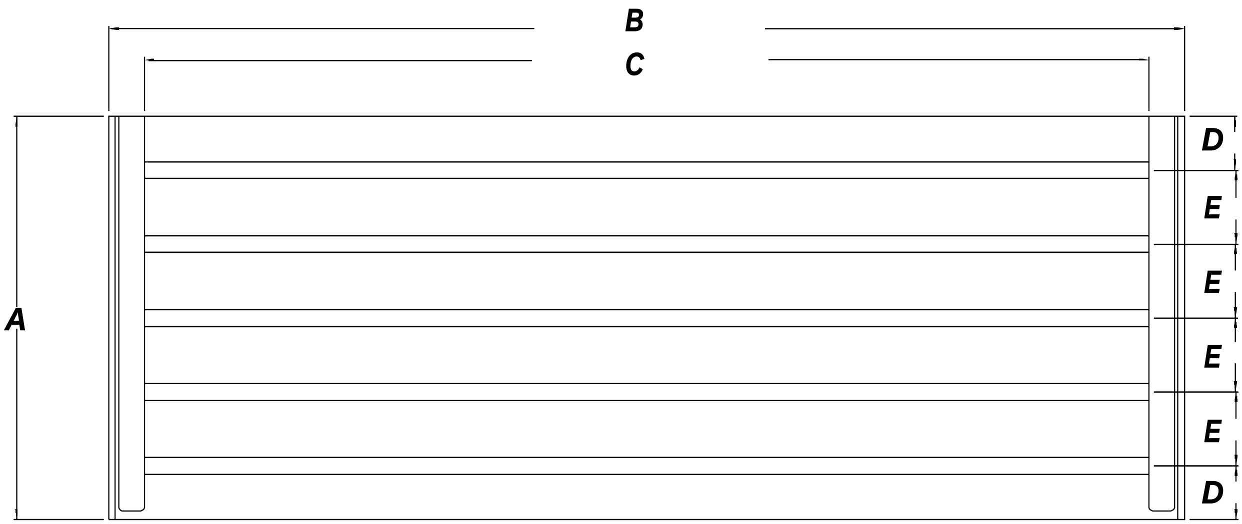


Figure 1-13: 8030 Table

Table 1-14: 8030 Table Dimensions

VMC 8030	
A	30.00” (762 mm)
B	83.50” (1612.9 mm)
C	78.00” (1473.2 mm)
D	3.976” (101 mm)
E	5.512” (140 mm)

1.2.6 6535 TABLE

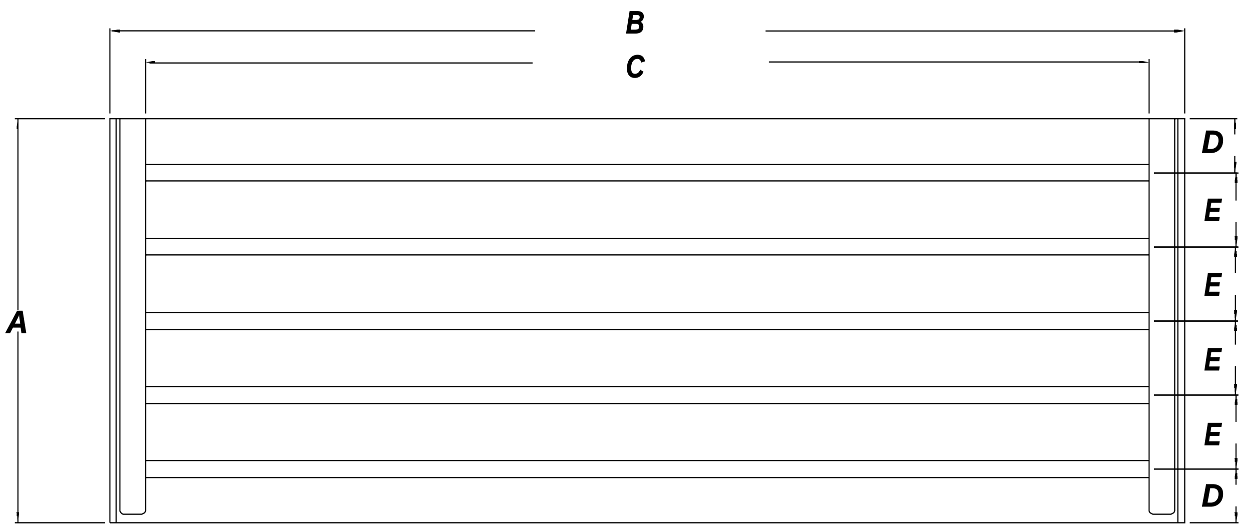


Figure 1-14: 6535 Table

Table 1-15: 6535 Table Dimensions

VMC 6535	
A	35.00” (889 mm)
B	74.76” (1899 mm)
C	69.50” (1765 mm)
D	2.74” (70 mm)
E	4.92” (125 mm)

1.2.7 T-SLOTS FOR ALL TABLES

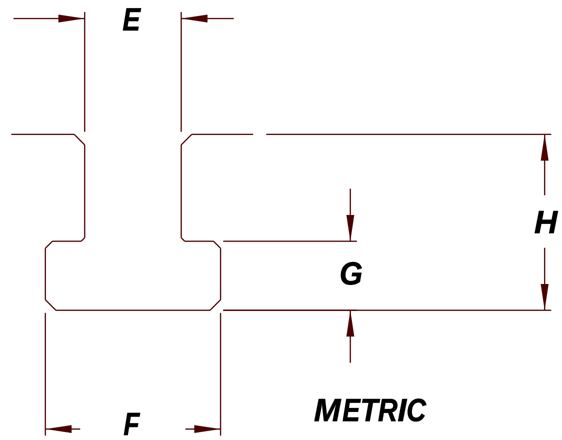


Figure 1-15: T-Slots for All Tables

Table 1-16: Metric T-Slot Dimensions for All Tables

T-SLOT DIMENSIONS	
E	0.7086" - 0.7093 " (17.998 mm - 18.016 mm)
F	1.190" - 1.250" (30.22 mm - 31.75 mm)
G	0.482" - 0.542" (12.24 mm - 13.77 mm)
H	1.299" (32.99 mm)

1.3 RECOMMENDED MAINLINE FUSES / CIRCUIT BREAKERS

Table 1-17: Circuit Breakers for the New Sheet Metal

SPINDLE TYPE	380-415 V 3 PHASE	480 V 3 PHASE
5 HP	30A	30A
10 HP	35A	30A
HT	35A	40A
VHT	70A	70A
50 Taper	70A	70 A

2.0 PRE-INSTALLATION PROCEDURES

2.1 FOUNDATION

> *WARNING!*
> The VMC *MUST* be placed on a surface that will support the combined weight of the VMC, options, fixtures, and tooling, etc. (refer to the VMC Specifications section at the beginning of this manual for VMC weights).

1. It is recommended that most models be placed on a isolated concrete pad 8-12" thick. For VMC 6030 and larger the foundation pad should be 12-15". (Figure 2-1:, Dimension C). For A and B dimensions, *see Table 2-1:Isolation Pad Dimensions*.

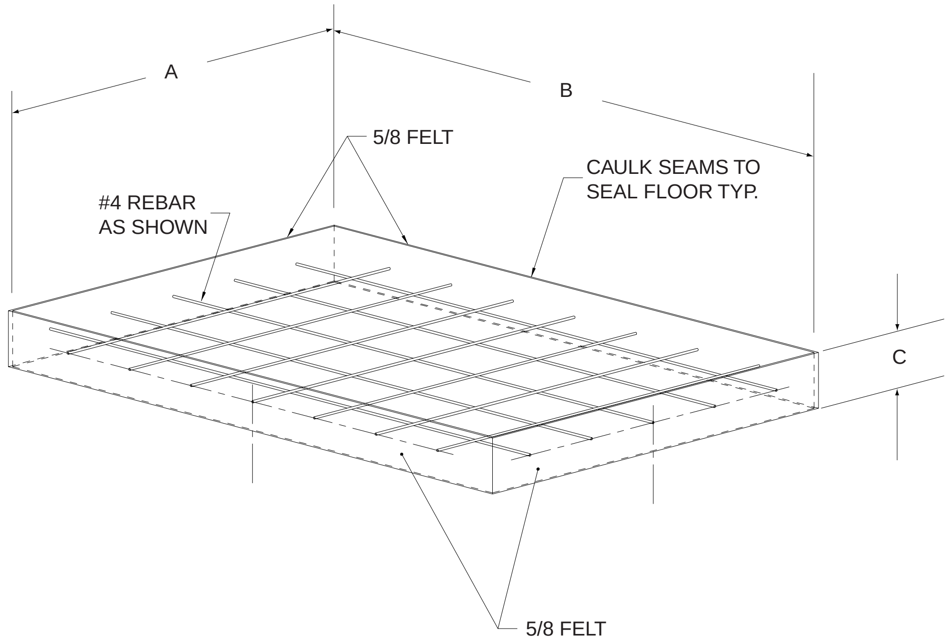


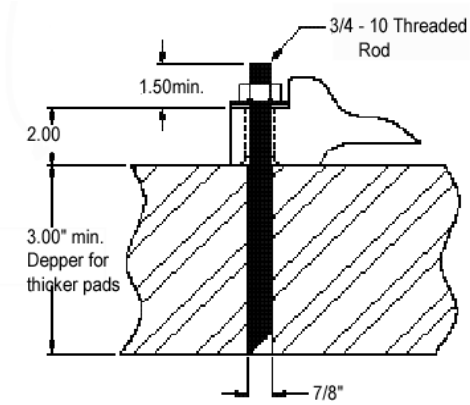
Figure 2-1: Typical Pad Construction

2. The VMC should be positioned on a single slab. Placing the VMC over an expansion joint may cause the VMC to shift when each individual slab moves.

3. The surface below the leveling pads should be free from cracks. Placing the VMC over a crack may cause the VMC to shift during use. *Inadequate flooring could result in mechanical degradation.*

4. Bolt the VMC directly to the pad through the .953" diameter holes that are provided in the base casting. The dimensions for the base mounting holes of all machines are in the VMC Specifications section *(See Specifications, Section 1.0, MAN-0126 R1)*. Anchors are to be installed as shown below (Figure 2-2: Anchor Stud

Installation). For high performance machines, the machine must be bolted to achieve maximum performance.



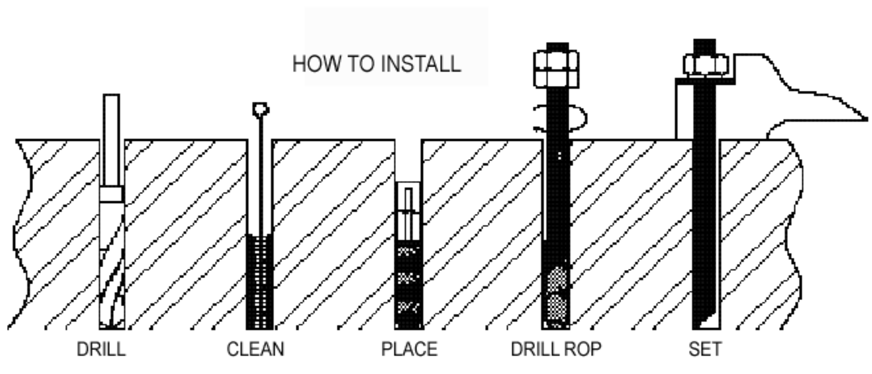


Figure 2-2: Anchor Stud Installation

Table 2-1: Isolation Pad Dimensions

MACHINE	A (DEPTH)	B (WIDTH)
2216/ 3016	7ft 9in	9ft 6in
4020	8ft 7in	11ft
3020	8ft 5in	10ft 2in
4525	8ft 10in	12ft
6030	9ft 11in	14ft 6in
6535	9ft 11in	15ft 10in
8030	9ft 11in	18ft 9in

Anchor stud installation:

1. Wear safety goggles.
2. Use 7/8 carbide tipped drill for the anchor you are using.
3. Use a rotary-hammer drill and drill the base material to depth.

4. **Use proper eye and hearing protection while performing this step**. Remove dust and rubble from the hole with compressed air and brush.

5. Insert capsule in the hole, either end first.

6. Select proper 1/2" SQ. drive socket and attach to sup-r-setter.

7. Jam nut on stud as per illustration.

8. Using a 1 1/8" socket insert the stud into the hole to break the capsule.

9. Under rotary power, push the stud to full depth, maintaining power for two or three seconds after the stud bottoms.

10. Promptly and carefully release the installation tool from the stud, leaving it undisturbed right through the prescribed curing time consistent with on-site temperature.

11. Install machine.

12. Level machine.

13. Add two flat washers, one lock washer and one nut per threaded rod.

14. Tighten nut, stop when washer gets flat, do not overtighten.

15. Recheck level.

Recommended curing time

58ºF to 68ºF	30 MIN
50ºF to 58ºF	1 HR
41ºF to 50ºF	2 HRs
32ºF to 41ºF	4 HRs
23ºF to 32ºF	8 HRs
14ºF to 23ºF	24 HRs

Ground should be compacted to 90%. A layer of 3/4" (1"nominal) crushed rock can be applied at 6" thickness for added support.

For rebar in all pads, use #4 rebar 18" on center, three inches off the ground.

For vibration dampening, 5/8 or thicker felt on all sides is sufficient. If the customer wants to have a larger pad to support several machines, the pads should be 10-12" or thicker with # 4 rebar 18” on center three inches off the ground.

For stress lines in the concrete make sure they are such that they do not go under any of the machines. (If they do, this will eventually defeat the purpose of the pad.)

The top of the felt, if used, should be sealed with a caulking compound to prevent oils and coolants from penetrating the ground. (Compound must be resistant to oils and coolants of course). A recommended product is Volcum.

Concrete to use for the pad should be rated at least 3000 psi. It should also contain 3/4” (1” nominal) crushed rock. Curing time should be at least 7 days. The longer foundation is allowed to cure, the better. If accelerants are used to cure the concrete in less time, cracking is more likely to occur.

2.2 SHIPPING DIMENSIONS

Table 2-2: VMC Shipping Dimensions

VMC	LENGTH	WIDTH	HEIGHT	WEIGHT	Z MTR DWN
8030	17ft 8in	8ft 8in	10ft 2in	19,000lbs	8ft 8in
6535	14ft 9in	8ft 10in	11ft 3in	30,000lbs	11ft 3in
6030	13ft 2in	8ft 8in	10ft 2in	17,000lbs	8ft 8in
4525	8ft 10in	7ft 10in	10ft	13,600lbs	8ft 5in
4020	9ft 7in	7ft	8ft 3in	10,500lbs	6ft 8in
4020	9ft 7in	7ft	9ft 1in ext column	10,500lbs	7ft 5in
3020	8ft 10in	6ft 10in	10ft	12,400lbs	8ft 5in
3016	8ft 3in	6ft 5in	8ft 2in	9,500lbs	6ft 8in
3016	8ft 3in	6ft 5in	8ft 8in ext column	9,500lbs	7ft 4in
2216	8ft 3in	6ft 5in	8ft 2in	9,100lbs	6ft 8in
2216	8ft 3in	6ft 5in	8ft 8in ext column	9,100lbs	7ft 4in
HYDRO	8ft 5in	4ft 2in	5ft 3in	820lbs	
PALLET	7ft 2in	3ft 3in	3ft 8in	911lbs	

Table 2-3: VMC Crated Dimensions & Weights

VMC	LENGTH	WIDTH	HEIGHT	WEIGHT
8030	17ft 8in	8ft 8in	10ft 2in	20,500lbs est
6535	20ft	10ft 4in	14ft 4in	35,000lbs est
6030	14ft	8ft 8in	10ft 2in	18,500lbs est
4525	10ft 5in	8ft	8ft 7in	16,000lbs est
4020	10ft 5in	8ft	8ft 7in	11,800lbs est
3020	9ft	8ft	8ft 7in	13,000lbs est
3016	9ft	7ft	8ft 7in	10,300lbs est
2216	9ft	7ft	8ft 7in	10,300lbs est
HYDRO	9ft 3in	4ft 9in	6ft	1,420lbs est
PALLET	7ft 9in	4ft 9in	6ft	1,411lbs est

NOTE
All VMCs 6535 and 8030 do not get crated. (Unless specified by customer or distributor.) They are placed on pallets and vacuum sealed.

2.3 POSITIONING

1. Place the VMC so that skylights or air vents are NOT directly overhead. Do not expose the machine to direct sunlight, or any other heat source. Do not place the machine in an area that will expose the machine to moisture, standing water, liquid or rain.

2. Ensure there is adequate room behind the VMC to fully open the rear cabinet door. Minimum clearance behind the machine is two feet (24"/ 60.96 cm.)

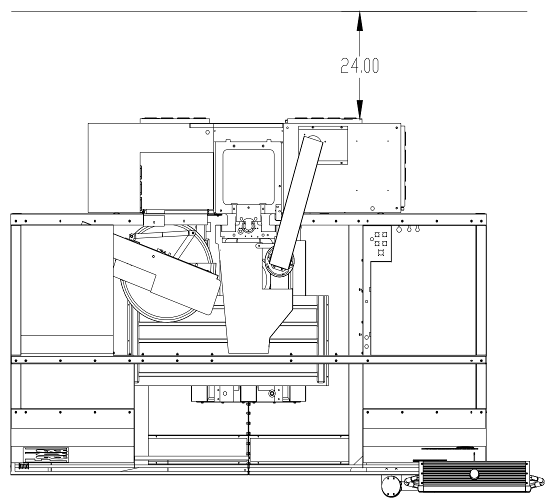


Figure 2-3: 24" Minimum Clearance Behind VMC

3. Ensure adequate ceiling clearance for the Z axis conduit with the Z axis in the Z+4.0" (10.16cm) position. VMCs with the Extended Travel option require an additional 8.0" (20.32cm) vertical clearance.

Table 2-4: Minimum Ceiling Clearances (inches/metric)

	VMC 2216, 3016	VMC 4020	VMC 6030, 8030	VMC 3020, 4525	VMC 6535
Regular Column (Z+4.0" (0.35m))	97.00" 2.56m	98.00" 2.5m	126.00" 3.2m	127.00" 3.22m	140.00" 3.55m
Extended Column 28.0" (0.7m)	105.00" 2.67m	106.00" 2.7m	N/A	135.00" 3.43m	N/A

2.4 AIR SUPPLY

> *WARNING!*
> Air pressure required: 120 psi before regulator, 80 psi after regulator, 15 scfm (standard cubic feet per minute) momentary.

1. From the main air supply line attach a 3/8” air supply line for the VMC. The distance from the air compressor and number of machines attached should be taken into consideration when determining the size of piping for the main air supply line.
2. Piping may consist of one or more of the following: galvanized pipe, PVC pipe or high pressure hose. Do not use quick disconnects; quick disconnects will restrict air flow.
3. A “T” riser should be used to connect the main air supply line with the air supply line to the VMC *(See Figure 2-4: Attach Drain to Lowest Point of Air Supply Line)*.
4. To prevent moisture from entering the VMC’s air system, attach a drain to the lowest point of the air supply line. *(See Figure 2-4: Attach Drain to Lowest Point of Air Supply Line)*. The drain could be a self-relieving moisture separator, a simple petcock, or a gate valve opened occasionally to release the water build-up. An air dryer is preferred where higher moisture levels exist.
5. To help prevent contaminants from entering the air system on the VMC, place a filter in-line on the main air supply line.

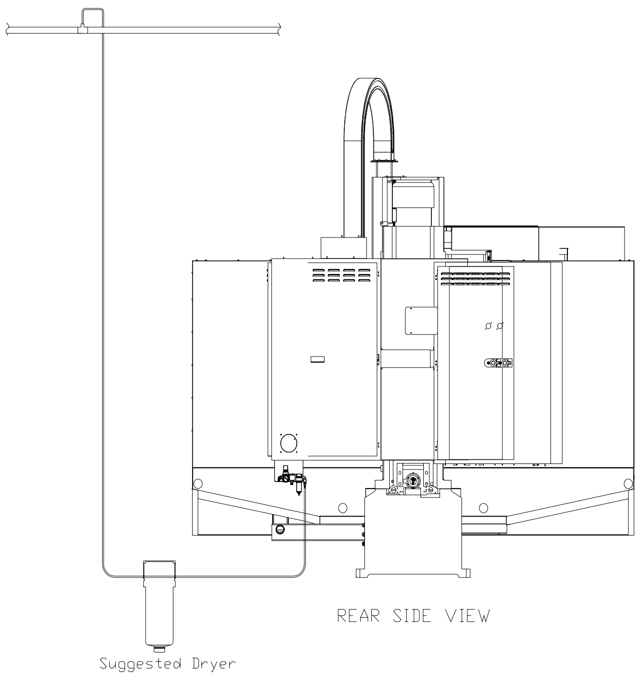


Figure 2-4: Attach Drain to Lowest Point of Air Supply Line

2.5 ELECTRICAL GROUNDING

WARNING!
The importance of proper grounding CANNOT be over-emphasized! Improper grounding will result in a wide range of hard-to-diagnose problems in communications, positioning, spindle motion, etc.

2.5.1 PRIMARY GROUNDING

1. The grounding conductor shall be of copper. The material selected shall be resistant to any corrosive condition existing at the installation or shall be suitably protected against corrosion.

2. The grounding conductor shall be a No. 8 AWG (10 mm^2) or larger equipment ground conductor, and must be:

- solid or stranded
- insulated, covered, or bare
- installed in one continuous length without a splice or joint.

3. Individually covered or insulated grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes.

4. A No. 8 AWG (10 mm^2) or larger equipment ground conductor and 3 phase conductors must be contained within one of the following:

- rigid metal conduit
- intermediate metal conduit
- electrical metallic tubing

5. The ground conductor shall be connected between the VMC's ground bus and the approved ground bus contained within the voltage supply panel board or enclosure.

6. The VMC branch supply conduit, phase conductors and ground conductors must be dedicated to a single VMC. They cannot be used to supply any other loads.

2.5.2 SUPPLEMENTAL GROUNDING

1. Supplementary grounding electrodes shall be permitted to augment the equipment grounding conductor; however, the earth shall not be used as the sole equipment grounding conductor.

2. The supplemental grounding conductor shall be a No. 6 (16 mm^2) or larger copper conductor in the form of a wire, and must be:

- solid or stranded
- insulated, covered or bare
- installed in one continuous length without splice or joint

3. A No. 6 (16 mm^2) or larger grounding conductor shall be run in one of the following:

- rigid metal conduit

- intermediate metal conduit
- electrical metallic tubing or cable armor

4. One end of the supplemental grounding conductor shall be attached to the VMC's ground bus. The other end shall be effectively bonded to a copper cold water pipe that is in direct contact with the earth for 10 feet or more *(See Figure 2-5: Bond Grounding Conductor to Copper Cold Water Pipe).*

5. Connections shall be made so that they are electrically continuous.

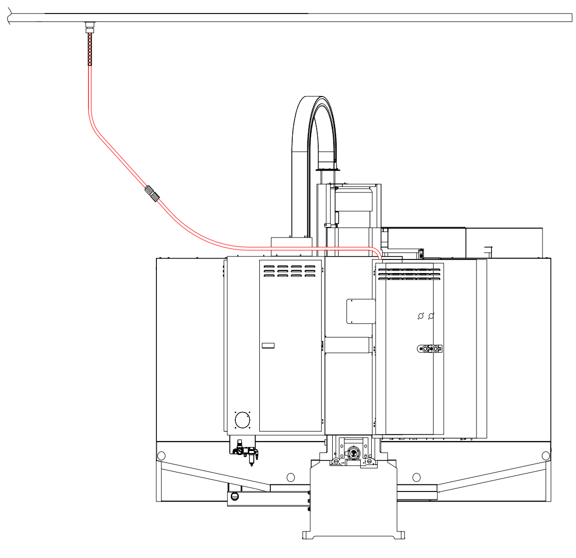


Figure 2-5: Bond Grounding Conductor to Copper Cold Water Pipe

> *WARNING!*
> Many problems that are difficult to diagnose can occur if the VMC is not properly grounded. Proper grounding cannot be overemphasized.

2.6 CHECKING GROUNDING INTEGRITY OF FADAL VMCS

2.6.1 SPECIFICATION - GROUNDING FOR THE FADAL MACHINE

1. MUST conferm to NEC code as stated in the Maintenance Manual.
2. MUST be a continuous wire 8 AWG or larger between the VMC's ground bus and the building power distribution panel serving the VMC.
3. MUST be dedicated to a single VMC. (The ground and phase conductors cannot be shared with any other equipment.)
4. Ground rods and other supplemental grounding may be used in addition to the ground specified above but not instead of it.

2.6.2 INSPECTION - CHECK GROUND WIRE COMING INTO VMC

1. The ground wire coming into the VMC and going to the building power distribution panel must be 8AWG or larger.
2. The ground wire must be connected to the ground bar in the back cabinet of the VMC. (It does not go to a screw in the disconnect box.)
3. The ground wire is to be a continuous wire from the VMC to the building power distribution panel serving the VMC. The conduit is not to be used as the grounding conductor. Ground rods and other supplemental grounding may be used in addition to the ground specified above but not instead of it. Servicemen are not the appropriate people to be inspecting power distribution panels or building wiring. The serviceman is not expected to physically verify the routing of the ground conductor, but should look for any indications that grounding is not as specified.

2.6.3 VERIFICATION - CHECK GROUNDING INTEGRITY WITH FLUKE METER

1. Measure the resistance (ohms) of a length of 16AWG or larger wire that is long enough to reach from the VMC to the building power distribution panel that supplies the VMC. Record reading.
2. Attach the wire of step 1 (test wire) to the ground bus of VMC. The other end will be used for measurement at the power distribution enclosure. (Do not open the enclosure. Use a bare screw or bare metal on the enclosure for measurements.)
3. Set meter to AC Volts; with VMC on, measure and record voltage between the test wire and the power distribution enclosure. Set meter to DC Volts; measure and record voltage. Voltages should be OV with machine on but not operating, (up to .O1OV is OK).

4. Turn off the VMC and measure the ground voltages (AC and DC) again. Record these readings. Voltages should be OV to .005V.
5. Voltages (AC or DC) across the ground wire will cause false resistance readings. If the ground voltages with VMC off are 0 (.005VAC max.), set meter to ohms and measure resistance between VMC ground bus and power distribution enclosure. Resistance measurement should be less than twice the resistance measured in step 1. (If resistance is negative (due to a ground current), reverse meter leads and average the two readings.)

2.6.4 ELECTRICAL SERVICE

> *WARNING!*
> Electrical installation of machine must be done by a qualified electrician.

1. The total connected load should not exceed 75% of the panel rating, allowing for the VMC load. Refer to the Electrical Rating Plaque for full load current.
2. If other CNC equipment, motor controllers, motors or electric-discharge lighting (fluorescent, mercury vapor, metal-halide, high and low pressure sodium) are connected to the same panel, the connected load should not exceed 50% of the panels rated capacity.
3. Prior to the installation of the VMC, the panel should be measured for average and peak loads across the three phases.

> *WARNING!*
> The VMC must NOT be installed on a panel where the measured surge demand current exceeds the panel’s supply amplitude.

2.6.5 PREFERRED SERVICE

The VMC should be supplied by a dedicated circuit connected directly to the Service Entrance panel.

2.6.6 ALTERNATE SERVICE

The VMC may be supplied by a dedicated circuit connected directly to the local branch panel.

2.6.7 WIRING

Table 2-5: Wiring Requirements

40 Taper	480 VAC 3 Ø	10 AWG (6 mm^2) stranded THHN copper within 100 ft. of panel. For VHT 6 AWG	8 AWG (10 mm^2) stranded THHN copper 100 ft. or more from panel. For VHT 4 AWG
50 Taper	480 VAC 3 Ø	4 AWG (25 mm^2) stranded THHN copper within 100 ft. of panel.	3 AWG (30 mm^2) stranded THHN copper 100 ft. or more from panel.

2.6.8 CONDUIT

1. The number and size of conductors in any raceway shall not be more than will permit dissipation of the heat.
2. The conduit must allow ready installation or withdrawal of the conductors without damage to the conductors or to their insulation.

Table 2-6: Conduit Selection

# OF CONDUCTORS	CONDUCTOR SIZE	MINIMUM SIZE OF CONDUIT
4	10 AWG THHN (6 mm^2)	1/2”
4	8 AWG THHN (10 mm^2)	3/4”
4	6 AWG THHN (16 mm^2)	3/4”
3	4 AWG THHN (25 mm^2)	1.0”

3.0 INSTALLATION PROCEDURE

WARNING!
Before beginning the Machine Installation & Hook-Up it is important to review the entire Installation Procedure section.

3.1 MACHINE INSTALLATION & HOOK-UP

3.1.1 UNPACKING

Tools Required

Hammer, 15/16” socket or wrench and knife

1. Remove the crate and/or protective material from around the VMC.
2. Remove the strapping material from the front doors.
3. Unload the boxes from the inside and/or around the VMC.
4. Remove each of the four 5/8” bolts and nuts between the base of the VMC and the pallet.

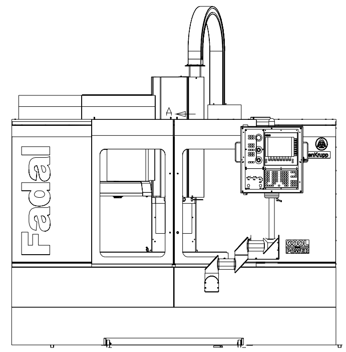
3.1.2 PLACING THE VMC

1. Place the leveling pads (countersink side up) under the leveling bolts. Be sure leveling bolts go into countersink on leveling pads.

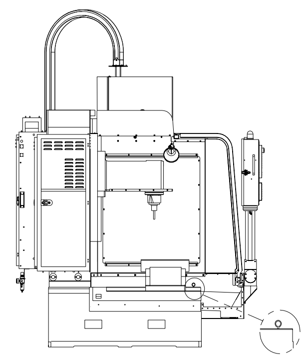
> *NOTE*
> Use leveling pad SHp-0002 (PLC-0063 for slant sheet metal machines, or machines equipped with the HydroSweep option) for placing the machine. Any other pad may cause damage to the machine.

2. Remove the fork lift bars or the eye bolts and the steel bar from the column.

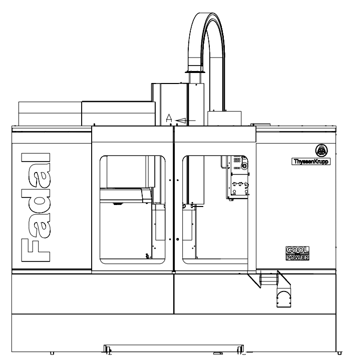
3. At this point the VMC is ready for power and air connections.



Hole provided for 1-1/4” bar
minimum bar length 36”



1-8”eye bolt 2 places
1.5” eye bolt 2 places for 6535



Maximum fork width is 6.00”

Figure 3-1: Placing the VMC

3.1.3 AIR SUPPLY

> *WARNING!*
> AIR PRESSURE REQUIRED: 120 psi before regulator, 80 psi after regulator, 15 scfm (standard cubic feet per minute) momentary.

1. Connect the 3/8” air hose to the VMC.

2. Check the pressure gauge for 120 psi and adjust the regulator on the VMC if necessary.
3. Check for air leaks at the fitting and around the air regulator.
4. It is important that the air compressor turns on when the pressure drops to approximately 120 psi. This assures the VMC a constant 80 psi.

3.1.4 POWER CHECK

WARNING!
Do NOT power on the VMC before completing this section.

Tools Required

Fluke DMM, screwdriver or Wago tool 210-141

(ST-26), 5/16” hex bit socket and 3/4” open or box wrench.

Verify the Main Power Fuses

Siemens requires 3 phase power. Voltage must be 400 or 480 Volts (depending on Module). The voltage differences between each lug and ground (measured at incoming terminal) must be less than 5%.

Verify the MOV Surge Suppressor Board

1. Locate the MOV Surge Suppressor Board *(see Figure 3-2: MOV Surge Suppressor Board).*

Figure 3-2: MOV Surge Suppressor Board

2. Find the part number on the board.
   a. If your incoming voltage is *over* 380 VAC, then PCB-0146 should be installed.

3. Identify the jumper and AC input locations. Use *Figure 3-3* through *3-7* for three phase transformers.
   a. Where are the jumpers located?
   b. Where are the AC inputs (L1, L2, L3) located?

4. With the jumper and AC input locations, locate the voltage setting of the transformer using the table.

Jumper (Step 6a)	AC Input (Step 6b)	=	Voltage Setting
3-6	8	=	380VAC

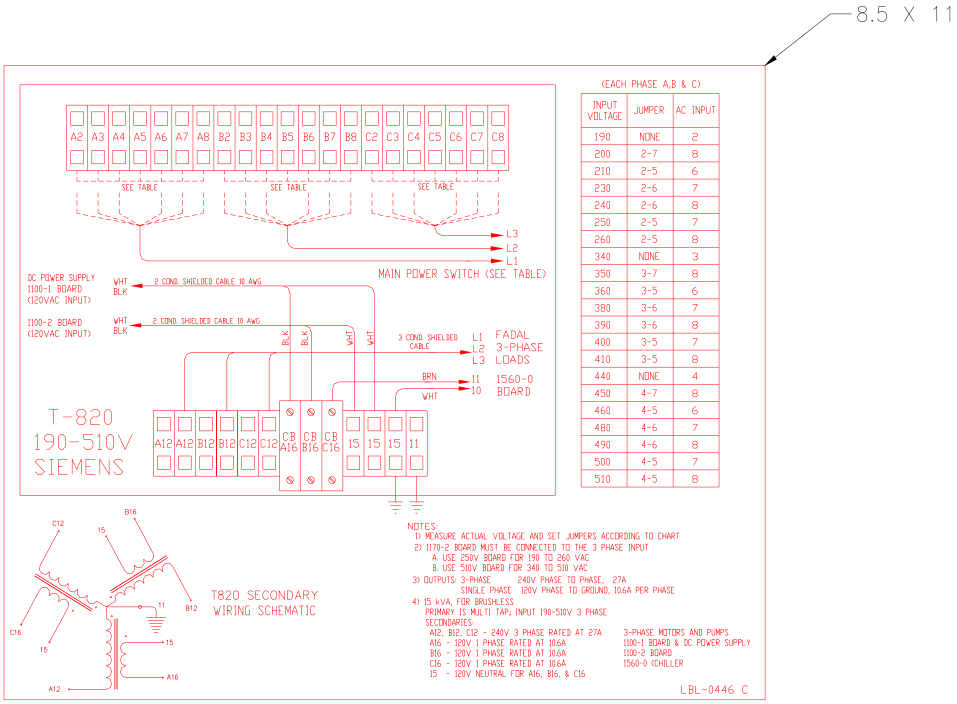


Figure 3-3:

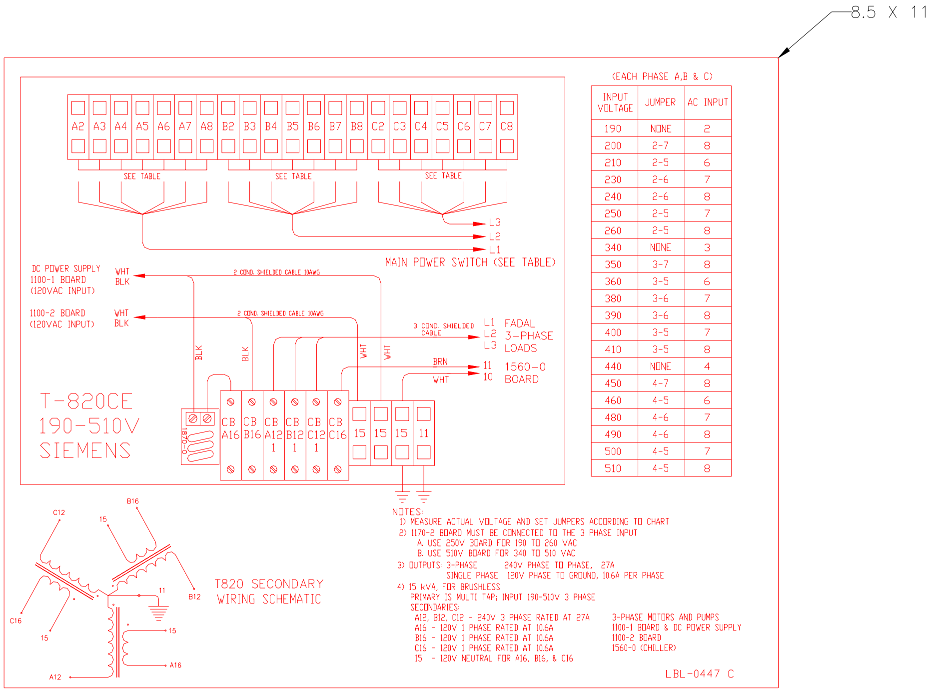


Figure 3-4:

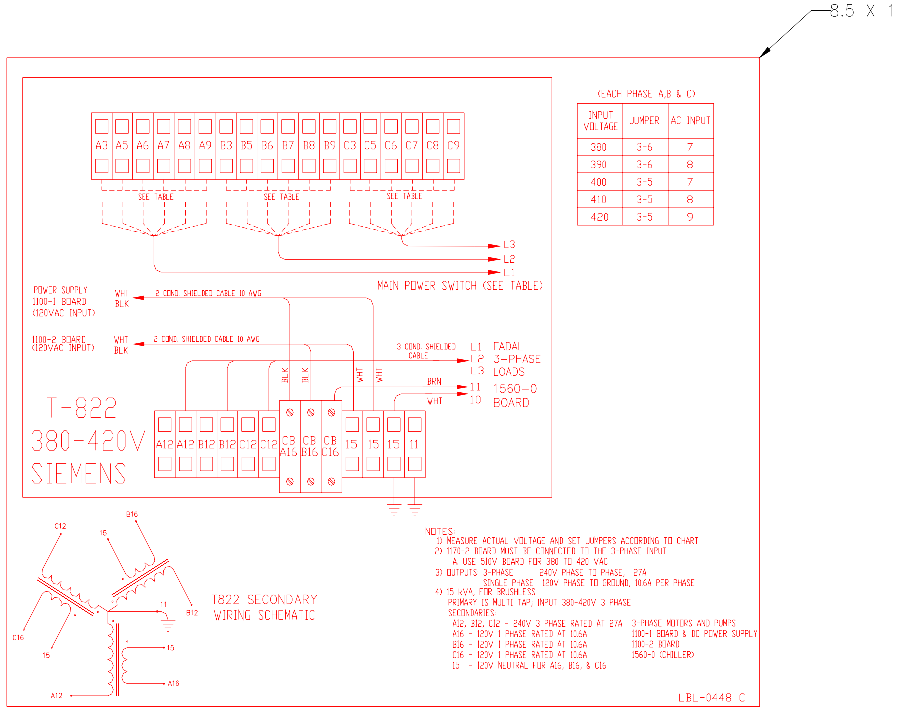


Figure 3-5:

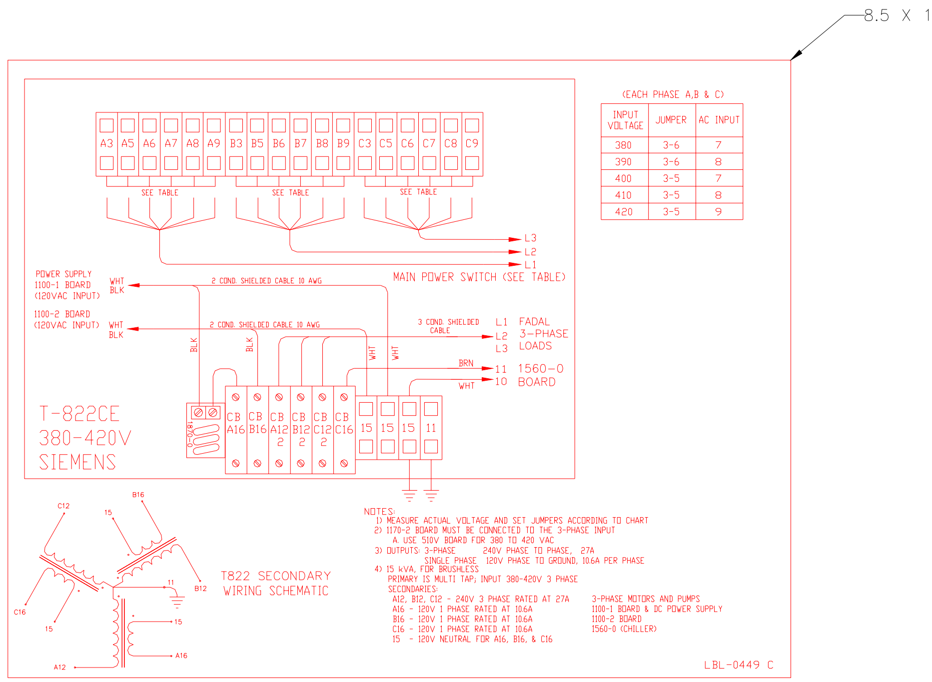
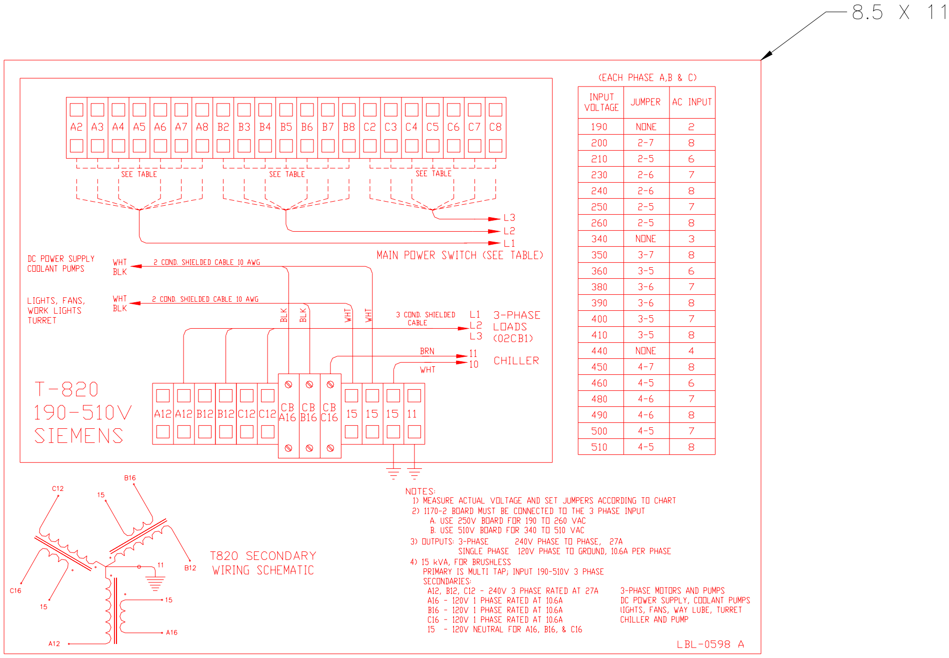


Figure 3-6:



INPUT VOLTAGE	JUMPER	AC INPUT
190	NONE	2
200	2-7	8
210	2-5	6
230	2-6	7
240	2-6	8
250	2-5	7
260	2-5	8
340	NONE	3
350	3-7	8
360	3-5	6
380	3-6	7
390	3-6	8
400	3-5	7
410	3-5	8
440	NONE	4
450	4-7	8
460	4-5	6
480	4-6	7
490	4-6	8
500	4-5	7
510	4-5	8

Figure 3-7:

3.2 TRANSFORMER TAPPING

1. With the machine main power switch turned OFF, verify that the chart on the door of the cabinet is the one for the transformer in the machine.
2. Measure the input voltage to the machine on the chart (Measure leg to leg the input power lines to the machine.).
3. Next to the voltage on the chart will be a “jumper” number, such as 3-6, and a “AC Input” number, such as 7.
4. Each phase has a group of terminals such as A3 to A8 for phase 1 and B3 to B8 for phase 2. Place a jumper between the two terminals listed on the chart for each phase. Using the same example place jumper from A3 to A6 for phase 1, B3 to B6 for phase 2 and one from C3 to C6 for phase 3.
5. Place the input tap wire in the proper terminal, as in example A7 for phase 1, B7 for phase 2 and C7 for phase 3.

The VMC is Ready for the Initial Power on Procedure

6. Push the EMERGENCY STOP switch to disable the axes.
7. Turn ON the main power switch.
8. Measure the voltage at the transformers secondary between A12-B12, A12-C12, B12-C12.
9. Measure the out voltage of transformer, labeled A12, B12, C12, leg to leg. Should be about 230 VAC with the range being from 220 to 240 VAC. If the difference between 230 and the measured voltage is greater then ten (10) volts then power down. If the voltage is too high then select the next higher voltage on the chart and change the jumper and / or input tap and recheck. If the voltage is too low then select the next lower voltage and change and check.
10. Check the voltages on the D.C. power supply, i.e. 5, + 12, -12 VDC, +24VDC.
11. Push the CNC POWER button.
12. Reset the EMERGENCY STOP switch.
13. Unbolt and remove the support between the table and the head.
14. Unbolt and remove the counterweight bars from the column, located next to the main disconnect box.
15. Jog the axis to the cold start indicators and cold start the VMC.

> *NOTE*
> It is acceptable to have the legs tapped differently by one voltage tap position. There should be no more than one position.

3.3 PHASE CONVERTER ROTARY

The normal Fadal VMC requires three phase-input power. Some customers prefer to use rotary phase converters. However, Fadal does not recommend the use of rotary phase converters.

Rotary phase converters input single-phase 208 to 230 VAC and output three phase 230 VAC. For a VMC close to a 5% voltage balance between legs and ground is required, in reference to the voltage differences of each phase. Most CNC machines would require the output power to be 1-1/2 to 2 times larger than the spindle motor (for a Fadal output must be at or higher than the minimum of the required input; *see Specifications, Section 1.0, MAN-0126 R1)*. A Voltage Stabilizer may also be required. The stabilizer’s function is to maintain a consistent voltage level of the three phases during light or no load conditions.

3.4 LEVELING

Leveling is an important first step in setting up the VMC. All calibration and squareness performed on the assembly line is done with the machine leveled. It is important to follow the sequence below precisely to ensure proper results.

Tools Required

Precision Level, such as the Starrett 12”, P/N 199Z

> *WARNING!*
> Verify that the scale reads the same when rotated 180 degrees.
> If using a flashlight to see the bubble, do not place the flashlight on the level, as it will warm the bubble and give an incorrect reading.

3.5.1 FOR ALL BOX WAY VMCS

1. The VMC should be positioned on one solid concrete slab *(see Pre-Installation, section 2, MAN-0126 R1)*. Do not straddle any cracks or seams.
2. Center the leveling pads under the leveling screws.
3. Level the VMC as close as possible to the leveling pads. The leveling screws should be extended as little as possible to reduce vibration through the sheet metal.

> *NOTE*
> Make sure that machines with the chip conveyor option are raised high enough so that the chip conveyor tank fits under the sheet metal of the VMC.

4. Verify the Cold Start indicators, then cold start the VMC.
5. Clean the level with alcohol.
6. Jog the Y axis to the Y+ limit.
7. Clean the outer base ways with alcohol.

8. Place the level on the right hand way (the outer right hand way on the 6535) of the base with the small bubble towards the column. Take an accurate reading. *(See Figure 3-8: Leveling Box Way.)*

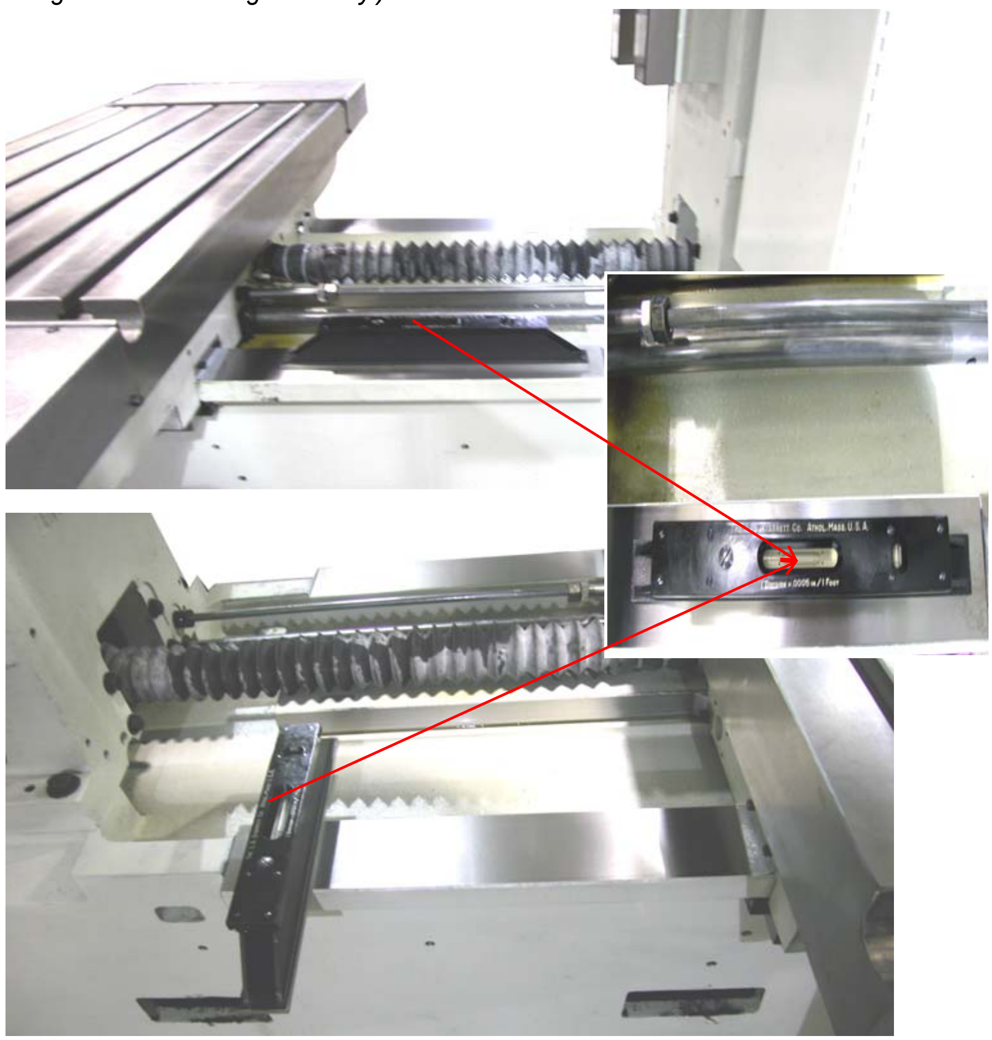


Figure 3-8: Leveling Box Way.

9. Now put the level on the left hand way (the outer left hand way on the 6535) of the base with the level pointing in the same direction as on the right hand way.

10. Adjust the leveling screws on the machine until the left hand way and the right hand way level are even.

11. The level will have a front to back bubble and a side to side bubble. Level the machine from front to back first and then from side to side. When adjusting the side to side, adjust both leveling screws of one side only.

12. If leveling larger machines, such as the 6535, 6030 or 8030 models, the center four leveling screws must not be touching the leveling pads during the leveling procedure. After the machine has been leveled, lower the four screws to the pad, then check the level and tram readings to ensure they have not changed.

13. Verify the spindle tram and, if necessary, adjust by slightly changing only the two front leveling screws.

3.5 HOLD DOWN CLAMPS

Larger machines may vibrate, bump on reversals, and degrade floor finish.

This may indicate that the base casting needs to be clamped to floor.

Larger machines need to be clamped to the floor to prevent movement between the machine and the floor, and clamping holes are provided on all base castings for this purpose.

The kit SHP-0116 has been developed to mount the machine to the floor without moving it.

1. The Clamp is first mounted into the clamping hole in the base.
2. The position is marked on the floor for drilling a ½” hole into the concrete.
3. The RedHead stud is mounted in the floor with one nut and washer on it.
4. The Clamp is mounted over the stud and then the two ½ inch Socket Cap screws are tightened, pinching the flange of the base casting.
5. The second washer and nut are tightened onto the stud, inhibiting any flexing up or down of the base casting.
6. Recheck machine level.

Hilti (mfg in Liechtenstein) makes a Right-Angle Hammer Drill, model TE-5, with a model TE-AC Right Angle Head attachment, that works very well in this application.

3.6 OPTICAL FIBER CABLE HANDLING

Careful handling of Optical Fiber Cable:

1. Even though reinforcing cover used on the optical fiber code has enough mechanical strength, be sure not to be damaged by heavy materials drop.

2. Detaching and attaching of optical connector should always be made by touching connector. Optical fiber code should not be touched when replacement.

3. Optical connector is automatically locked with upper side lock levels after being connected. It is impossible to pull out the connector without releasing the lock levels.

4. Optical connector can not be connected oppositely. Be sure the connector direction when connection is done.

5. Optical connector should be processed as follows before laying of optical fiber cable.

    Fix a reinforcing cover to a wire with hook or tension member by a tape. At laying hook the wire or pull the tension member taking enough care that optical connector does not receive pulling strength.

6. Reinforcing cover is fixed to cable lamp so that optical fiber cable could not weight directly the connecting part of connector.

7. Notice that optical connector’s chip is clear. The attached protect cap must be always put on when optical connector is not used.

8. Remove dirt with a clear tissue or absorbent cotton (cotton with ethyl alcohol is applicable). No other organic solvent than ethyl alcohol can be used.

3.7 COUPLER INSTALLATION ON AXIS MOTOR OR BALLSCREW

NOTE
Motor and Ball Screw shaft must be clean and oil free.

Follow the next procedure:

1. Loosen both coupler HUB screws.

2. Mark coupler HUBs and SPIDER before disassembling to insure coupler is assembled back together the same way.

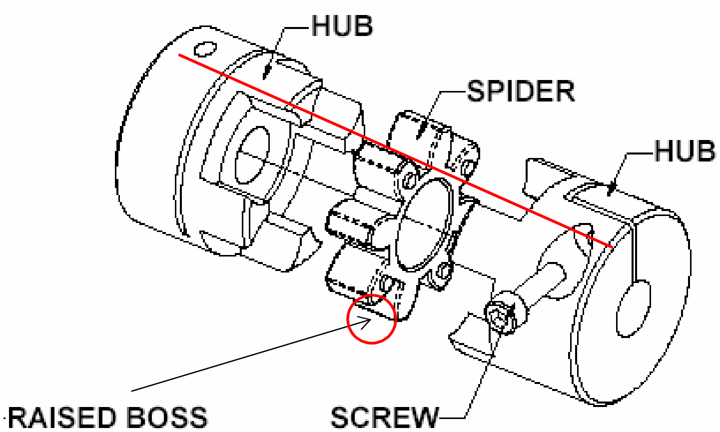


Figure 3-9: Coupler

3. Separate coupler HUBs.

4. Install bottom coupler HUB on to axis motor shaft.

5. Coupler must be gaged 0.10” (2.54mm) away from axis motor face.

6. Install the SPIDER and set the tolerance on all 4 RAISED BOSSes to 0.015”-0.030” from the HUB using 2 (two) 0.015”(0.381mm) and 0.030” (0.762mm) feeler gages.

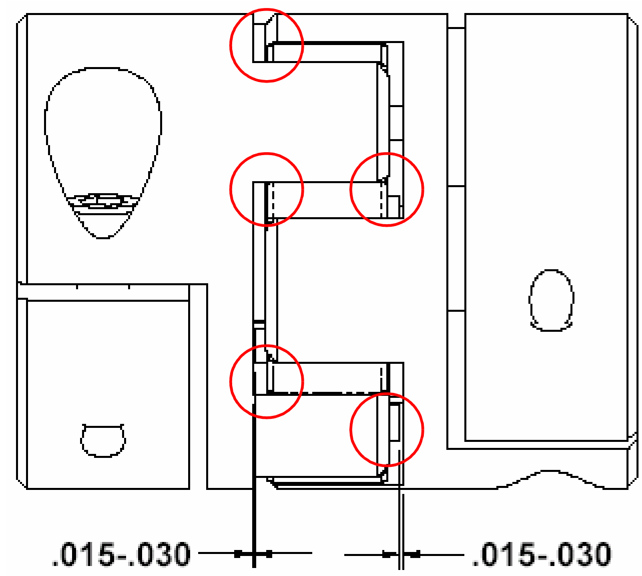


Figure 3-10: Gages

7. Install Ball Screw coupler HUB on the SPIDER and set the tolerance on all 4 RAISED BOSSes to 0.015 “ - 0.030” (0.381-0.762mm) from the HUB using 2 (two) 0.015” or 0.030” feeler gages and torque coupler HUB to Ball Screw shaft using correct torque specification.

> *NOTE*
> Verify when the coupler assembly is completely installed all 8 RAISED BOSSes must be checked and set to 0.015” - 0.030”(0.381-0.762mm).

8. Clean marked notes from coupler assembly when installation is complete.

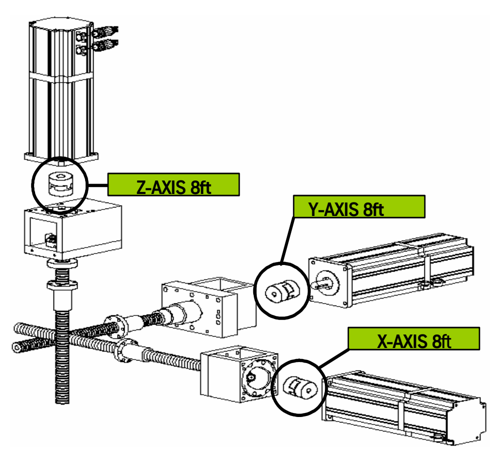


Figure 3-11: Motors

Table 3-1: Couplers

MACHINE	X AXIS	Y AXIS	Z AXIS
2216	KTR ROTEX GS24 .625x24mm	KTR ROTEX GS24 .625x24mm	KTR ROTEX AI GS24 .625x19mm
3016			
3020			
4020			
4525			
6030			
8030			

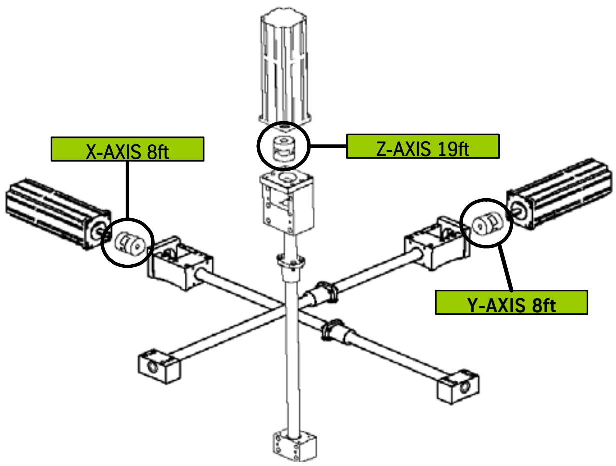


Figure 3-12: Motors

Table 3-2: Couplers

MACHINE	X AXIS	Y AXIS	Z AXIS
6535/40T	KTR ROTEX GS 28 .875x32mm	KTR ROTEX GS 28 .875x32mm	KTR ROTEX GS 28 .875x32mm
6535/50T			

3.8 PENDANT INSTALLATION

In order to install pendant, follow the next procedure:

VMC 6535

1. Carefully remove shipping crate, with pendant inside, from machine and place it close to the right side of the machine.
2. Remove second (smaller) box from the machine.
3. Find the lower pivot pendant support and mount it on an appropriate position.
4. Carefully remove pendant from crate, place it on the mounted lower pivot pendant support, and hold it.
5. Mount the upper pivot support while holding the pendant.
6. Mount pendant to both (upper and lower) pivot supports using screws and nuts from the small box.
7. Open back panel of the pendant housing.
8. Pull all the cables coming from the machine through the upper pivot support and the hole on the right top side of the pendant housing.
9. Connect these cables to appropriate positions according wiring diagram.
10. Connect remote bulk-head connector.

VMCs 2216, 3016, 6030, 8030

1. Carefully remove shipping crate, with pendant inside, from machine and place it close to the right side of the machine.
2. Pull out cables and wires from the pendant support arm attachment point.
3. Mount the pendant support arm to this attachment point using screws and nuts from the plastic bag.
4. Connect all the cables located at the junction in the support arm attachment point.
5. Mount support arm caps back to appropriate positions using screws from the plastic bag.

3.9 GENERAL

Detach column breaks from spindle head and tool changer arm.

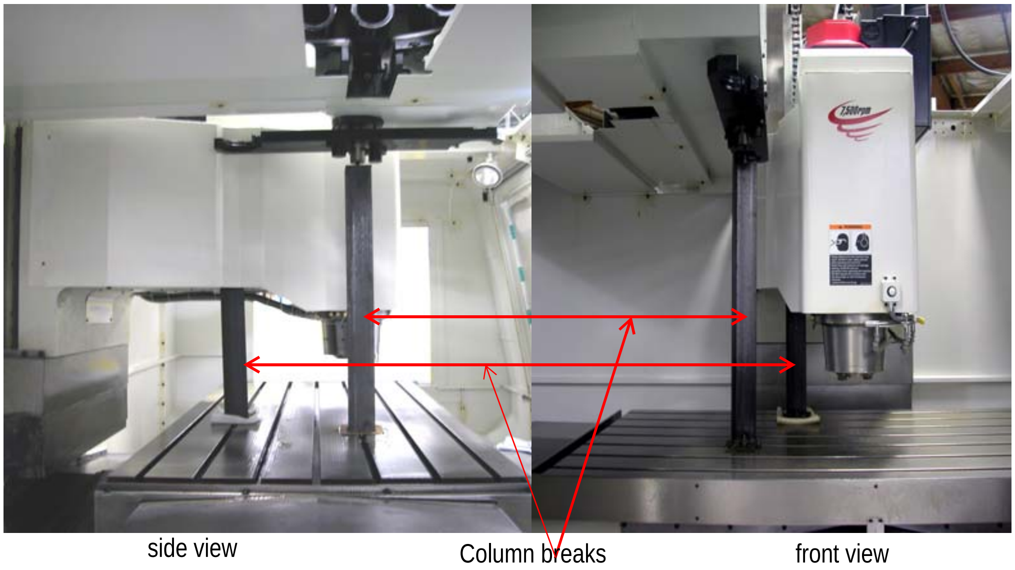


Figure 3-13: Column breaks

Place the cable carrier (black flexible arc on top of the machine) onto appropriate screws and tight them with nuts.

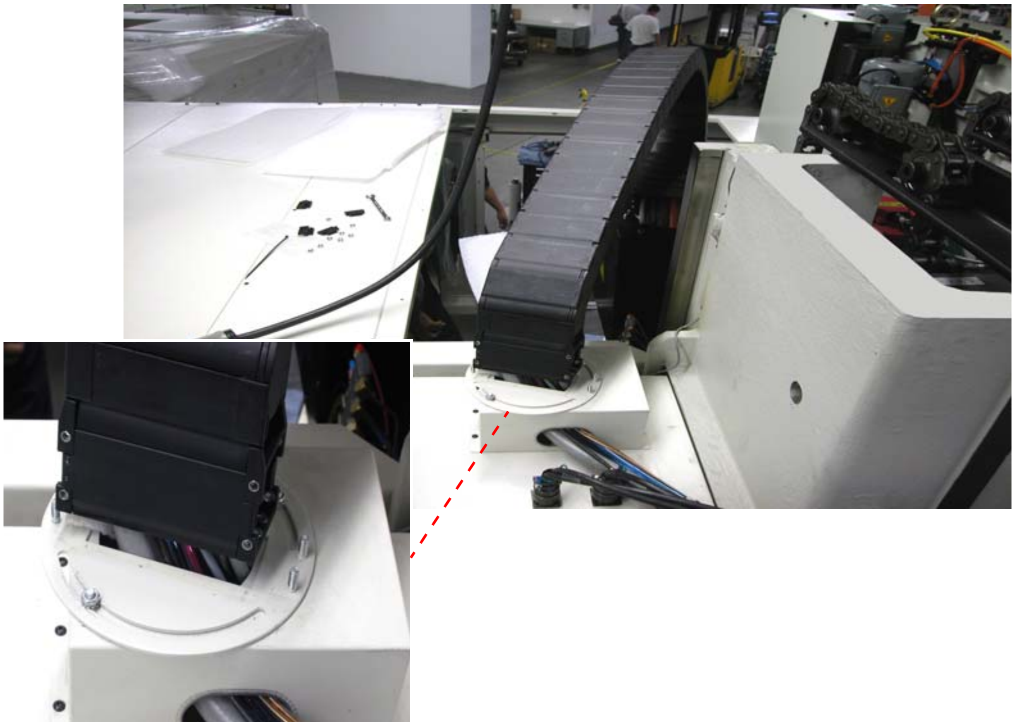


Figure 3-14: Cable carrier

3.10 CHIP CONVEYOR

3.10.1 INSTALLATION PROCEDURE

1. Place the chip conveyor in the coolant tank.
2. Measure the height to the top of the conveyor sheet metal (should be approximately the height of the coolant tank).
3. Set the machine height (the machine should be on the small leveling pads) to slightly above the height established in step 2 above.
4. Slide the coolant tank/conveyor underneath the machine.
5. Slide the coolant tank/conveyor so that conveyor is against the left side of the sheet metal *(Figure 3-15: Conveyor Against Left Side of Sheet Metal)*.

Figure 3-15 Conveyor Against Left Side of Sheet Metal

6. Slide the coolant tank/conveyor so that the face of the sheet metal coolant tank is slightly in front of the machine sheet metal. It should overlap the machine sheet metal *(Figure 3-16: Sheet Metal Coolant Tank Slightly in Front of Machine Sheet Metal).*

Figure 3-16: Place Sheet Metal Coolant Tank Slightly in Front of Machine Sheet Metal

7. Adjust the machine height (during leveling and installation) to minimize the gap (or overlap) between the coolant tank face and the machine sheet metal, *(Figure 3-17: Minimize Gap of Overlap).*

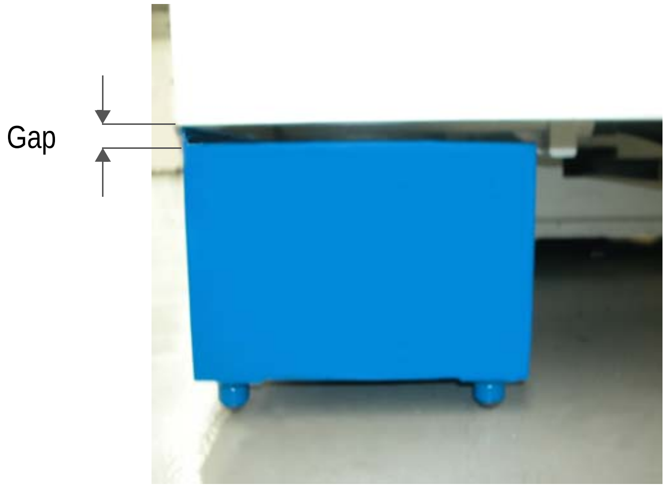


Figure 3-17: Minimize Gap or Overlap

8. Coolant, wash down and flood pumps are connected per normal installation/setup.

9. A standard 55 gallon drum can be positioned underneath the conveyor discharge to collect the chips.

3.10.2 CHIP CONVEYOR POWER AND CONTROLS

> *NOTE*
> The conveyor must be plugged into the provided outlet on the VMC which is dedicated for the chip conveyor.

1. The control has 3 operating positions:

Forward	- Controls the forward motion of the conveyor belt
Stop/Reset	- Shuts off the conveyor
Reverse	- Reverses direction of the conveyor belt (for clearing jams)

2. The control also has a variable speed control for the belt speed. The belt speed can be controlled from 2.60 ft./min. to 10.80ft/min.

Figure 3-18: Control Operating Positions

Figure 3-19: Emergency Stop (CE machines only)

4.0 MACHINE MAINTENANCE

4.1 SCHEDULED MAINTENANCE

4.1.1 MAINTENANCE & LUBRICATION SCHEDULE

Daily

1. Check air pressure: Right regulator 120 psi. max. (Tool Out Only). Left Regulator 80-90 psi.
2. Check way lube level. Use Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra #2 ONLY.
3. Check way lube system for adequate oil flow to all way surfaces.
4. With tool in spindle blow chips from around ATC and slide. NEVER blow chips from around these areas during automatic tool change or without a tool in the spindle.
5. Remove heavy chip build up from guards and way covers.
6. Wash ATC and machine work area.
7. Check coolant level.
8. Clean coolant screen.
9. Clean the area around the machine.
10. Immediately clean any spills in the area.

Weekly

1. Check spindle cooler pump and refrigeration unit for proper operation.
2. Check fluid level of chiller tank and refill, if needed, with a 50/50 mix of DOWFROST™ CLEAR and de-ionized water. If de-ionized water is not available, sodium-free distilled water can be substituted. *Do not accept any substitutes for DOWFROST™ CLEAR!*
3. Clean ATC slide.
4. Check air regulator.
5. Drain and clean water separator.
6. Fill oiler if needed.
7. Activate thru-tool coolant system for 2-3 minutes (if machine has this option).
8. Grease axis way cover using molygraph.
9. Grease retention rings using molygraph.

10. Grease Geneva wheel and gear using Kopr-Kote.
11. For high torque machines, check fluid level in the hydraulic actuator reservoir. Refill, if needed, with Mobil DTE Heavy Medium.
12. Inspect all cooling fans, clean screens if necessary.

Every 4 months

Service way lube filter. Machines with an external filter require less frequent replacement; however, do not exceed 4 months. When replacing the external filter, fill the new filter with way lube prior to installation.

4.1.2 LUBRICATION OF THE WAYS

Waylube System

Use waylube type Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #2.

The Positive Displacement Injection (PDI) lube system is a solenoid-controlled pneumatic system. When the solenoid is activated, the pump sends oil to the junction block assemblies, which may contain several different size valves, at a pressure ratio of 5:1. The pump is activated for 10 seconds, within a 4 minute cycle, during which oil is distributed to all of the valves on the junction block assemblies. When the solenoid is deactivated the oil flow stops and creates back pressure which escapes through a relief valve. When the pressure on the valve drops below 50 psi, a spring inside the valve is then able to inject oil into the lines.

The CNC has direct control of the automatic lube system. The cycle is activated by executing an axis motion in a CNC program, commanding an axis move in MDI mode or pressing the JOG key. Once activated it monitors the oil level to be sure the reservoir is above the minimum level. In addition, it shuts the oil system down if the machine sits idle longer than one cycle of the lube system.

Frequently clogging filters indicate that the wrong waylube is being used. *Use Castrol Magna BD68, Shell Tonna 68V or Mobil Vactra Oil #2 ONLY.*

Procedure for Flushing a Contaminated Waylube System

This procedure is necessary when the waylube that was being used in the machine was incorrect. Other waylubes may contain paraffin wax or silicone.

1. Replace the 10-port way lube junction block that is located at the left side of the saddle.
2. Replace the External filter on the BIJUR PDI way lube pump (Part # LUB-0049).

3. Remove the oil line that is between the way lube pump and the three port junction T that is located near the pump mount.
4. Verify that the flush pump air regulator is fully counterclockwise.
5. Attach an air line to the flush pump.

> *WARNING!*
> Verify that the air regulator is closed.

6. Insert the 3/8" hose from the flush pump into a container of grade A kerosene.
7. Slowly open the air regulator clockwise to start the flush pump.
8. Increase the air pressure being careful that the output pressure does not exceed 180 psi at the gauge.
9. The pump is 4:1 ratio, 45 psi input air pressure is 180 psi output.
10. Enter a program that will exercise all axes to their limits. Start running the program.
11. The flow of kerosene through the way lube system should be steady.
12. If the kerosene is dripping slowly down the column from underneath the Z axis head the manifold filters are probably clogged. Replace the eight-port junction block located on the Z axis head. Start over at step D.
13. Remove the 3/8” hose from the kerosene and place the hose in a can of clean fresh waylube.
14. Slowly open the regulator clockwise on the flush pump. Pump waylube through the lines until the system is well lubricated.
15. Stop the machine and return it to the COLD START position.
16. Turn the flush pump air regulator fully counterclockwise and remove the air line.
17. Remove the flush pump and reattach the oil line from the Bijur pump to the 3 port junction.

4.1.3 COOLING FANS

> *WARNING!*
> Power off the machine at the main disconnect switch and lockout/tagout the main disconnect.

There are numerous cooling fans on the VMC that require periodic inspection. Located in the CNC box and the junction box.

> *WARNING!*
> Wear safety glasses!

If the fan is turning slowly or not at all, it may require cleaning or replacement. The fan on the bottom of the junction box has a screen that requires periodic inspection and removal for cleaning.

4.1.4 SPINDLE & BALLSCREW COOLING SYSTEM

The spindle and ballscrew cooling system is made up of a motor pump assembly, ambient-liquid temperature sensor assembly and a DP5P chiller. As long as there is power to the machine the chiller pump is circulating DOWFROST™ through the system. The ambient sensor is used to measure casting/air temperature and the liquid sensor to measure Dowfrost temperature in the return line. When there is a one degree temperature differential between the two sensors the chiller is then powered on.

4.1.5 PUMP FILTER

There is a small filter and pressure gauge located on the pump head assembly. Normal pressure is 3-5 pounds, cooled ball screws are 10 to 30 pounds. If the pressure gauge shows a pressure above normal the filter should be inspected and cleaned.

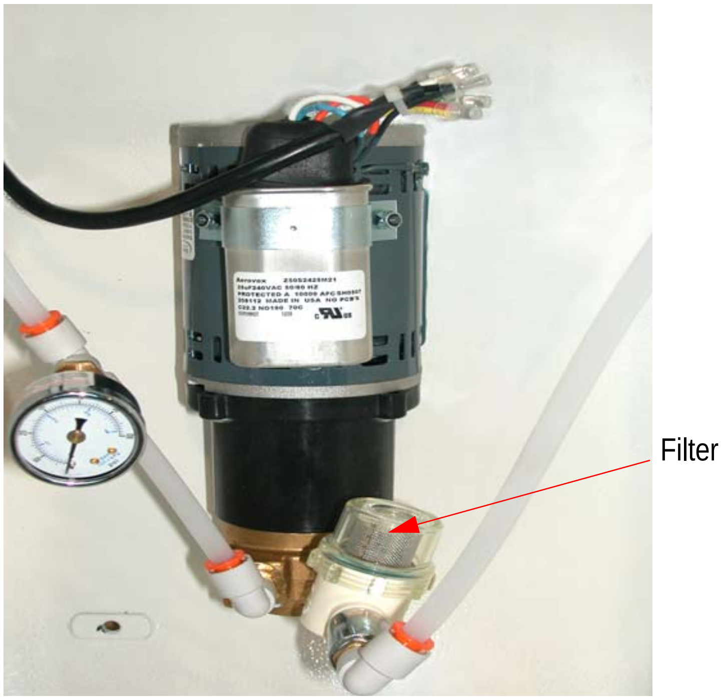


Figure 4-1 Pump Filter

4.1.6 TANK RESERVOIR

The tank reservoir is located next to the motor pump assembly in the chiller cabinet. The tank has a 2 1/2 gallon capacity. Visually check the fluid level with the machine powered on. If the fluid level is less than 1/2 of the tank, mix the DOWFROST™ to a 50:50 solution, with deionized water, or sodium free distilled water and fill to no more than 3/4 full.

Figure 4-2: Tank Reservoir

> *Source for DOWFROST™*
> *GOLDENWEST LUBRICANTS*
> *1816 POTRERO AVE.*
> *SOUTH EL MONTE, CA 91733*
> *(626) 443 - 3441*
> *(800) 540 - 5823*
> *Do not accept any substitutes for DOWFROST™!*

Pressure

The cooling system should maintain a constant pressure of 3 to 5 psi on machines with 400 I.P.M. rapid or 10 to 30 psi with 900 I.P.M. rapid.

If the pressure rises, the following conditions may exist:

- clogged pump filter;
- pinched oil lines;
- clogged cross tubes (only on 900 I.P.M. machines equipped with cooled ball screws (8030, 6030, with cool Y ball screw)).

If the machine is losing pressure and the DOWFROST™ level keeps dropping, the following conditions may exist:

- the O-ring that seals the ballscrew cross tubes is leaking;
- there is a hole in one of the lines.

4.1.7 FLUIDS

Table 4-1: Fluids

RESERVOIR	FILL WITH
Waylube	CASTROL MAGNA BD68 SHELL TONNA 68V or MOBIL VACTRA #2
Spindle Cooling System	DOWFROST™ CLEAR (Mixed 50/50 with de-ionized water or sodium free distilled water)
Rotary Tables	MOBIL GEAR 626
Hydraulic Hi/Low	MOBIL DTE HEAVY MEDIUM
Hydraulic Brake	HYDRAULIC OIL 32
Spindle Oil (air/oil)	UNI-LUBE 32

4.1.8 DUAL ARM TOOL CHANGER

The causes of abnormal wear and fractures will be apparent when the tool changer is used without lubricant. It is very important to grease all moving parts of the tool changer at least once a week.

Lubricant

The lubricant should be changed annually, or when it has become visibly deteriorated. The recommended lubricant is SAE 90-140. The DATC uses approximately 5 liters of lubricant (1.3 gallons).

Grease

Grease should be spread once a week in the following locations:

1. The claws of the tool changing arm unit.
2. The tip of the release pin of the tool changing arm unit.

Cleaning

1. Remove the chip powder from around the proximity switch inducing box.
2. Remove the chip powder from around the inverted moving body of the tool pot.
3. The tool changing mechanism must be cleaned frequently to prevent excess build up of chip powder.

Inspection

Check the parts of the tool falling mechanism regularly and, check for grease on the sliding base of the tool falling mechanism and the sliding base of the pull rod. Check the parts of the tool pots and tool discs for tightness and overall condition.

4.1.9 SCHEDULED MAINTENANCE FOR DUAL ARM TOOL CHANGER

The maintenance schedule is based on machine usage of eight hours a day, five days a week.

Daily Maintenance

Perform the following daily:

1. Cleaning
   a. Remove the chips and debris surrounding the proximity switch inducing block.
   b. Remove the chips and debris that have accumulated on the inverted moving body of the tool pot.
   c. Clear the tool changing mechanism of all debris before any operation.

2. Inspection:

    a. Check the parts of the tool falling mechanism for damage and wear. Add grease to the sliding base of the tool falling mechanism and the pull rod.
    b. Check the parts of the tool pots, tool discs, and snap rings for damage and tightness.

Grease Maintenance

1. Perform the following weekly:

    a. Grease the claws of the tool changing arm unit.
    b. Grease the tip of the release pin of the tool changing unit.

2. Check and replenish the following parts with grease every six months:

SECTION	PARTS NAME
Too magazine	Driving roller
Index mechanism	Cylindrical cam
Tool pot	Roller wheel
Tool arm	Plunger
	Tool holding rod

Lubricant Maintenance

The lubricant inside the lubricant container of tool changing mechanism should be changed after working for 2400 hours. When the cam, rollers and bevel gear are in use without lubricant abnormal wear and fractures will occur. Appropriate quantity of lubricant should be a little more than half of the lubricant container.

Change the lubricant annually or as needed. The recommended lubricant is SAE 90-140. The Dual Arm Tool Changer uses approximately:

40T fill oil to the middle line of oil glass about 6L (1.5 gallons)
50T fill oil to the middle line of oil glass about 10L (2.5 gallons).

4.2 TESTS FOR CE SAFEGUARDS ON FADAL MACHINES

These tests should be done when machine is first installed and after servicing when any components are replaced.

1. Power on machine but do reference.

Start spindle. (Press Shift-Spindle on)

- Spindle will not start OR
- Press Emergency Stop; spindle must stop.
- Immediately release Emergency Stop; spindle does not start.

2. Reference machine.

Start spindle.

- Press Emergency Stop; spindle must stop.
- Immediately release Emergency Stop; spindle shall not start, VMC remains in emergency stop.
- Repeat test in Auto, MDI, and Jog modes.

3. Start spindle. (Press Shift-Spindle on)

- Open front door; spindle must stop.
- Try to restart spindle; spindle does not start with doors open.
- Check contactor for spindle; contacts should be out. (There may be a 5 to 10 second delay between the opening of the door and the release of the contactor. This allows a controlled stop).

4. Close doors.

- Repeat test with left side panel.
- Repeat test with right side panel.

Daily & Weekly Safety Tests for CE Safety Circuits

To ensure proper functioning of safety circuits, the following tests should be performed on a regular basis.

Daily

Front Door Lock Daily Test for 2030-OA

1. Close all doors. Make sure machine is not in emergency stop.
2. Open front door. You may be able to hear the spindle contactor open, if not a second person will be needed to watch the contactor.
3. Close front door. You may be able to hear the contactor close, if not see 2 above.
4. Start spindle. Attempt to open front door. Front door should be locked.
5. Stop spindle. There should be a delay of 1 to 5 seconds after the spindle comes to a complete stop before the door unlocks. (This delay can be adjusted from 1 to 5 seconds.)
6. In either automatic or manual mode command a tool change. Attempt to open the door. Front door should be locked while turret is moving toward spindle or while dual arm tool changer arm is in motion.

Dual Arm Tool Changer Daily Test

No daily test.

4.3 CHIP CONVEYOR

4.3.1 MAINTENANCE SCHEDULE CHIP CONVEYOR

Please carry out daily, monthly, and yearly inspection according to the following directions.

Daily Inspection

1. Always keep oil in the speed reducer at the specified oil level.
2. Check motor for abnormal operation, i.e. noise, heat excessive current, etc.
3. Lubricate conveyor chain and roller chain every 150 hours.
4. Discard chips on the surface of the belt and inside of frame (place a rag on the belt and reverse until the rag is discarded).

Monthly Inspection

1. Change oil at 100 hours initially, every 1,500 to 2,000 hours thereafter.
2. Check motor for abnormal operation, i.e. noise, heat excessive current, etc.
3. Keep correct tension of conveyor chain by adjusting take-up bearing.
4. Check roller chain between motor and conveyor for proper alignment and correct tension.
5. The greatest care should be exercised to keep friction surface of torque limiter free from oil when lubricating roller chain.
6. Lubricate conveyor chain and roller chain every 150 hours.

Yearly Inspection

1. Carry out all monthly inspection items.
2. Pull out belt and clean inside of frame.
3. Check for worn out parts inside of frame and belt assembly and replace with new if necessary.
4. Check bolts for looseness.
5. Check friction disk for abrasion, and replace if necessary.

1. At the initial running, confirm the following before turning power on.
   a. Inspect for and remove any article other than material (chip, etc.) to be transported on conveyor link belt portion.

> *WARNING!*
> Make sure hands, feet and clothing are clear of all moving parts.

2. Confirm the direction of rotation by turning switch on for about two seconds.
   a. If motor rotates in reverse, correct electrical connection.
3. Run conveyor continuously while machine tool is exhausting chips.

4.3.2 STOPPING THE CHIP CONVEYOR ON US AND CE MACHINES

On US machines, hitting the VMC Emergency Stop will stop all machine operations including the chip conveyor.

On CE machines, hitting the VMC Emergency Stop, opening the front door, or switching off an Estop switch at the conveyor chute will stop the chip conveyor.

> *NOTE*
> The Estop switch at the chute stops only the conveyor; it has no effect on the VMC.

4.3.3 RESTARTING THE CHIP CONVEYOR

When the chip conveyor is stopped, it must be restarted at the chip conveyor control by switching it off, and then on again. Closing the front doors on a CE machine or resetting the Estop switch will not restart the chip conveyor.

4.3.4 OBSERVANCE AND INSPECTION

1. Maintain oil level in the speed reducer at specified level; check at least once a year.
2. Keep correct tension of conveyor chain by adjusting take-up bearing. (Obtain equal tension on both right and left hand conveyor chains by adjusting screw.)

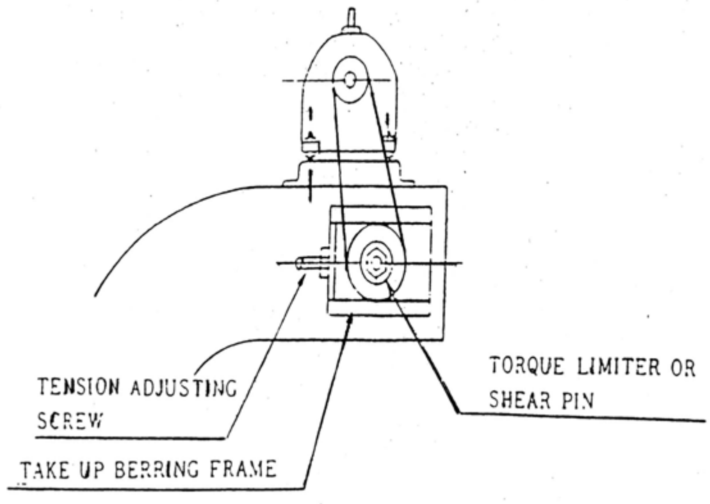


Figure 4-3: Adjust Take-Up Bearing

3. Check roller chain between motor and conveyor for proper alignment and correct tension.

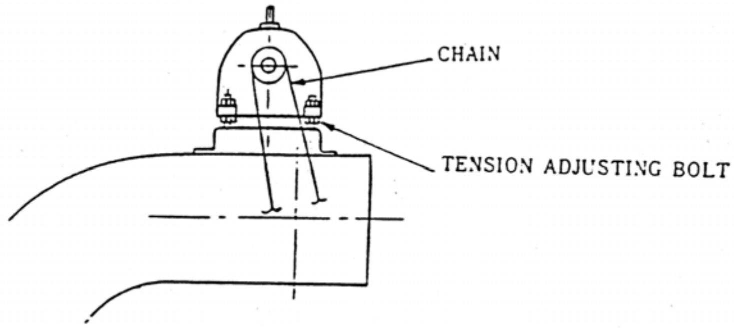


Figure 4-4: Check Roller Chain

4. The greatest care should be exercised to keep friction surface of torque limiter free from oil when lubricating roller chain.

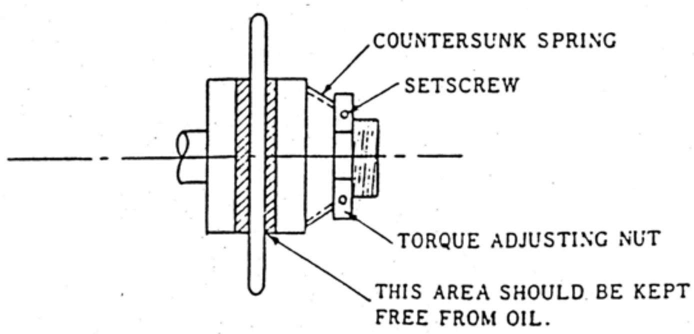


Figure 4-5: Torque Limiter

5. Lubricate conveyor chain and roller chain every 150 Hours.

5.0 GENERAL INFORMATION

5.1 HELPFUL FORMULAS

5.1.1 TEMPERATURE

Degrees Fahrenheit (F) = (9/5 x degrees C) + 32

Degrees Celsius (C) = 5/9 x (degrees F-32)

5.1.2 CONVERSION FACTORS

Inch (in) = millimeter x 0.03937

Inch (in) = centimeter x 0.3937

Millimeter (mm) = inch x 25.4

Centimeter (cm) = inch x 2.54

Liter = gallon (U.S.) x 3.7854

Gallon (U.S.) = liter x 0.2642

Bar = Pounds per Square Inch (psi) x 0.0689

Pounds per Square Inch (psi) = Bar x 14.5

Newton-metre (N/m) = pound/foot x 14.5939

Pound/foot = Newton-metre (N/m) x 0.0685

Newton-metre (N/m) = ounce-inch x 0.00706

Ounce-inch = newton-metre (N/m) x 0.1416

5.1.3 ELECTRICAL REFERENCES

Formulas from Ohm’s Law

Amperes (I) = Volts (E) / Resistance (R)

Resistance (R) = Volts (E) / Amperes (I)

Volts (E) = Amperes (I) x Resistance (R)

Single-Phase

Kilovolt-Amperes (KVA) = (Volts x Amperes) / 1000

Three-Phase

Kilovolt-Amperes (KVA) = (Volts x Amperes x 1.73) / 1000

5.1.4 EXPANSION COEFFICIENTS

Formula

Expansion amount =

Coefficient x distance x degree of temperature change (Fahrenheit)

Coefficients

Steel	=	.00000633
Cast Iron	=	.00000655
Aluminum	=	.00001244
pathname	=	C:\CNCDATA\
filename	=	PN1234.NC
>	=	> (the > is required DOS syntax to redirect file to COM2)
port	=	COM2

> *NOTE*
> Before typing these two lines, the VMC should be in the TA,1 mode ready to receive the program at 2400 baud.
> Refer to the DOS manual for answers to additional questions about the DOS commands used here.
> Running DOS-based software from Windows may not work for communications.

5.2 THERMAL EXPANSION

5.2.1 OVERVIEW

Thermal expansion is a natural occurrence in materials subject to heat, and there are several sources of heat in any machining operation. In addition, different materials react to heat at different rates, and different subsystems of the VMC react to specific machining operations to different degrees, further complicating matters. Finally, some machining practices designed to save time may actually aggravate the expansion problem. Fortunately, there are a number of ways in which the unwanted effects of thermal expansion can be reduced to acceptable tolerances.

5.2.2 RECOGNIZING THERMAL EXPANSION

Changes in positioning can have many causes, and correctly identifying the cause is the key to solving the problem. Thermal expansion has a unique 'signature' which can aid in recognizing it as the culprit in a given situation. Position changes that are due to thermal expansion occur gradually over time, and continue to move in one general direction at a more or less constant rate. The best way to combat thermal expansion is to accept the inherent nature of it in a machining operation, and to take corrective measures, like those suggested in this document, ahead of time.

5.2.3 ACCURACY AND REPEATABILITY

It should be noted that when accuracy and repeatability are quoted for a machine, thermal expansion is not considered. These values are measured and recorded only when the machine and all of its components are thermally stable, usually by limiting test repetitions and time duration so that thermal growth does not have a chance to come into play. For example, a typical industry test for linear repeatability involves only seven to ten moves away from and back to a position.

5.2.4 EXPANSION COEFFICIENTS

The rate of expansion of any particular material, due to temperature, can be measured. This rate of expansion is referred to as the expansion coefficient, and is measured per degree per inch. Using this rate of expansion, and the temperature of the material, the effects from heat can be predicted.

Table 12-1: Expansion Coefficients for Specified Materials

MATERIAL	LOCATION / USAGE	EXPANSION COEFFICIENT
Steel	Ball Screws, Spindle, Fixtures, Sub Plates, Tooling, part stock	.00000633
Cast Iron	Head, Table, Column, Glass Scales, part stock	.00000655
Aluminium	Fixtures, Sub Plates, part stock	.00001244

Formula: coefficient * distance * degrees of temperature change = expansion amount

For example, if a nut is 23 inches from the motor mount and the temperature of the screw has changed 20 degrees, the screw length would have expanded .0029118 inches (.00000633*23*20 = .0029118).

5.2.5 HEAT SOURCES

It comes as no surprise that the primary source of heat in machining is friction; however, some of the sources of friction, and all of the areas affected by a given friction source, may not be readily apparent. Additionally, the effects on the ambient temperature from various heat sources in the machine shop are often overlooked.

5.2.6 FRICTION

The most obvious heat source from friction is the cutting of material itself. Heat is transferred to the chips, which then can transfer their heat to the table. Heat is also transferred to the tool, and then to the spindle, and then to the head. Finally, heat is transferred to the part material itself, and from there to any fixture or sub plate holding the blank.

Movement of the table, and of the head, also generates heat from the friction. The ball screws turning produces friction between the nut and the screw, heating the screw and causing expansion, with the Y axis of the machine experiencing more thermal expansion than the X axis because the Y axis is moving more weight than the X axis. The movement of the table on the ways produces friction which can increase the expansion of the ball screws.

5.2.7 AMBIENT TEMPERATURE

The general temperature of the shop environment will affect the machining process, but the most significant effect will be seen when temperature differences are created. Sunlight on a VMC will cause the side of the machine in the sun to expand at a different rate than the side in the shade. Radiant heat sources, such as ovens or hydraulic pumps, will heat the side of the VMC closest to them significantly more than the side furthest from the radiant heat source, causing uneven expansion. Cooling vents without diffusion gratings can blow cooler air onto one area of the VMC than another area, once again causing uneven expansion.

The goal is to surround everything with an even temperature. A shop at 90 degrees will experience more thermal expansion than a shop at 70 degrees, but a shop at 70 degrees with an air conditioning vent blowing directly on the VMC will experience more problems with uneven thermal expansion.

5.2.8 MACHINING PRACTICES

There are a few machining practices that can aggravate thermal expansion, or its perceived effects, and deserve special mention. One is the use of rapid moves in a CNC program, which can vastly increase the friction, and therefore the thermal expansion, on the ball screws. The obvious drawback of reducing rapid moves is a slower production rate, however, this may be compensated for by increased accuracy and reduced scrap rates.

Another practice is using ceramic (or other) cutters without coolant and allowing the chips to sit on the table. The chips absorb the majority of the heat from the cutting process, and then transfer this heat to the table, causing the table to expand independently from any other part of the VMC.

A third practice is the use of cutting oil in place of water-soluble coolant. Although cutting oil does reduce friction at the surface of the cut, coolant does a much better job of carrying away the heat of the cut and minimizing the effects of thermal expansion resulting from that heat.

Yet another practice that deserves mentioning is machining parts at temperatures significantly different from those at which the parts are inspected. If the inherent expansion of the part material from the heat of the machining process is outside tolerance once the part has cooled to inspection temperatures, the problem can only be resolved by correcting for the heat generated during machining so as to keep the part material closer to inspection temperatures while the part is being machined. Along those same lines, it is important to use a gauge at approximately the same temperature as the temperature at which the gauge was calibrated.

Finally, the use of blanks for which the outside dimensions have been established prior to cutting is another practice which aggravates the effects of thermal expansion. Since the blank is going to expand locally from the heat of cutting, the actual distance from edge to feature may change.

5.3 NON-UNIFORM EXPANSION

5.3.1 MATERIAL DIFFERENCES

The differing rates of expansion by unlike materials further complicate the problems created by the heat generated in the machining process. This applies both to parts stock, like aluminum, and to fixtures and sub plates, often also made of a material like aluminum. Aluminum's coefficient of expansion is nearly twice that of steel or cast iron (the primary VMC materials), which means the aluminum will expand nearly twice as much as the ball screws, head, spindle, or table.

5.3.2 FIXTURES / SUB PLATES

Fixtures or sub plates of material other than the steel/cast iron of the VMC will cause the greatest problems in this area, unless the bottom of the fixture or sub plate is flat within .001° (please note that "parallel" is not the same as "flat", and flatness is the key in this area). For example, a sub plate made of aluminum has an expansion coefficient nearly double that of the table to which it is secured. If the flatness is not within. 001", the heat of the machining process causing the sub plate to expand at twice the rate of the table will result in the sub plate actually bending the VMC's table. This will cause binding which will both affect position accuracy and cause undue wear on the mating surfaces under the table.

5.3.3 MACHINE ASSEMBLIES

Various assemblies of the VMC itself will be affected by different sources of heat in the machining process, and the effect of each assembly on positioning will vary accordingly.

For instance, the head will expand from two heat sources, the spindle heat and the ambient temperature. The effects of thermal expansion in the head will be seen in the directions of the Y axis and the Z axis, but not in the X axis, with the Y axis expanding away from the column (toward the operator) and the Z axis expanding down toward the table. Meanwhile, the Y axis itself will be expanding away from the column due to the expansion of the ball screw, which will compensate for the effect of the head's expansion in the same direction.

The ball screws will expand due to the friction of the nut. The effect will

increase with the distance of the nut from the motor mounts (the effective length of the screw), and will be in the direction away from the motor mounts. Thermal growth of the ball screws is independent of growth in the head or the table.

The spindle experiences heat not only from the actual cutting, which is transferred through the tool, but also from its bearings. The spindle also transfers most of this heat to the head, and the thermal growth is reflected in the head position, as mentioned above, and is independent of changes in the ball screws or table.

The table receives most of its heat secondhand, through the heat of the nut, the heat from the part (through the fixture or sub plate), and the heat carried by hot chips that lay on the table. Because of its large size, the table seems less affected by the heat of machining. It will expand, but it takes longer to heat or cool the entire table. In addition, the use of coolant tends to stabilize the temperature of the table at or close to coolant temperature.

A machining operation using rapid moves and low spindle speeds, with additional cooling at the part through FADAL's servo coolant subsystem, will generate much more thermal expansion in the ball screws, and hence the X axis and Y axis, than will be seen in the Z axis from the spindle or in the part material from the cutting. An operation using very high RPM spindle speeds with slower interpolated moves would experience more Z axis expansion, but would experience less expansion in the X axis and Y axis, and might actually experience less expansion in the part material because the high rate of chip removal carries much of the heat away from the part.

Each machining operation has a unique combination of factors that apply to predicting and managing the thermal expansion inherent in machining. Finding the right solution is a matter of combining various approaches, many of which are outlined in the pages that follow.

5.4 SOLVING THE THERMAL EXPANSION PROBLEM

5.4.1 GENERAL CONSIDERATIONS

A simplified description of the thermal environment in machining would state that heat is generated through friction, and also input through ambient factors. That heat is transferred among the system components, and is either removed from the system through radiation, convection and evaporation, or absorbed by the components of the system (part, fixture, VMC).

In its simplest form, any solution designed to combat thermal expansion must reduce friction, reduce ambient influences, or increase heat removal through radiation, convection or evaporation. A complementary approach is to simply compensate for the changes brought on by thermal expansion. In a real life situation, a balance of approaches is required.

5.4.2 AMBIENT SOURCES

Sunlight

Do not allow direct sunlight on the VMC. Window shades that diffuse sunlight can be acceptable, but any source of warmth that only heats one side of the VMC at a time will cause uneven warming and further complicate thermal considerations.

Cooling Systems

Diffusion gratings on air conditioning vents can be used to prevent any air from directly blowing on the machine or part. Again, an unevenly heated part or machine will cause the heated, or cooled, portion of the part or machine to expand at rates different from the rest of the part or machine.

Radiant Heat

If an operator can detect the radiant heat from other devices, a protective wall needs to be erected between the machine and the device radiating the heat. This type of heat source will cause the machine to heat up on one side and cause uneven expansion.

5.5 READING STATUS GROUP

Reading a status in a computer can be very helpful for troubleshooting. Status is usually a byte or a word. The status is normally represented in hexadecimal. To demonstrate how a status byte is decoded, the command 1 byte in the diagnostics – display switches will be used. Each binary bit in the status byte will represent one relay in this case. Because Fadal uses negative logic, a value of zero (0) turns the relay on (activates it). B0 is the right-most bit. Each Hexadecimal digit is representing four (4) binary bits.

B0 = M68/M69

B1 = High range Idler

B2 = Unused

B3 = Drawbar / Geneva / Slide Enable

B4 = Drawbar

B5 = Air indexer

B6 = Coolant 1 On

B7 = Coolant 2 On

For example if the command 1 displayed “BD” then the binary equivalent would be “1 0 1 1 1 1 0 1”. To decode remember that “0” is On. In this example, B1 the high range idler would be On and Coolant 1 would be On.

5.6 VMC MAINTENANCE

5.6.1 CABINET FANS

The fans in the cabinets must be functioning properly. The purpose of the fans in the cabinets is to cool the electronics and to move the heat out the vents. An excessive amount of heat in the cabinets, from clogged holes or nonfunctional fans, will transfer to the column and cause it to expand, as well as damaging the electronics. On a regular basis, remove and clean the vent hole grates, as the vents occasionally become clogged with dust or other particles, and inspect the fans to see that they are working.

5.6.2 LUBRICATION

Lubrication is essential for the free motion of the table, saddle, and head, as well as for the nut on each ball screw. Each way must be lubricated, and the ball screws greased, to minimize both the wear on the machine and the excess heat generated by friction. The lubrication system must be inspected and serviced regularly. Inspect all of the ways to confirm that each way is getting lubricated. The lubrication system may need to be flushed by a qualified service person to remove any contaminants on the inside of the tubes and joints.

5.6.3 MACHINING PRACTICES

Warm Up

The first step in combating thermal expansion effects is also the simplest. Run the machine through a series of moves, at feeds and speeds equivalent to what will be encountered in the production run, long enough to reach an equilibrium; that is, where the amount of heat being generated is balanced by the amount of heat being removed (via convection, evaporation, or absorption through expansion of material). After that point is reached, the effect of thermal expansion in the VMC stabilizes, and the only corrections needed are for the expansion of the part material as each successive part feature is machined.

Locate fixture offsets and establish tool length offsets after the machine has attained the optimum operating temperature. Avoid using moves or spindle speeds that exceed those used in the part program.

In addition to running a warm up routine at the beginning of the production shift, the same kind of routine can be run during breaks. This will maintain the VMC at operating temperature, especially the two subsystems that heat up or cool down the most (the spindle and the ball screws).

Rough Cut / Cool Down / Finish Cut

A complement to the warm up of the VMC is the use of a rough cut to remove most of the material from the part. Although the part material heats up, the material can then be cooled to a stable temperature. Then, a series of finish cuts can complete the part in a short time, so that the material doesn't have time to expand beyond acceptable tolerance.

This process is also effective for inspecting parts. By cooling the part prior to the finish cuts, the temperatures at final cut and at inspection can be brought closer. In this situation, the target temperature should also be close to the temperature at which the gauge is calibrated.

Monitoring Position Changes

The home position of the part will change as the temperature of the screws change. The operator can follow the home position changes throughout the production run and change the fixture home position and offsets accordingly.

Coolant

Using soluble and synthetic coolants that are mixed with water is the single most effective factor in removing the heat generated during cutting. Coolant is formulated specifically to absorb a great deal of heat within its molecular structure without having to radiate that heat onto the next material it contacts. Cutting oils are formulated for cutting, and lack the cooling quality of soluble and synthetic coolants mixed with water. Flood coolant is a better choice than either mist coolant or cutting oils because it benefits the cutting process in addition to providing heat removal.

The temperature of the coolant can be conditioned further through any of a few simple actions. Bags of ice floating in the coolant tank can be used to maintain the temperature. Pumping the coolant through a radiator, or through a copper coil in the coolant tank, or through a copper coil placed in a small refrigerator can all be used to condition the temperature of the coolant.

One side benefit of coolant is its cooling effect on the table as well as the part. As it is splashed around, the coolant's direct contact and its evaporation tends to keep the table at or near the temperature of the coolant, directly compensating for the effect of hot chips falling on the table. If the coolant temperature is being conditioned through some of the steps just mentioned, the thermal stability of the table benefits even more.

Cooled Ballscrews and Spindle

The only effective way to greatly reduce the thermal expansion of the ball screws is to provide coolant through the center of the screws. Building on the Coolant Through Spindle concept, machines equipped with this feature pump a fluid through the screws and the spindle. A refrigeration unit, coupled to a thermostat, is used to control the temperature of the fluid, which consequently conditions the temperature of the screws and spindle as the fluid flows through them.

5.6.4 VMC OPTIONS

There are options that can be added to a standard VMC to help manage the thermal expansion problems.

Probe

A probe in the spindle can be used as a part of the program to discover what adjustments are required to compensate for thermal expansion. The probe can be used to pick up the new home position at the beginning of each program, or even at various times within the program. A probe can quantify the rate of expansion in the Z axis and a change can then be made to the tool table. The probe can also track the Y axis and X axis growth and, by using a macro, the fixture offsets can be altered without operator intervention. Because the amount of expansion differs depending on where the fixture is located on the table, each fixture should be relocated with the probe. A consideration when using a probe is that if a chip is in the spindle or on the probe's holder the probe will indicate an incorrect position.

Coolant ThruSpindle

FADAL's Coolant ThruSpindle option is designed to work in conjunction with specific tooling (with a hole in the center) to allow coolant to be pumped deep into the part, where normally coolant does not reach. This significantly improves the rate at which heat is removed from the area of the cut, reducing the expansion of the part material. In addition, there is less heat to be transferred through the tool to the spindle and the head, so expansion of the spindle and the head is also significantly reduced, improving Z axis positioning and accuracy.

Auto-Aim Servo Coolant

Auto-Aim Servo Coolant is an automatic positioning coolant nozzle system. A closed loop servo motor automates the coolant stream. Servo Coolant memorizes where coolant is aimed on each tool adjusting the nozzle position automatically while the machine is running. The system consists of a nozzle assembly with closed loop servo motor, a control unit, a remote adjustment knob, cabling, and mounting hardware. The nozzle assembly is fastened to the machine’s head, oriented so the coolant stream is aligned to the spindle centerline. Servo Coolant runs off the machines coolant pump.

The nozzle position is set, or taught, for each tool by turning the adjustment knob to precisely aim the coolant stream. This is done once for each tool in the machine. From that point on, coolant adjustment is automatic. There are no M-codes to write into your program, and adjustments can be made and rememorized at any time during the machining cycle.

5.6.5 CONCLUSION

Thermal expansion is a natural occurrence in any machining operation, and, when ignored, can significantly impact positioning repeatability. By identifying and eliminating unwanted heat sources, by calculating or measuring expansion effects and altering positioning accordingly, by performing regular maintenance on the VMC, and by adopting the machining practices outlined above, the effects of thermal expansion can be reduced. For higher accuracy requirements, several options can be added to a standard VMC to further reduce expansion effects. Thermal expansion itself is unavoidable, but its undesirable effects can be eliminated.

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