

GE FANUC 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

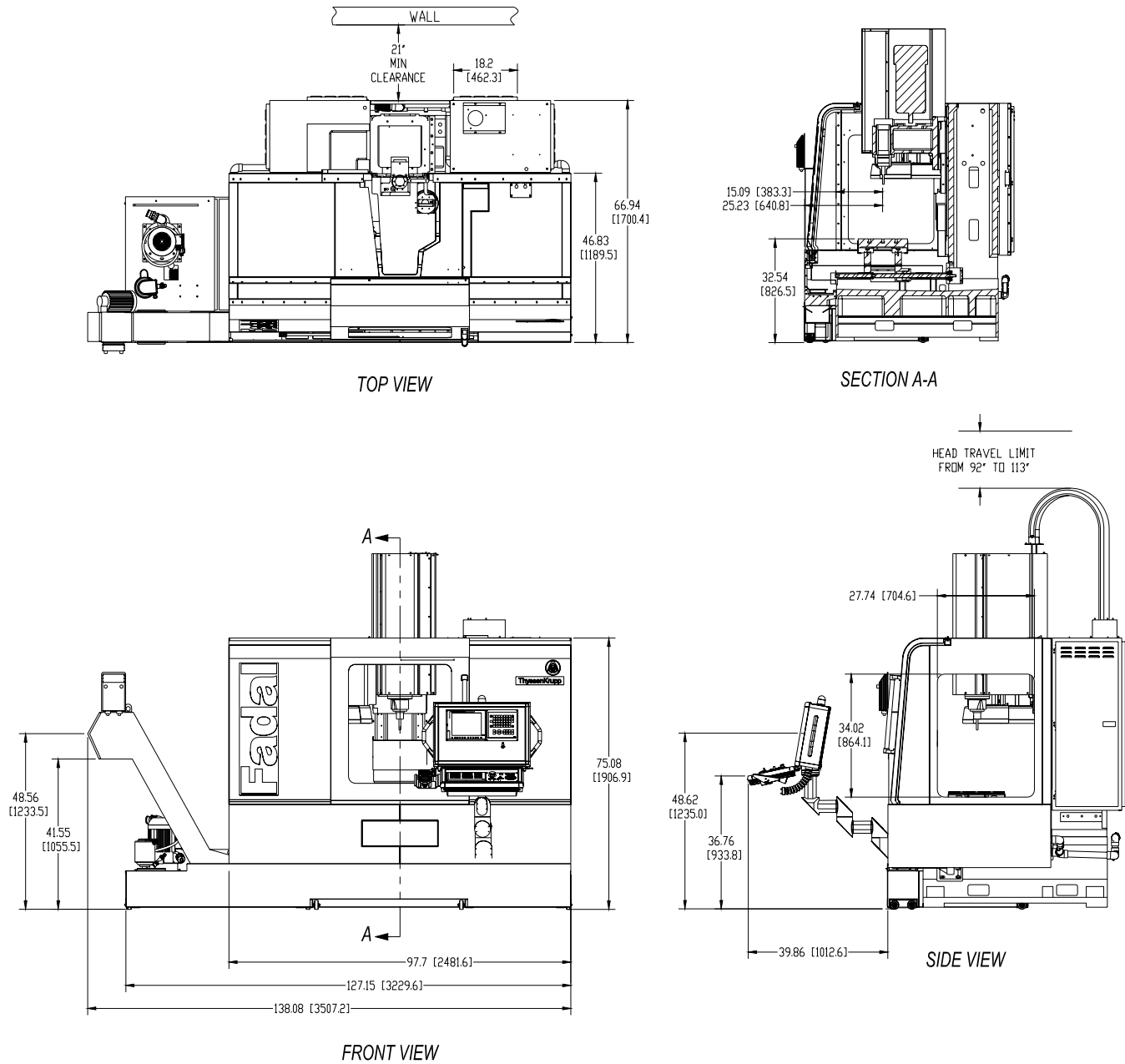


Figure 1-1: VMC 2216



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 .562" x 4.33"	3 x 14 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	
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)	40/45 amps, 230 VAC	
Single Phase (Optional)	60 amps, 230 VAC	
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

1.1.2 VMC 3016

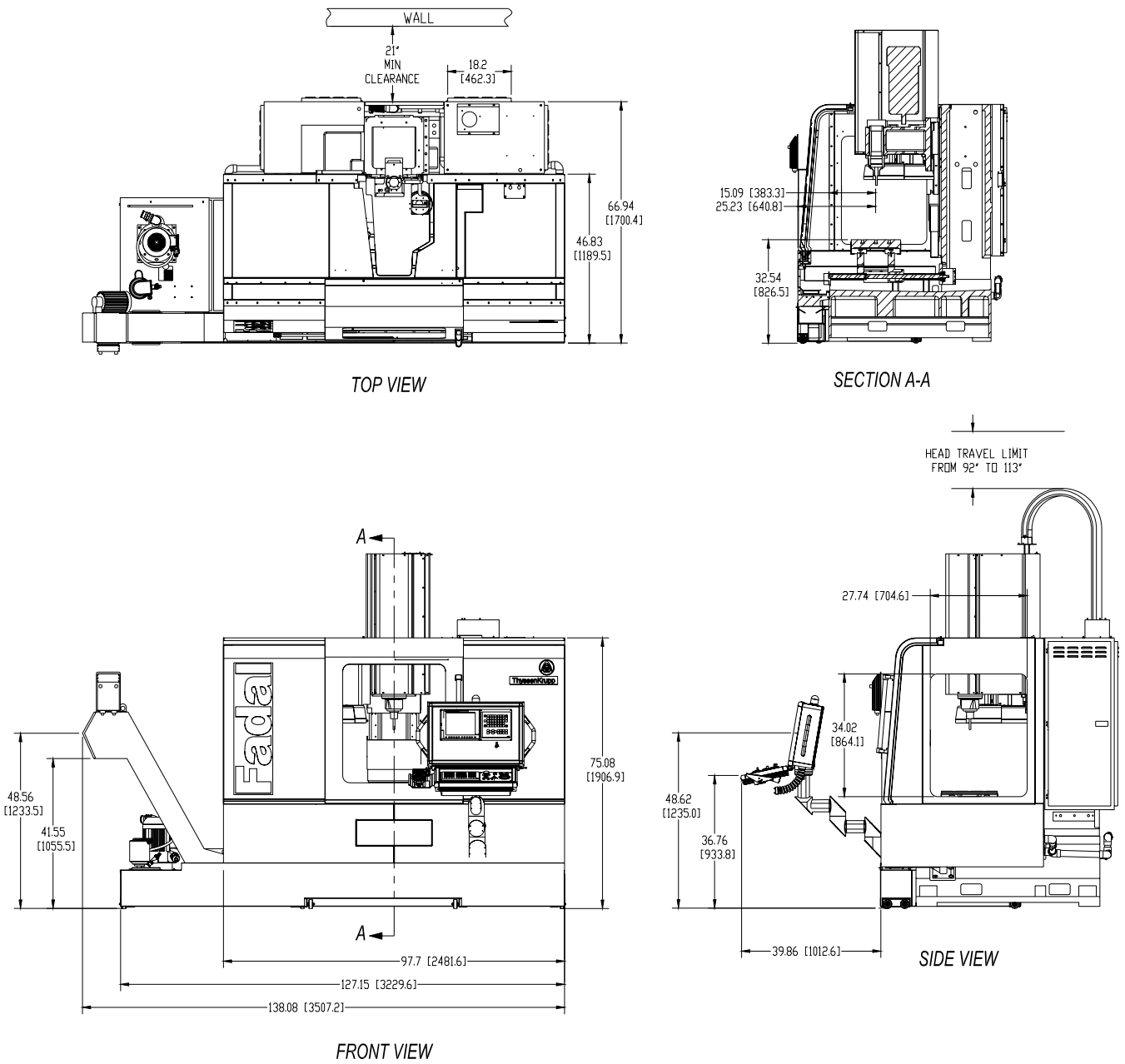


Figure 1-2: VMC 3016



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 .562" x 4.33"	3 x 14 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)	40/45 amps, 230 VAC (20/25 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

1.1.3 VMC 4020

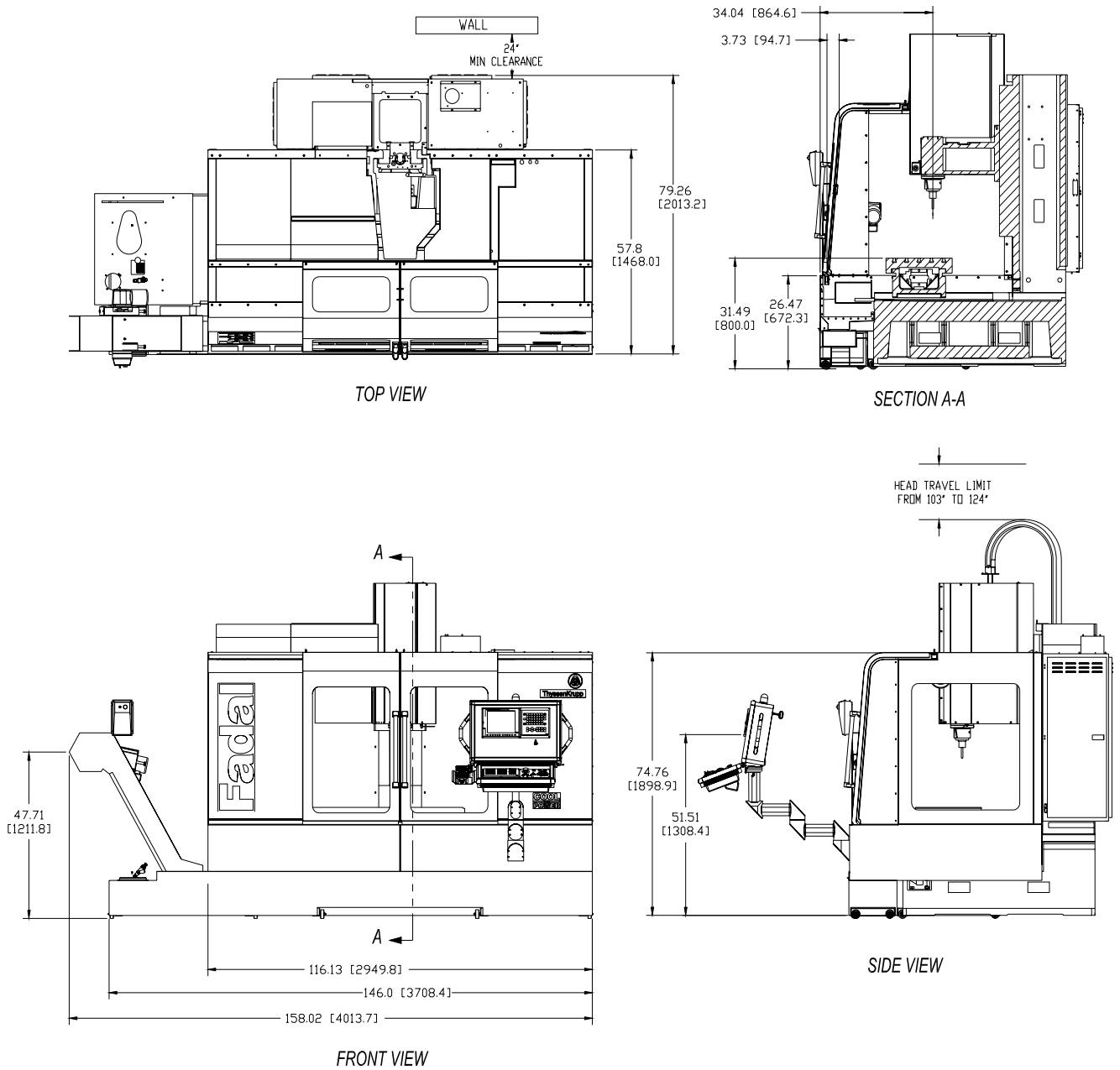


Figure 1-3: VMC 4020



NOTE

Dimensions represented in inches and [millimeters].
 Optional Very High Torque Motor 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56, Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

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 .687" x 3.75"	5 x 17.5 mm x 95.3 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	
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.)	
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)	40/45 amps, 230 VAC (20/25 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

1.1.4 VMC 6030

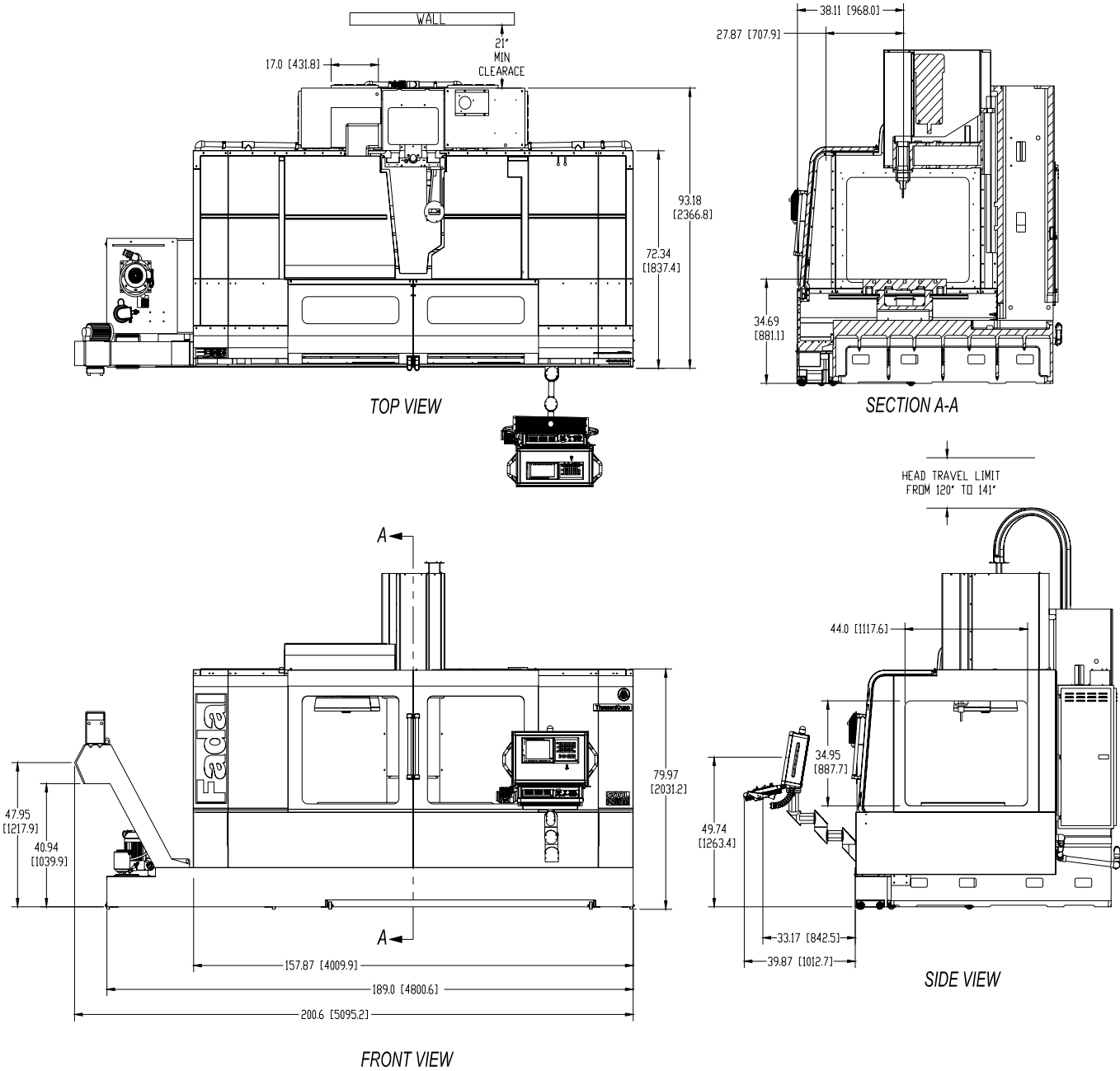


Figure 1-4: VMC 6030



NOTE

Dimensions represented in inches & [millimeters].

Optional Very High Torque Motor 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

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 .687" x 5.5"	5 x 17.5 mm x 139.7 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	
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.)	
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)	40/45, 230 VAC (20/25, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

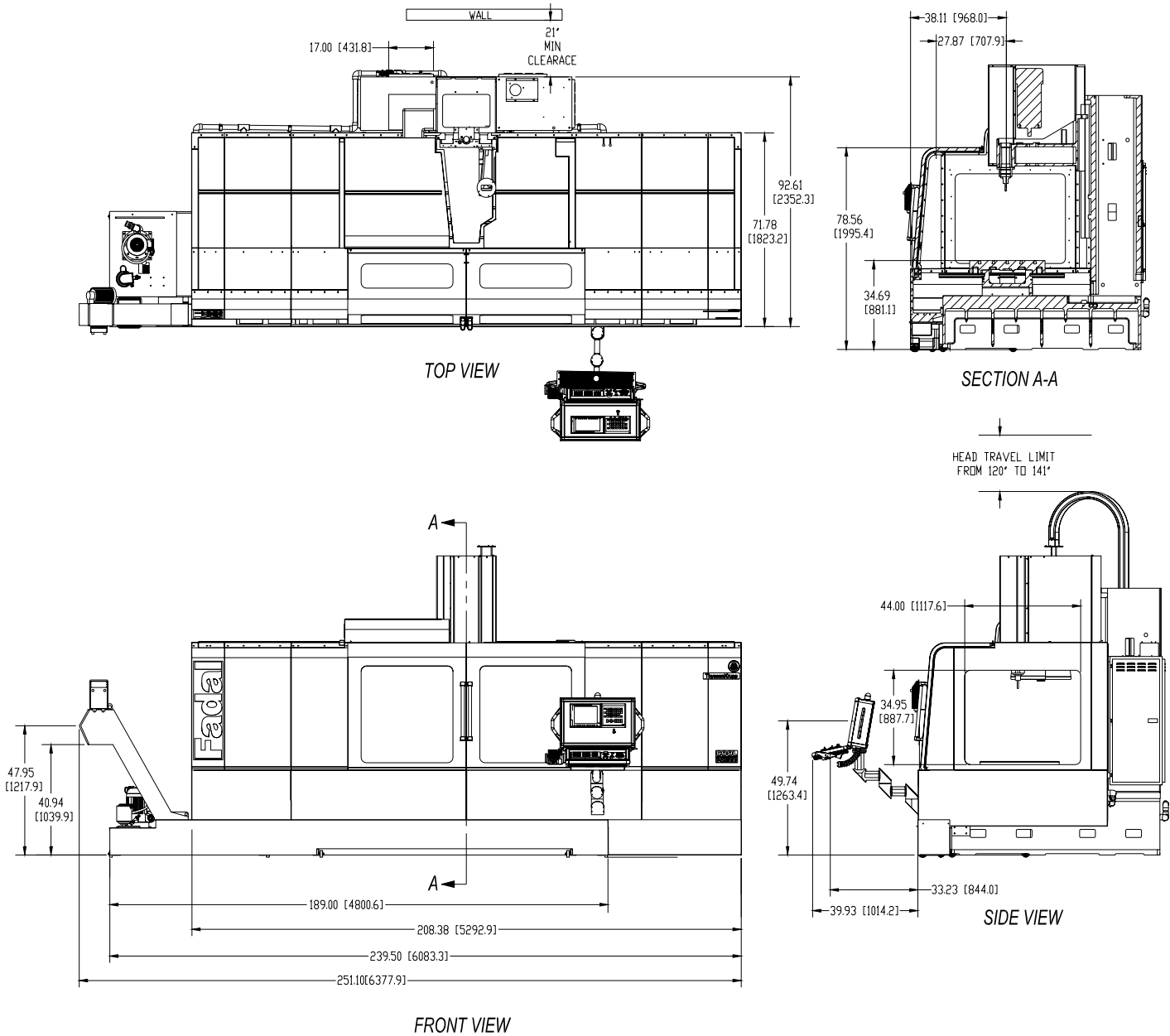


Figure 1-5: VMC 8030



NOTE

Dimensions represented in inches & [millimeters].

Optional Very High Torque Motor 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

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 .687" x 5.5"	5 x 17.5 mm x 139.7 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"	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	
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)	45 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

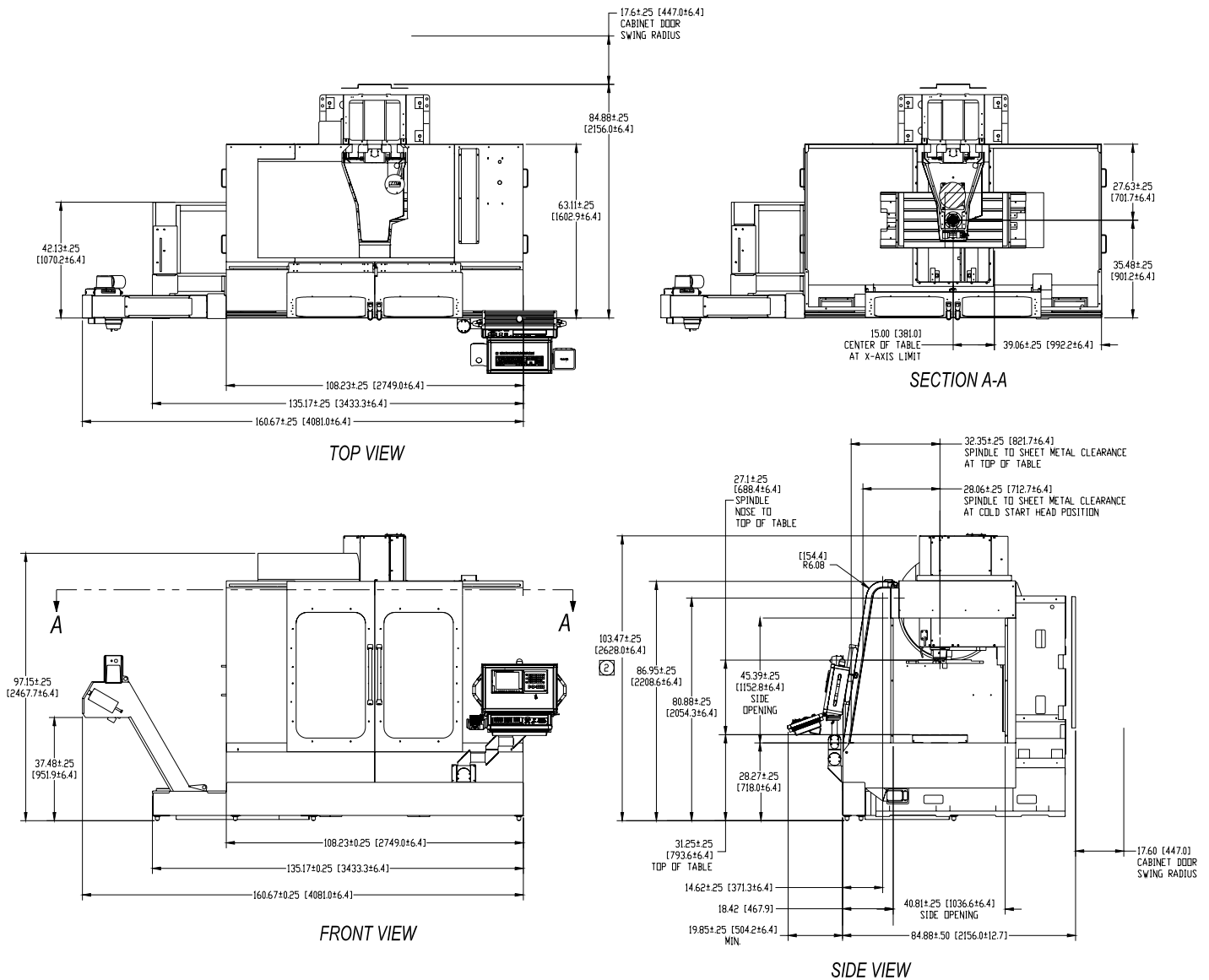


Figure 1-6: VMC 3020



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].

Optional Very High Torque Motor 30 Peak Horsepower, 32 Amps continuous current in WYE mode, 56 Amps continuous current in DELTA mode, Peak current may run as high as 70 Amps.

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 .709" x 3.75"	5 x 18 mm x 95.3 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)	20" (24" Opt.)	508 mm (610 mm)
Spindle Nose to Table	4"-24" (28" Opt.)	102 mm-610mm-(711 mm Opt.)
Spindle Center to Column Ways	22.875"	581 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, 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	21 (30 Opt.)	
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 conveyor 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)	45 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

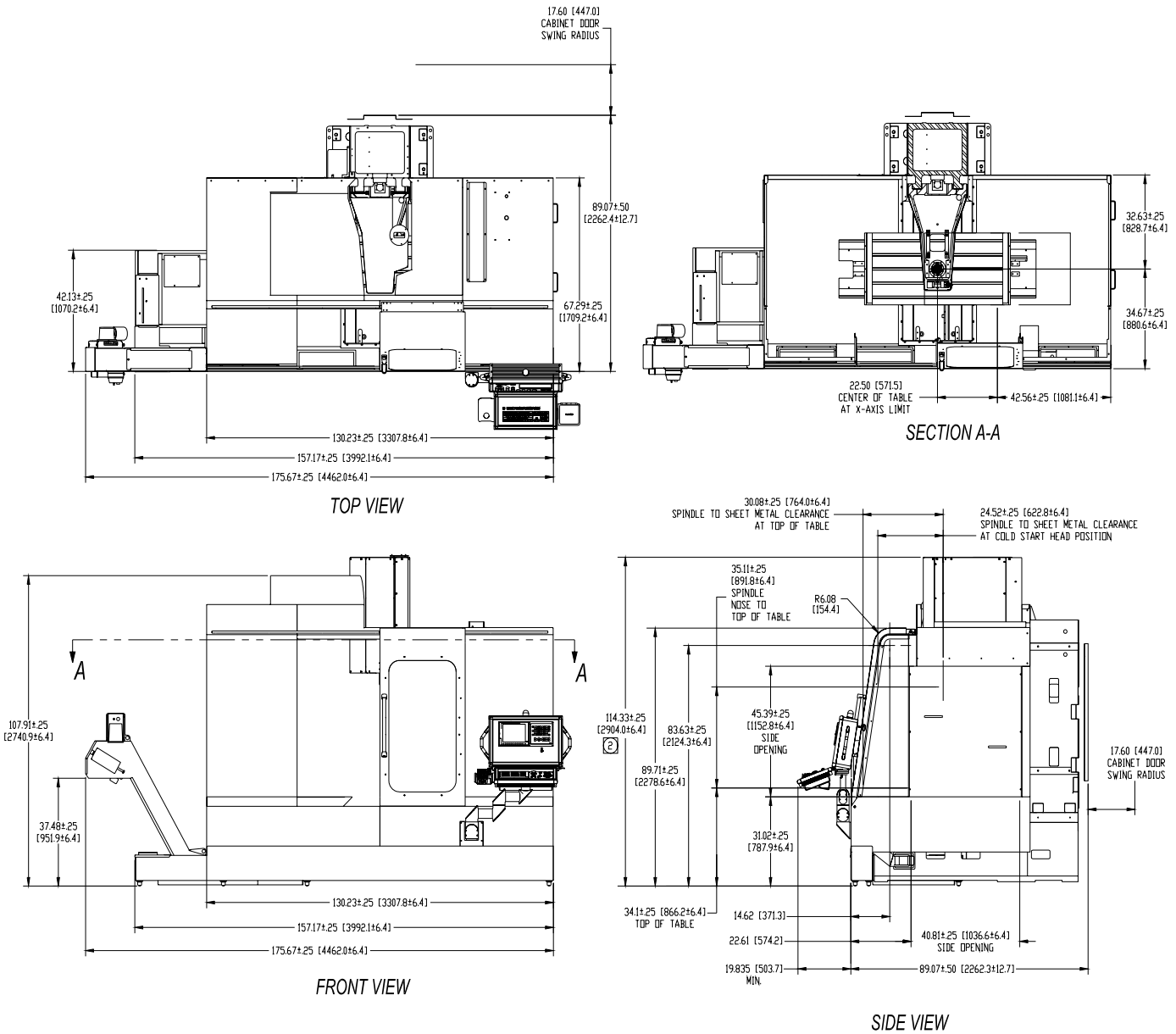


Figure 1-7: VMC 4525



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 .709" 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. HT 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)	40/60 amps, 230 VAC (20/25 amps, 480 VAC)	
Single Phase (Optional)	60 amps, 230 VAC	
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

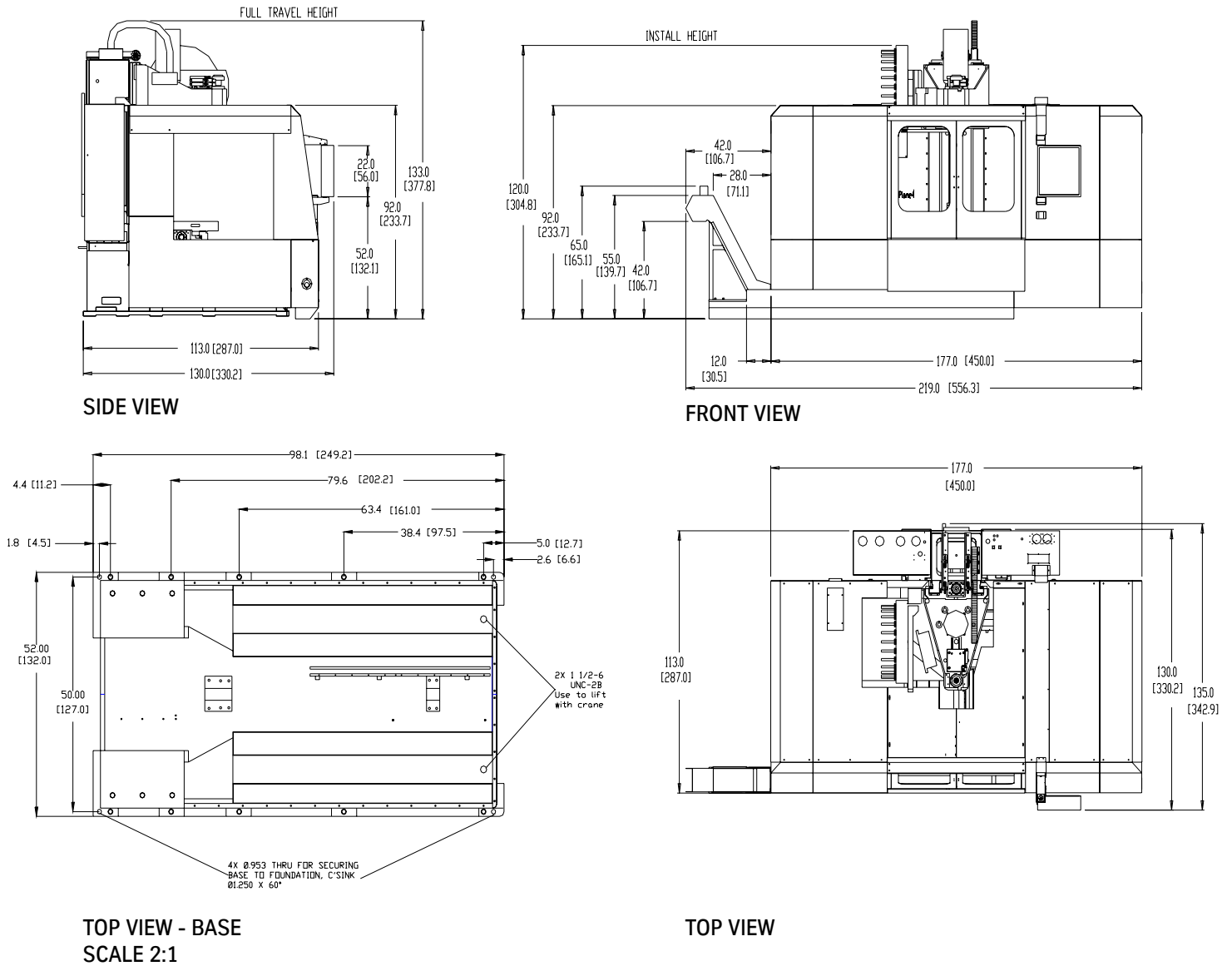


Figure 1-8: VMC 6535



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 .709" 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
Main Motor - Automatic 2 Speed Vector	22.5 HP*, 16.8 KW	
Opt. HT 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 tools (32, 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 x 130" 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)	40/60 amps, 230 VAC (20/25 amps, 480 VAC)	
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

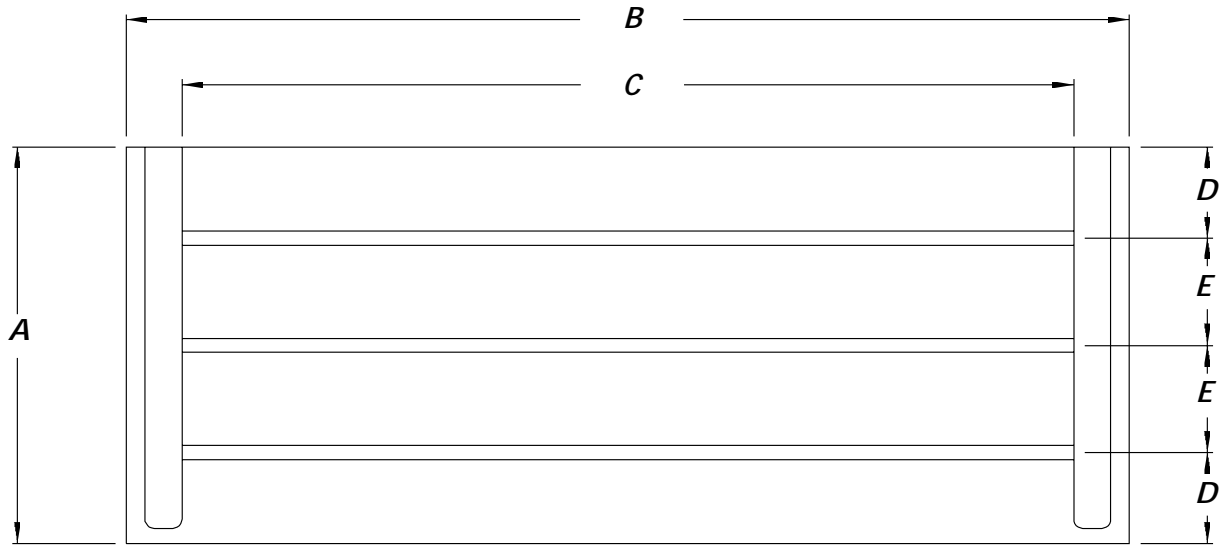


Figure 1-9: 2216 & 3016 Table

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

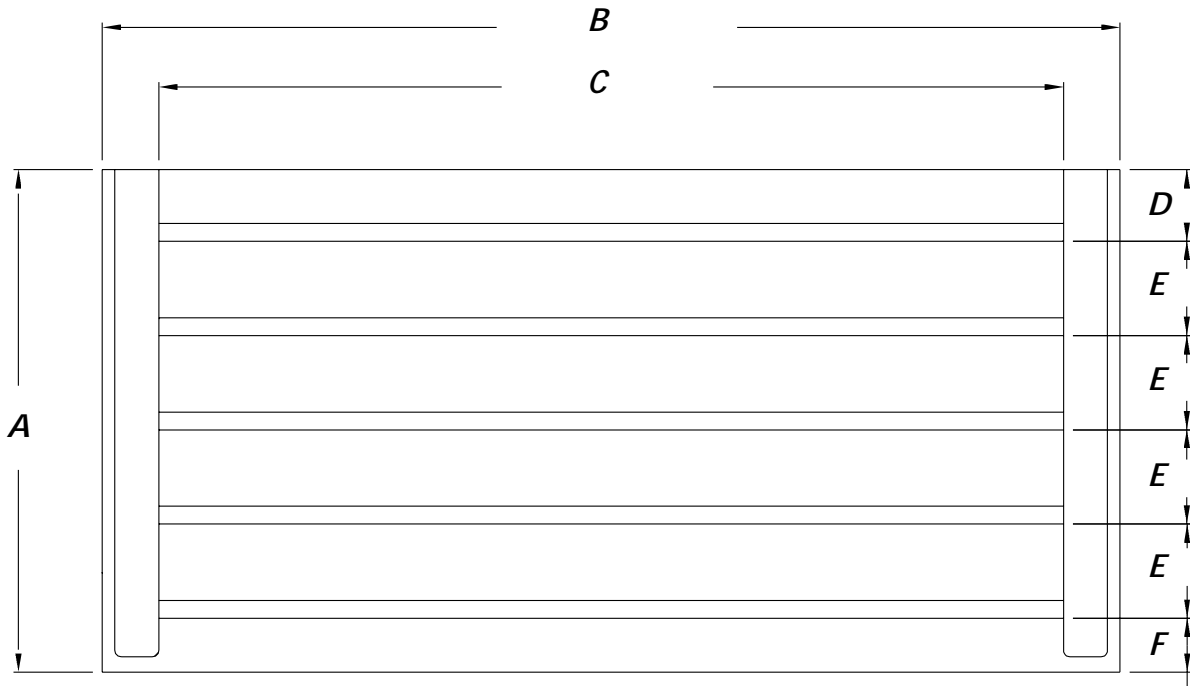


Figure 1-10: 3020 & 4525 Table

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	2.874" (730 mm)	D	3.0125" (76.51 mm)
E	3.74" (95 mm)	E	4.921" (124.99 mm)
F	2.1655" (55 mm)	F	2.3035" (58.51 mm)

1.2.3 4020 TABLE

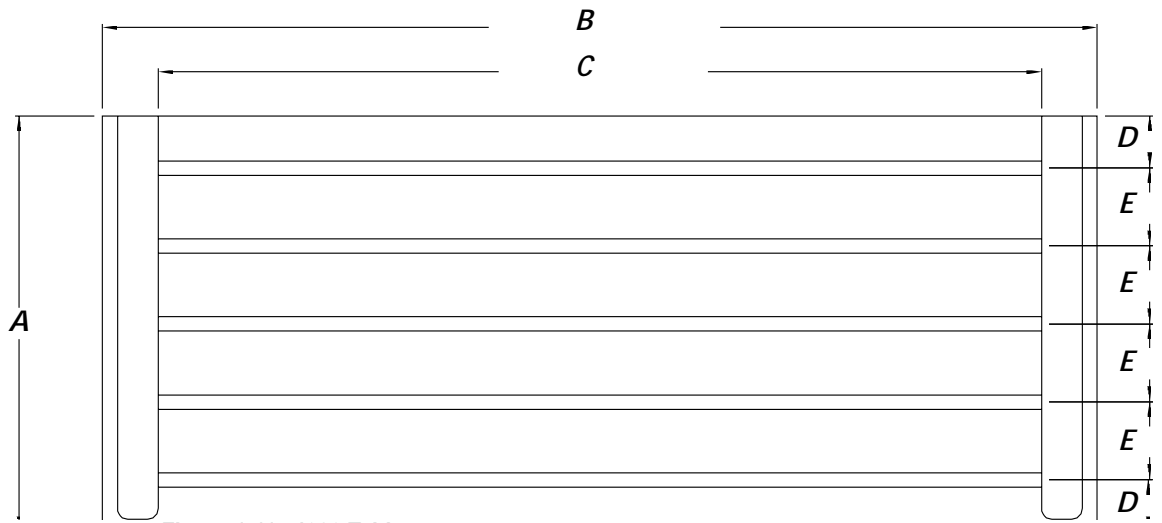


Figure 1-11: 4020 Table

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

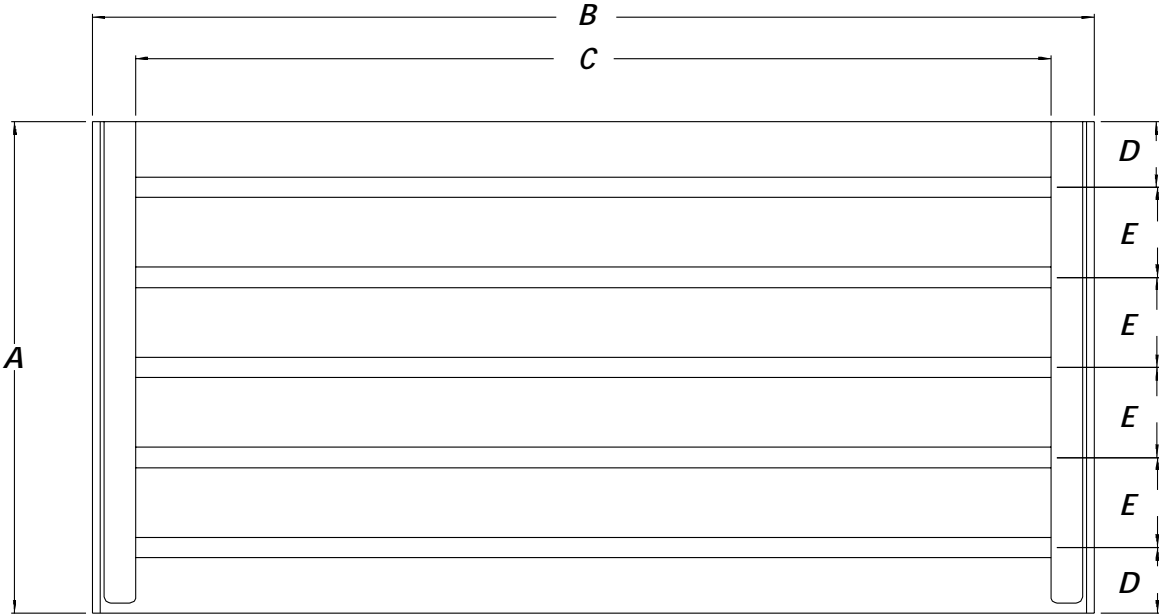


Figure 1-12: 6030 TABLE

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

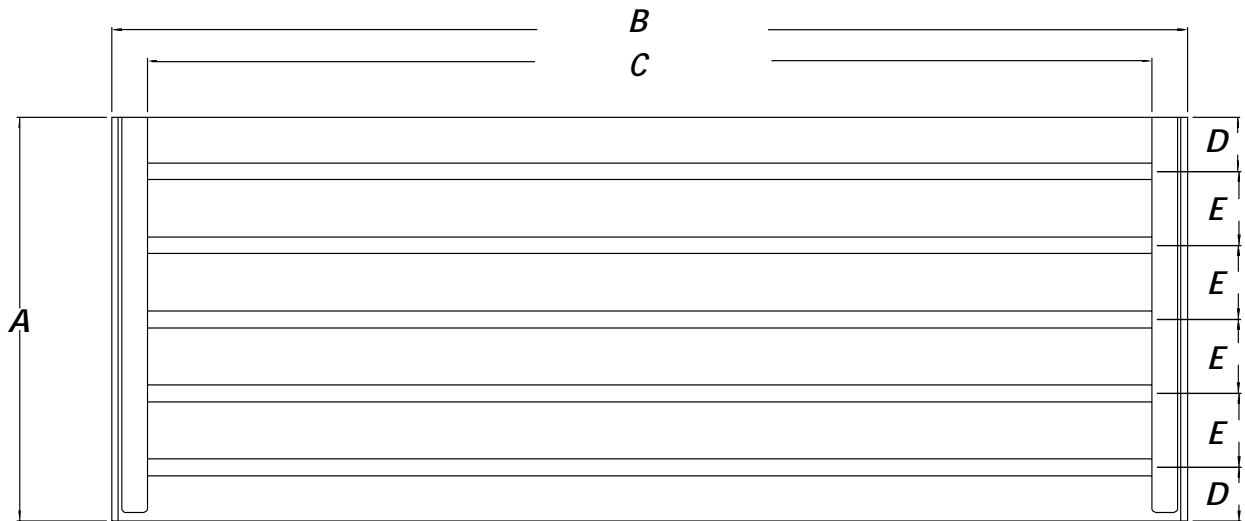


Figure 1-13: 8030 Table

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

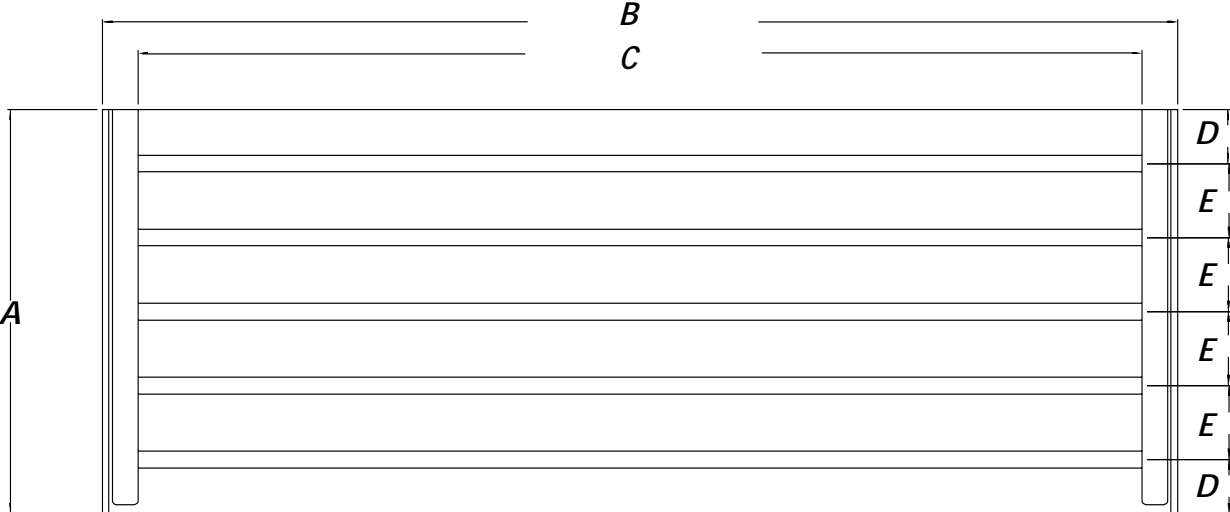


Figure 1-14: 6535 Table

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

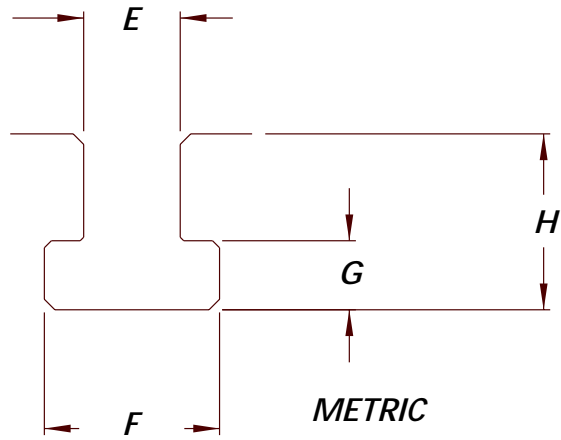


Figure 1-15: T-Slots for All Tables

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	208 V 3 PHASE	240 V 3 PHASE	380-415 V 3 PHASE	480 V 3 PHASE	240 V SINGLE PHASE
5 HP	30A	30A	30A	30A	50A
10 HP	50A	50A	35A	25A	70A
HT	70A	70A	35A	35A	90A
VHT	N/A	90A	70A	N/A	N/A
50 Taper	N/A	N/A	70A	70 A	N/A

Table 1-18: Electrical Service Circuit Breaker

SPINDLE TYPE	208 V 3 PHASE	240 V 3 PHASE	380-415 V 3 PHASE	480 V 3 PHASE	240 V SINGLE PHASE
5 HP	30 A	30 A	30 A	30 A	50 A
10 HP	50 A	40 A	25 A	25 A	60 A
HT	70 A	45 A	35 A	25 A	60 A
VHT	N/A	90 A	70 A	N/A	N/A
50-Taper	N/A	N/A	70 A	70 A	N/A



NOTE

VHT with Fadal control runs only on 220-240V. External transformer required for any other voltage.
VHT with Siemens Control only runs on 400V. External transformer required for any other voltage.

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*.

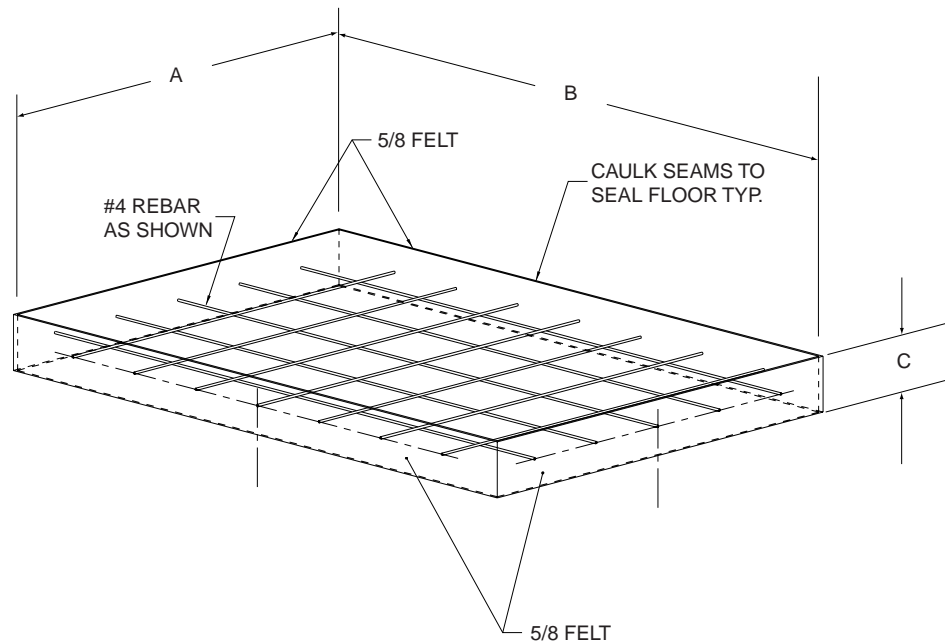


Figure 2-1: Typical Pad Construction

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-0121 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.

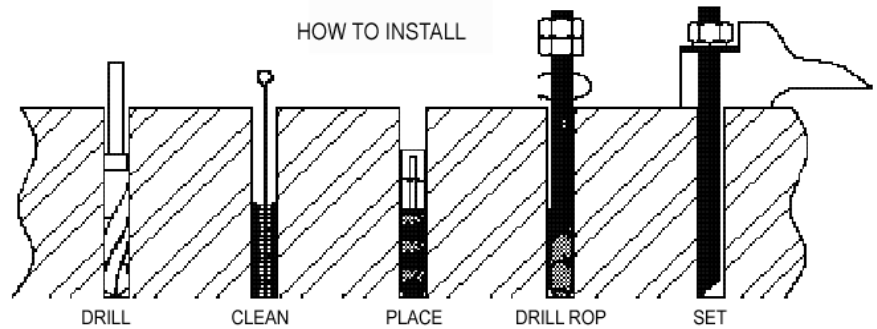
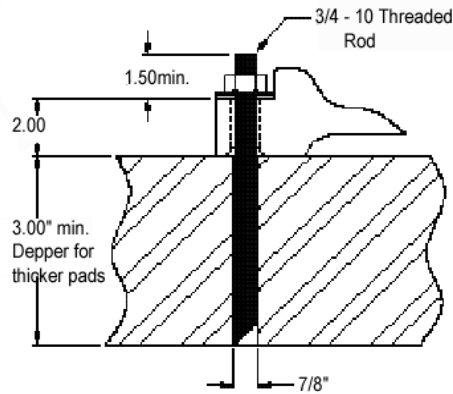


Figure 2-2: Anchor Stud Installation

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

58°F to 68°F	30 MIN
50°F to 58°F	1 HR
41°F to 50°F	2 HRs
32°F to 41°F	4 HRs
23°F to 32°F	8 HRs
14°F to 23°F	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.)

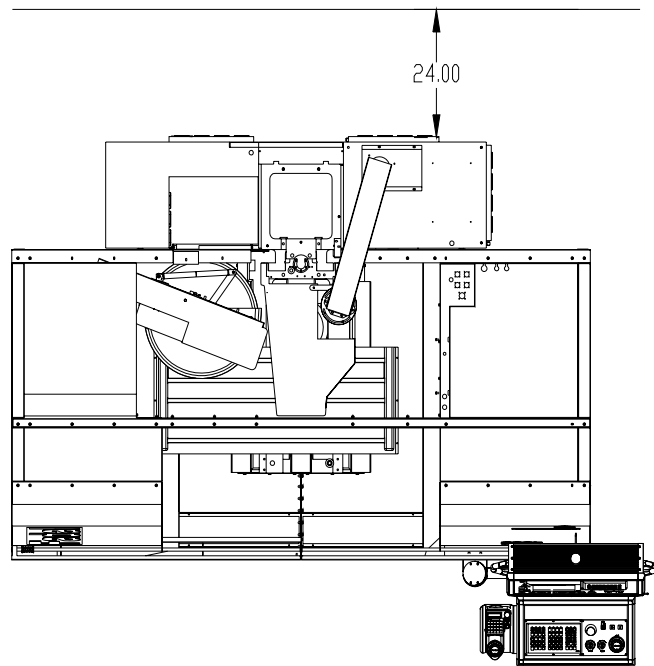


Figure 2-3: 24" Minimum Clearance Behind VMC

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: 120psi 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.

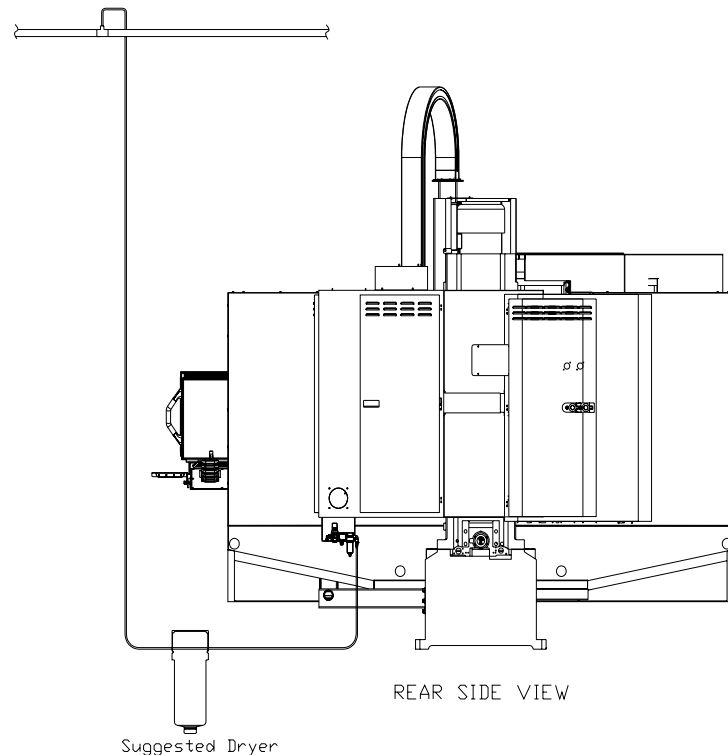


Figure 2-4: Attach Drain to Lowest Point of Air Supply Line

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 mm²) 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 mm²) 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 mm²) 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 mm²) 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.

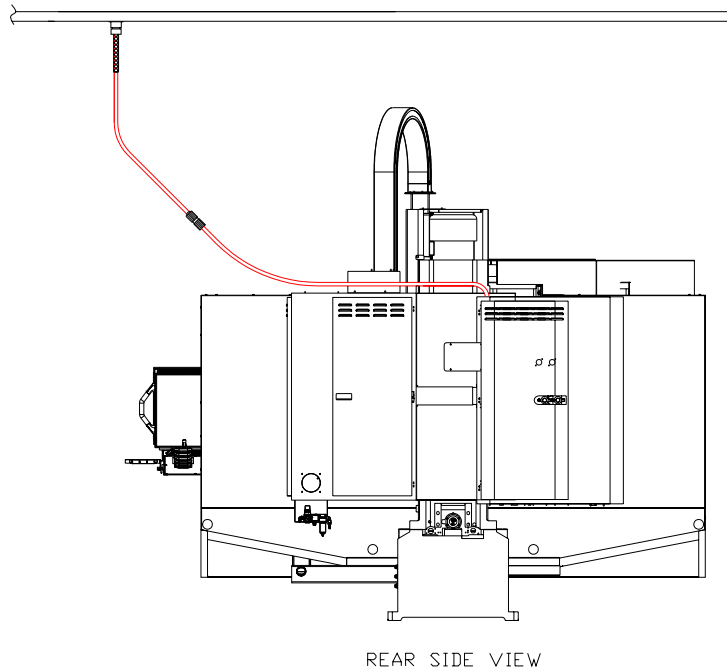


Figure 2-5: Bond Grounding Conductor to Copper Cold Water Pipe



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 conform 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 0V with machine on but not operating, (.010V is OK).

4. Turn off the VMC and measure the ground voltages (AC and DC) again. Record these readings. Voltages should be 0V 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	240 VAC 3 Ø	8 AWG (10 mm ²) stranded THHN copper within 100 ft. of panel. For VHT 4AWG	6 AWG (16 mm ²) stranded THHN copper 100 ft. or more from panel. For VHT 3 AWG
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
40 Taper	240 VAC Single Ø	6 AWG (16 mm ²) stranded THHN copper within 50 ft. of panel.	4 AWG (25 mm ²) stranded THHN copper from 50 to 100 ft. from panel.
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.
50 Taper	240 VAC 3 Ø	1AWG (50 mm ²) stranded THHN copper within 100 ft. of panel.	1/0 AWG (60 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

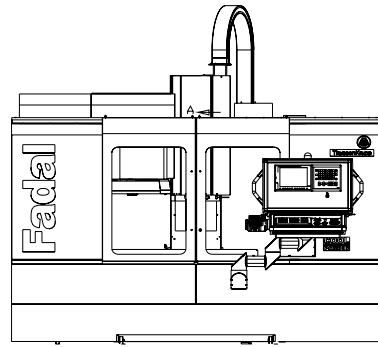
1. Place the leveling pads (countersink side up) under the leveling bolts. Be sure leveling bolts go into countersink on leveling pads.

**NOTE**

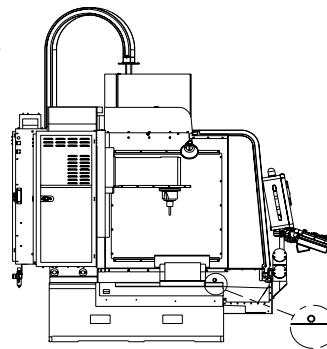
Use leveling pad SHP-0002 (PLC-0063 for slant sheet metal machines, or machines equipped with the HydroSweep option) for placing the machine. Any other pad may cause damage to the machine.

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

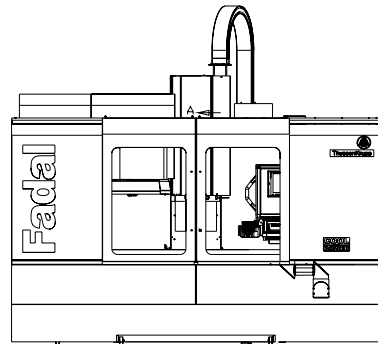
- At this point the VMC is ready for power and air connections.



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.

- 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

With the main disconnect switch in the off (down) position, open the cover to the main disconnect box.

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 *under* 250 VAC, then an 1170-2 (PCB-0145) should be installed.
 - b. If your incoming voltage is *over* 250 VAC, then an 1170-2 (PCB-0146) should be installed.
3. Identify the jumper and AC input locations. Use *Figure 3-3* through *3-5* for three phase and single 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 in either (3 phase) or (single phase).

Jumper (Step 6a)	AC Input (Step 6b)	=	Voltage Setting
3-6	8	=	240VAC

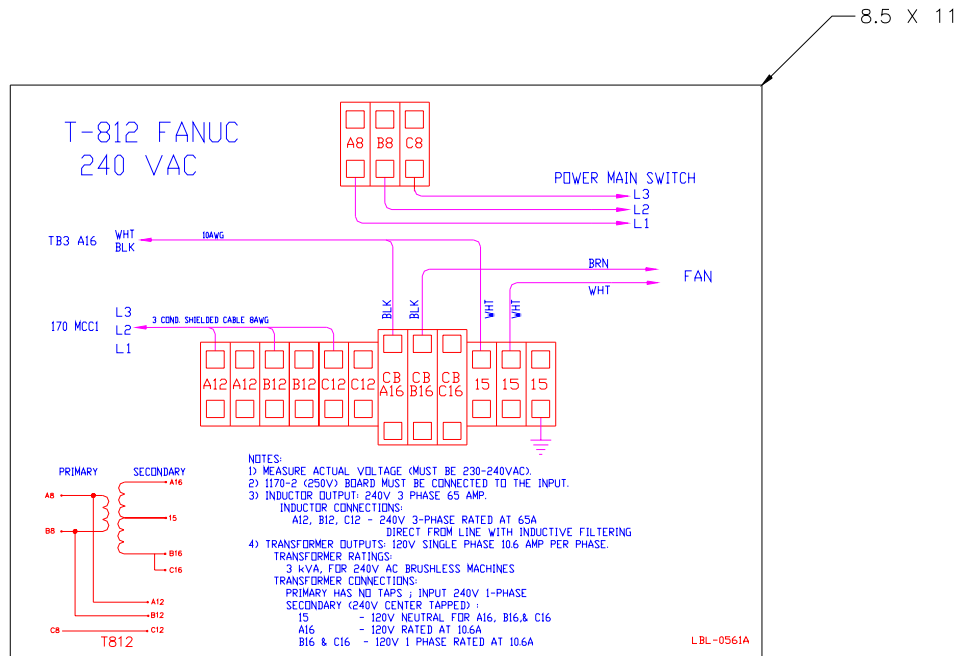


Figure 3-3:

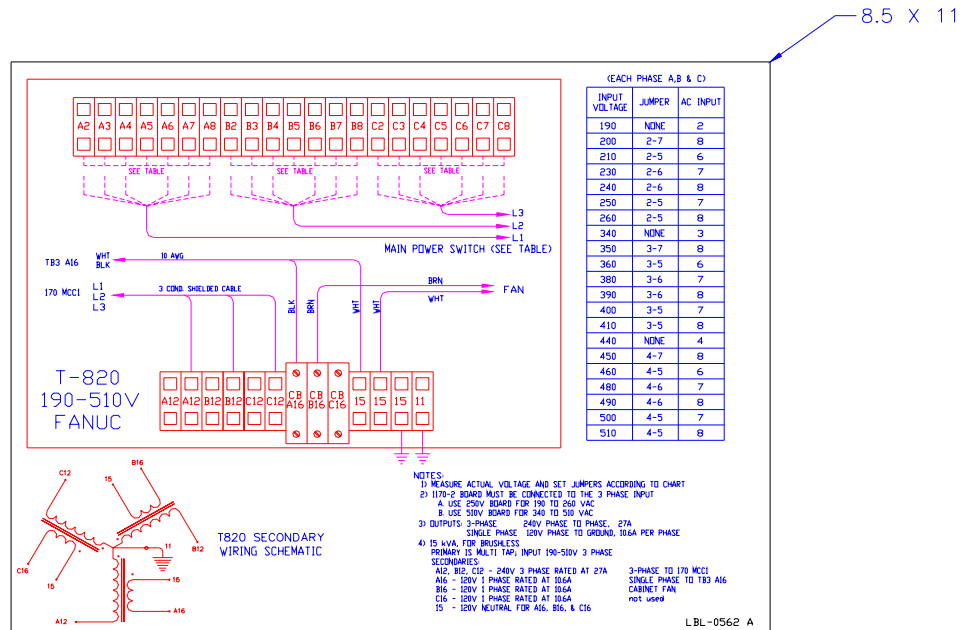


Figure 3-4:

8.5 x 11

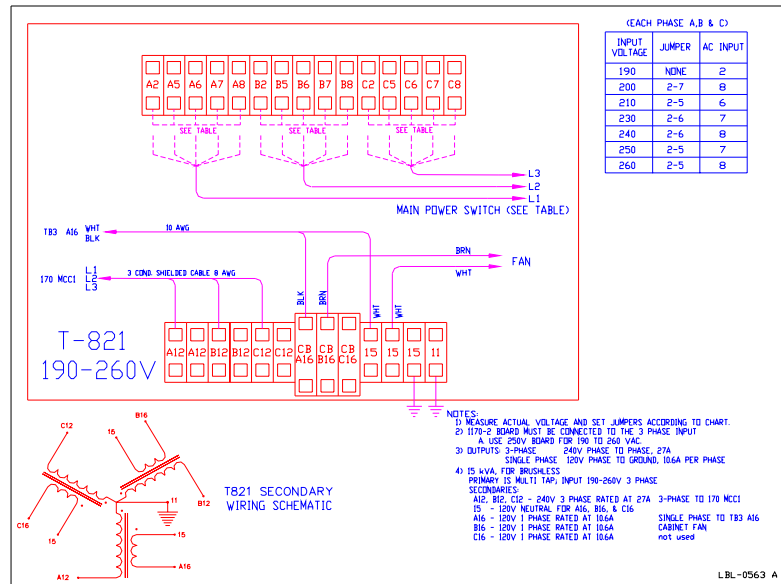


Figure 3-5:

The VMC is Ready for the Initial Power on Procedure

1. Move the main disconnect switch to the ON (up) position.
2. Measure the voltage at the transformers secondary between A12-B12, A12-C12, B12-C12.
3. For single phase measure across A8-C8. The voltage should be between 230-240 VAC, correct if necessary.
4. Push the EMERGENCY STOP switch to disable the axes, then push the CNC POWER button.
5. Check the voltages on the D.C. power supply, i.e. 5, + 12, -12 VDC.
6. Reset the EMERGENCY STOP switch.
7. Unbolt and remove the support between the table and the head.
8. Unbolt and remove the counterweight bars from the column, located next to the main disconnect box.
9. Jog the axis to the cold start indicators and cold start the VMC.

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.
6. Turn ON the main power switch.
7. Measure the input voltage to the spindle drive, usually labeled L1, L2 & L3, 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 than 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.

**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 SINGLE PHASE INPUT POWER

The Fadal VMC line is designed for three phase input power. However, three-phase power is not always available. If this is the case, Fadal offers a single-phase input power option. Most Fadal machines are capable of operating on single-phase line input. The torque ratings will be at 60% of the published performance. The rapid traverse rate is reduced to not more than 700 IPM for machines with higher speed capability. This is because as the DC bus capacitors are drained and the bus voltage drops, the single-phase input can not recharge the capacitors as fast as the three-phase. Lower bus voltage equals lower speed and more current. Single-phase requires 73% more current to maintain the same performance (square root of 3). The main limitation is the spindle drive. It will not draw more than its rated current. The current rise is steeper in single-phase and will, therefore, trip sooner.

Fadal does not recommend single-phase power for the High torque or the 6535, 6030 and 8030 machines and cannot be used with VHT or 50 taper. This option can be ordered on a new machine and can be installed in the field. Some wiring changes are also necessary. Please see the single-phase transformer charts and wiring instructions.

3.4 PHASE CONVERTER ROTARY

The normal Fadal VMC requires three phase-input power. The machines are also configured in a single-phase power configuration when requested. 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 is desirable, 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-0121 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.

3.5 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-0121 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 3-6: Leveling Box Way.*)

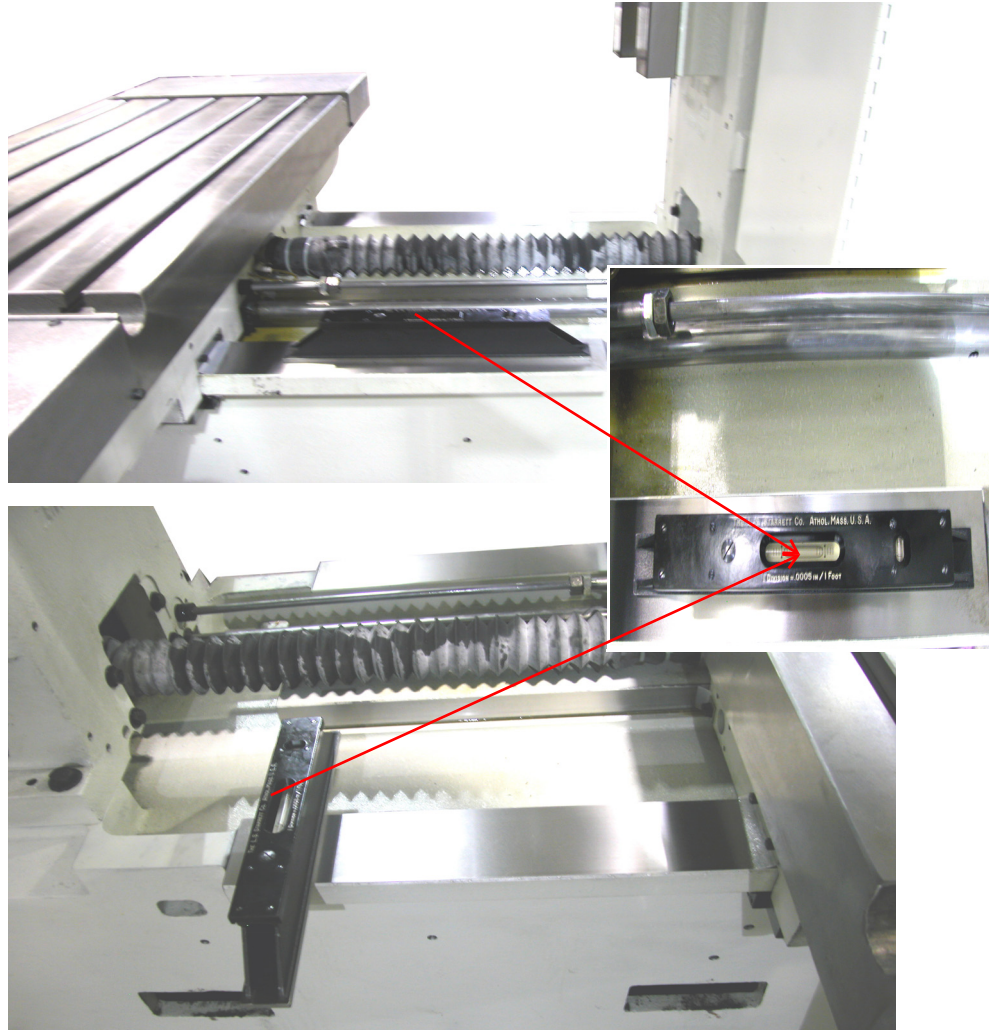


Figure 3-6: Leveling Box Way.

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.

3.6 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.

3.7 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.

3.8 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.

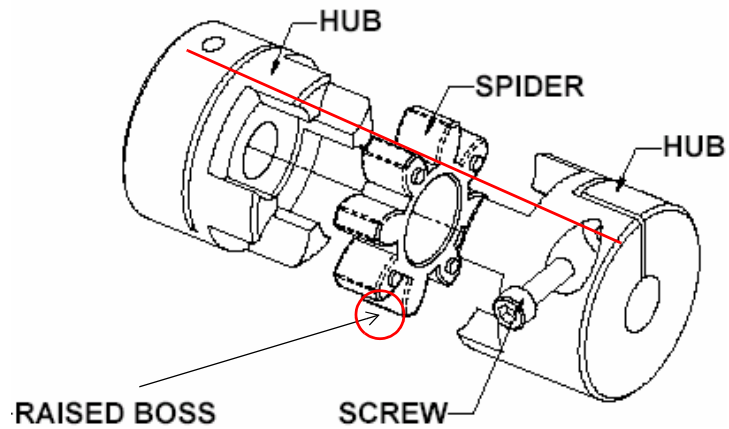


Figure 3-7: Coupler

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.

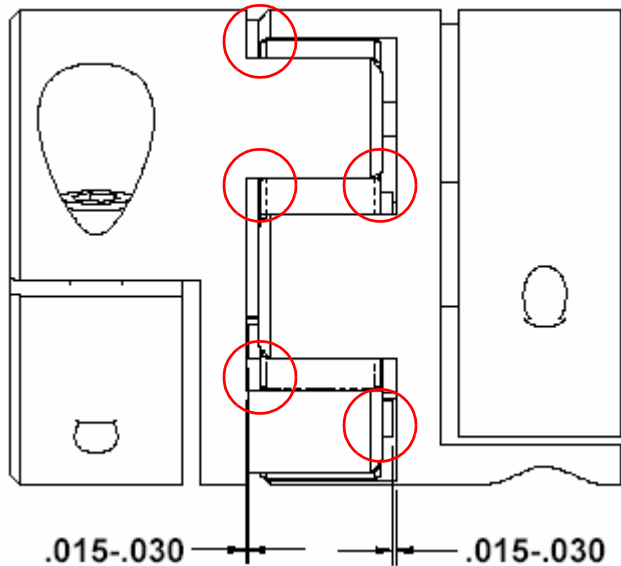


Figure 3-8: Gages

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.

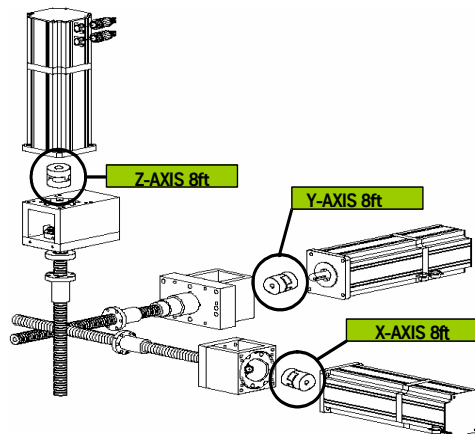


Figure 3-9: Motors

Table 3-1: Couplers

MACHINE	X AXIS	Y AXIS	Z AXIS
EMC	KTR ROTEX GS 24.625x24mm	KTR ROTEX GS 24.625x24mm	KTR ROTEX AI GS 24.625x19mm
2216			
3016			
4020			
6030			
8030			
5020A			
4020A			
3016L	KTR ROTEX GS 24.625x24mm		
2016L	KTR ROTEX AI GS 24.625x19mm		

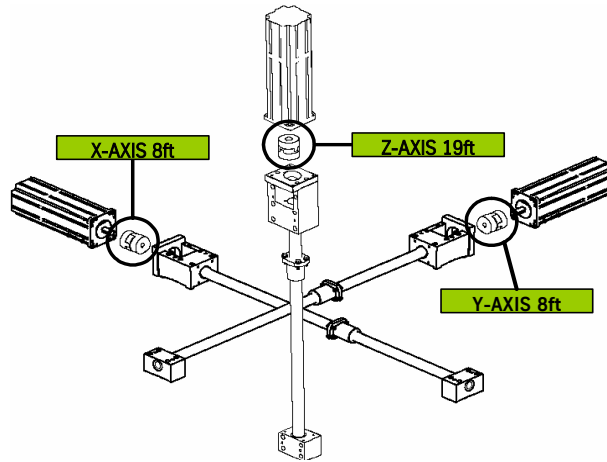


Figure 3-10: Motors

Table 3-2: Couplers

MACHINE	X AXIS	Y AXIS	Z AXIS
3020	KTR ROTEX GS 24.625x24mm	KTR ROTEX GS 24.625x24mm	KTR ROTEX AI GS 24.625x19mm
4525			
6535/40T			KTR ROTEX GS 24.625x24mm
6535/50T			

3.9 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.



NOTE

Two people required.

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.

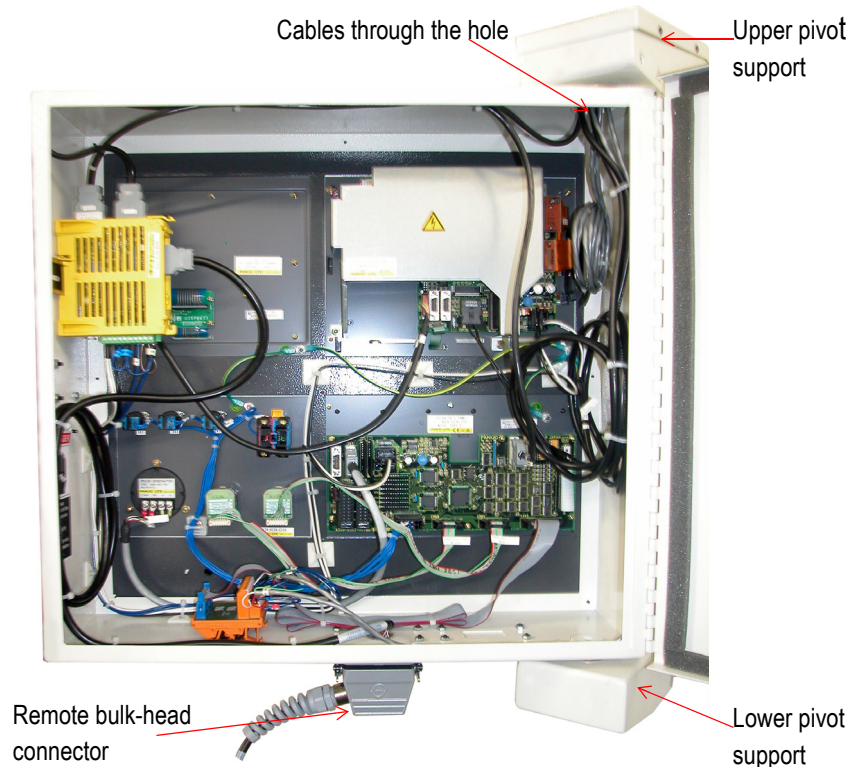


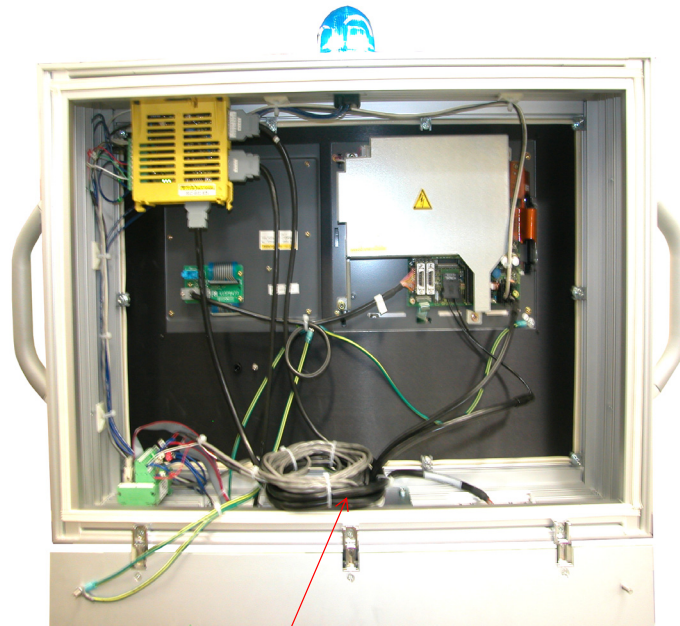
Figure 3-11: 6535 Fanuc Control

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. Run all the cables and wires, coming from the machine, through the pendant support arm.
5. Pull these cables and wires through the hole on the bottom of the pendant housing display.
6. Mount support arm caps back to appropriate positions using screws from the plastic bag.

7. Connect these cables and wires to appropriate positions according wiring diagram.



Cables through the hole

Figure 3-12: 2216, 3016, 6030, 8030 Fanuc control

3.10 GENERAL

Detach column breaks from spindle head and tool changer arm.

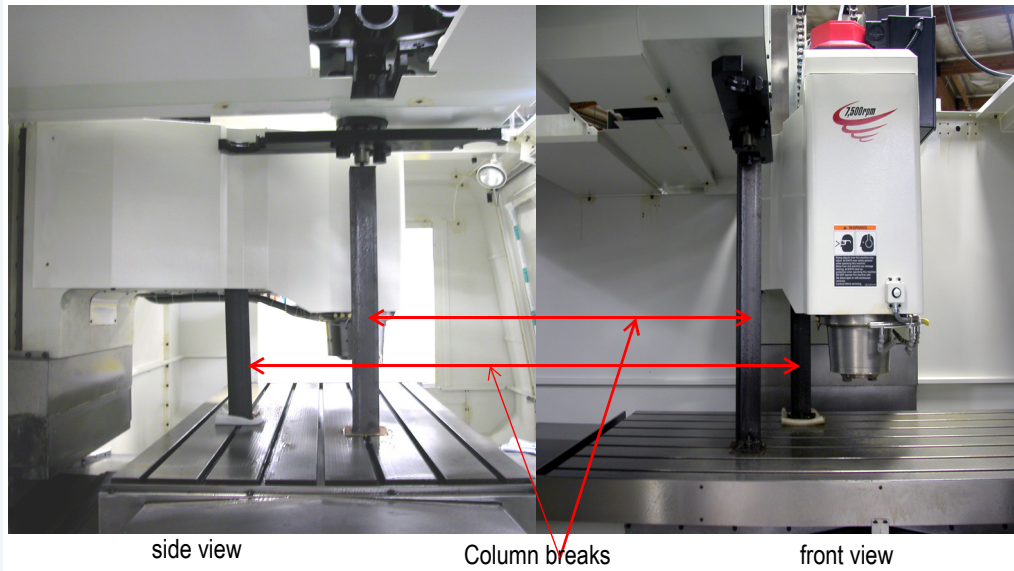


Figure 3-13: Column breaks

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

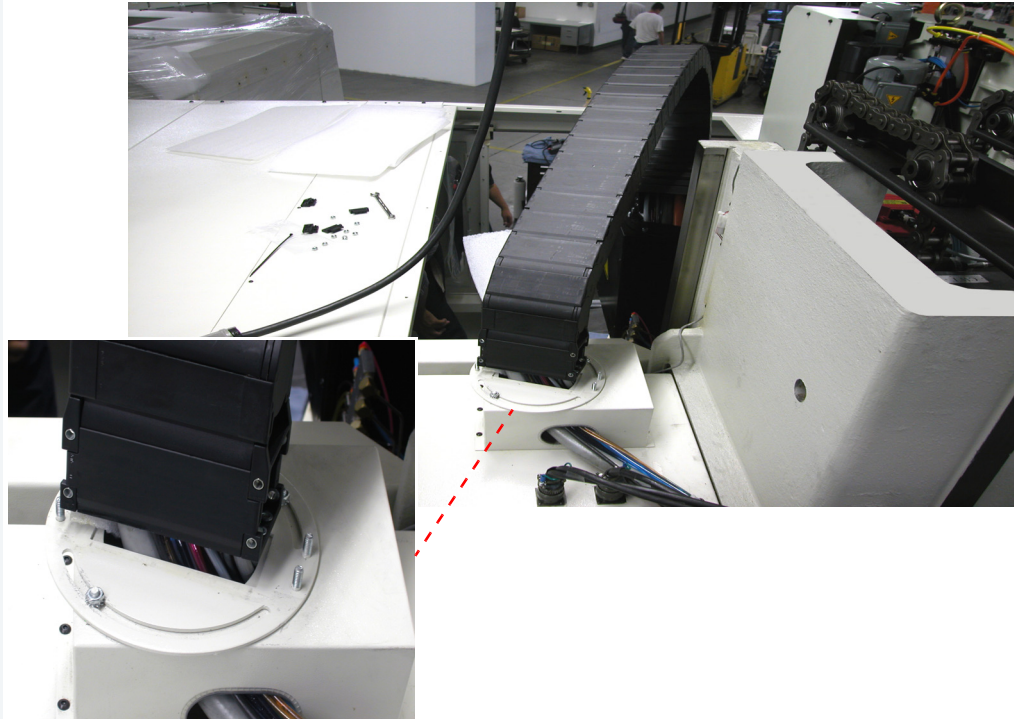


Figure 3-14: Cable carrier

3.11 CHIP CONVEYOR

3.11.1 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*).

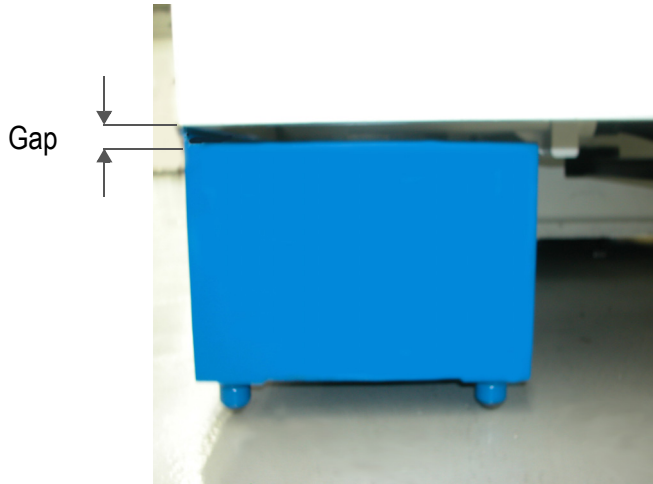


Figure 3-17: Minimize Gap or Overlap

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.

3.11.2 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 chip conveyor requires 220 volt single phase power.

2. 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)

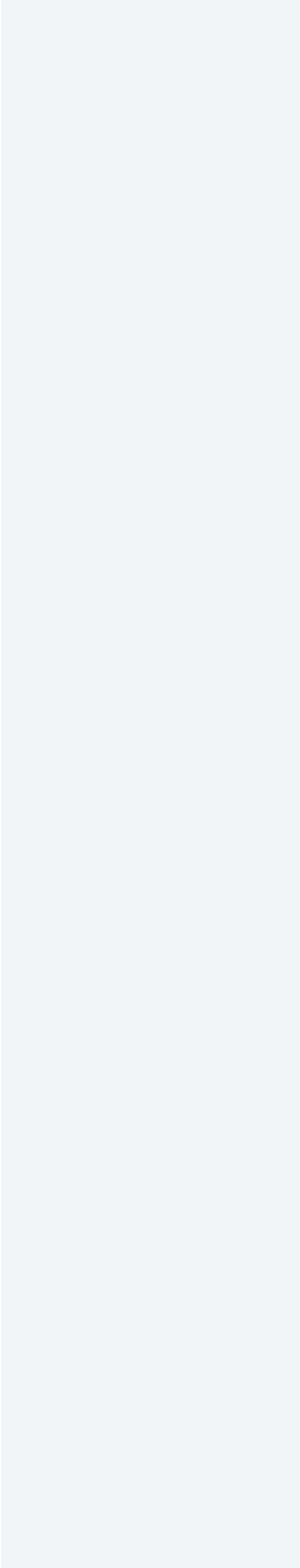
- The control also has a variable speed control for the belt speed. The belt speed can be controlled from 2.60 ft./min. to 10.80ft/min.



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.

4.1.2 LUBRICATION OF
THE WAYS

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.

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 COOL- ING 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.)

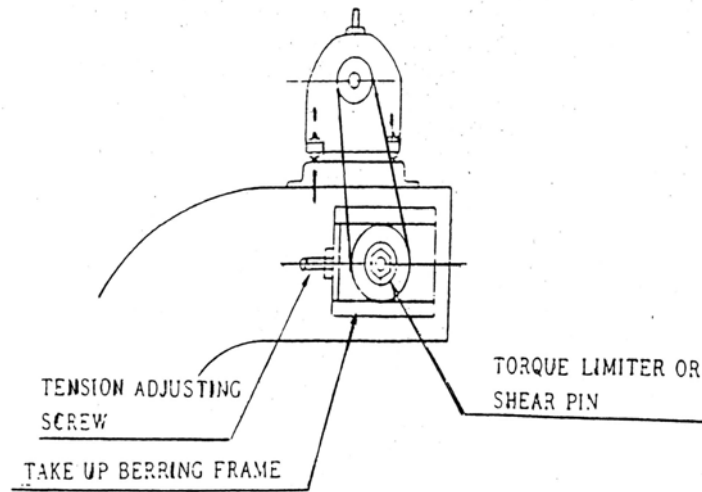


Figure 4-3: Adjust Take-Up Bearing

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

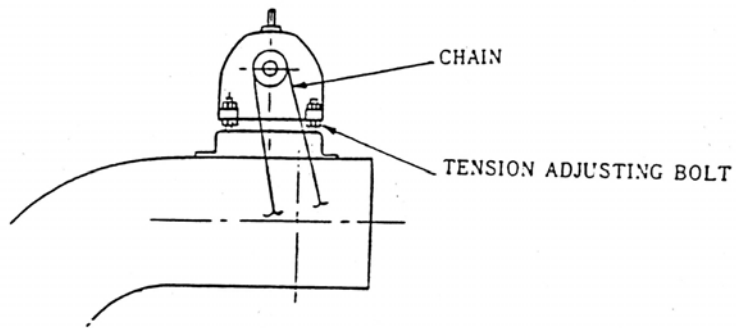


Figure 4-4: Check Roller Chain

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

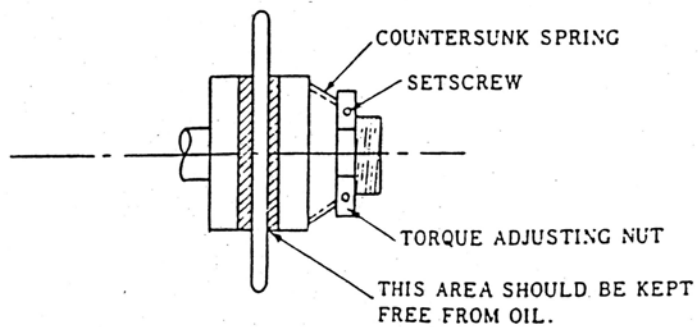


Figure 4-5: Torque Limiter

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

5.0 FANUC CONTROL

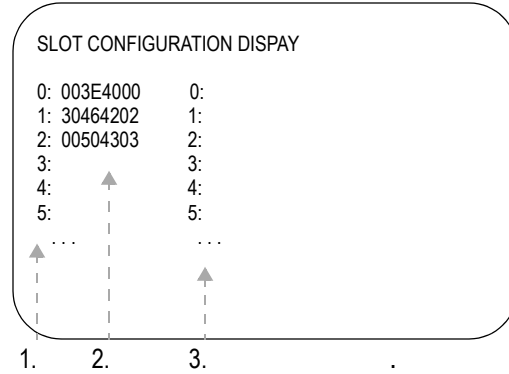
This chapter covers those items, displayed on the screen, that are related to maintenance. It describes how to display various screens by the function keys.

5.1 SCREEN DISPALYED IMMEDIATELY AFTER POWER IS TURNED ON

5.1.1 SLOT STATUS DISPLAY

If a hardware trouble or an incorrect mounting is found, the following screen is displayed.

Slot state screen



- 1-physical slot number (primary side)
- 2-module ID of the PCB mounted (*1)
- 3- physical slot number (2ndary side)

Module ID

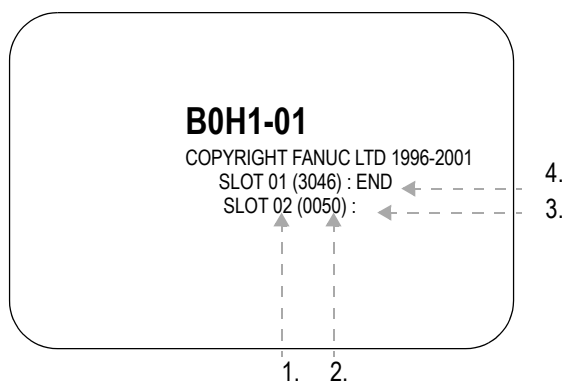
Table 5-1: Module ID

ID	NAME
D5	Series 16i motherboard
C5	Series 18i motherboard
CC	Series 160i motherboard
EC	Series 180i motherboard
CD	Serial communication board; remote buffer/DNC2
	Serial communication board: DNC1
	C language board
	CAP II board
CE	Sub-CPU board
CF	RISC board
A3	Data server board
D3	Loader control board
AA	HSSB interface board
C9	Pc function card

5.1.2 SETTING
MODULE SCREEN

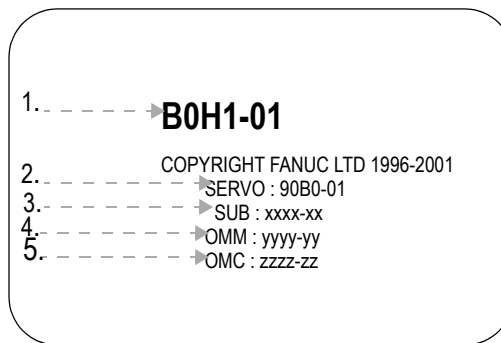
Software ID

40 : Main CPU
 41 : C language
 43 : Sub CPU
 49 : CAP II
 4A : Remote buffer
 4F : PMC-RE
 53 : Loader control
 59 : RISC board for high-precision contour control
 5E : HSSB interface (with PC)



1-slot number
 2-module ID
 3-setting incomplete (space)
 4-setting complete (end)

5.1.3 CONFIGURATION DISPLAY OF SOFTWARE



- 1-CNC control
- 2-digital servo ROM
- 3-sub CPU (remote buffer
- 4-order made macro/macro compiler
- 5-PMC

5.2 SYSTEM CONFIGURATION SCREEN

After the system has been installed correctly, you can find the PCBs installed and the softwares integrated on the system configuration screen.

5.2.1 DISPLAY METHOD

Follow the next steps:

1. Press **SYSTEM** key.
2. Press soft key [**SYSTEM**], then the system configuration screen is displayed.
3. The system configuration screen is composed of three screens and each of them can be selected by the page key **PAGE UP** and **PAGE DOWN**.

5.2.2 CONFIGURATION OF PCBs

Screen

SYSTEM CONFIG (SLOT)					PAGE01
SLOT	MODULE ID	SERIES	VERSION		
00	3008	: 40	BOH1	0001	
01	00CF	: 66	B435	0001	
↑	↑	↑	↑	↑	
1.	2.	3.	4.	5.	

- 1-slot number (80 to 8F is 2nd side)
- 2-module ID
- 3-software ID (type)
- 4-software series of module with CPU
- 5-software version of module with CPU

Software ID

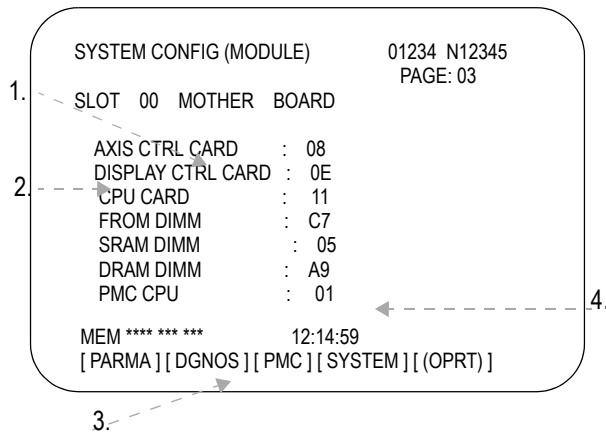
- 40 : Main CPU
- 41 : C language
- 43 : Sub CPU
- 49 : CAP II
- 4A : Remote buffer
- 4F : PMC-RE
- 53 : Loader control
- 59 : RISC board for high-precision contour control
- 5E : HSSB interface (with PC)

Module ID

ID	NAME
D5	Series 16i motherboard
C5	Series 18i motherboard
CC	Series 160i motherboard
EC	Series 180i motherboard
CD	Serial communication board: remote buffer/DC2
	Serial communication board: DNC 1
	C language board
	CAP-II board
CE	Sub-CPU board
CF	RISC board
A3	Data server board
D3	Loader control board
AA	HSSB interface board
C9	PC function card

5.2.3 MODULE CONFIGURATION SCREEN

Configuration of the modules displayed on PCB.



- 1-slot number (the number is corresponding to PCB configuration screen)
- 2-typr of PCB mounted
- 3-name of card PCB or DIMM module
- 4-hardware ID of mounted card PCB or DIMM module

Pressing the page **PAGE UP** or **PAGE DOWN** key displays the system configuration screen of other PCBs.

5.3 SCREEN DISPLAY

Displaying the operation history.

1. Press the SYSTEM function key.
2. Press the continue menu key . The **[OPEHIS]** (operation history) soft key are displayed.
3. Press the **[OPEHIS]** soft key twice. The operation history screen is displayed.

OPERATION HISTORY		01234 N12345
		PAGE: 123
NO .DATA	NO. DATA	NO.DATA
01 01/06/03	11 F0000.7	21 F0001.0
02 08:40:00	12 F0000.5	22 <POS>
03 <DELETE>	13 F0001.0	23 <PROG>
04 F0000.6	14 F0000.5	24 <RESET>
05 MEM	15 P/S0010	25 EDIT
06 G0009.0	16 01/06/03	26 0
07 G0009.1	17 09:27:49	27 1
08 G0009.2	18 <PROG>	28 2
09 ST	19 <RESET>	29 3
10 ST	20 F0000.7	30 4
EDIT **** ** *		08:20:52
[TOP]	[BOTTOM] [] []	[PG . SRH]

4. To display the next part of the operation history, press the PAGE DOWN key. The next page is displayed.
To display the interface between two pages, press cursor key left or right. The screen is scrolled by one row. On a 14-inch CRT screen, pressing the cursor key scrolls the screen by half a page.

These soft keys can also be used:

- Pressing the **[TOP]** soft key displays the first page (oldest data).
- Pressing the **[BOTTOM]** soft key displays a specified page (latest data).
- Pressing the **[PG. SRH]** soft key displays a specified page.

EXAMPLE: By entering 50 then pressing the **[PG. SRH]** key, page 50 is displayed.

Data displayed on the operation history screen.

1. MDI keys

Address and numeric keys are displayed after a single space.

Soft keys are displayed in square brackets ([]).

Other keys (**RESET/INPUT**, for example) are displayed in angle brackets (< >).

A key pressed at power-on is displayed in reverse video.

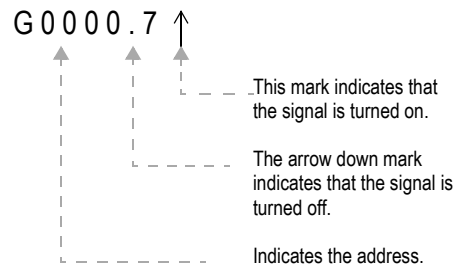
For two-path control, the operations of paths 2 are displayed in the same way, but preceded by **S_**.

- Function key :<POS>, <PROG>, <OFFSET>, etc.
- Address/numeric key: **A** to **Z**, **0** to **9**; (**EOB**), **+**, **-**, **(**, etc.

- Page/cursor key: <PAGE↑>, <CUR↓>, <CUR→>
- Soft key: [SF1], [SF2], etc.
- Other key <RESET>, <CAN>, etc.
- Key pressed at power-on

2. Input and output signals

General signals are displayed in the following format:



Some signals are indicated by their symbol names.

Mode selection signals and rapid traverse override signals are displayed as indicated below:

INPUT SIGNALS					NAME DISPLAYED
MD1	MD2	MD4	REF	DNC1	
0	0	0	0	0	MDI
1	0	0	0	0	MEM
1	0	0	0	1	RMT
0	1	0	0	0	NOMODE
1	1	0	0	0	EDT
0	0	1	0	0	H/INC
1	0	1	0	0	JOG
1	0	1	1	0	REF
0	1	1	0	0	TJOG
1	1	1	0	0	THND

INPUT SIGNAL		NAME DISPLAYED
ROV1	ROV2	
0	0	R100%
1	0	R50%
0	1	R25%
1	1	RF0%

3. NC alarms

NC alarms are displayed in reverse video.

P/S alarms, system alarms, and external alarms are displayed together with their numbers.

For other types of alarms, only the alarm type is displayed. (No details are displayed.)

For two-path control, the operations of path 2 are displayed in the same way, but preceded by **S**._.

EXAMPLE: P/S0050, SV_ALM, S_APC_ALM

4. Time stamp (date and time)

The following time data (date and time) is recorded:

- Date and time of power-on
- Date and time of power-off
- Date and time when an NC alarm occurs
- The clock time is recorded at predetermined intervals, together with each new calendar day.

EXAMPLE: 01/01/20 ==== Year/Month/Day

09:15:30 ==== Hour:Minute:Second

The clock time is recorded for a specified interval only when data is stored within that interval.

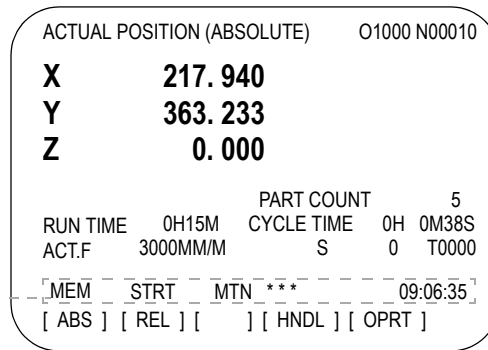
If a system alarm is issued, the system alarm occurrence time is used for power-off display.

5.3.1 INPUT SIGNAL OR OUTPUT SIGNAL TO BE RECORDED IN THE OPERATION HISTORY

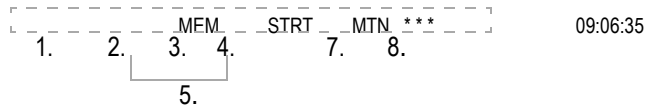
1. Press the **SYSTEM** function key.
2. Press the continuous menu key. The **[OPEHIS]** (operation history) soft key is displayed.
3. Press the **[OPEHIS]** soft key, then press the **[SG-SEL]** soft key. The operation history signal selection screen is displayed.

OP_HIS SIGNAL SELECT			01000 N02000		
NO.	ADDRESS	SIGNAL	NO.	ADDRESS	SIGNAL
01	X0000	00001000	11	G0000	00000001
02	X0004	10000000	12	G0004	00000011
03	X0008	00001100	13	G0008	00000111
04	X0009	00111000	14	G0003	00001111
05	X0012	00001111	15	G0043	01100000
06	Y0000	01000000	16		*****
07	Y0004	00110000	17		*****
08	Y0007	00011100	18		*****
09	Y0008	00011100	19		*****
10	Y0010	00011100	20		*****
>					
EDIT *****			00:00:00		
[OPEHIS] [SG-SEL] [] [] [(OPE)]					

5.4 CNC STATE DISPLAY



- display example and explanation.
 - indicates the current status of the CNC.



1. Mode selection status

- MEM: Automatic operation (memory operation).
- MDI: Manual data input/MDI operation.
- EDIT: Program editing.
- RMT: Remote operation.
- JOG: Jog feed.
- REF: Reference position return.
- INC: Incremental feed mode = step feed.
- HND: Manual handle feed mode.
- TJOG: Teaching in jog feed mode.
- THND: Teaching in handle feed mode.

2. Automatic operation status

- STRT: Automatic operation has started (and program execution is under way).
- HOLD: Automatic operation has been suspended.
- STOP: Automatic operation has stopped.
- MSTR: The tool is returning or being repositioned when the tool retract and return function is executed.
- ***: Other status (when the power is switched on, or automatic operation has ended).

3. Automatic operation status

- MTN: Program-specified axis movement is under way.
- DWL: Program-specified dwell command (G04) is being executed.

*** : Other status

4. Auxiliary function status

FIN: The completion signal FIN for an auxiliary function is being awaited.

*** : Other status

5. Emergency stop and reset status (displayed at the location of items mentioned in (3) and (4)).

EMG: Emergency stop status

RESET: CNC reset status (The state in which the reset signal or the MDI RESET key remains active).

6. Alarm status

ALM: An alarm condition has been detected

BAT: The lithium battery (CNC back-up battery) voltage is low (the battery is to be replaced).

7. Clock display

Input: Data is being input.

Output: Data is being output.

SRCH: A data search is under way.

EDIT: Editing such as insertion or modification is under way.

LSK: Label skip enabled at data input (until valid information is read).

PTRR: Retract or return/re-positioning is under way when the tool retract and return function is used.

HPCC: High-precision contour control mode.

AICC: AI contour control mode.

AI NANO: AI nano contour control mode.

AI HPCC: AI high-precision contour control mode.

NANO HP: AI nano high-precision contour control mode.

AIAPC: AI advanced preview control mode.

RVRS: Reversing based on the retrace function.

RTRY: Re-advancing based on the retrace function.

RVED: Reversing based on the retrace function has ended.

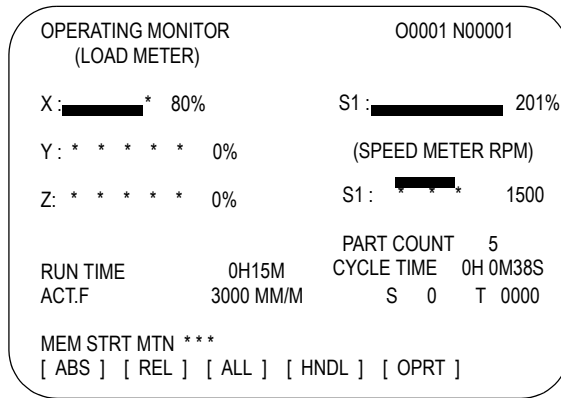
Blank: Editing is not under way.

5.5 OPERATING MONITOR

Load meter of the servo axis and the serial spindle and speed meter can be displayed.

5.5.1 DISPLAY METHOD

1. Set a parameter to display operating monitor. (Bit 5 (OPM) of parameter No.3111)
2. Press the **POS** key to display the position display screen.
3. Press continuous menu key, then soft key **[MONI]** is displayed.
4. Press the soft key **[MONI]**, then the operating monitor screen is displayed.



CAUTION

The bar graph for the load meter shows load up to 200%.
 The bar graph for the speed meter shows the ratio of the current spindle speed to the maximum spindle speed (100%). Although the speed meter normally indicates the speed of the spindle motor, it can also be used to indicate the speed of the spindle by setting bit 6. (OPS) of parameter 3111 to 1.
 The servo axes for their load meters are displayed are set to parameter No. 3151 to 3. If parameters 3151 to 3153 are all zero, the load meter of the basic axes are displayed.
 For color display, the bar of the load meter that exceed 100% shows purple color.

5.6 MAINTENANCE INFORMATION SCREEN

The maintenance information screen is provided to record the history of maintenance performed by a service person of Fadal.

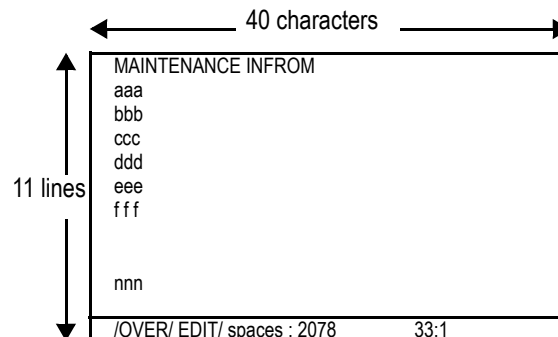
The screen has the following features:

- MDI alphabetical input is allowed
- the recording screen can be scrolled in units of lines
- edited maintenance information can be read and punched
- the screen can be saved in flash ROM

5.6.1 SCREEN DISPLAY AND OPERATION

Screen display

1. Press the function key.
 2. Press the continuous menu key several times **[M-INFO]** soft key appears.
 3. Press the **[M-INFO]** soft key. The maintenance information screen appears.
- when selected the maintenance screen shows the latest information
 - the recording screen has an input of 40 characters by 11 lines
 - the status (mode number of empty character spaces cursor line column number) is displayed at the bottom of the screen



Status display

OVER/INSERT -- OVER Overwrite mode INSERT Insert mode

EDIT/VIEW --- EDOT Editing allowed VIEW Editing inhibited

Number of empty character spaces

Current cursor line

Current cursor column

Screen operation

The maintenance information screen has view mode and edit mode which are selected by pressing the **[END]** or **[EDIT]** soft key.

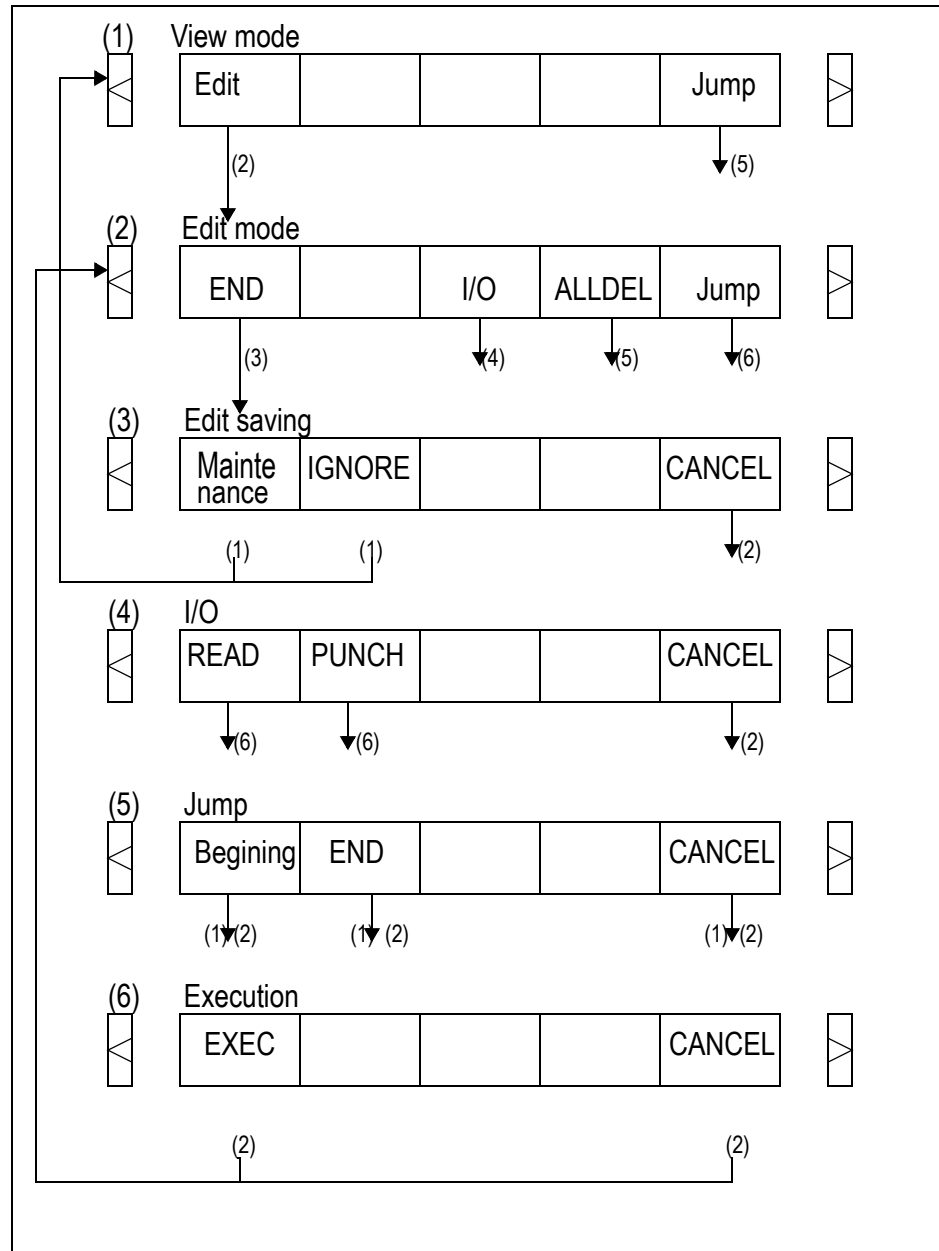
Initially view mode is selected. To start editing select edit mode by pressing the **[OPRT]** and **[EDIT]** keys. When the editing is completed press the **[END]** key. Then select **[STORE]** or **[IGNORE]**. Unless **[STORE]** is selected the edited data will be lost at next power-up. To scroll the screen showing the recorded information press a cursor key or page key on the MDI screen.

The following keys are used for editing (character input) and viewing.

Operation table

MODE	KEY	DESCRIPTION
View	Soft keys [EDIT] [JUMP]	Allows editing Displays the beginning or the end
	Cursor key	Scrolls the screen up or down
	Page key	Scrolls the screen up or down in units of whole screens
Edit	Soft keys [END] [ALLDEL]	Ends editing. Select whether to store the edited data Clears all maintenance information. (This key is enabled when the MDC bit (bit 3 of parameter 3118) is set to 1)
	[I/O] [JUMP]	Reads or punches the maintenance information Moves the cursor to the beginning or end
	Cursor key	Moves the cursor position up or down
	Page key	Scrolls the screen up or down in units of whole screens
	Alphanumeric/ special character key	Allows alphabetical numeric or special character input
	INSERT key	Select either insert mode or overwrite mode
	Function key	Deletes a single character
	CAN key	Deletes a single character before the cursor position
	INPUT key	Starts a new line

Operation of the soft keys



5.6.2 MAINTENANCE INFORMATION INPUT/OUTPUT

The maintenance can be read and punched:

When the maintenance information is input from or output to a memory card a file name MAINTINFDAT is used.

1. Format

_____ Data _____ % %

2. Reading

When a MAINTINFDAT file generated in the format shown above is read the data is added at the end of the existing maintenance information.

**NOTE**

A TAB code is converted to one to four blanks depending on the input position. Control codes (00H to 1FH) except TAB and LF are discarded in reading. %% cannot be input.

5.7 POWER MOTION MANAGER

When the Power Motion series is used as an additional axis (slave) of the CNC the power motion manager allows the slave data to be displayed and set by the CNC.

The power motion manager enables the following display and setting:

1. Current position display (absolute/machine coordinates)
2. Parameter display and setting
3. Diagnosis display
4. System configuration screen display
5. Alarm display

The Power Motion series that can be used as the slave is a β amplifier with I/O Link.

5.7.1 PARAMETER

	#7	#6	#5	#4	#3	#2	#1	#0
960		2CH	ASG	SLPWE	PMN	MD2	MD1	SLV

[Data type] Bit

SLV - - When the power motion manager is selected the screen shows the data of:

- 0 A single slave
- 1 Up to four slaves by dividing the screen into four segments

MD1, MD2 - -The slave parameters are input from and output to the following devices:

MD2	MD1	I/O device
0	0	Part program storage
0	1	Memory card

The parameters are input or output in the program format no matter which I/o device is selected.

PMN - - The power motion manager finction is:

- 0 Enabled
- 1 Disabled (Communication with the slave is not performed)

SLPWE - - Settings of slave parameters

- 0 Can be made by Power mate CNC manager regardless of the PWE setting
- 1 Are made according to the PWE setting

ASG - - Whether or not the number of bytes allocated to the input/output destination of the β amplifier with I/O links is 16

- 0 Is checked
- 1 Is not checked

2CH - - Power mate CNC manager

- 0 Communicates with channel 2
- 1 Communicates with channel 1

5.7.2 SCREEN DISPLAY

1. Press the function key.
2. Press the continuous menu key several times. The [PMM] soft key appears.
3. Press the [PMM] soft key. The system configuration screen which is the initial screen of the power motion manager appears. The screen has the following soft keys (function selection soft keys)

([POS] [] [] [SYSTEM] [MSG])

The currently active soft key is displayed in reverse video. Pressing a soft key enables the corresponding function as indicated below:

POS Current position display
 SYSTEM System information
 MSG Alarm list

To select another function after one of the functions listed above is selected press the return menu key several times until the soft keys are displayed as shown above. Then select the desired function.

4. To terminate the power motion manager repeatedly press the return menu key until the function selection keys are displayed as shown above. Then press the return menu key once more. The soft keys of the CNC system appear and the power motion manager terminates. The system configuration screen of this function is displayed as the termination screen.

Alternative termination method is to select another function while this function is enables. To do this press an MDI function key (**POS, PROG, ...**)



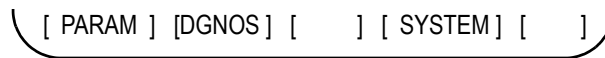
NOTE

After another screen is displayed by pressing a function key pressing the function key restores the initial status of this function. That is the soft keys shown above are restored. The data that was being input is canceled.

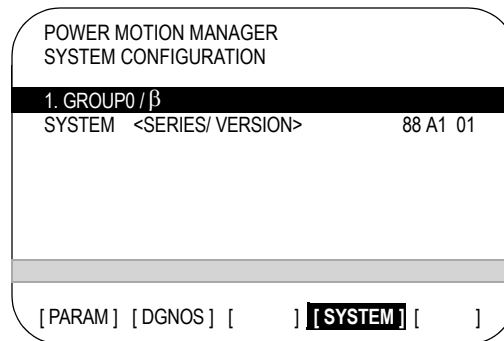
System configuration

This screen displays the system software information of the slave. The screen is displayed first when the power motion manager function is selected. This screen is automatically displayed also at the termination of hte function.

1. Press the [SYSTEM] function selection soft key. The following soft keys are displayed together with the screen displayed when SYSTEM was last selected. The currently active soft key is displayed in reverse video.



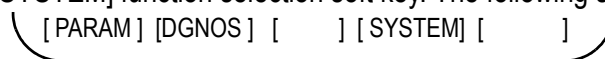
2. Press the [SYSTEM] soft key again. The system configuration screen appears. While this screen is displayed, the [SYSTEM] soft key is left displayed is reverse video.



Parameter screen

The parameters necessary for the functions of the slave must be specified in advance.

1. Press [SYSTEM] function selection soft key. The following soft keys appear:



2. Press the [PARAM] soft key. The parameter screen appears.

POWER MOTION MANAGER PARAMETER			
1. GROUP0 /β			
0000	00001000	0010	11110000
0001	00010101	0011	01010000
0002	11111011	0012	00000000
0003	00000000	0013	00000000
0004	00000000	0014	10110001
0005	10100001	0015	00000000
0006	00000000	0016	00000000
0007	10000000	0017	10000010
0008	00000000	0018	00000000
0009	00000000	0019	00000000

[PARAM] [DGNOS] [] [SYSTEM] []

The screen displays just the bit and decimal data.

Searching can be made for the parameter to be displayed.

1. Select the active slave.
2. Press the [(OPRT)] soft key. The following soft keys appear.

[NO.SRC]	[]	[]	[]	[INPUT]
----------	-----	-----	-----	-----------
3. Enter a desired number in the key-in field by using MDI numeric keys. Then, press the [NO.SRC] soft key. The search starts.

A parameter of a slave Power Motion unit can be directly set from the CNC.

1. Select the active slave.
2. Press the [OPRT] soft key. The following soft keys appear:

[NO.SRC]	[]	[]	[]	[INPUT]
----------	-----	-----	-----	-----------
3. Move the cursor to the parameter to be set.
4. Enter desired data in the key-in buffer by using MDI numeric keys. Then, press the [INPUT] soft key. Alternatively, press the MDI INPUT key.

Diagnosis screen

This screen shows the current status of the slave.

1. Press the [SYSTEM] function selection soft key. The following soft keys appear:

[PARAM] [DGNOS] [] [SYSTEM] []

2. Press the [DGNOS] soft key. The diagnosis screen appears. The displayed data is basically the same as the data displayed on the parameter screen,

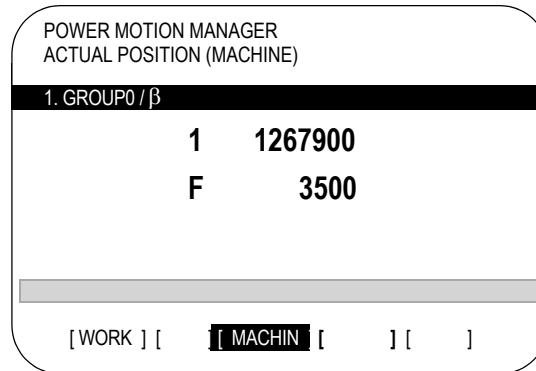
Current position display

The screen shows the current position on the workpiece coordinate system or machine coordinate system.

1. Press the [POS] function selections soft key. The following soft keys appear:

[WORK] [] [MACHIN] [] []

2. To see the absolute coordinate screen, press the [WORK] soft key. To see the machine coordinate screen, press the [MACHIN] soft key.

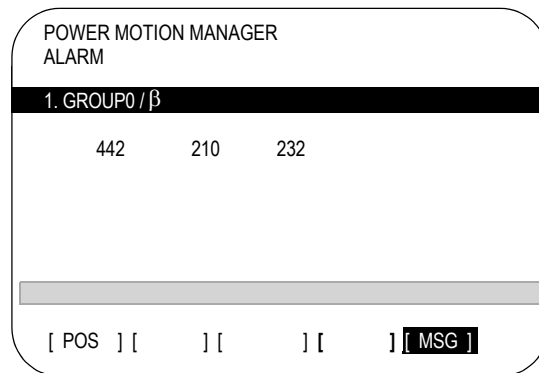


Alarm screen

If an alarm is issued during operation, the group number of the slave causing the alarm is indicated at the right end of the message field on the screen.

EXAMPLE: (13) means that the first and third power motion units are in the same alarm state.

1. Press the [MSG] function selection soft key. just the error code is displayed on the screen.



Up to forty (40) codes can be displayed on the screen.

Operating the active slave

The active slave is subjected to the ZOOM function, which will be described later, and parameter overwrite. The title of the active slave is displayed in a color different from the display color of the other slave titles.

The active slave can be selected by pressing the [NEXT] or [BACK] soft key, which is displayed after the continuous menu key is pressed several times.

NEXT: Displays the screen of the Power Motion unit connected after the currently active slave. The equipment other than the Power Motion unit is ignored.

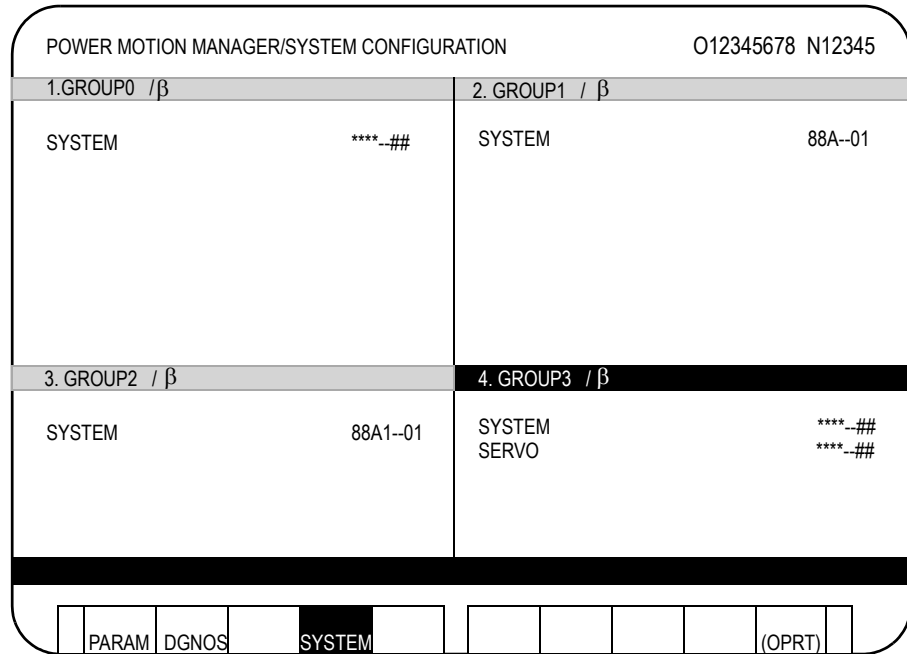
BACK: Displays the screen of the Power Motion unit connected before the currently active slave.

Single-slave display/four-slave display

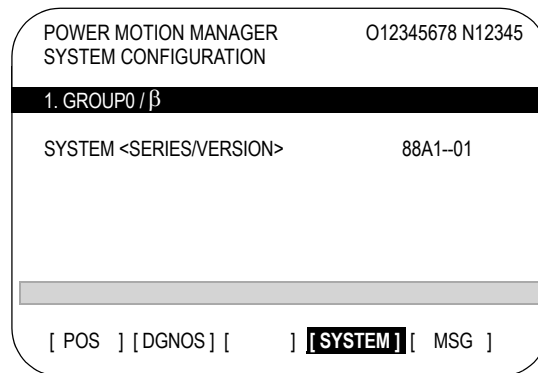
Whether the screen displays the data of just a single unit or of four units in four segments is specified in the SLV bit (bit 0 of parameter 960)

To switch the four-slave display to the single-slave display, press the [ZOOM] soft key, which is displayed after the continuous menu key is pressed several times. The single-slave display shows the data of the active slave. To switch the single-slave display to the four-slave display showing the data of four slave including the active slave, press the [ZOOM] key.

When five or more slaves are connected, the four-slave display has two or more pages. to see the slave data that is not displayed on the current page, press soft key [NEXT].



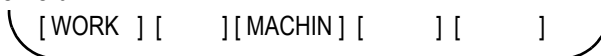
The figure above shows a sample four-slave display screen on a display unit with twelve soft keys. A unit with seven soft keys can also display the four-slave display screen.



The figure above shows a sample single-slave display screen on a display unit with seven soft keys. A unit with twelve soft keys can also display the single-slave display screen.



Guidance message

While the following soft keys are being displayed a guidance message is displayed in the message field.



[PARAM] [DGNOS] [] [SYSTEM] [(OPRT)]

[POS] [] [] [SYSTEM] [MSG]

When the soft keys are displayed as shown above SELECT ACTIVE   is displayed.

Key-in field

When the [(OPRT)] soft key is pressed the message line may turn into a key-in field as require. The numeric data input by using DMI keys is displayed after the prompt (>).

5.7.3 PARAMETER INPUT/OUTPUT

Saving parameters

Parameters can be saved in CNC memory or a memory card as a data file of program format. Specify the first digit of the registration program number in parameter 8760. programs with predetermined numbers are created for individual slaves. When the parameters are saved in CNC memory a program having the speicified program number is created. When the parameters are saved in a memory card a file is created to which the file name consists of the specified program number and an extension PMM.

EXAMPLE: When parameter 8760 is set to 8000.

The program number for group n is $8000+n*10$.

The group number n is indicated in the title area of each slave.

In case that the parameters are saved in a memory card if the specified program number already exists on memory card the corresponding program is overwritten with new data.

Specify a desired input device in the MD1 and MD2 bits (bits 1 and 2 of parameter 960). Connect a memory card. Alternatively check the free area of CNC memory. Then follow the steps given below:

1. Select the active slave.
2. Press the [(OPRT)] soft key.
3. Press the continuous menu key.

4. Press the [READ] soft key.
5. Press the [EXEC] soft key.

During input INPUT blinks in the message field.

Writing parameters

The data file of parameters saved in CNC memory or a memory card as a program is written into the slave determined by the program number. The program number and memory device are determined as described in Saving parameters.

1. Press the active slave.
2. Press the [(OPRT)] soft key.
3. Press the next-menu key.
4. Press the [PUNCH] soft key.
5. Press the [EXEC] soft key.

During input INPUT blinks in the message field.

The screen cannot be changed to another screen during parameter input/output.

When the RESET key is pressed or when an alarm status is detected in communication the input/output stops.

5.8 PERIODIC MAINTENANCE SCREENS

Using the periodic maintenance screens makes it easy to manage consumable (such as LCD unit backlight and backup battery) that are to be replaced periodically.

5.8.1 OVERVIEW

The following configuration

The following periodic maintenance screens are available.

- Status screen. Displays item names remaining service time countdown status and lets you specify item names.
- Setting screen. Lets you specify service life remaining service time and count type (countdown method).
- Machine system menu screen. Displays the names of registered consumable used in the NC.

Procedure

To use this function follow the steps below:

1. Select a number for registration (using the cursor key on the status screen)
2. Specify an item name
 - Selecting a name from a menu screen (machine or NC system menu screen)
 - Entering a name to the status screen directly from the MDI. Using the machine system menu screen requires that item names be registered previously.
3. Specify the service life remaining service time and count type for a target item.

Once they are specified the remaining service time can be checked on the status screen.

5.8.2 SCREEN DISPLAY AND SETTING

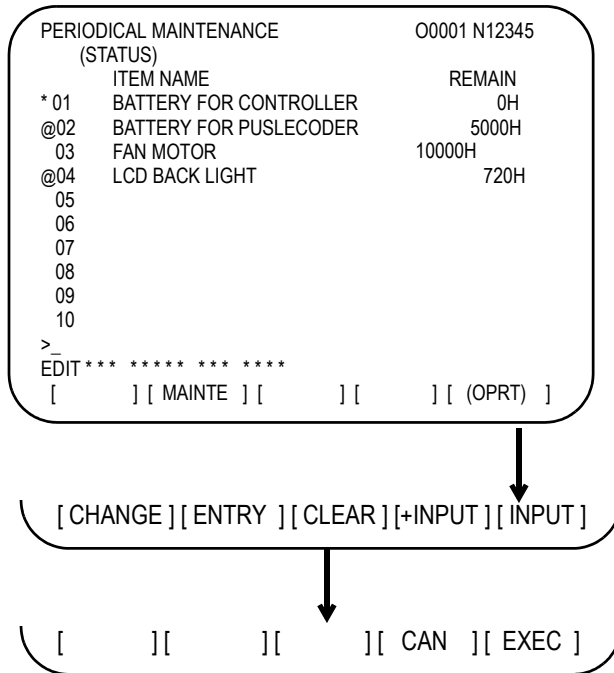
Follow the next steps:

1. Press the function key.
2. Press the continuous menu key several times. Soft key [MAINTE] appears.
3. Press soft key [MAINTE]. A periodic maintenance screen appears .

There are two periodic maintenance screens status and setting screens. Either screen can be selected using soft key [CHANGE].

5.8.3 STATUS SCREEN DISPLAY AND SETTING

Up to 10 consumable items can be registered for management. Their remaining service time and count status are displayed on the status screen.



Item name

The name of an item to be subjected to periodic maintenance is specified under ITEM name.

Two methods can be used to specify item names. The first method uses the menu screen and the second the MDI keypad.

1. Method of using the menu screen.

- place the cursor on the target item name and press soft key [ENTRY]. A menu screen appears. The menu screen is either the machine or NC system system.
- press soft key [MACIN] or [NC]. A machine system menu appears. It holds the names of consumables typical to the machine system or NC system.
- place the cursor on a registered item name and press soft key [SELECT] then soft key [EXEC]. The status screen appears again enabling the selected item to be set up.
- press soft key [CAN]. The previous soft key displays appear again.
- press soft key [MAINTE]. The status screen appears again.

Using the machine system menu screen requires that item names be registered on the screen previously.

This can be done using two methods (a) and (b).

(a). Program-based registration.

Executing a program in the following format enables item names to be registered on the machine system menu screen.

G10 L61 Px [n]

x Registration number

n Item name
[Alphanumeric characters two-byte characters
alphanumeric characters].

(b). MDI keypad-based registration.

An item name can be registered on the machine system menu screen by first entering it in the following format then pressing soft key [INPUT].

Pressing soft key [+INPUT] adds the item name to the list of previously registered item names.

Alphanumeric characters two-bytes characters alphanumeric characters.

The two-byte characters shall comply with the FANUC code.

When entering a two-byte character sandwich it with a * pair.

The item name can consist of up to 24 alphanumeric characters (if no two-byte character is included) or 12 two-byte characters (if no alphanumeric character is included).

EXAMPLE: To register LCD backlight enter

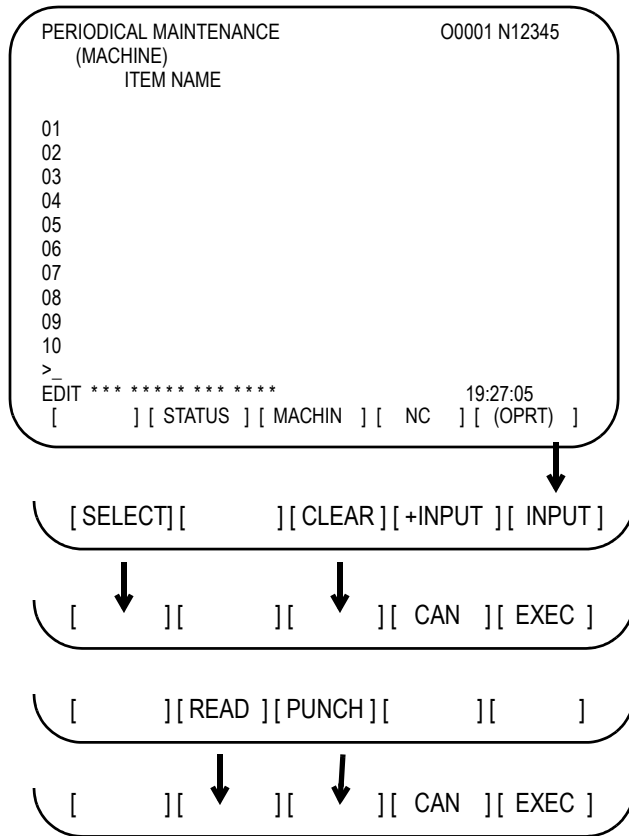
```
>LCD*110E10F410CC114010B610FE_
```

**NOTE**

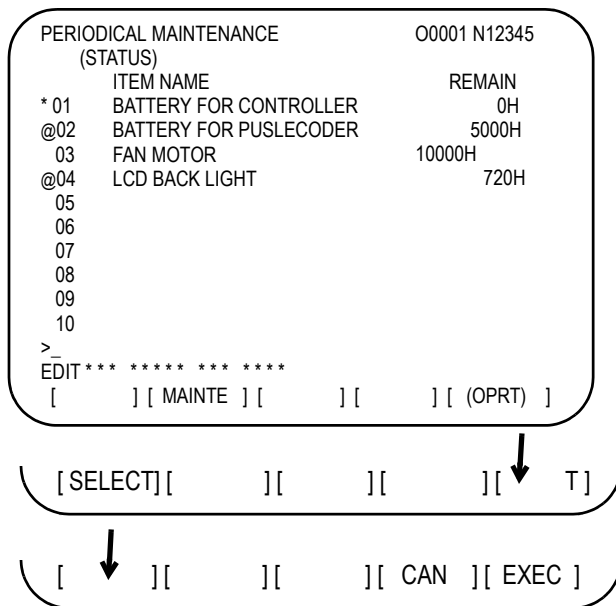
* cannot be used in item names because it is used as control code [] (or) also cannot be used in item names.

To erase the registered data for an item place the cursor on the target item name and press soft key [CLEAR] then soft key [EXEC].

[Machine system] menu screen:



[NC system] menu screen:



**NOTE**

On the CNC system screen no item name can be registered erased input or output.

2. MDI keypad-based setting.

An item name can be registered on the status screen by first entering it in the following format using keys then pressing soft key [INPUT]. Pressing soft key [+INPUT] adds the item name to the list of previously registered item names.

Alphanumeric characters two-bytes characters alphanumeric characters.

The two-bytes characters shall comply with the FANUC code.

When entering a two-byte character using keys sandwich it with an * pair.

The item name can consist of up to 24 alphanumeric characters (of no two-byte character is included) or 12 two-byte characters (if no alphanumeric character is included)

EXAMPLE: To register LCD backlight enter

>LCD*110E10F410CC114010B610FE_

**NOTE**

* cannot be used in item names because it is used as control code [] (or) also cannot be used in it names.

To erase the registered data for an item place the cursor on the target item nam press soft key [CLEAR] then [EXEC].

When an item name is deleted the related service life remaining service time and count type are also deleted.

3. Remaining service time.

The remaining service time of an item (the time allowed before the item is replaced) is obtained by count-down and displayed under remaining service time. When the remaining service time decreases to a specified percentage (specified in parameter No 8911) of the service life or lower it is displayed in red.

Count-down continues even after the rservice life has expired.

**NOTE**

Setting is impossible on the status screen. it should be done on the setting screen.

4. Count status.

The count status is displayed at the left of the corresponding item number as listed below:

DISPLAY	COUNT STATUS
Blank	Count suspended
@	Count inder way
	The service life has expired

5.9 LANGUAGE SETUP

MACRO VARIABLE	VALUE	LANGUAGE
#598	0	English
	1	Japanese
	2	Germany
	3	French
	4	Chinese
	5	Italian
	6	Korea
	7	Spanish
	8	Dutch
	9	Portuguese

1. Change the language setting in the macro variable table.
 - Press **[OFFSET/SETTING]** key on the MDI panel.
 - Press once or twice on the LCD screen until **MACRO** soft key comes out.
 - Press **[MACRO]** soft key on the LCD screen.
 - Input **"598"** on the MDI panel.
 - Press **NO.SRH** on the LCD screen, the variable No. 598 will be displayed on the LCD screen.
 - Input **"VALUE"** number (value number depends on the language, see table above) from the MDI panel.
 - Press **[INPUT]** from the MDI panel.

2. Run the production program P8820 to enable the ENGLISH language option.
 - Press **[EDIT]** key to select edit mode.
 - Press **[PROG]** key on the MDI panel.
 - Press **[DIR]** soft key on the LCD screen.
 - Input **O8820**.
 - Press **[INPUT]** key on the MDI panel.
 - Press **[O.SRH]** soft key on the LCD screen, make sure that program comes out on the screen.
 - Press **[AUTO]** key on the machine pendant
 - Press **[DOOR OVR]** key on the machine pendant until the door override is enabled.
 - Press **[CYCLE START]** key on the machine pendant.

3. Cycle the CNC power.

4. Check the following screen on the CNC. If screen displays with the right language, the software insatallation is successful. Otherwise, repeat steps above all over again.

Follow these step to setup any language.

EXAMPLE:

ENGLISH

JAPANESE

GERMAN

IST-POSITION 08809 N00000

(ABSOLUT)		(MASCHINE)		(RESTWEG)	
X	-0.002	X	-0.002	X	0.000
Y	-0.001	Y	-0.001	Y	0.000
Z	-0.748	Z	-0.748	Z	0.000

(MODAL)

G00	G40	G97	F	M
G17	G49	G54		
G90	G80	G64	H	
G22	G98	G69	D	T
G94	G50	G15		
G21	G67	G25	S	
			IST-S	0

F MM/MIN

JOG F 17700 WSTK. ZAEHL. 5000
LAUFZEIT 113H 0M VORSCH-ZEIT 0H 0M 0S

S 0 T00000000

MDI **** * * * * 07:42:33

ABS REL ALLE (BETR)

FRENCH

POSITION PRESENTE 08809 N00000

(ABSOLU)		(MACHINE)		(RESTE)	
X	-0.002	X	-0.002	X	0.000
Y	-0.001	Y	-0.001	Y	0.000
Z	-0.755	Z	-0.755	Z	0.000

(MODAL)

G00	G40	G97	F	M
G17	G49	G54		
G90	G80	G64	H	
G22	G98	G69	D	T
G94	G50	G15		
G21	G67	G25	S	
			SACT	0

F MM/M

MAN F 17700 PIECE COMPT 5000
TEMPS OPER 113H 0M TEMPS CYCL 0H 0M 0S

S 0 T00000000

MDI **** * * * * 07:46:54

ABSOLU RELATI TOUS (OPRT)

CHINESE

現在位置 08809 N00000

<絕對座標> X -0.002 Y -0.001 Z -0.760		<機械座標> X -0.002 Y -0.001 Z -0.760		<余移動量> X 0.000 Y 0.000 Z 0.000	
--------------------------------------------	--	--------------------------------------------	--	-----------------------------------------	--

<持續>

600	640	697	F	M
617	649	654		
690	680	664	H	
622	698	669	D	T
694	650	615		
621	667	625	S	
			SACT	0

F 0 MM/分

JOG F 17780 加工部品數 5088
 運轉時間 113H 8M 切削時間 0H 0M 0S

S 0 T00000000

MDI **** * 07:50:36

絕對 相對 綜合 (操作)

ITALIAN

POSIZIONE ATTUALE 08809 N00000

<ASSOLUTO> X -0.002 Y -0.001 Z -0.762		<MACCHINA> X -0.002 Y -0.001 Z -0.762		<DIST MANCANTE> X 0.000 Y 0.000 Z 0.000	
------------------------------------------------	--	------------------------------------------------	--	--------------------------------------------------	--

<MODALE>

600	640	697	F	M
617	649	654		
690	680	664	H	
622	698	669	D	T
694	650	615		
621	667	625	S	
			SACT	0

F 0 MM/M

MAN F 17780 CONT PEZZI 5088
 TMP LAV 113H 8M TMP CICLO 0H 0M 0S

S 0 T00000000

MDI **** * 07:55:59

ASSOLT REL TUTTO (OPRT)

KOREAN

현재위치 08809 N00000

〈절대좌표〉		〈기계좌표〉		〈남은거리〉	
X	-0.002	X	-0.002	X	0.000
Y	-0.001	Y	-0.001	Y	0.000
Z	-0.766	Z	-0.766	Z	0.000

〈계속유호〉

G00	G40	G97	F	M
G17	G49	G54		
G90	G80	G64	H	
G22	G98	G69	D	T
G94	G50	G15		
G21	G67	G25	S	

실속도 0

F 0 MM/분

JOG F 17780 가공부품수 5088
 자동시간 113H 8M 절삭시간 0H 0M 0S

S 0 T00000000

MDI ***** 08:00:27

절대 상대 전부 〈조작〉

SPANISH

POSICION ACTIVA 08809 N00000

〈ABSOLUTAS〉		〈MECANICAS〉		〈DISTANCIA A IR〉	
X	-0.002	X	-0.002	X	0.000
Y	-0.001	Y	-0.001	Y	0.000
Z	-0.768	Z	-0.768	Z	0.000

〈MODAL〉

G00	G40	G97	F	M
G17	G49	G54		
G90	G80	G64	H	
G22	G98	G69	D	T
G94	G50	G15		
G21	G67	G25	S	

SACT 0

F 0 MM/M

P/P F 17780 PART CALC 5088
 TIEM OPE 113H 8M TIEM CICLO 0H 0M 0S

S 0 T00000000

MDI ***** 08:03:39

ABSOLU RELATI TODO 〈OPRD〉

DUTCH

HUIDIGE POSITIE
08809 N00000

<p><ABSOLUUT></p> <p>X -0.002</p> <p>Y -0.001</p> <p>Z -0.768</p>	<p><MACHINE></p> <p>X -0.002</p> <p>Y -0.001</p> <p>Z -0.768</p>	<p><WEG TE GAAN></p> <p>X 0.000</p> <p>Y 0.000</p> <p>Z 0.000</p>
--------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------

<p><MODAAL></p> <p>G00 G40 G97 F M</p> <p>G17 G49 G54</p> <p>G90 G80 G64 H </p> <p>G22 G98 G69 D T</p> <p>G94 G50 G15</p> <p>G21 G67 G25 S </p> <p style="text-align: right;">SACT 0</p>	<p>F 0 MM/M</p> <p>JOG F 17700 STUKSTELLER 5000</p> <p>LOOP TIJD 113H 0M CYCLUS TIJD 0H 0M 0S</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

S 0 T00000000

MDI **** * 08:08:08

ABS

REL

ALLES

(OPRT)

PORTUGUESE

POSICAO ATUAL
08809 N00000

<p><ABSOLUTO></p> <p>X -0.002</p> <p>Y -0.001</p> <p>Z -0.769</p>	<p><MAQUINA></p> <p>X -0.002</p> <p>Y -0.001</p> <p>Z -0.769</p>	<p><DIST. A PERCORRER></p> <p>X 0.000</p> <p>Y 0.000</p> <p>Z 0.000</p>
--------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------

<p><MODAL></p> <p>G00 G40 G97 F M</p> <p>G17 G49 G54</p> <p>G90 G80 G64 H </p> <p>G22 G98 G69 D T</p> <p>G94 G50 G15</p> <p>G21 G67 G25 S </p> <p style="text-align: right;">SATUAL 0</p>	<p>F 0 MM/MIN</p> <p>F MAN 17700 CONT. PECAS 5000</p> <p>TEMPO TRAB 113H 0M TEMPO CICLO 0H 0M 0S</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

S 0 T00000000

MDI **** * 08:10:45

ABS

REL

TUDO

(OPRT)

**5.10 FINAL FILES
BACKUP PROCEDURE**

Follow these steps:

I STEP:**Prepare operation**

1. Smoothly put the COMPACT FLASH CARD inside the M-CARD slot of LCD.
2. Press EDIT PB. to change edit mode.
3. Press SYSTEM on the MDI panel until parameter screen comes out.
4. Press “+” twice using the soft key until ALL IO displays below the LCD.
5. Press ALL IO.

Backup the parameter

6. Press “<” to return to the previous page.
7. Press PARAMETER.
8. Press OPRT.
9. Press PUNCH.
10. Press EXEC.

Backup the MACRO

11. Press “<” to return to the previous page.
12. Press “+” to the next page.
13. Press MACRO
14. Press OPRT
15. Press PUNCH
16. Press EXEC

Backup the PITCH

17. Press “<” to return to the previous page.

18. Press PITCH.
19. Press OPRT.
20. Press PUNCH.
21. Press EXEC.

II STEP:**Backup the PLC software**

1. Put the flash card into the slot on the LCD.
2. Press EDIT PB. to change edit mode.
3. Press SYSTEM on the MDI panel until parameter screen comes out.
4. Press PMC soft key.
5. Press I/O
6. Select the page as following (move the cursor, and use key to select the correct data type);

M-card
Write
Ladder
PMC-SB.000
7. Press EXEC.

Backup the PLC parameter

8. Move the cursor to the DATA TYPE.
9. Press PARAM soft key on the LCD.
10. Select the page as following;

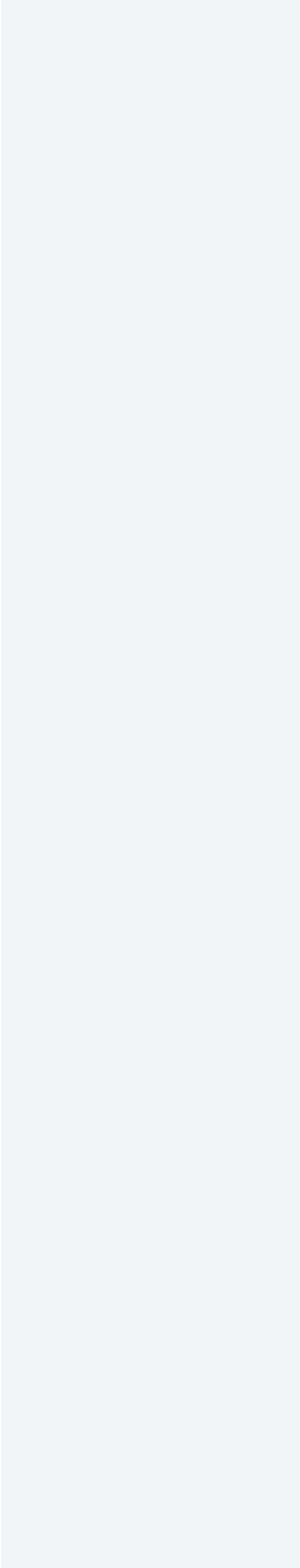
M-card
Write
PARAM
PMC-SB.PRM
11. Press EXEC.

III STEP:**Sram backup procedure**

1. Power of the machine.
2. Put the flash card into the slot.
3. Press the most right side two soft key on the LCD screen and hold.
4. Wait until the CNC system screen comes out.
5. Wait until the CNC system screen displays.
6. Press the DOWN soft key to move the cursor to the item 5 (highlighted).

System data backup

7. Press SELECT soft key will display two choices
 “1. SRAM BACKUP (CNC -----Flash Card)”
 “2.”
8. Make sure the cursor is in the first line.
9. Press SELECT soft key and you will be asked “Backup SRAM Data OK?”
10. Select “YES” to continue (or “NO” to return to the previous menu).
11. Wait a few seconds. The screen will display complete information.
12. Press SELECT soft key.
13. Press DOWN soft key until the cursor moves to item : END.
14. Press SELECT.
15. Press DOWN soft key until the cursor moves to item : END.
16. Press SELECT.
17. Press “YES”.
18. End, the CNC system will boot up..



6.0 OPTIONS SETUP

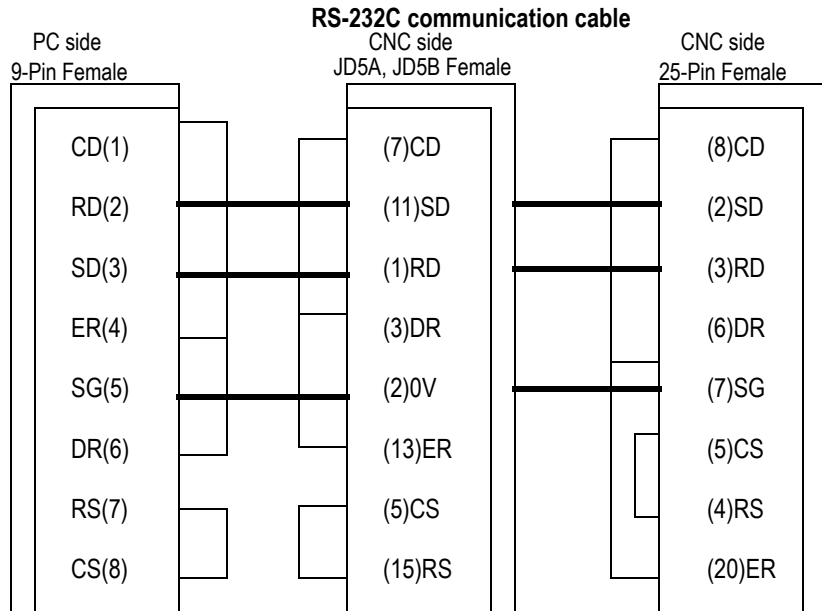
6.1 FANUC SOFTWARE INSTALLATION PROCEDURE

6.1.1. OPTION INSTALLATION PROCESS

Find the activation key from the Fanuc SFT-xxxx floppy disk. The activation key is located at the A disk: **SFT-0095.txt** second paragraph. Write down this number on your paper.

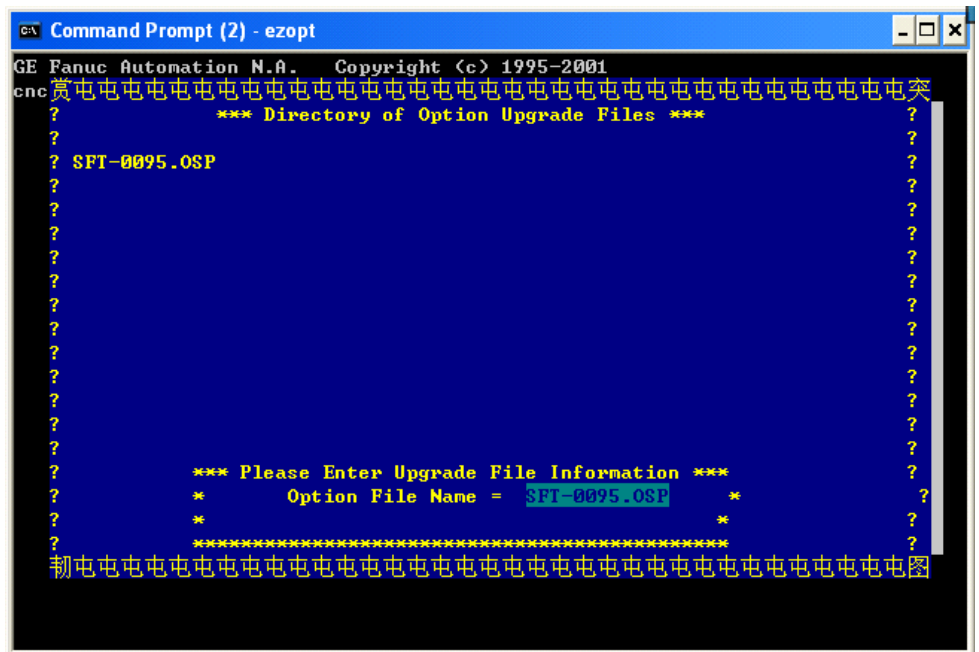
1. Install any hardware required by the Fanuc option before installing software options.
2. Move all the axes **XYZAB** to the cold start position.
3. Backup all the files (including SRAM) according to files backup procedure. (See Fanuc control, section 5.0)
4. Verify whether **RS232C serial data cable** is connected from JD5A of Fanuc CNC to the COM1 port of your PC.

PC 9 pin RS232C port ----- CNC JD5A (RS232-1)port.



5. From the Fanuc control, run the program O8850 to activate the communication parameter:
 - Press **EDIT** key on the pendant.
 - Press **PROG** key on the MDI panel.
 - Press **DIR** soft key on the LCD screen.
 - Input **O8850**.

- Press **NO.SRH** soft key on the LCD screen, the program will display on the screen.
 - Press **DOOR OVR** (the light above the DOOR OVR should flick).
 - Press **AUTO** key on the pendant.
 - Press **CYCLE START** key to run the program.
 - Make sure the program is finished and **M30** is displayed on the screen area.
6. Boot your computer from A drive using the **MS-DOS boot disk**.
 - Insert the **MS-DOS boot disk** into the floppy drive A of PC.
 - Restart the computer.
 - Wait until the system boot up and display **A: />**
 7. Take MS-DOS disk out of the A drive of PC, and then put Fanuc software option disk (SFT-0095) in drive A of PC.
 8. Type **EZOPT** on the PC and press **ENTER** key on the PC keyboard.
 9. The following screen displays on the PC, then enter the filename as shown at the top left of screen.



10. Once this screen displays on the PC, enter the activation key which is from the **SFT-0095.txt** and press ENTER.



NOTE

ACTIVATION KEY is located in the A disk file: SFT-0095.txt second paragraph.
 44A728229-G01 EZOPT(TM) CNC OPTION INSTALLATION UTILITY for GE
 Fanuc series 0C, 15A/B, 16B/C, 18B/C, and all series i controls.

Prepared: 02/01/05 12:50:17 for FADAL

CNC type: S18i Serial number: SFT-0095

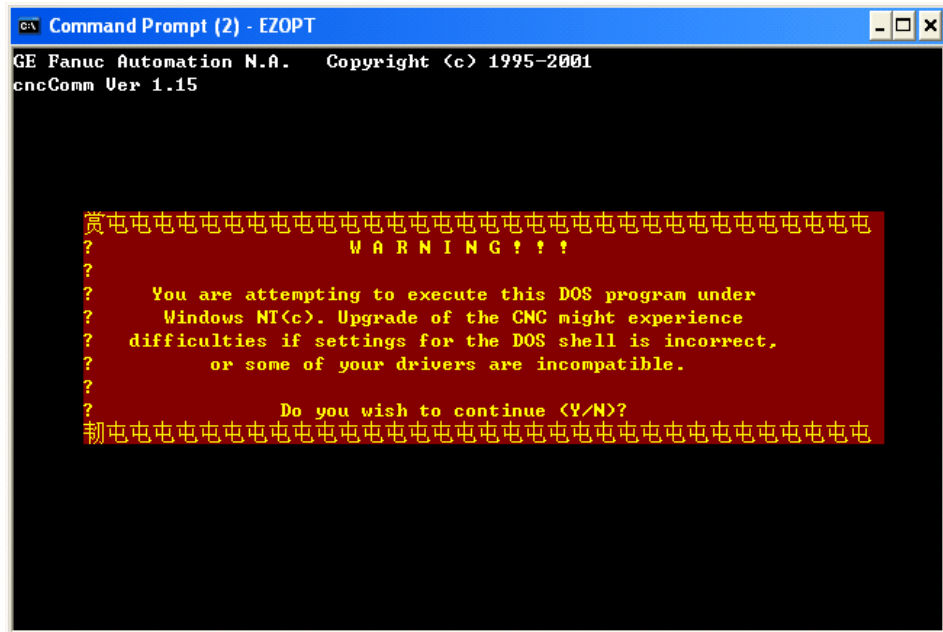
GE Fanuc Order: 44A733128-G10R00, Customer PO: **CONTROL AXIS**

DETACH

Activation key: 948A8372

Follow instructions on the PC to computer the option installation. Help is available for each step. I you experience a LINK FAILURE error message, review the *README.TXT* file again

11. The system displays the following screen on the PC.



- Press "Y " (yes) on the PC, the system will enter another screen.
- Press "Y" on the PC again, the system will display another screen.
- SYSTEM** → **PARAM** → **OPRT** → + → **PUNCH** → **ALL** → **EXEC**
- Press "Y" on the PC.
- Press "C" (continue) 7 (seven) times on the PC.
- Press "0" on the PC.
- Press "C" on the PC.
- Select **EDIT** mode on the Fanuc control, then press "Y" on the PC.

12. Release the E-stop on the machine pendant until the CNC did not indicate an alarm on the screen, then press "Y" on the PC.

13. Verify whether series cable is connected from PC to Fanuc CNC, then press “Y” on the PC.
14. Check the download link:
 - Quickly press following keys and soft keys on the Fanuc control:
 - Until the PC displays press **MDI** and **RESET**, then press **MDI** key and **RESET** key on the machine pendant.
 - Press “Y” on the PC if screen displays saying, “Link Ok Continue?”
 - Press **EDIT** on the pendant again.
 - ** Press “Y” on the PC to repeat step 14. (above) if download link check has failed.
15. Download parameters
 - Quickly press following keys and soft keys on the Fanuc control:
SYSTEM → **PARAM** → **OPRT** → **+** → **PUNCH** → **ALL** → **EXEC**
 - Press “Y” on the PC until the screen displays saying, “Download ok Continue?”
 - ** Press “Y” on the PC to repeat step 15. (above) if download parameter has failed.
16. Select “**MDI**” mode on the machine pendant, then press “Y” on the PC.
17. Press E-stop switch on the machine pendant until the CNC enters the E-stop status, then press “**C**” on the PC.
18. Upload link check.
 - Quickly press following keys and soft keys on the Fanuc control:
SYSTEM → **PARAM** → **OPRT** → **+** → **READ** → **EXEC**
 - Press “Y” on the PC until the screen displays saying, “Option successfully updated?”
 - Press “Y” on the PC to repeat step 18. (above) if upload parameter has failed.
19. Cycle the CNC power. Once CNC displays the “normal” screen press “**C**” on the PC.
20. Press any key to exit the Fanuc software update program.
21. Check all the files and make sure that files still are in the system. (Program library, CNC parameter, PMC parameter, PMC ladder, Pitch compensation, Offset, Macro Variable.)
22. Set a new cold start position on the machine according the “Cold start procedure” (See *Machine Cold Start Setup, Section 6.2, MAN-0121-R1*).

23. Run the program O8851 to recover the communication parameter to original one.
 - Press EDIT key on the pendant.
 - Press PROG key on the MDI panel.
 - Press DIR soft key on the LCD screen.
 - Input O8851.
 - Press NO.SRH soft key on the LCD screen, the program will display on the screen.
 - Press DOOR OVR (the light above the DOOR OVR key should flick).
 - Press AUTO key on the pendant.
 - Press CYCLE START key to run the program.
 - Make sure the program is completed and M30 is displayed on the screen area.
24. Load backup pacific files from the flashcard to CNC and make sure if files still are in the system.
25. Setup is completed.

6.2 MACHINE COLD START SETUP

Fadal Fanuc VMC comes with absolute encoders which is setup at Fadal already. The machine will remember the position even if it is powered off. We need to remake the cold start position if the alarm No.300 appears on the screen which can be caused by a low battery or disconnect the servo motor encoder.

Follow the next procedure:

1. Prepare: In MDI mode input G21 to change machine to Metric display.
 - 1.1 Press the MDI push button on the operator panel A.
 - 1.2 Press PROGRAM key one/two times on the MDI panel until PROGRAM (MDI) screen is displayed.
 - 1.3 Press G21 using MDI panel.
 - 1.4 Press EOB key on the MDI panel.
 - 1.5 Press INSERT key.
 - 1.6 Press CYCLE START push button on the operator panel A.
 - 1.7 Make sure the screen is changed to Metric Mode (X***,*** is displayed).
 - 1.8 Press REF RETURN push button on the operator panel A.
 - 1.9 Press Z push button on the operator panel A (Manual Z axis zero return).
 - 1.10 Press X push button on the operator panel A (Manual X axis zero return).
 - 1.11 Press Y push button on the operator panel A (Manual Y axis zero return).
 - 1.12 Preparation is done.
2. Install the tool.
 - 2.1 Press JOG push button on the operator panel A.
 - 2.2 Press TOOL REL push button on the operator panel and keep it. (Draw Bar will be released)
 - 2.3 Put the tool inside of spindle nose.
 - 2.4 Release the TOOL REL push button.
3. Find out X axis zero position manually, make the cold start.
 - 3.1 Press HANDLE and select MPG mode, press X1/X10/X100 to select MPG resolution, and press X select to select X axis.
 - 3.2 Use TAPE MEASURE find out the X axis middle point of the table, and make a mark.

- 3.3 Use MPG move the X axis to the X axis middle position mark.
- 3.4 Record the X coordinate displayed on the CNC screen as A.
- 3.5 Press MDI push button on the operator panel A.
- 3.6 Press SYSTEM key on the MDI panel.
- 3.7 Press PARAMETER soft key below the LCD screen.
- 3.8 Press 1850 using MDI panel.
- 3.9 Press NO.SRH soft key below the LCD screen (Parameter 1850 will be displayed).
- 3.10 Move the cursor to X.
- 3.11 Press the X coordinator as following format: 34560 (3.456x10000).
- 3.12 Press INPUT key on the MDI panel (34560 will be displayed on the parameter 1850X column)
***Alarm 000 will pop up on the alarm window.
- 3.13 Power OFF the CNC (Press "O" button on the operator panel B).
- 3.14 Power ON the CNC (Press "T" button on the operator panel B).
***Alarm 300X will be displayed on the screen (it is normal).
- 3.15 Press JOG push button on the operator panel A.
- 3.16 Press X push button on the operator panel A.
- 3.17 Press "-" minus push button to move the X axis 55.0mm or more (press "+" push button if machine is 2016, 3016, EMCD, 2216).
- 3.18 Press "+" plus push button to move the X axis middle position (press "-" push button if machine is 2016, 3016, EMCD, 2216).
- 3.19 Press REF RETURN push button.
- 3.20 Press X push button. (X axis will automatically move to the zero position)
- 3.21 In case if zero position is wrong, repeat the previous steps starting with pressing MDI push button of the operator panel A.
- 3.22 Double check the cold start position using tape measure.
- 3.23 Press RESET key on the MDI panel. That will reset the 300 alarm.
4. Find out Y axis zero position manually, make the cold start.
 - 4.1 Install the indicator on the spindle.
 - 4.2 Repeat the same procedure as 4.1-4.23 to find out the Y axis cold start position.

5. Find out Z axis zero position manually, make the cold start.
 - 5.1 Install tool on the arm (DATC) or Magazine (ATC).
 - 5.2 Measure the height of the tool.
 - 5.3 Install the tool on the spindle.
 - 5.4 Use MPG move the Z axis to the same height as the tool on the ARM/Magazine.
 - 5.5 Repeat the same procedure as 4.5-1.23 to find out the Z axis cold start position.
6. Repeat the same procedure for A/B axis.
7. Cold Start setup is finished.

6.3 TOOL OFFSET SETUP

Fanuc Software option related with tool offset.

6.3.1 TOOL OFFSET 200 PAIRS

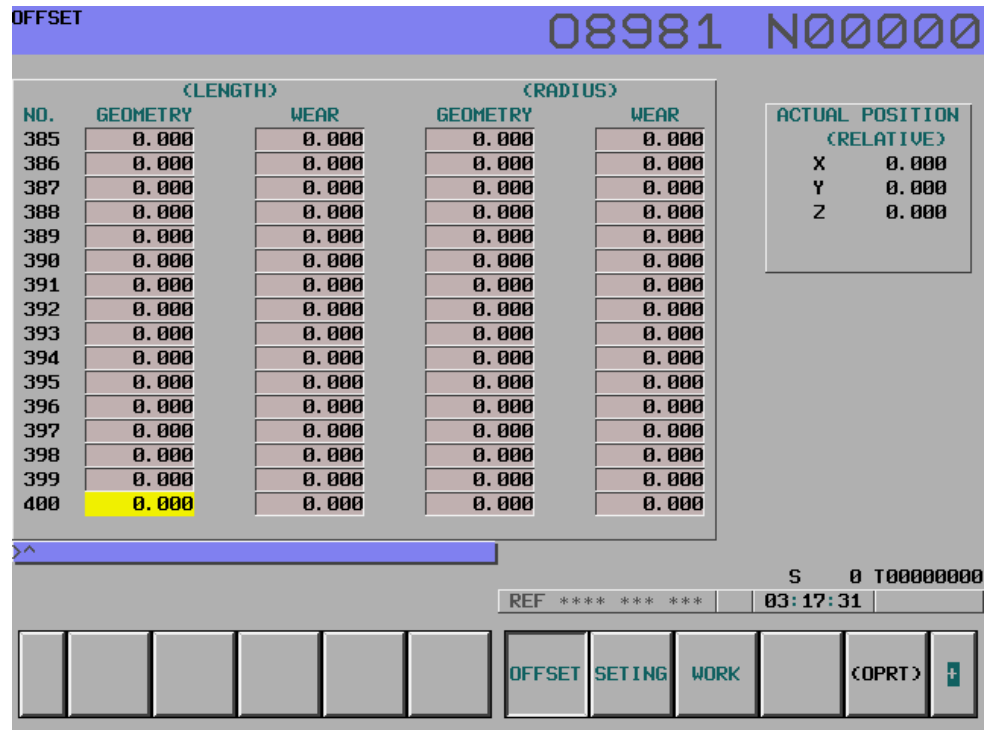
1. Update the software option from EZOPT disk according to Fanuc Software Option Installation Procedure. (See Option Installation process, section 6.1.1)
2. Cycle the CNC power.
3. Follow these steps to display the following screen:
 - Press **OFFSET/SETTING** key on the MDI panel.
 - Press **OFFSET** soft key on the LCD screen.
 - Press **PAGE UP** key once on the MDI screen.
 - Check the following screen on the CNC. If **200 pairs** offset appears on the screen, the software installation is successful. Otherwise, repeat all the steps above all over again.

LENGTH		RADIUS		ACTUAL POSITION (RELATIVE)
NO.	GEOMETRY	WEAR	GEOMETRY	
193	0.000	0.000	0.000	X 0.000
194	0.000	0.000	0.000	Y 0.000
195	0.000	0.000	0.000	Z 0.000
196	0.000	0.000	0.000	
197	0.000	0.000	0.000	
198	0.000	0.000	0.000	
199	0.000	0.000	0.000	
200	0.000	0.000	0.000	

6.3.2 TOOL OFFSET 400 PAIRS

1. Update the software option form EZOPT disk according to Fanuc Software Option Installation Procedure. (See section 6.1, MAN-0121 R1)
2. Cycle the CNC power.
3. Follow these steps to display the following screen.
 - Press **OFFSET/SETTING** key on the MDI panel.
 - Press **OFFSET** soft key on the LCD screen.

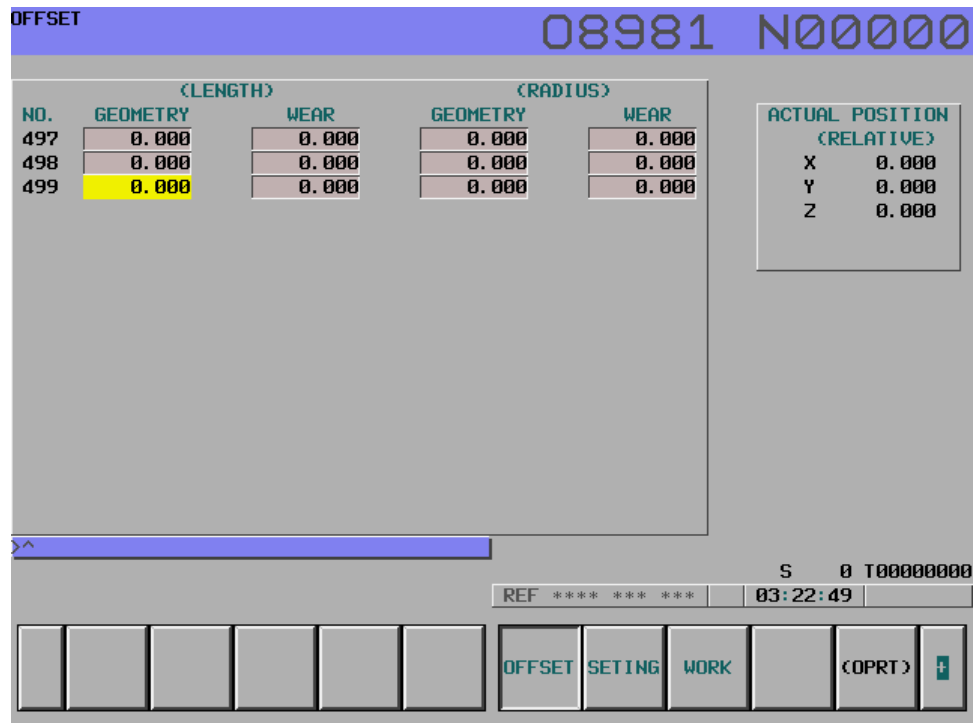
- Press **PAGE UP** key once on the MDI pane.
- Check the following screen on the CNC. If **400 pairs** offset appears on the screen, the software installation is successful. Otherwise, repeat all the steps above all over again.



6.3.3 TOOL OFFSET
499 PAIRS

1. Update the software option form EZOPT disk according to Fanuc Software Option Installation Procedure. (See section 6.1, MAN-0121 R1)
2. Cycle the CNC power.
3. Follow these steps to display the following screen.
 - Press **OFFSET/SETTING** key on the MDI panel.
 - Press **OFFSET** soft key on the LCD screen.
 - Press **PAGE UP** key once on the MDI pane.
 - Check the following screen on the CNC. If **499 pairs** offset appears on the screen, the software installation is successful. Otherwise, repeat all the steps above all

over again.



6.3.4 TOOL OFFSET 999 PAIRS

1. Update the software option form EZOPT disk according to Fanuc Software Option Installation Procedure. (See section 6.1, MAN-0121 R1)
2. Cycle the CNC power.
3. Follow these steps to display the following screen.
 - Press **OFFSET/SETTING** key on the MDI panel.
 - Press **OFFSET** soft key on the LCD screen.
 - Press **PAGE UP** key once on the MDI pane.
 - Check the following screen on the CNC. If **999 pairs** offset appears on the screen, the software installation is successful. Otherwise, repeat all the steps above all over again.

OFFSET 08981 N00000

NO.	<LENGTH>		<RADIUS>		ACTUAL POSITION <RELATIVE>
	GEOMETRY	WEAR	GEOMETRY	WEAR	
993	0.000	0.000	0.000	0.000	X 0.000 Y 0.000 Z 0.000
994	0.000	0.000	0.000	0.000	
995	0.000	0.000	0.000	0.000	
996	0.000	0.000	0.000	0.000	
997	0.000	0.000	0.000	0.000	
998	0.000	0.000	0.000	0.000	
999	0.000	0.000	0.000	0.000	

S 0 T00000000

REF **** * * * * 03:41:53

OFFSET SETING WORK <OPRT>

6.4 MULTI STEP SKIP

Follow the next procedure:

1. Update the software option from EZOPT disk according to the Fanuc Software Option Installation Procedure. (See section 6.1, MAN-0121 R1)
2. Install the probe hardware and make sure that signal is working properly **TS27R**, **MP12**.
3. Input the testing program O5004 from EDIT mode.

O5004 (MULTI STEP SKIP)

N01 G01 G90

N02 G28X0Y0Z0

N03 G31P1X5.0F10.0

N04 G31P2Y5.0F10.0

N05 G31P3Z-5.0F10.0

N06 M30

4. Run the testing program O5004 from AUTO mode.
 - Press **EDIT** key to select edit mode.
 - Press **PROG** key on the MDI panel.
 - Press **DIR** soft key on the LCD screen.
 - Input **O5004**.
 - Press **INPUT** key on the MDI panel.
 - Press **O.SRH** soft key on the LCD screen, make sure that program displays on the screen.
 - Press **AUTO** key on the machine pendant.
 - Press **DOOR OVR** key on the machine pendant until the door override is enabled.
 - Press **CYCLE START** key on the machine pendant.
5. Press the probe head to trig the probe **MP12** when the program is running at block N03. If program skips to the next block N04 as soon as one trig the probe, MP12 is working.
6. Press the probe head to trig the probe **TR27R** when the program is running at block N04. If program skips to the next block N05 as soon as one trig the probe, TS27R is working.
7. Block the beam of NC1 to trig the probe **NC1** when the program is running at block N05. If program skips to the next block N06 as soon as one trig the probe, NC1 is working.
8. If steps from 5. through 7. are succeeded without an alarm alert, the software installation is successful. Otherwise, repeat these steps all over again.

**6.5 OPTION SETUP
PROCEDURE FOR K
BITS**

1. Setup the machine type.

- 1.1 Push the OFFSET/setting key to select offset screen, push the “+” soft key below the LCD to find out MACRO soft key, and then select it.
- 1.2 Input 599.
- 1.3 Press “O>SRH”, the No.599 variable will be displayed on the current screen.
- 1.4 Input the machine type according the machine.

EXAMPLE: Input 4020 if machine is 4020

Input 4525 if machine is 4525

- 1.5 Press INPUT key to input the data to the variable No.599.
- 1.6 Move the cursor to the No.600, repeat steps 1.4 and 1.5 to input the tool changer type according the machine configuration and option data sheet.
 600=0 if machine comes with DATC
 600=1 if machine comes with ATC
- 1.7 Move the cursor form No.601 to No.624, repeat the steps 1.4 and 1.5 to input the correct data for different option according the machine configuration and option data sheet.

Table 6-1: Option Data Sheet

VARIABLE NO.	VARIABLE VALUE	MEANING OF	REMARKS
#599	MACHINE TYPE		
	1016	EMCD	
	2016	2016	
	2216	2216	
	3016	3016	
	3020	3020	
	4020	4020	
	4525	4525	
	5020	5020	
	6030	6030	
	8030	8030	
#600	TOOL CHANGER TYPE		
	0	DATC	(*#600=0 DATC ACT=1 SERVO ATC=2), EAK-0037
	1	ATC	EAK-0035, EAK-0056
	2	Servo ATC	EAK-0047

Table 6-1: (Continued) Option Data Sheet

VARIABLE NO.	VARIABLE VALUE	MACHINE TYPE	REMARKS
#601	TOOL CHANGER POCKET NUMBER		
	16	ATC	(*#601=24 MAGZINE POCKET NO.), ATC/DATC
	21	ATC	
	30	ATC	
	20	DATC	
	24	DATC	
	32	DATC	
	62	DATC	
	40	HMC DATC	
	92	HMC DATC	
#602	EXTEND COLUMN SELECTION		
	0	Standard column	(*#602=0 STD=0 EXTEND COLUMN=1)
	1	Extend column	
#603	SPINDLE MOTOR TYPE		
	1	10HP/7.5KW Fanuc spindle motor	Spindle motor type (STD)
	2	15HP/11KW Fanuc spindle motor	(High Torque Fanuc motor)
	3	20HP/15KW Fanuc spindle motor	(Very High Torque Fanuc motor)
	4	30HP/22.5KW Fanuc spindle motor	(Fanuc motor for 6535)
#604	SPINDLE GEAR SHIFT SELECTION		
	1	Mech HI/LO	
	2	Elec. HI/LO	
	3	Neither Mech. nor Elec.	

Table 6-1: (Continued) Option Data Sheet

VARIABLE NO.	VARIABLE VALUE	MACHINE TYPE	REMARKS
#605	SPINDLE MAX CLAMP SPEED		
	7500	7500RPM	7.5K Spindle
	10000	10000RPM	15KSpindle 7.5 k
	15000	15000RPM	15K Spindle
#606	SPINDLE SHIFT SPEED (*spare parameter)		
	2501		Mech HI/LO=2501. Electrical HI/LO=2501
#610	A AXIS SELECTION		
	0	No A axis	
	1	A axis exists	
#611	B AXIS SELECTION		
	0	No B axis	
	1	B axis exists	
#612	X AXIS SCALE SELECTION		
	0	No X axis scale	EAK-0041
	1	X axis exists	EAK-0041
#613	Y AXIS SCALE SELECTION		
	0	No Y axis scale	EAK-0041
	1	Y axis exists	EAK-0041
#614	Z AXIS SCALE SELECTION		
	0	No Z axis scale	EAK-0041
	1	Z axis exists	EAK-0041

Table 6-1: (Continued) Option Data Sheet

VARIABLE NO.	VARIABLE VALUE	MACHINE TYPE	REMARKS
#615	A AXIS SCALE SELECTION		
	0	No A axis scale	EAK-0041
	1	A axis exists	EAK-0041
#616	B AXIS SCALE SELECTION		
	0	No B axis scale	
	1	B axis exists	
#617	A AXIS TYPE SELECTION		
	1	VH165	A4/5000is, EAK-0042
	2	TR165	A4/5000is, EAK-0043
	3	V300/V400	B8/3000is, EAK-0044
	4	SMW-175	A2/5000i, EAK-0063
	5	SMW-225/275	AC8/2000i, EAK-0064
#618	B AXIS TYPE SELECTION		
	2	TR165	A4/5000is, EAK-0043
#619	SPEED		
	0	Standard rapid speed	
	1	1200IPM rapid speed	
#620	AIR OIL SELECTION		
	0	No	
	1	Yes	
#621	MIDACO PALLET		
	0	No	EAK-0046
	1	Yes	EAK-0046

Table 6-1: (Continued) Option Data Sheet

VARIABLE NO.	VARIABLE VALUE	MACHINE TYPE	REMARKS
#622	WAY LUBRICATION TYPE		
	0	Except	PDI TYPE (with air solenoid)
	1	2016L, 3016L, 4020A, 5020A	NO-PDI TYPE (without air solenoid)
#623	COOL SPINDLE OPTION		
	0	No	EAK-0070
	1	Yes	Only 2216, 2016, 3016
#630	CHANGE X AXIS DIRECTION		
	0	No	
	1	Yes	

- 1.8 Run the option program from O8800 to O8805 one by one to active all the options.
 - 1.8.1 Press EDIT key to select edit mode, and push PROGRAM key on the MDI keyboard until program directory is displayed on the CNC screen..
 - 1.8.2 Use PAGE UP/PAGE DOWN key to review all the programs inside CNC.
 - 1.8.3 Input O8800 using MDI keyboard, and push CURSOR DOWN to call this program out and display it on the CNC program window.
 - 1.8.4 Press AUTO key to select Auto mode and press CYCLE START key to execute the program.
 - 1.8.5 After executing program O8800, and CNC screen indicates an alarm "000", cycle the CNC Power.
 - 1.8.6 Repeat steps 1.8.1 through 1.8.5 to execute all the option programs:

O8800: Soft limit and ATC option

O8801 : Spindle motor setup

O8803: PMC data setup

O8804: A axis setup

O8805: B axis setup

- 1.9 Cycle the power again.
- 1.10 Disable the 1050 alarm by setting the K4.6=1 if it is mechanical HI/LO.

If the machine comes with a mechanical High/Low gear shift, this alarm will come out after first power on. Operator can disable the alarm by following procedure, but this bit should be changed back to "0" when the spindle is ready to run.

- Press MDI to change the to the MDI mode
- Press SYSTEM key on the MDI panel (press one more time if it need until the parameter screen comes out)

- Press PMC soft key
- Press PMCPRM soft key
- Press KEEPLY soft key
- Move to the cursor to K4
- Move to the bit 6 using cursor
- Change the K4.6=1
- Cycle the power
- The alarm 1050 will disappear

K4

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	1						

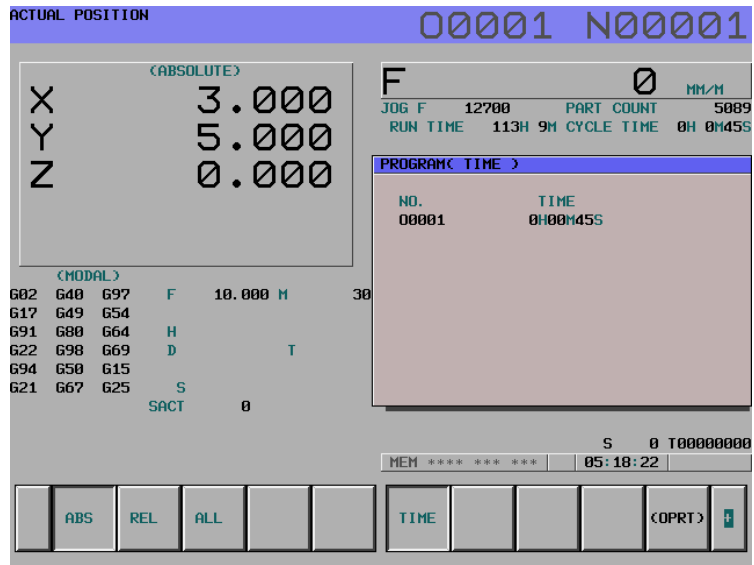
1.11 ***Run the M84 when the spindle assembly is ready to run.

6.6 MACHINE TIME STAMP

Follow the next procedure:

1. Update the software option from **EZOPT** disk according to Fanuc software option installation procedure.
2. Input the testing program P5006 from EDIT mode.
3. Run the testing program O5006 from AUTO mode.
 - Press **EDIT** key to select edit mode
 - Press **PROG** key on the MDI keyboard
 - Press **DIR** soft key on the LCD screen
 - Input **O5006**
 - Press **INPUT** key on the MDI panel
 - Press **O.SRG** soft key on the LCD screen, make sure that program comes out on the screen
 - Press **AUTO** key on the machine pendant
 - Press **DOOR OVR** key on the machine pendant until the door override is enabled.
4. Machine time calculation procedure.
 - Select the memory operation mode, then press **RESET** key
 - Press **CYCLE START** button on the machine pendant to execute the program to perform actual machining
 - When **O5006** is complete, machining time count operation stops
5. Display machine time. When machining time display screen is selected, the program number of the stopped program and its machining time are displayed.
 - Press the function key **PROG**
 - Press the rightmost soft key “+” once or twice to display soft key **TIME**
 - Press soft key **TIME**

Machining time screen displays.



O5006
 G21
 G91
 G02 X3.0Y5.0R3.1234567
 M30

6.7 MOUNTING AND REMOVING OPTION BOARD



WARNING!

The replacement described here should be performed by a person fully trained in maintenance and safety. If the care not to touch any high-voltage area. If the area is uncovered, direct contact with this area will result in an electric shock. cabinet is opened to replace the option board, take extreme.



NOTE

Before starting the replacement, take a back-up copy of the contents (parameters, programs, etc.) of the SRAM memory of the CNC. The backup copy can be used in case the contents of the SRAM memory are lost during the replacement.

6.7.1 MOUNTING AND REMOVING MAIN CPU BOARD AND FULL-SIZE OPTION BOARD

Removing the board

1. Removing cables other than the battery cable. (The battery cable is connected only to the main CPU board.)
2. Hold handles A and B.
3. Pushing down the hook of handle A and pushing up the hook of handle B, pull out the printed circuit board.



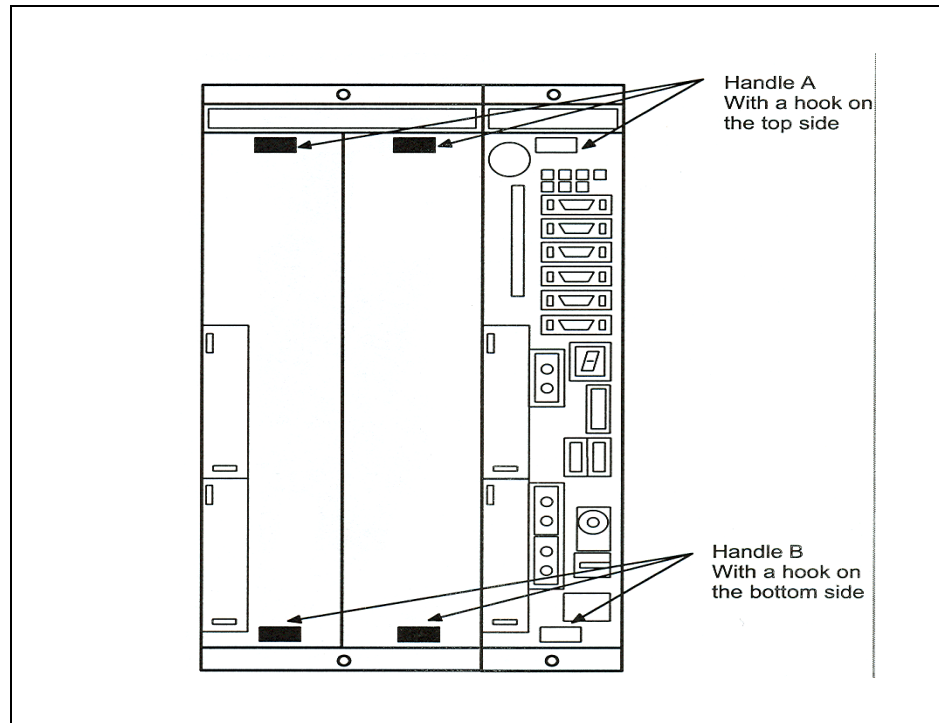
NOTE

- 1 The battery is mounted on the face place of the main CPU board. The battery is pulled out together with the main CPU board.
- 2 The main CPU board or a full-size option board can be removed without removing mini-slot option boards. (If a cable connected to a mini-slot option board obstructs the removal, the cable must be removed.)

Mounting the board

1. Holding handles A and B, insert the board into the cabinet until the connector on the back panel is connected.

2. Connect the removed cables to correct positions.



6.7.2 MOUNTING AND REMOVING A MINI-SLOT OPTION BOARD (EXCEPT DEVICENET BOARD)

Removing the board

1. Remove cables connected to the target mini-slot option board. Remove other cables that would obstruct the removal of the mini-slot option board.
2. Hold handles C and D.
3. Pushing the latch of handle C to the right, pull out the printed circuit board.

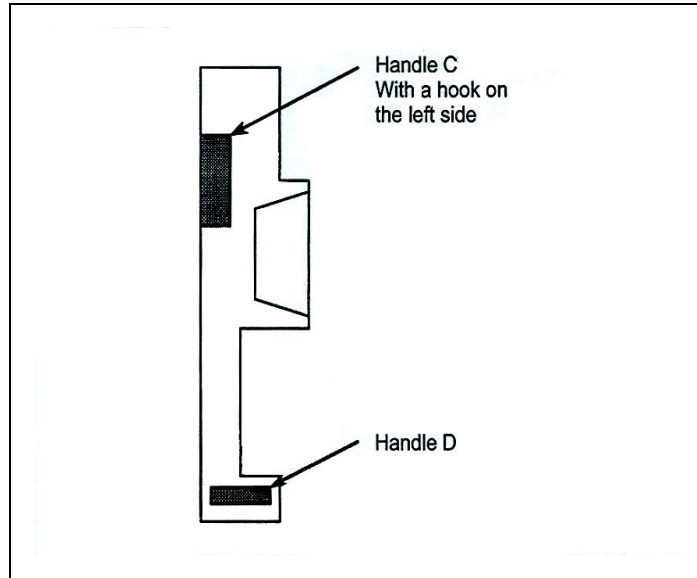


NOTE

The mini-slot option board can be removed without removing the main CPU option board or full-size option board.

Mounting the board

1. Holding handles C and D, insert the board into the cabinet until the connector on the back panel is connected.
2. Connect the removed cables to correct positions.




6.7.3 MOUNTING AND REMOVING THE BACK PANEL

WARNING!

The replacement described here should be performed by a person fully trained in maintenance and safety. If the care not to touch any high-voltage area. If the area is uncovered, direct contact with this area will result in an electric shock. cabinet is opened to replace the back panel, take extreme.

NOTE

 Before starting the replacement, take a back-up copy of the contents (parameters, programs, etc.) of the SRAM memory of the CNC. The backup copy can be used in case the contents of the SRAM memory are lost during the replacement.

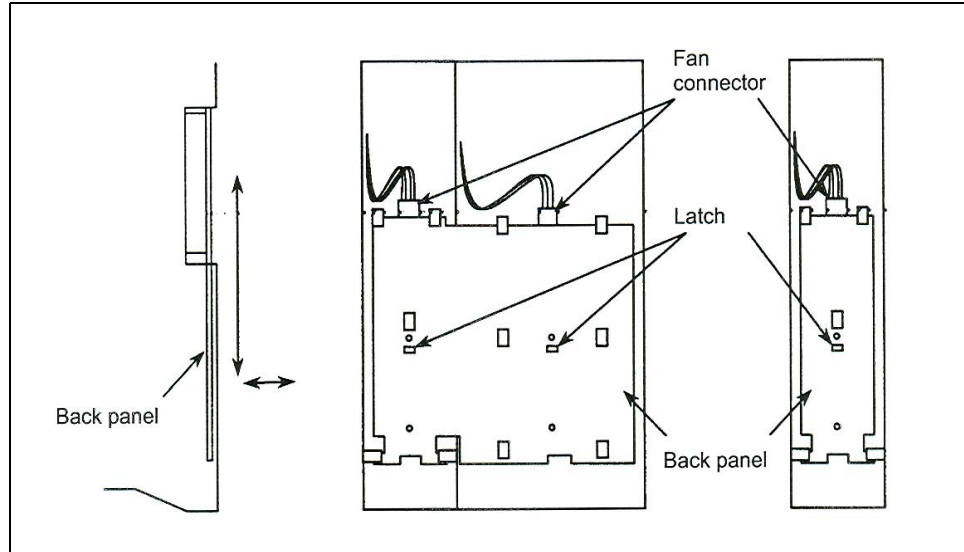
Removing the Panel

1. Remove the main CPU board and all option boards, following the steps described in Section 3.6.
2. Remove the connector of the fan connected to the back panel.
3. Push down the latch securing the back panel until the latch is disengaged.
4. Pull down and detach the back panel to the rear.

Mounting the Back Panel

1. Aligning the positioning hole of the back panel with the positioning pin, fit the back panel on from the rear.

2. Pull up the back panel until the latch is engaged.
3. Connect the fan connector to the back panel.
4. Mount the main CPU board and option boards.



6.7.4 REPLACING THE FUSE OF THE CONTROL UNIT

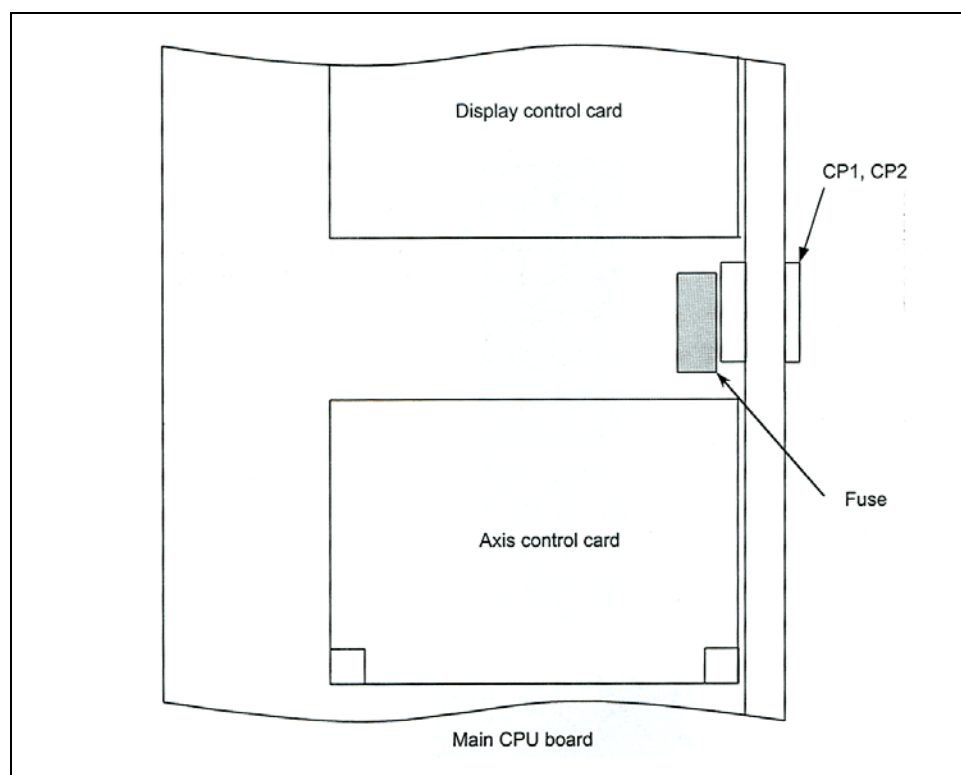


WARNING!

Before starting the replacement of a fuse, remove the cause of the fuse burn-out. Accordingly, the replacement should be performed by a person fully trained in maintenance and safety. If the cabinet is opened to replace the fuse, take extreme care not touch any high-voltage area. If the area is uncovered, direct contact with this area will result in an electric shock.

Mounting position of the fuse of the control unit

The fuse of the control unit is mounted on the main CPU board.



6.7.5 REPLACING THE BATTERY

Part programs, offset data, and system parameters are stored in CMOS memory in the control unit. The power to the CMOS memory is backed up by a lithium battery mounted on the front panel of the control unit. The above data is not lost even when the main battery goes dead. The backup battery is mounted on the control unit at shipping. This battery can maintain the contents of memory for about a year. When the voltage of the battery becomes low, alarm message "BAT" blinks on the display and the battery alarm signal is output to the PMC. When this alarm is displayed, replace the battery as soon as possible. In general, the battery can be replaced within two or three weeks, however, this depends on the system configuration. If the voltage of the battery becomes any lower, memory can no longer be backed up. Turning on the power to the control unit in this state causes system alarm 910 (SRAM parity alarm) or 935 (SRAM ECC error) to occur because the contents of memory are lost. Clear the entire memory and reenter data after replacing the battery. The following two kinds of batteries can be used.

- Lithium battery built into the CNC control unit.
- Two alkaline dry cells (size D) in the external battery case.



NOTE

A lithium battery is installed as standard at the factory.

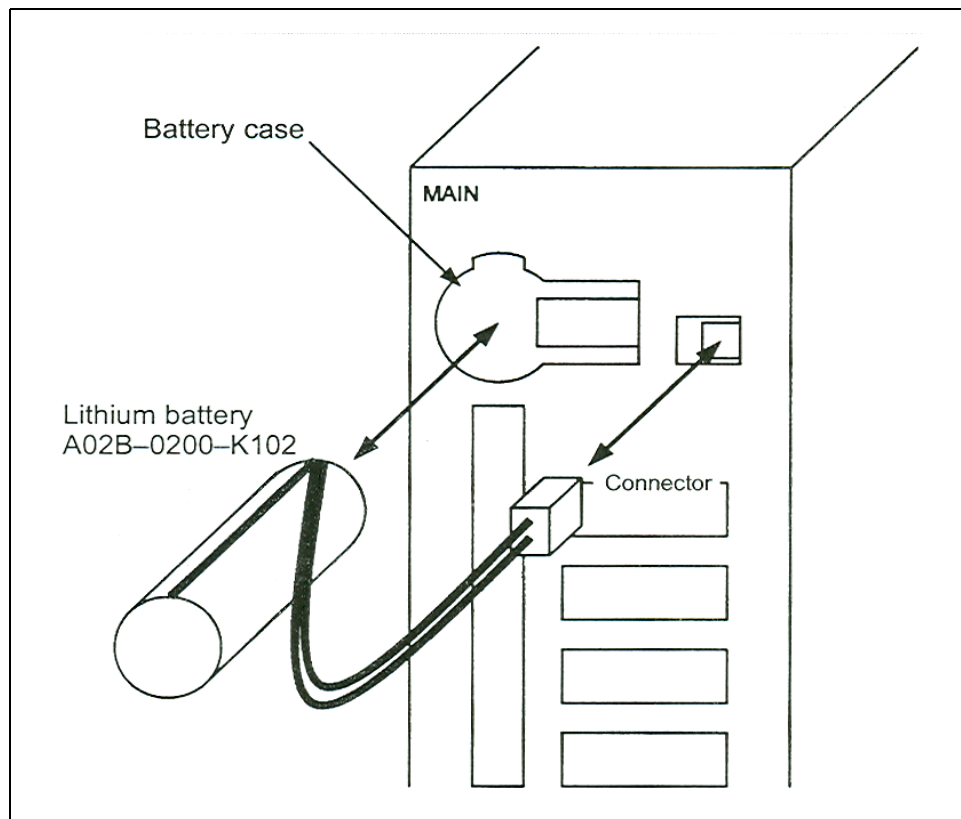
Replacing the battery

If a lithium battery is used, have A02B-0200-K102 (FANUC internal code: A98L-0031-0012) handy.

1. Turn the CNC on. About 30 seconds later, turn the CNC off.
2. Remove the battery from the top area of the CNC unit.

Disconnect the connector first. Then, remove the battery from the battery case. The battery case is provided in the top area of the face plate of the main CPU board.

3. Replace the battery, then connect the connector.



WARNING!

The incorrect mounting of the battery may cause an explosion. Avoid using any battery other than the one specified here (A02B-0200-K102).

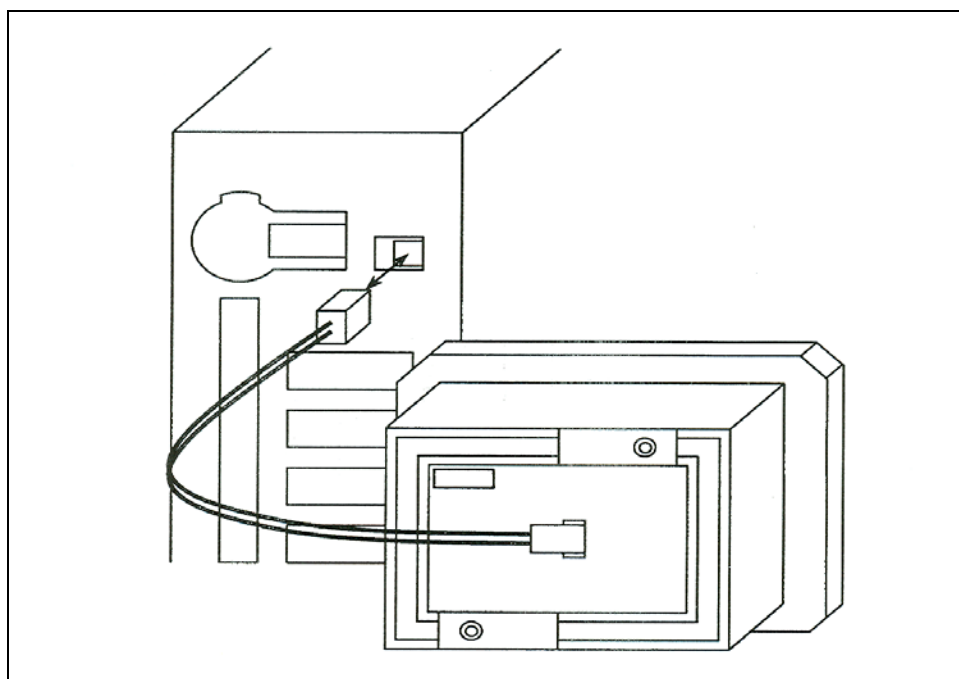
Complete steps (1) to (3) within 30 minutes. If the battery is left removed for a long time, the memory would lose the contents. If there is a danger that the replacement cannot

be completed within 30 minutes, save the whole contents of the CMOS memory to a memory card. The contents of the memory can be easily restored with the memory card in case the memory loses the contents.

Discard the dead battery, observing appropriate municipal rules and regulations. When discarding the battery, insulate the terminal with a tape so that no short-circuit would occur.

General method of using commercial D-size alkaline dry cells

Use the connector connected to the lithium battery for an external battery. Following the battery replacement procedure described above, replace the standard lithium battery with an external battery in a battery case (A02B-0236-C281).



1 Place the battery case (A02B-0236-C281) in such a position that the battery can be replaced even while the control unit is active.

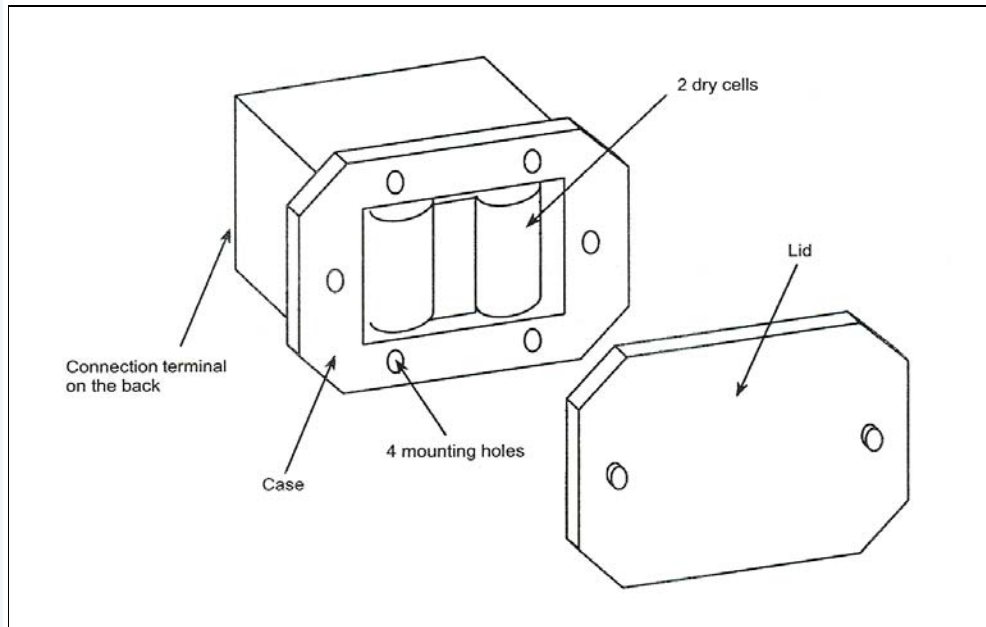
2 The connector of the battery cable uses a simple lock system. Fix the cable within an area of 50 cm from the connector, removing tension on the cable. This is required to prevent the connector from coming off because of the weight of the cable or tension on the cable.

Replacing the battery

1. Have commercial D-size alkaline dry cells handy.
2. Turn the CNC on.

3. Remove the lid from the battery case.
4. Replace the old dry cells with new ones. Mount the dry cells in a correct orientation.
5. Replace the lid on the battery case.

In the power-off state, the battery should be replaced as in the case of the lithium battery, which is described above. on the back



6.7.6 REPLACING A FAN UNIT



WARNING!

If the cabinet is opened to replace a fan unit, take extreme care not to touch any high-voltage area. If the area is uncovered, direct contact with this area will result in an electric shock.

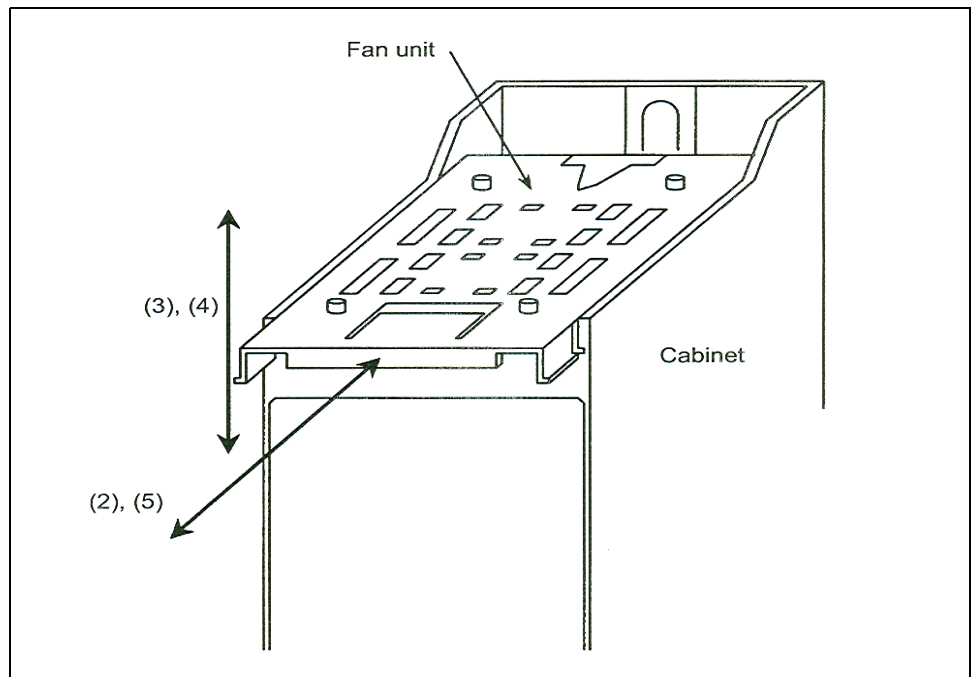
Ordering information of fan units

	ORDERING INFORMATION	QUANTITY
For 1-slot cabinet	A02B-0265-C101	1
For 2-slot cabinet	A02B-0260-C021	1

Replacing a fan unit

1. Before starting the replacement of a fan unit, turn the CNC off.

2. Pull the fan unit to be replaced.
3. Lift the pulled fan unit until the fan unit is detached from the cabinet.
4. Place a new fan unit on the cabinet.
5. Push the new unit as far as it goes. When a click is heard, the unit is connected to the fan connector.



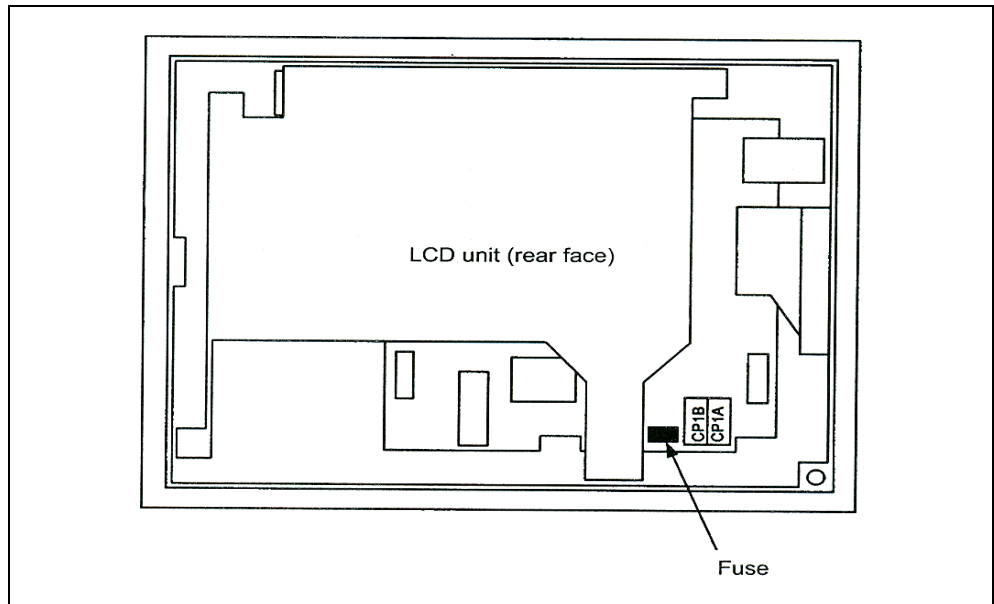
6.7.7 REPLACING THE FUSE OF LCD UNIT



WARNING!

Before starting the replacement of the fuse, remove the cause of the fuse burn-out. Accordingly, the replacement should be performed by a person fully trained in maintenance and safety. If the cabinet is opened to replace the fuse, take extreme care not touch any high-voltage area. If the area is uncovered, direct contact with this area will result in an electric shock.

Mounting position of the fuse



- Information of the fuse
 Ordering information: A02B-0265-K101
 Rating: 2.0 A
 Individual information: A60L-0001-0290#LM20C

6.7.8 REPLACING THE LCD BACKLIGHT



WARNING!

The replacement described here should be performed by a person fully trained in maintenance and safety. If the tocabinet is opened to replace the unit, take extreme care not touch any high-voltage area . If the area is uncovered, direct contact with this area will result in an electric shock.

Ordering information of the backlight

Backlight	Ordering information	Individual information
For 9.5"LCD	A02B-0281-K114	A61L-0001-0154#BLC



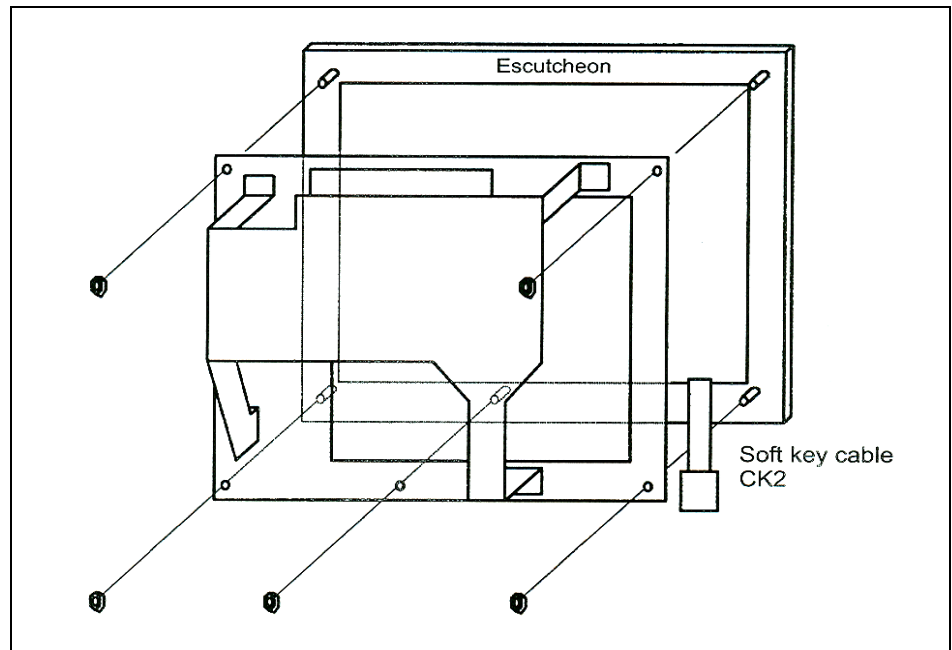
NOTE

The back-light of the 10.4 color LCD cannot be replaced.

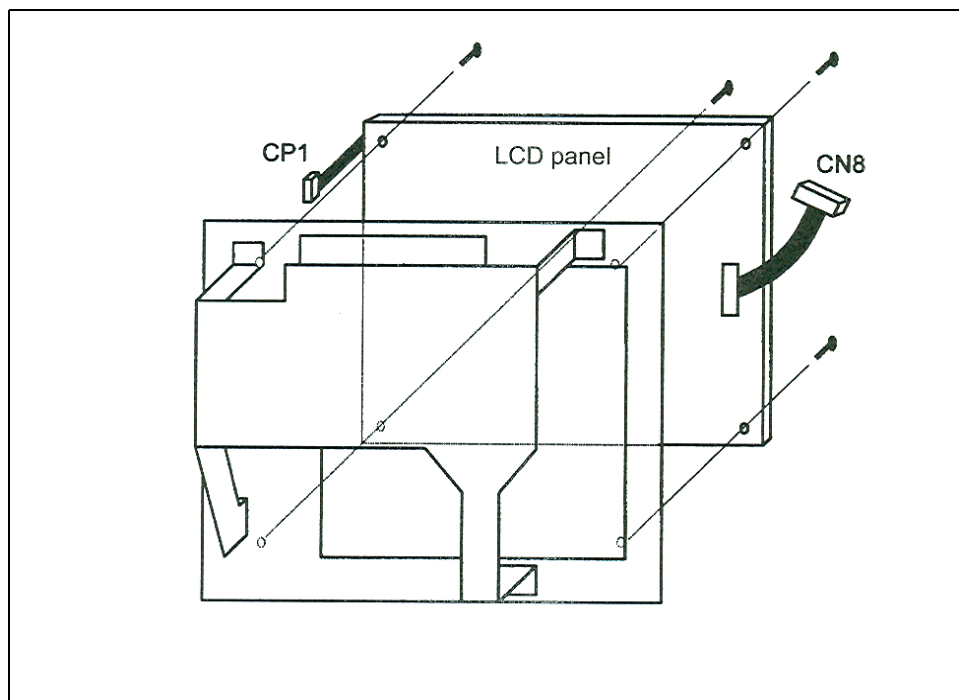
Replacing the backlight

1. Remove soft key cable connector CK2, then remove the escutcheon from the LCD unit.

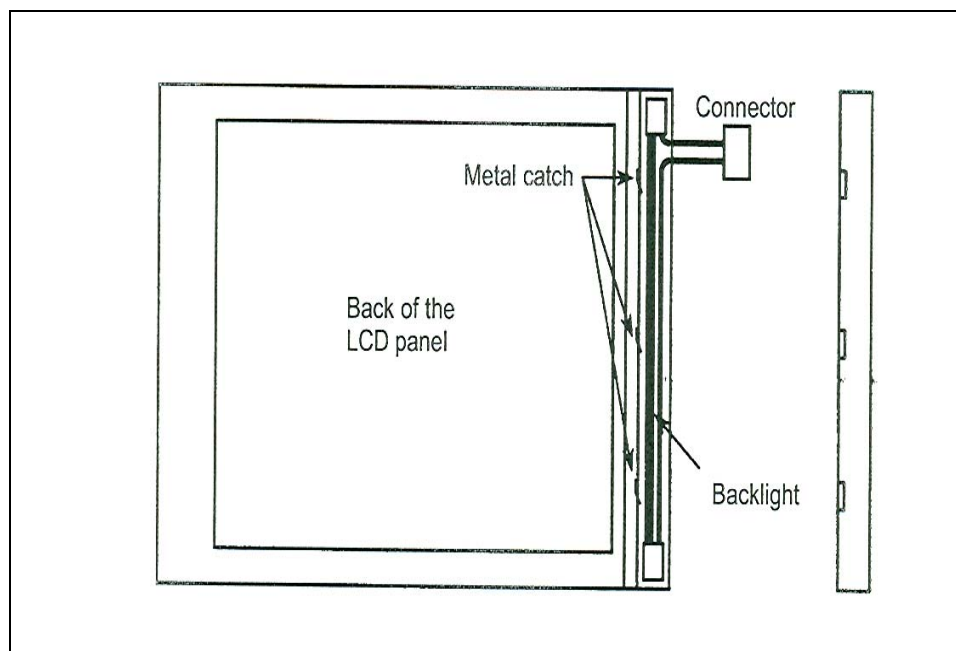
If the unit has a touch panel, remove touch panel signal cable connector CN1 as well.



2. Disconnect inverter cable connector CP1 and video signal cable connector CN8, then remove the LCD panel from the unit.



3. For 9.5. monochrome LCD



6.7.9 HEAT GENERATION OF THE UNITS

4. After replacing the backlight, assemble the unit, reversing the disassembly procedure of steps (1) to (3).

During the assembly, take care to keep dust out.

Table 6-2: Heat Generation

UNIT		HEART GENERATION	REMARKS
Control unit	1-slot cabinet	30W	(*1)
	3-slot cabinet	43W	
Option board	HSSB board	4W	
	Sub-CPU board	14W	
	PMC C board	7W	
	Serial communication board	7W	
	Symbol CAPI T board	10W	
	RISC board	9W	
	Data server board	6.3W	Including 0.3 W of the ATA card(*2)
	RISC + data server	15.3W	Including 0.3 W of the board ATA card(*2)
	Loader control board	15W	(*3)
	I/O Link II board	9W	
	Ethernet board	6W	
	DeviceNet interface board	4W	
	PROFIBUS board	9W	
	FL-net board	7W	
NOTE			
1 The values of the main CPU board and MDI unit are included. The values of option boards are not included.			
2 The heat generation of the ATA flash card may be different if a large-capacity card is used or if the card specifications are changed.			
3 The values are taken when 50% of inputs are turned on.			
MDI unit		0W	
Operator's panel I/O module		12W	(*1)
Connector panel I/O module (basic)		8W	(*1)
Connector panel I/O module (expansion)		5W	(*1)
Separate detector interface unit		9W	Unit with 4 basic axes only
Separate detector interface unit		14W	4 basic axes + 4 additional axes(*2)



NOTE

- 1 The values are taken when 50% of the module inputs are turned on.
- 2 The heat generated in the separate detector is not included.

7.0 AUTOMATIC TOOL CHANGERS

VMC models 3020, 4525, 6535 come standard with the Dual Arm Tool Changer. VMC models 2216, 3016, 4020, 6030, 8030 (DATC optional) come standard with a 21 tool capacity (30 tool capacity optional for 4020, 6030, 8030) Geneva drive tool changer.

7.1 OPERATION

7.1.1 PROGRAMMING

To make an automatic tool change, an *M6* code is used. This code can be used in a program or in Manual Data Input (MDI) mode.

In a Program

When another tool is needed, an *M6* followed by a tool location. (T_) is entered and the tool changer will make the appropriate tool change and then continue on with the program.

In MDI

The operator can make a tool change with out running a program. If the operator is testing the tool changer or setting tool lengths, the *M6* code followed by the tool location will command the tool changer to make the necessary tool change.

7.1.2 TOOL CHANGE SEQUENCE

The following is the order of operations for the CNC when making a tool change (Geneva driven):

1. Move the Z axis to the machine home (Cold Start) position.
2. Turn the spindle slowly while looking for the Orientation Sensor signal.
3. When orientation signal is received, stop the spindle.
4. Activate the orientation arm.
5. Move the ATC turret to the tool position of the tool in the spindle.
6. Verify the orientation sensor.
7. Check the ATC Home sensor and verify that the ATC is at the home position.
8. Activate the ATC slide reverse circuit.
9. Activate the ATC slide motor circuit.
10. Watch for the ATC extended sensor signal.
11. Stop the slide motor when the extended position sensor is read.
12. Activate the draw bar.
13. Watch for the drawbar sensor detection (air feed parameter).
14. Check for the ATC fault switch.
15. Move the Z axis up to 3.8" above the cold start position.

16. Activate the turret motor and the turret reverse (if the reverse direction is required) circuit(s).
17. Count the turret sensor signals, with a dwell time for coasting as set by the turret factor, until the requested tool position is reached.
18. Stop the turret motor.
19. Move the Z axis downward to the machine home position.
20. Check for the ATC fault switch.
21. Release the drawbar circuit.
22. Activate the ATC slide motor.
23. Watch for the ATC Home sensor, to determine the ATC home position.
24. Stop the ATC slide motor.
25. Release the orientation arm.

**NOTE**

The hall effect sensors have three wires. One for 5vdc, one for ground, and one for the signal. The signal will be about 5vdc until a magnet is over it, then it will become active, and the signal will be about zero.

7.1.3 ATC FAULT MESSAGES

ATC FAILURE: The machine is receiving a signal from the ATC fault switch. This would indicate that the ATC spindle is out of position. Check the position of the ATC spindle. If it is in the proper position, check the switch, the switch wiring.

ATC TURRET FAILURE: The machine did not receive a signal from the ATC Turret Sensor, when the tool position change was commanded. If the turret moved to the next position, then the sensor is not operating. This could be caused by a bad sensor, wiring problem, sensor to magnet spacing, or chips on the sensor or magnet. If the turret does not move, then the turret motor circuit is not operating. This may be caused by a mechanical bind, turret motor, wiring problem.

ATC WILL NOT MOVE TO POSITION: When the ATC is commanded to move to either the extended or home positions and the appropriate sensor does not send a signal within the allotted time, this fault is displayed. The possible causes for this fault are mechanical problems including chips in the track area preventing the rollers from rolling, misalignment of the ATC or spindle position, bad sensor or gap setting on cylinder, wiring problem, motor.

ATC WILL NOT MOVE TO SPINDLE: Same as the ATC WILL NOT MOVE INTO POSITION except the direction (reverse) is known.

7.2 ADJUSTMENTS

There are four motions that influence the automatic tool changer alignment. These motions are:

- Z-axis up & down.
- Spindle orientation.
- Turret in & out.
- Turret rotation.

7.2.1 Z AXIS COLD START ADJUSTMENT

1. Remove the ATC upper cover.

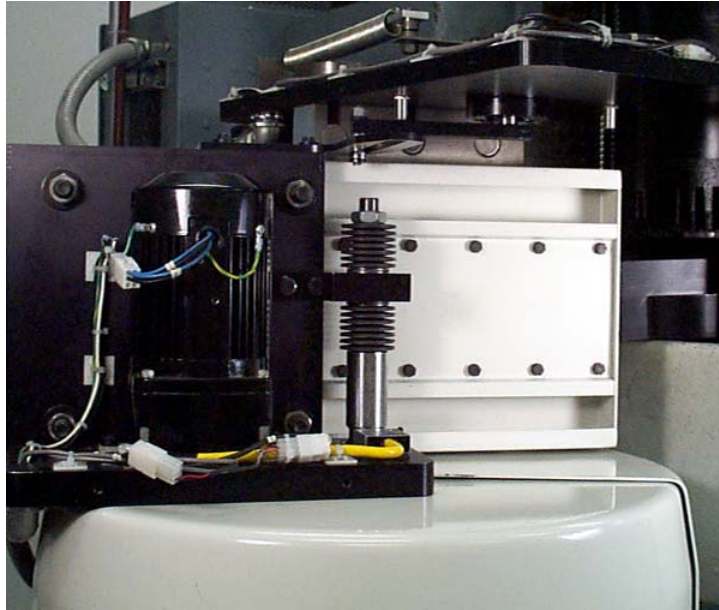


Figure 7-1 Remove ATC Upper Cover

2. Position the Z-axis head to the machine zero position (G28 G91 Z0.0).
3. Orientate Spindle (M190).
4. Manually move the ATC slide in toward the spindle following the next steps:
 - Disconnect the air to the machine.
 - Manually move the ATC slide towards the spindle.
 - Re-connect the air to the machine for added pressure against the spindle.



NOTE

ATC will come back with a force. Make sure that nobody is inside of the machine.



Figure 7-2: Move ATC Slide Toward Spindle

5. Measure the distance from the ATC carriage to the nose of the spindle with a thickness gauge. Adjust the Z axis until the nose of the spindle is .050" [1.27mm] above the turret carriage for CAT taper, .250" [6.35mm] for BT tooling.

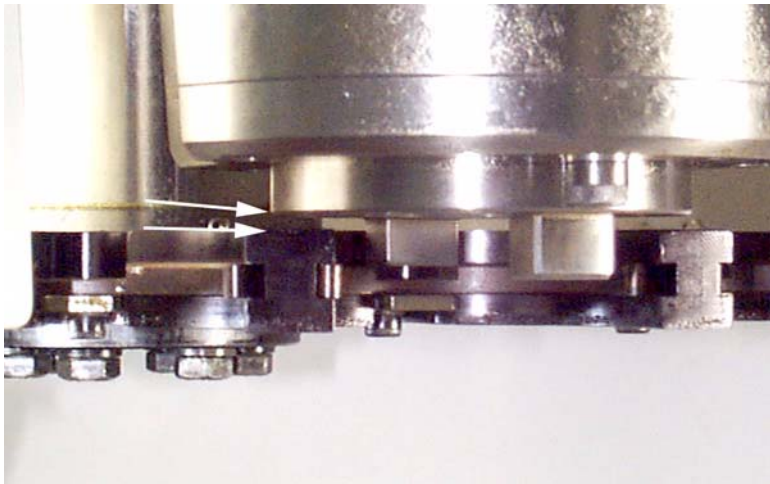


Figure 7-3: Measure Distance from ATC Carriage to Spindle

6. When the Z axis is in the correct position, tighten the screws. For AC machines, determine their offset by cold starting the machine then jogging the Z axis. Enter the value in G28 G91 Z0.0.
7. Cold Start the machine and recheck the position.

7.2.2 SPRING CONFIGURATION 16, 21 & 30 TOOL CHANGERS

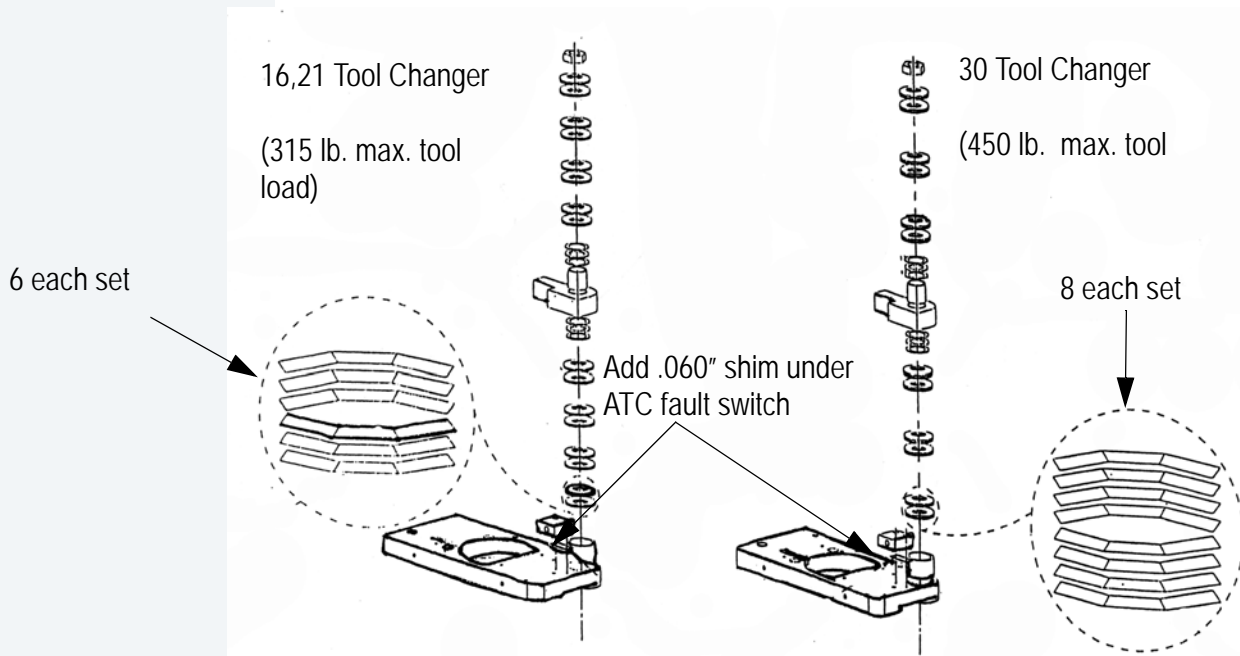


Figure 7-4: Spring Configuration

7.2.3 ATC TURRET SLIDE ADJUSTMENT

1. Position the Z-axis to the machine zero.
2. Orient the spindle using M190 from MDI mode.
3. Insert a tool holder in the spindle.
4. Manually move the slide to the spindle until fully engaged. Loosen the 2 each 1/4" hex bolts on the top of the Carriage Plate.



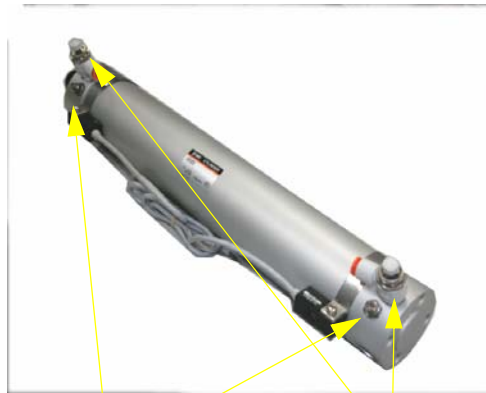
NOTE

The machine uses an air cylinder for the turret movement. To manually move the ATC as suggested in step (4) several steps must be taken:

- Disconnect the air to the machine.
- Switch the air lines connected to the air cylinder (see figure 7-5)
- Manually move the ATC slide towards the spindle.
- Re-connect the air to the machine for added pressure against the spindle.



Figure 7-5: Loosen Hex Bolts / Move Slide to Spindle Until Engaged



Adjust the cushion

Adjust the air flow

Air lines to switch for ATC adjustment

Adjust the cushion

Figure 7-6: ATC Cylinder

5. Give the slide a firm push toward the spindle. Retighten the 2 bolts.
6. If the slide does not fully engage, loosen each of the six 3/8" hex bolts holding the tool carrier. This will allow the slide to fully engage.



Figure 7-7: Loosen Hex Bolts Holding Tool Carrier

7.2.4 TOOL TURRET ROTATIONAL ADJUSTMENT

7. Tighten all bolts on tool carrier and upper Geneva slot. If the slide still does not engage, check the spindle orientation.
 8. Disconnect the air to the machine.
 9. Move the ATC slide back.
 10. Switch the air lines connected to the air cylinder.
 11. Re-connect the air to the machine.
 12. Adjust the air flow. Make sure that the ATC doesn't move too quickly or too slowly on a tool change.
 13. Adjust the cushion. Make sure that during the tool change the ATC doesn't "bang" at either end of it's travel.
1. Position the Z-axis to the machine zero.
 2. Orient the spindle using M190 from MDI mode.
 3. Loosen each of the six 3/8" hex bolts on the under side of the tool carrier.



Figure 7-8: Loosen Hex Bolts on Under Side of Tool Carrier

4. With the tool in the spindle, manually move the slide into the spindle, until fully engaged.

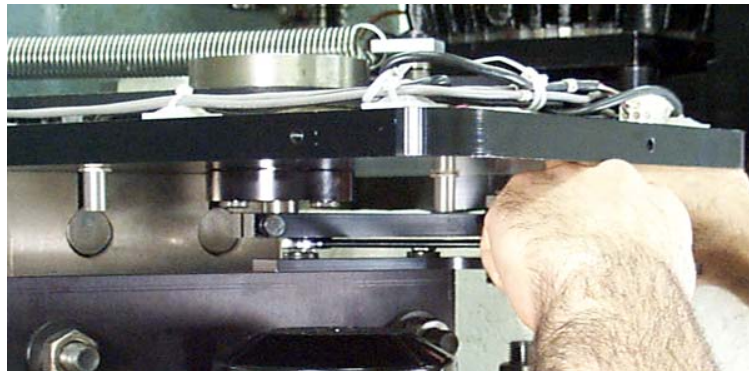


Figure 7-9: Manually Move Slide Into Spindle

5. Tighten the 6 each 3/8" hex bolts.

7.3 ATC MOTOR REPLACEMENT PROCEDURE

7.3.1 REPLACING THE TURRET MOTOR ON A GENEVA WHEEL ATC

1. Remove the ATC cover.
2. Remove the Motor cover.
3. Disconnect the Molex connector with the motor wires.
4. Disconnect the ground wire.
5. Remove the four bolts holding the motor down.
6. Remove the motor.
7. Measure the distance from the bottom of the motor to the top of the Geneva gear.
8. Remove the Geneva gear.
9. Install Geneva gear on replacement motor at same position as on old motor.
10. Place motor in ATC and slide it firmly toward the Head.
11. Tighten motor mounting bolts.
12. Connect ground wire and Molex connector.
13. Perform alignment procedures.
14. Replace the covers.

7.3.2 TURRET FACTOR SETTING

This parameter is set at the factory. This parameter should not be changed unless the turret motor has been replaced or the tool turret rotation is over or under shooting.



NOTE

VMCs equipped with the Servo Turret ATC, instead of the Geneva-driven ATC, must ALWAYS have a turret factor of 1. A proper turret factor will have the Geneva driver positioned as in Figure 7-10a. An incorrect turret factor will have the Geneva driver positioned approximately as shown in Figure 7-10b.

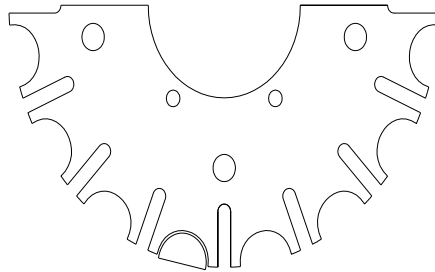


Figure 7-10a

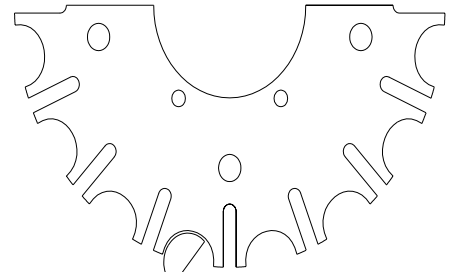


Figure 7-10b

7.3.3 PULLEY ALIGNMENT

Fadal Spindle Pulleys have lines for the orientation alignment of the spindle. To achieve proper alignment, the line on the top of the spindle must be aligned with one of the three lines on the spindle pulley.

- The **Long Line**, which is for all Machines except for VMC 4020 with 30 tool ATC, and the Dual Arm ATC.
- The **Short Line**, which is for VMC 4020 machines with 30 tool ATC.
- The Long and Short Lines are next to one another.
- The new pulleys will also have a **Third Line**, which is for the Dual Arm ATC.

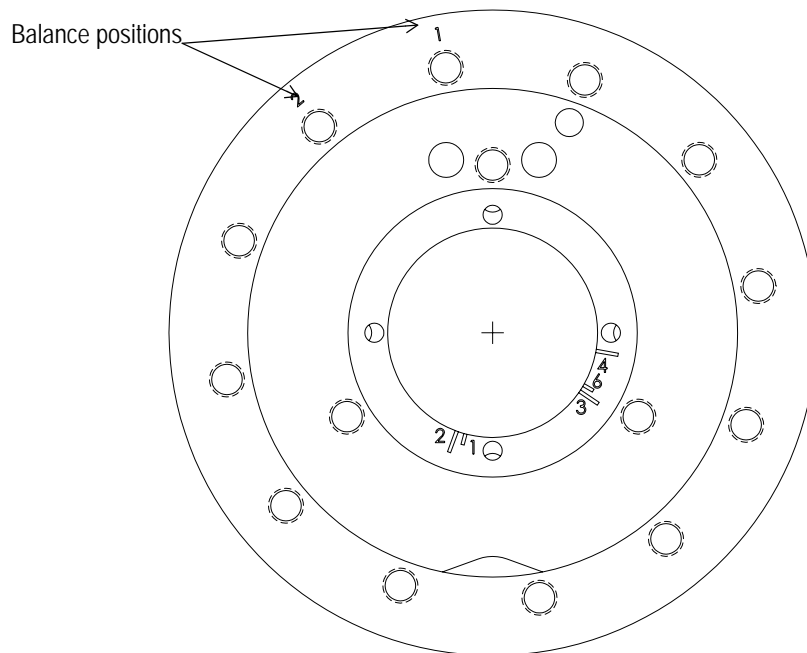


Figure 7-11: Fadal Spindle Pulleys

NOTCH NO.	DESCRIPTION
1	ATC 16T, 21T, 30T, except 4020, 4020A, 5020A,
2	ATC 30T, 4020, 4020A, 5020A
3	DATC 24T, 6535
4	DATC 24T, except 6535
6	DATC 3016D

7.4 DUAL ARM TOOL CHANGER

7.4.1 TOOL CHANGER SPECIFICATIONS

Table 7-1: DATC Tool Changer Specifications

SPECIFICATIONS		2216	3016	4020	6030	8030	4525	6535/40T
Type of Tool		CAT-40/BT-40						
Number of Tools		20	24				21/62	
Maximum Tool Diameter	All Pockets Full	100mm (4in.)						
	Adjacent Pockets Empty	180mm (7.2in.)						
Maximum Tool Length		350mm (13.8in.)						
Tool Weight	Maximum	6.5kg (14.3lbs.)						
	Average	5.0kg (11lbs.)						
Tool Magazine Drive Source	Motor Voltage	220VAC, 3 Phase						
	Air Pressure	5-7kg/sqcm (12.5psi)						

7.4.2 SUB-ASSEMBLIES

INDEX MECHANISM

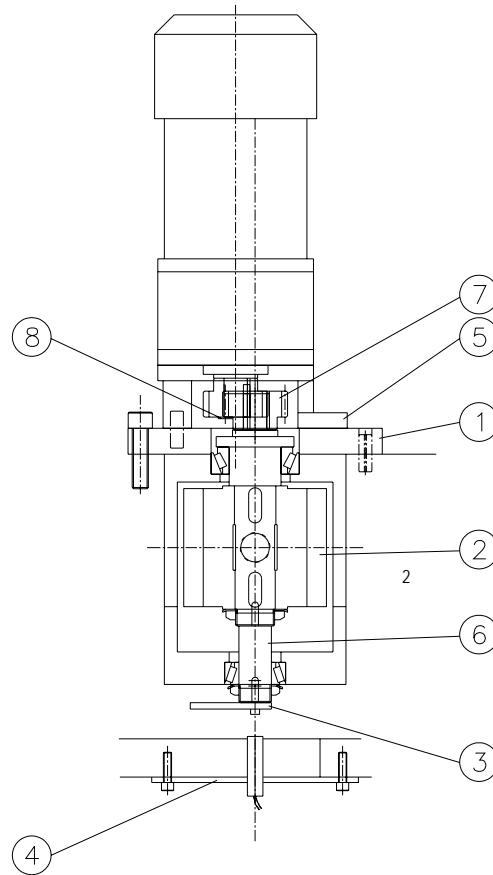


Figure 7-12: Index Mechanism

Table 7-2: Index Mechanism

No.	Part Description
1	Cam Base
2	Cylindrical Cam
3	Sensor Block
4	Proximity Switch Bracket
5	Motor Base
6	Driving Shaft
7	Gear
8	Gear Plate

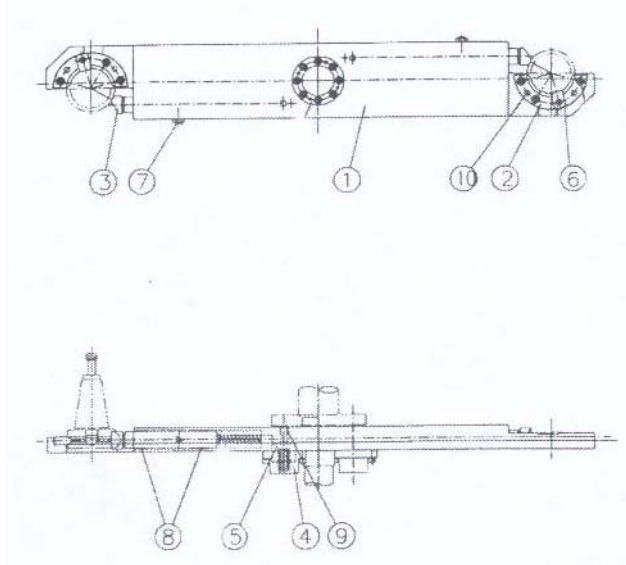


Figure 7-13: Tool Arm

Table 7-3: Tool Arm

No.	Part Description
1	Tool Arm
2	Tool Draw
3	Tool Holding Rod
4	Spring Cover
5	Plunger
6	Positioning Key
7	Positioning Screw
8	Self Lubricating Bearing
9	Self Lubricating Bearing
10	Spring Pin

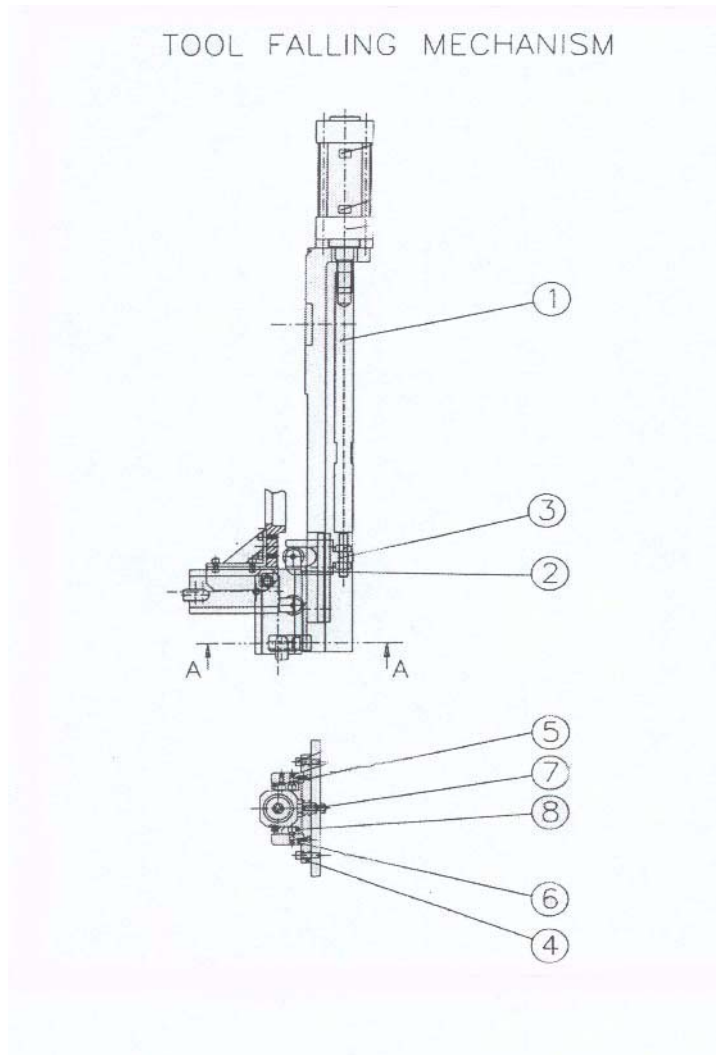


Figure 7-14: Tool Falling Mechanism

Table 7-4: Tool Falling Mechanism

No.	Part Description
1	Tool Rod
2	Sliding Block
3	Sliding Block Cover Plate
4	Positioning Block Stand
5	Positioning Sliding Block (1)
6	Positioning Sliding Block (2)
7	Fixing Base of Tool Pot
8	Positioning Sliding Block (3)

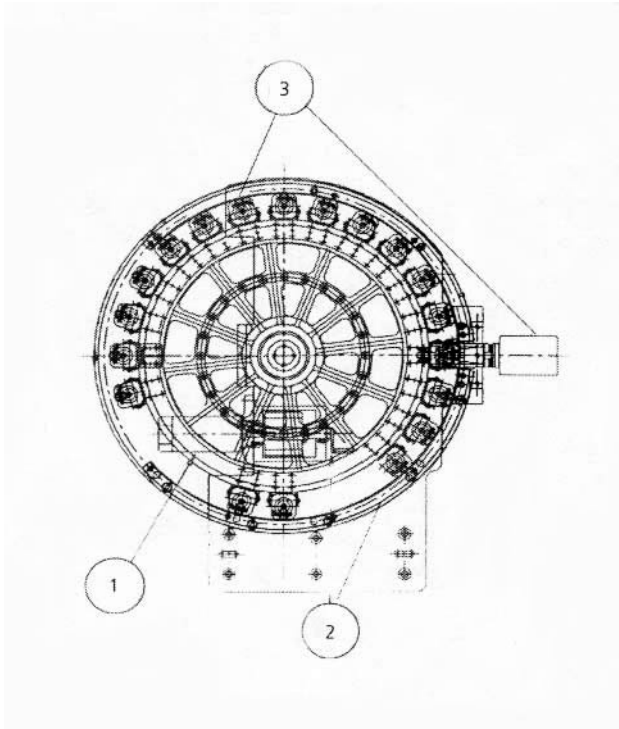


Figure 7-15: Tool Turret

Table 7-5: Tool Turret

No.	Part Description
1	Tool Magazine Motor
2	Tool Magazine
3	Tool Buckets

7.4.3 INSTALLATION & TESTING

Dual Arm ATC Installation and Alignment:

1. Verify that all bolts are properly tightened.
2. Remove the main cover surrounding the ATC arm and falling mechanism.
3. Remove the oil inlet plug and fill the ATC oil reservoir with lubricant (MOBIL DTE OIL HEAVY MEDIUM) to approximately 1-1/2 gallons or 5 liters. Observe the sight glass to verify that the oil reservoir does not over fill (see Figure 7-16, positions 1 and 2). The alternative way to fill the oil reservoir is by utilizing the plugged air vent on top and to the rear of the main ATC casting. This does not require the removal of the main cover.



NOTE

Use caution during installation. Check all of the control elements for damage (sensors and wires).

4. Install the ATC onto the machine using: 8 1/2 – 13 X 1 3/4 inch UNC-2B HHC hex cap screws with eight split lock washers.
5. Do not tighten the mount bolts completely. They will need to remain loose to allow for the front to back and side to side alignments to be made.
6. Using a crane or forklift, position the ATC as needed to assist in the adjustments.
7. Install the alignment fixture to the spindle mount surface using two 3/8-16X1" bolts. Verify that the fixture is centered. Slowly tighten the fixture. Keep the fixture centered throughout the procedure.

**NOTE**

Before proceeding to the next step, review the applicable job sheet to confirm that the ATC is set-up for the specified tool holder configuration (CAT-40 or BT-40). The tool grippers and tool orientation (or positioning) keys may need to be changed if the tool holder configuration needs to be changed.

8. Remove the socket head cap screws plus the 2-8mm Roll pins mounting the gripper onto the ATC arm body (the gripper has 3 bolts for the 4525 and 4 for the 3020 and 6535).
9. Install and tighten the gripper with the proper tool orientation (or position) key. See Figure 7-16:, positions 1, 6, and 7.
10. When manually rotating the tool arm, use the proper socket on top of the tool changing mechanism motor shaft. The drill motor should turn forward or CW.
11. While rotating the ATC arm, pull the motor brake switch up. This is the electromagnetic brake that will be holding the motor back from turning smoothly. The switch is located on top and to the front of the ATC motor (the switch must be held up). See Figure 7-16:, position 3.
12. The ATC arm body will turn 80 degrees for the 3020, 65 degrees for the 4525 and 35 degrees for the 6535. The tool falling mechanism will engage. The arm will then move down and turn 180 degrees, for both the 3020 and 4525, to exchange gripper positions. Stop turning the motor when the arm reaches the down position.
13. With the falling mechanism in the down position, put the proper tool holder type in the forward tool gripper and orient the tool so that it goes into the arm gripper with the deepest relief engaging the gripper key way.
14. To install the tool holder manually, it will be necessary to push the plunger mechanism down, to release the pressure of the tool holding rod. See Figure 7-16:, positions 2 and 3.
15. Begin manually turning the motor of the ATC. The falling mechanism will start moving back up. Stop turning the motor when the arm reaches the top most position or has reached the dead spot, before changing direction.

16. JOG the Z-axis down and position the head and spindle fixture at or near the normal Z-axis cold start position. This will put the tool holder up inside the fixture. Do not allow the sides of the tool holder to touch the Inner Diameter (I.D.) of the spindle fixture.
17. If the ATC is off alignment, adjust the front to back and side to side as needed, until the tool can be inserted into the spindle fixture to a minimum of 1".
18. Put a small level on the ATC arm body to check the level. Typically, this would be the same level adjustment as the base casting. Check the base way, with the small level, as the reference position.
19. With a dial-caliper (Vernier-Caliper) or a depth micrometer, check the distance from the outer diameter (O.D.) of the tool holder to the O.D. of the spindle fixture using the fixture through holes. Split the difference between the front to back readings.
20. Check the distance between the O.D. of the tool holder to the O.D. of the spindle fixture, using the through holes, and split the difference between the side to side readings. See Figure 7-16, positions 4, 5, 6 and 7.
21. The reading that was obtained in step #20 will be the shim size required.
22. If required, install the shims in groups of twos, one along the top row of the ATC mount bolts and one underneath the bottom row of mount bolts. See Figure 7-17, positions 4, 5, and 6.
23. With a forklift or crane still connected to the ATC, loosen the support bolts to reposition the ATC. Using a rubber mallet, shift the tool changer forward or backward, or bring the front up or down. The forward and backward movement of the ATC is used to adjust the horizontal straightness. The front of the tool changer being moved up or down is used to adjust the level.
24. To properly adjust the side to side position of the ATC, use one of the following methods:
 - a. Remove one of the shims from in between the main casting and the extended mount bracket. These items were used to compensate for dimension tolerances that resulted from the manufacturing process. Shims may or may not be present.
 - b. Remove the ATC extension mount bracket and mill it down to the proper dimension and then reassemble the part to the machine (This is only in the case of not having shims present between the ATC and extension bracket).
 - c. Manufacture shims that will be inserted between the extended mount bracket and the column casting of the machine. Loosen the support bolts to allow the shims to be inserted in along the top and bottom rows of the ATC mount bracket, at the column.

25. Recheck the level and alignment of the ATC for front to back and side to side. If necessary, re-adjust the alignment and tighten the ATC into position. See Figure 7-18:.
26. Repeat above steps for the opposite tool gripper to ensure consistent alignment before pinning the ATC into its final position.
27. Drill and ream the four dowel-pin holes to accept tapered pins. The drill size is 5.953mm. The tapered Reamer size is: #5

**NOTE**

When reaming the holes for the dowel pins, observe that the pins do not extend past the edge of the hole by more than 6.35mm (1/4 in.).

28. Install four #5 tapered dowel-pins into the ATC arm mount at the column. See Figure 7-16:, position 4.
29. Switch to the reverse direction on the drill motor to manually rotate the tool arm back, so the tool holder can be removed.
30. While rotating the ATC arm, pull the motor brake switch up. This is the electromagnetic brake that will be holding the motor back from turning smoothly. The switch is located on top and to the front of the ATC motor (the switch must be held up). See Figure 7-16:, position 3. When the motor has reached the lowest position, press the plunger and remove the tool holder.
31. Start turning the ATC motor again, in the same direction as in step #30. The falling mechanism will reverse, sending the arm back up. At the highest position, the arm body will turn back (80 degrees for the 3020, 65 degrees for the 4525 and 35 degrees for the 6535) to the stand by position 1 (ATC Home Position).

32. Remove the spindle fixture from the head.

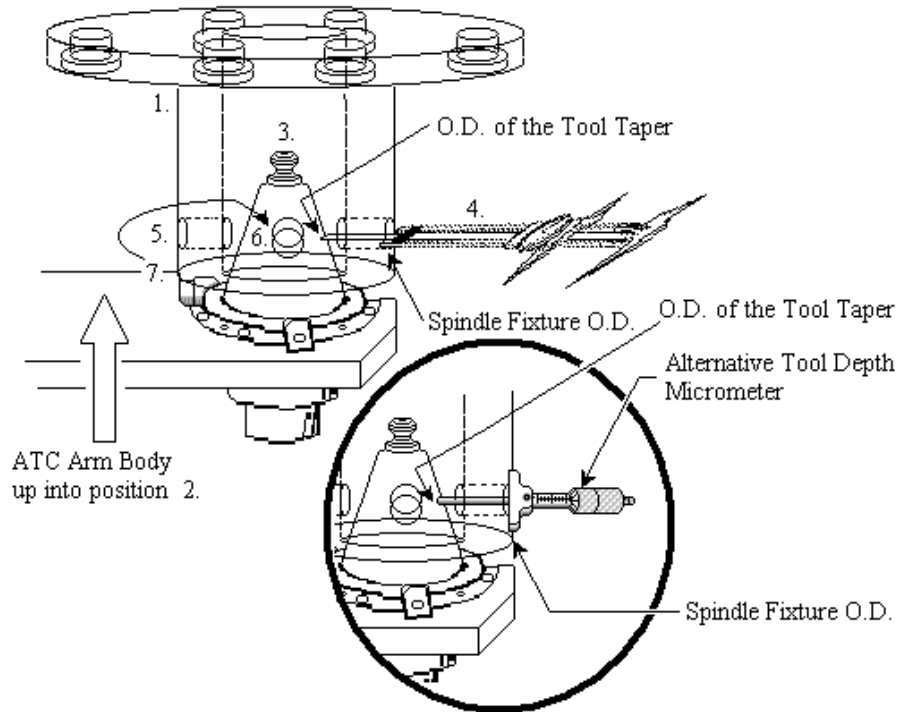


Figure 7-16: Manual Rotation of Tool Arm

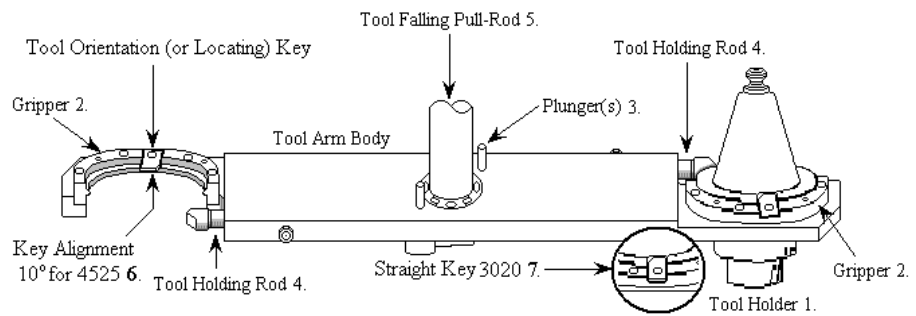


Figure 7-17: Pull Motor Brake Switch

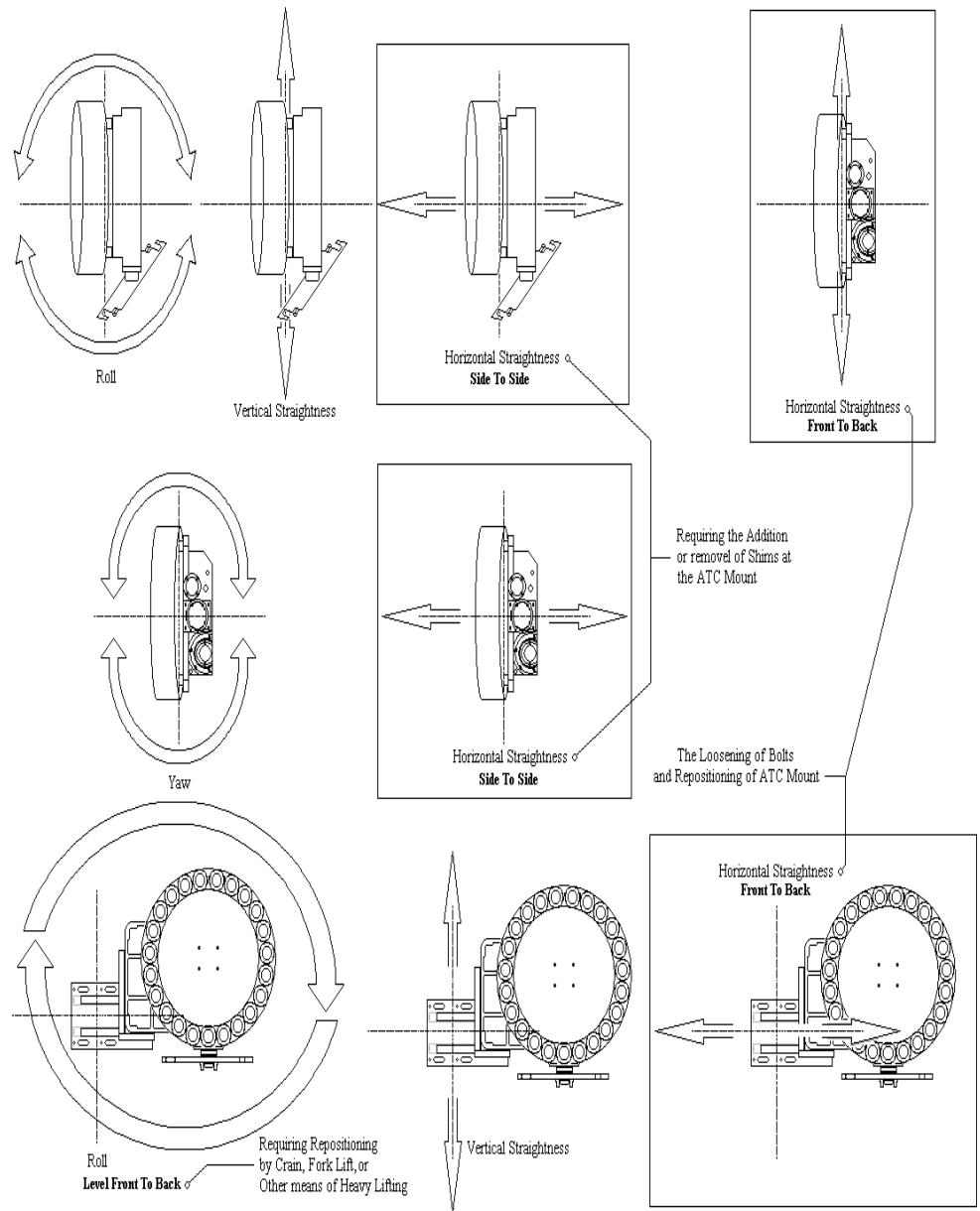


Figure 7-18: ATC Movement

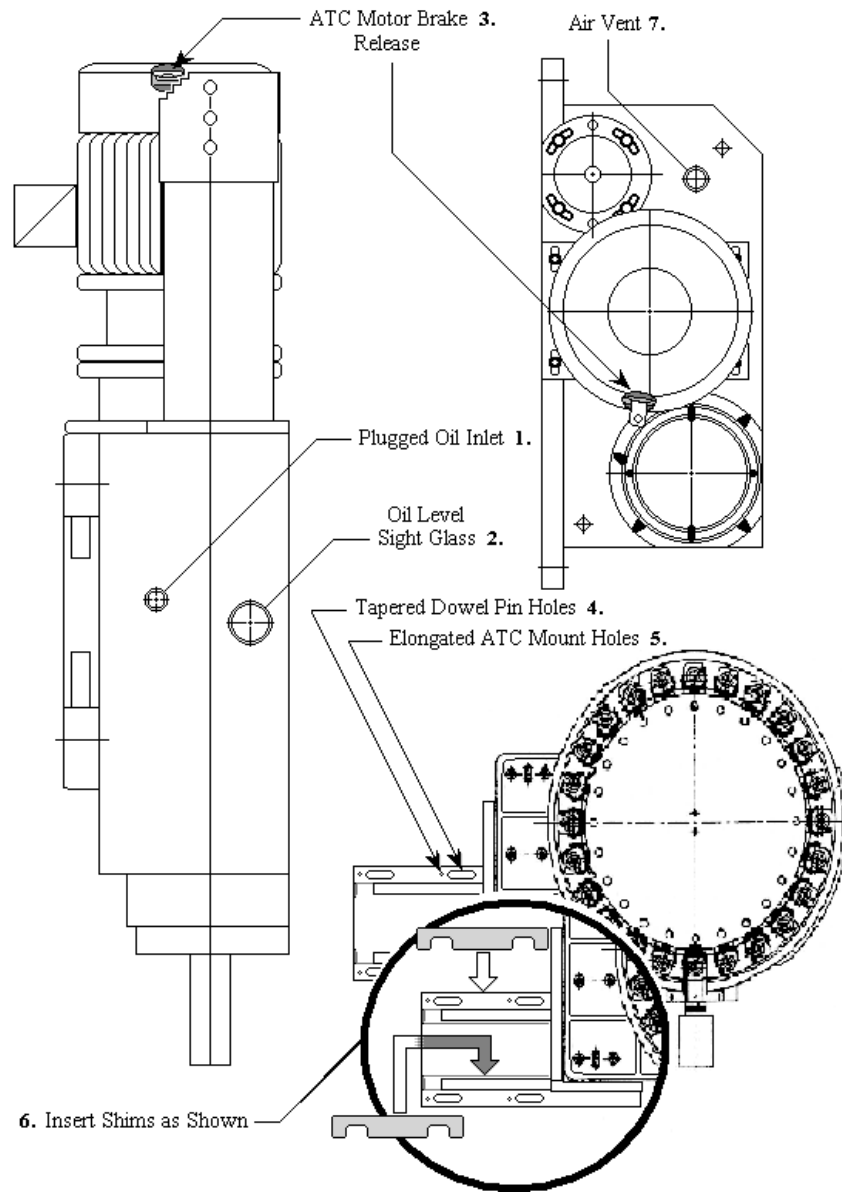


Figure 7-19: Engage Gripper Key Way

7.4.4 SCHEDULED MAINTENANCE

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.

Weekly Maintenance

Perform the following weekly:

1. Greasing:

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

Miscellaneous Maintenance

Perform the following as necessary:

1. Change the lubricant annually or as needed. The recommended lubricant is SAE 90-140. The Dual Arm Tool Changer uses approximately 5 liters (1.3 gallons).

7.5 DATC TOOL CHANGER ADJUSTMENT PROCEDURE

***Verify the cold start position.

****First, should finish the M84 spindle belt calibration and spindle orientation setup before setup the tool changer.

***Preparation: Verity the spindle orientation using M190.

Follow the next adjustment procedure:

1. Turn on the special keep relay to active related function manually to adjust the tool changer.
2. Change to MDI mode.
3. Press Parameter key, then press PMC soft key, select PMC PRM, then press KEEPRLY menu.

<u>K0030</u>	0	0	0	0	0	0	0	0	00
---------------------	---	---	---	---	---	---	---	---	----

K0030.0	Bypass Z axis Tool Changer Location Switch (Fadal Assembly Floor Use Only)	Bypass = 1 Normal = 0
K0030.1	Bypass Door Open Switch (Fadal Assembly Floor Use Only)	Bypass = 1 Normal = 0
K0030.2		
K0030.3	Force Spindle Air On (Y8.6) (Fadal Assembly Floor Use Only)	Force = 1 Normal = 0
K0030.4	Force Spindle Draw Bar Open (Y8.5) (Fadal Assembly Floor Use Only)	Force = 1 Normal = 0
K0030.5	Manual Index (Up/Down) of DATC Tool Drum Pot (Fadal Assembly Floor Use Only)	Enable = 1 Normal = 0
K0030.6	Manual Toggle In/Out of Tool Change Orient Arm (Fadal Maintenance Use Only)	Enable = 1 Normal = 0
K0030.7	Manual Jog of Tool Arm (Fadal Maintenance Use Only)	Enable = 1 Normal = 0

K30 Keep Relays are provided for Fadal manufacturing and Fadal factory & authorized service. Relays are provided to enable manual operation of machine functions. Due to requirements when used for service, normal interlocking of machine mechanisms are not enforced. Use with extreme caution. Operator message indicating "setup mode" is

active displayed when any Keep Relays are set to "1". All settings are always to be set to "0" for use of machine by Auto/MDI commands.

K0030.0 Z axis Tool Changer Position Proximity Switch

Bypass door open proximity switch. Intended for factory assembly use only, prior to sheet metal and Z axis position switch mounting.

K0030.1 Ignore Door Open Switch

Bypass door open proximity switch. Intended for factory assembly use only, prior to sheet metal and door switch mounting.

K0030.3 Turn On Spindle Air for Service

Turn on output Y8.6 for spindle air pressure.

K0030.4 Turn On Spindle Draw Bar

Turn on output Y8.5 for spindle draw bar.

K0030.5 Manual Index (Up/Down) of DATC Tool Drum Pot

Enable manual, command of bottom tool pot in tool carousel. Must be in Incr Jog mode. Use 1KX pushbutton for tool down motion, 100X pushbutton for tool up motion. use with extreme caution. Intended for use by setup/maintenance work only.

K0030.6 Manual Toggle In/Out of Tool Change Orient Arm

Enable manual activation of tool change orient locking arm for maintenance work. Must be in Jog mode. Use 10X pushbutton to toggle locking arm In/Out. Use with extreme caution.

K0030.7 Manual Jog of Tool Arm

Enable manual rotation of tool change dual swing arm for machine setup/maintenance work. Must be in Jog mode. Use 1KX pushbutton for forward rotation, 100X pushbutton for reverse rotation. Please use with extreme caution. Remove tool from spindle before using. Draw bar will not release if tool in spindle is grabbed by tool arm.

4. Check the K bit according the DATC tool changer

K5.3=1-- DATC 20
 K5.4=1-- DATC 24
 K5.5=1-- DATC 32
 K5.6=1-- DATC 62

K5.7=1-- DATC 40

5. Spindle Orientation M code

M190

7.6 50 TAPER DUAL
ARM TOOL CHANGER

7.6.1 TOOL CHANGER
SPECIFICATIONS

Table 7-6: Tool Changer Specifications

SPECIFICATIONS		6535/50T
Type of Tool		CAT-50/BT-50
Number of Tools		32
Maximum Tool Diameter	All Pockets Full	Ø125mm (4.92in.)
	Adjacent Pockets Empty	Ø250 (9.85in.)
Maximum Tool Length	Maximum	400mm (15.75in.)
Tool Weight	Maximum	18kg. (40lb.)
Tool Magazine Drive Source	Motor Voltage	AC 220 V, 3 Phases
	Air Pressure	5~7kg/Cm (70-100 psi)

7.6.2 SUB-ASSEM-
BLIES

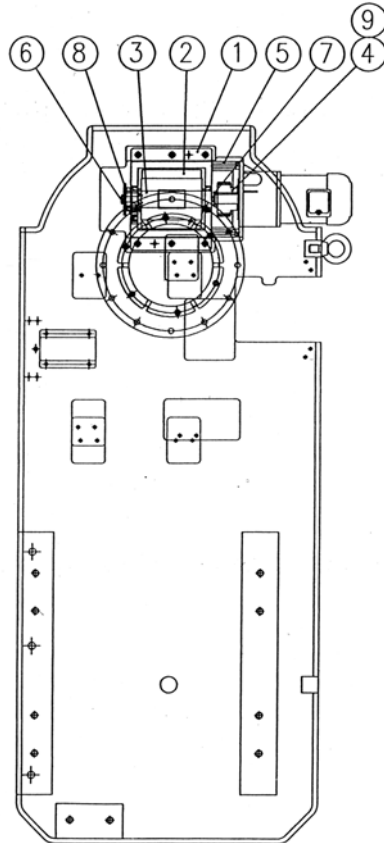


Figure 7-20: Index Mechanism

Table 7-7: Index Mechanism

No.	Part Description
1	Cam Base
2	Cylindrical Cam
3	Driving Spindle
4	Gear
5	Motor Base
6	Proximity Switch Base
7	Gear's Locking Basket
8	Proximity Switch Block
9	Gear

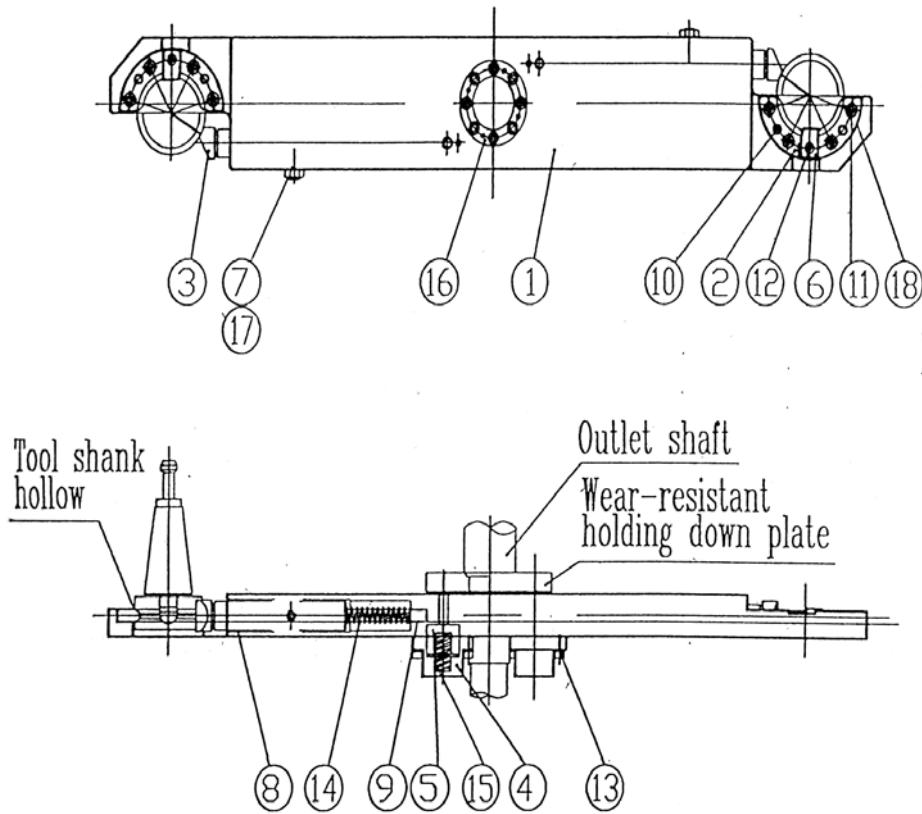


Figure 7-21: 50 Taper Tool Arm

Table 7-8: 50 Taper Tool Arm

No.	Part Description	No.	Part Description
1	Tool Arm Body	12	Counter Sunk Screw
2	Gripper	13	Female Hexagon Bolt
3	Tool Holding Rod	14	Spring(2)
4	Spring Cover	15	Spring(1)
5	Fixing Rod	16	Locking Ring
6	Positioning Key	17	Hexagon Nut
7	Positioning Bolt	18	Catching Claw Pad
8	Self Lubricating Bearing		
9	Self Lubricating Bearing		
10	Pin		
11	Female Hexagon Bolt		

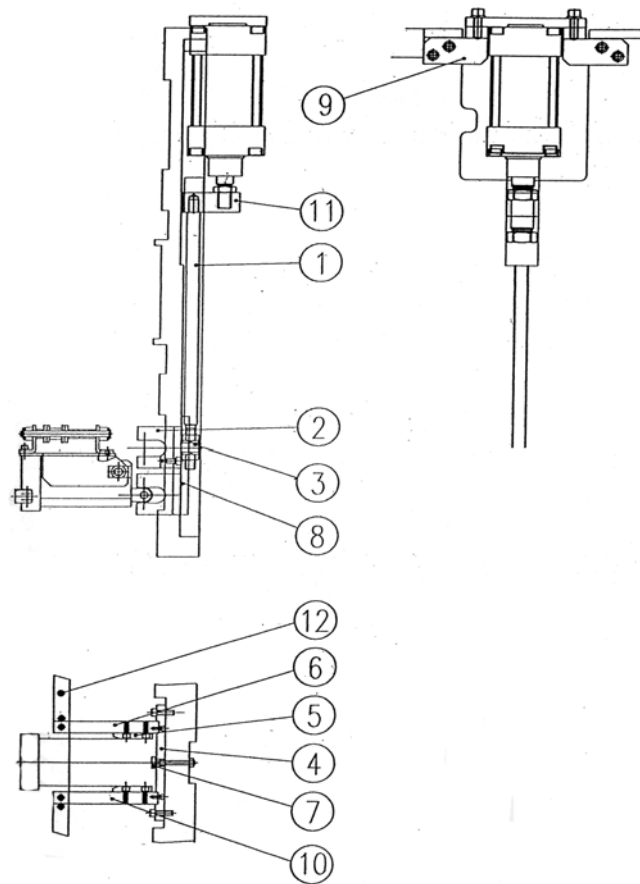


Figure 7-22: Tool Falling Mechanism

Table 7-9: Tool Falling Mechanism

No.	Part Description	No.	Part Description
1	Tool Falling Pull Rod	9	Cylinder Base
2	Sliding Block	10	Positioning Slide Block
3	Sliding Block Cover Plate	11	Connecting Block
4	Positioning Block	12	R-Fixing Plate
5	Positioning Sliding Block (1)		
6	Positioning Sliding Block (2)		
7	Pot Fixing Base		
8	Positioning Block		

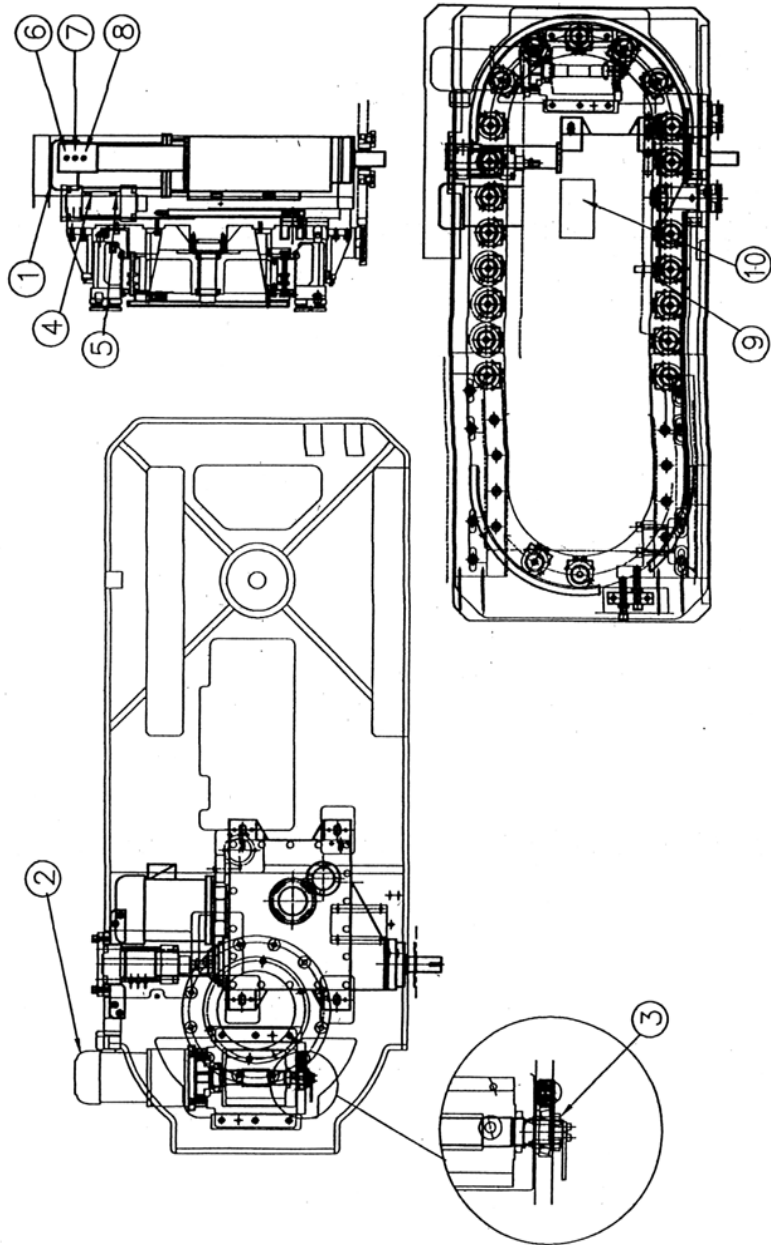


Figure 7-23: Control Elements

Table 7-10: Control Elements

No.	Part Description
1	Tool Changing Mechanism Motor
2	Index Mechanism Motor
3	Proximity Switch 1
4	Reed Switch 2

Table 7-10: (Continued) Control Elements

No.	Part Description
5	Reed Switch 1
6	Proximity Switch 2
7	Proximity Switch 3
8	Proximity Switch 4
9	Proximity Switch 4
10	Control Box

7.6.3 INSTALLATION

1. Check if all the bolts and parts are affixed tightly (they might be loose during transportation). If not; fasten them tightly.
2. Check if the automatic tool changer has any interference with the column of machining center or other area while connecting to the interface.
3. Check voltage specification of motors, sensors and wiring condition to see if they are all compatible with the control system of the machining center.
4. Insure that the conducting wire of control elements during installation is not damaged.
5. Install the automatic tool changer with the machining center, adjusting the relative position between the tool arm and spindle.
 - a. When manually rotating the tool arm for the proper angle, put the wrench on the top of the tool changing mechanism motor shaft to rotate the arm.
 - b. While rotating the arm, pull rod of the motor brake must be released for smooth rotation.
 - c. Adjust the shaft of the arm and spindle in the vertical direction so that they are parallel.
6. Connect each control element according to the diagrams with the relative points of the machining center.
7. When programming the automatic tool changer, note the protection programming between each single action and refer to 'SEQUENCE OF ELECTRIC ACTIONS' and 'INSTALLATION NOTICE.'
8. Check all the wiring and the relative connections to see if they are accurate before trial running.
9. When performing the trial running, take single action in the beginning, then go for successive actions.

7.6.4 INSTALLATION NOTICE

10. If the trial running of single action is not smooth, stop running to check, in order to avoid any damage.
11. If it is necessary, prolong the time between each related action.
12. When performing the successive running, be careful not to miss any interlock protection programming between all the relative actions.

1. Make the necessary interlock protection programming for all the relative connections. The following chart is for reference.

Table 7-11: Interlock Protection Programming

Relay Control	Tool Disk Rotation	Tool Falling	Tool Returning	Tool Changing Mechanism Action
Tool Disc Starting		Off	Off	Off
Reed switch of tool returning (protruding of cylinder)	On			
Reed switch of tool returning (protruding of cylinder)				On
Proximity switch of tool counting and positioning of tool disk		On	On	On
Relay of tool changing mechanism motor starting	Off	Off		
Proximity switch of origin of tool changing mechanism	On	On		

2. After the tool falling of the tool pot is completed, there must be little prolonged time (0.10.25 seconds) before the tool catching of arm. The purpose is to have sufficient air pressure inside the cylinder to avoid shaking of the tool pot while tool catching.
3. After the sensor of the tool unclamping or the tool clamping of the spindle claw is sensed, there could be some prolonged time if necessary. If the tool arm is proceeding the next action before the tool has been unclamped or clamped completely from spindle claw, tool might be forced to be pulled out or the tool might be falling.
4. Adjust the pressure of cylinder to be 5-7 kg/c m².

7.6.5 TROUBLESHOOTING

Table 7-12: Troubleshooting

SYMPTOM	POSSIBLE REASONS	SOLUTION
Tool disk is not rotating while tool selecting	<ol style="list-style-type: none"> 1) Proximity switch of tool counting and positioning of tool disc is not sensed 2) Proximity switch is out of order 3) Index mechanism motor is out of order 4) Motor brake is out of order 5) Reed switch of tool returning (protruding of cylinder) is not at the proper position 	<ol style="list-style-type: none"> 1) Adjust the proximity switch to the proper position 2) Change a new proximity switch 3) Repair the motor or change a new one 4) Check the wiring or change its parts 5) Adjust it to the proper position
Tool disc does not stop at locating position	<ol style="list-style-type: none"> 1) Brake of index mechanism motor is not working 2) Distance between proximity switch of tool counting & positioning of tool disc and inducing block is too long 3) Proximity switch is out of order 	<ol style="list-style-type: none"> 1) Check if wiring of brake is correct or if its parts are out of order 2) Adjust the distance between proximity switch and inducing block to be closer 3) Change a new proximity switch
Tool disc keeps Rotating	<ol style="list-style-type: none"> 1) Distance between proximity switch of tool counting & positioning of tool disc and inducing block is too long 2) Proximity switch is out of order 	<ol style="list-style-type: none"> 1) Adjust the distance between proximity switch and inducing block to be closer 2) Change a new proximity switch
Fixing base of tool pot is deformed	Tool disc rotates while tool pot is falling	Change a new set of fixing base, and adjust, then put spring in
Tool disc is stuck while rotating	<ol style="list-style-type: none"> 1) "C" snap ring is loose, or parts of tool pot fixing base are falling apart 2) Cylinder works while tool disc is rotating, so tool pot is stuck at tool falling position 	<ol style="list-style-type: none"> 1) Disassemble the scattered fixing base and check each part if they are all workable of change a new set of fixing base 2) Check if the tool pot fixing base is deformed. Put sliding block of tool falling and roller back if they are falling apart
Tool pot is shaking while tool returning or tool falling.	<ol style="list-style-type: none"> 1) Sliding base of tool falling is not lubricated enough 2) Speed of cylinder is not even 	<ol style="list-style-type: none"> 1) Apply grease 2) Adjust intake pressure and speed adjusting device of cylinder
Tool pot is not at locating position while tool falling or tool returning	Blots of pull rod of tool falling are loose	Adjust bolts of pull rod of tool falling to be normal and tighten them

Table 7-12: (Continued) Troubleshooting

SYMPTOM	POSSIBLE REASONS	SOLUTION
Cylinder is not acting	<ol style="list-style-type: none"> 1) Reed switch of tool falling (contracting of cylinder) is out of order 2) Reed switch of tool returning (protruding of cylinder) is out of order 3) Tool disc is not at locating position 4) No intake pressure in cylinder 	<ol style="list-style-type: none"> 1) Change a new reed switch 2) Change a new reed switch 3) Set tool disc to the locating position 4) Check if air resource has air and if solenoid valve is working
Arm is not rotating while tool changing	<ol style="list-style-type: none"> 1) Inducing block of origin of tool changing mechanism is not at the proper position 2) Proximity switch is out of order 3) Reed switch of tool falling (contracting of cylinder) is not at the proper position 	<ol style="list-style-type: none"> 1) Adjust it to the proper position 2) Change a new proximity switch 3) Adjust it to the proper position²
Arm is not rotating after tool catching	<ol style="list-style-type: none"> 1) Inducing block of tool catching of tool changing mechanism is not at the proper position 2) Proximity switch is out of order 	<ol style="list-style-type: none"> 1) Adjust it to the proper position 2) Change a new proximity switch
Tool catching of arm is not accurate	The relative position between arm and spindle is not correct	<p>How to Adjust Arm:</p> <ol style="list-style-type: none"> 1) Pull the pull rod of clutch downwards. 2) Use hexagon handle to turn motor and make the arm rotate to the angle of tool catching. 3) Adjust the arm until the arm sticks to the caught tool. 4) Tighten the fixing bolt of the arm.
Arm is not rotating after 180° tool changing	<ol style="list-style-type: none"> 1) Inducing block of tool catching of tool changing mechanism is not at the proper position 2) Proximity switch is out of order 	<ol style="list-style-type: none"> 1) Adjust it to the proper position 2) Change a new proximity switch
Arm stops at origin position but proximity switch of origin is not sensed	<ol style="list-style-type: none"> 1) Inducing block of origin is not at the proper position 2) Proximity switch is out of order 	<ol style="list-style-type: none"> 1) Adjust it to proper position 2) Change new proximity switch

Table 7-12: (Continued) Troubleshooting

SYMPTOM	POSSIBLE REASONS	SOLUTION
Arm is supposed to stop at origin position but is not accurate	Inducing blocks are not at the proper position	Turn the 3 inducing blocks simultaneously to the proper angle
Motor is too hot	1) Brake is not released 2) Brake is out of order 3) Commutator is out of order	1) Check commutator is with electricity or not 2) Repair the brake or change to a new one 3) Change a new commutator
Timing belt of tool changing mechanism is sliding from pulley	1) The timing belt is too loose 2) The timing belt is worn	1) Adjust timing belt tight 2) Change a new timing belt

7.6.6 MAINTENANCE

1. The lubricant inside the lubricant container of the tool changing mechanism should be changed after working for 2400 hours.

When the cam, rollers and the 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.

2. Change of lubricant

The lubricant should be changed annually or when the lubricant becomes worse. Recommended lubricants viscosity: SAE 90140. Amount of lubricant: 5L.

3. Apply grease weekly

- a. On the grippers of tool arm
- b. On the tip of tool holding rod of tool arm
- c. On the sliding block of tool falling, fixing base of pull rod of tool falling

4. Cleaning

- a. Remove the chips around all the proximity switches and reed switches.
- b. Remove the chips inside the tool pot.
- c. The tool changing mechanism parts should be cleaned frequently so that the chips will not stick to it.

5. Check the tool falling mechanism parts regularly.

6. Check the parts of tool pots & tool disc and also check if "C" snap rings are tight regularly. If not, fasten them tightly or change new parts.

7.6.7 DUAL ARM TOOL CHANGER - ARM INSTALLATION



WARNING!

The arm of the dual arm tool changer moves suddenly and with great force. Make sure that while performing the following procedure you and others are out of range of the arm.

7.6.8 INSERTING THE ARM ASSEMBLY



NOTE

It is recommended that two people perform the following procedure.

1. Place the taper lock and arm assembly into the tool changer spindle. It is recommended that the side of the arm is parallel with side sheet metal wall of the tool changer. Make sure that there is a 3 to 4 mm space between the tool changer arm and the top of the tool changer spindle (see picture below).



Figure 7-24: Place Taper Lock and Arm Assembly into Tool Changer Spindle

2. While holding the arm assembly, insert the installation tool (SVT-0149) and tighten with the 12mm bolt.



Figure 7-25: Insert and Tighten Installation Tool

3. Snugly fasten (do not tighten!) the eight taper lock bolts at the bottom of the tool changer in a typical eight bolt crossing pattern.
4. Lower the tool pot to the tool change position.

5. Insert a tool holder into the spindle and the lowered tool pot.
6. Jog the Z axis to correct tool change position.
7. Lock the spindle with the M190 command.
8. Again enter the Dual Arm Tool Changer Menu and select number 4 (Move Arm Reverse) or 3 (Move Arm Forward) to slowly bring the arm into both tool holders.
9. Use your hands to push the tool changer arm into both tool holders making sure that both tool holders are gripped entirely by the tool changer arm.
10. Tighten the eight taper lock bolts at the bottom of the tool changer in a typical eight bolt crossing pattern.
11. Remove the installation tool (SVT-0149).

7.6.9 DUAL ARM TOOL CHANGER ALIGNMENT

1. Remove the dual arm head position sensor and replace with Jumper ELE-0088.
2. Lock the spindle with the M190 command.
3. Jog the Z axis up.

8.0 AXES DRIVE SYSTEM

8.1 ROTARY TABLES, 4TH AXIS

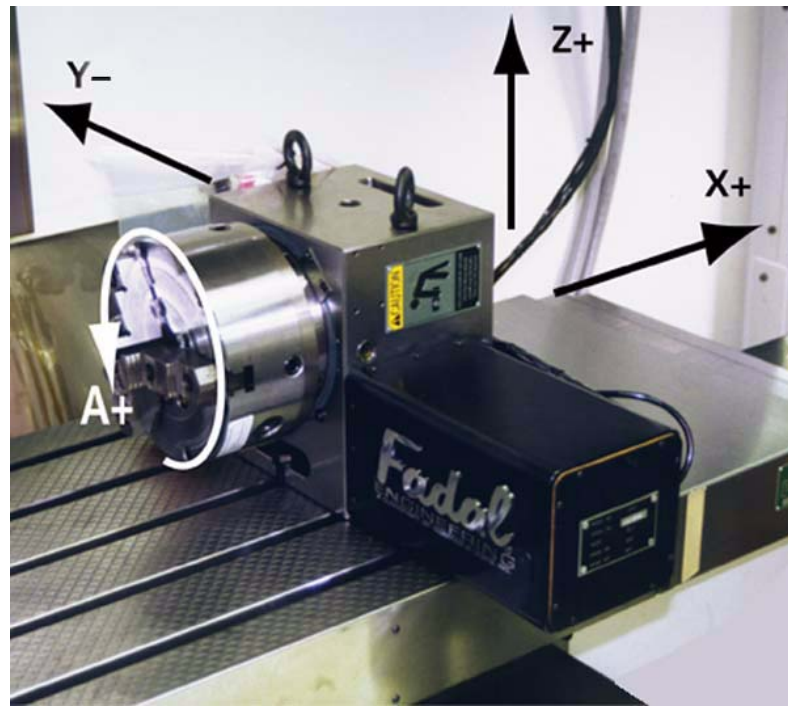


Figure 8-1: Rotary Table

8.1.1 PRE-INSTALLATION

Remove the top of the shipping crate:

1. With a large screwdriver gently pry the clips from the bottom of the crate.
2. Remove the crate top.

Install all items except the Rotary Table itself. These items are included specifically for your VMC configuration, and may include:

- Amplifier Servo Card
- Axis Controller Card
- Brake Solenoid
- Overload Relay
- Air Lines and Fittings
- Prewire Harness

8.1.2 REMOVE THE ROTARY TABLE FROM THE SHIPPING CRATE



WARNING!

Wear Safety goggles, steel toe shoes and gloves to reduce the risk of injury. The VMC table, or any surface on which the rotary table rests, must be free of chips, or anything else that might damage it.

1. Loosen 3/8-16 bolts securing the rotary table and/or tail stock to the crate.
2. Using proper lifting procedures to reduce the risk of muscle strain. Remove the rotary table and/or tail stock.
3. Save the shipping crate. It will be needed if the rotary table needs to be returned to FADAL for any reason.

8.1.3 INSTALLATION

1. Stone both the table and the bottom surface of the rotary table to remove any possible dings. Wipe clean with a light oil.
2. Jog the VMC's table to the X+ and Y+ limits to ease installation. The rotary table normally sits on the right side of the VMC table.
3. Using proper lifting procedures, position the rotary table above the VMC's center T slot, and attach the supplied table keys with two 1/4-20 x 3/4 socket head cap screws.
4. Secure the rotary table to the table using two 1/2-13 x 1 3/4 hex head bolts and hard washers with two 1/2-13 T-nuts. **DO NOT TORQUE BOLTS UNTIL THE ROTARY TABLE IS SQUARE.**

8.1.4 SQUARING THE VH-65

1. Place a tool holder with indicator in the VMC spindle.
2. Square the rotary table at the face plate surface using a soft-face mallet, and tighten the 1/2-13 bolts when square.

8.1.5 SETTING THE VH-65 WORM GEAR BACKLASH



After disassembly or repairs, set the mechanical backlash for the VH-65 as follows:

NOTE

Setting the backlash requires a granite plate or other precision surface.

1. The Higgins nut pre-load should be no more than hand tight.

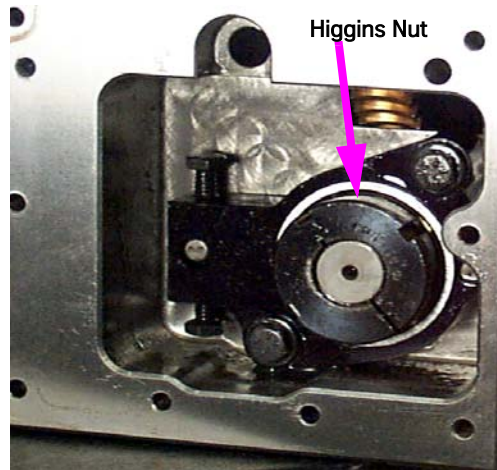


Figure 8-2: Higgins Nut

2. Secure the Higgins nut to the worm shaft by tightening the set screw.

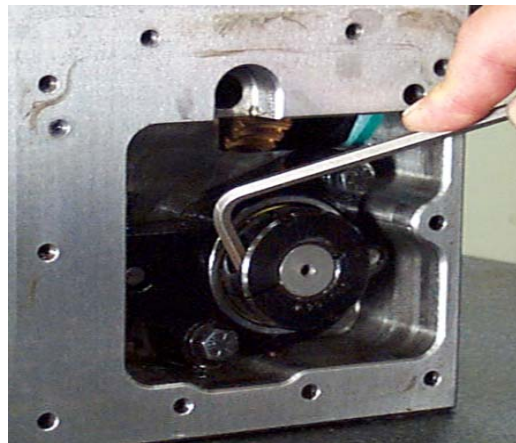


Figure 8-3: Tighten Set Screw

3. The bolts holding the worm pivot plate must be loose to allow setup for the adjustments.

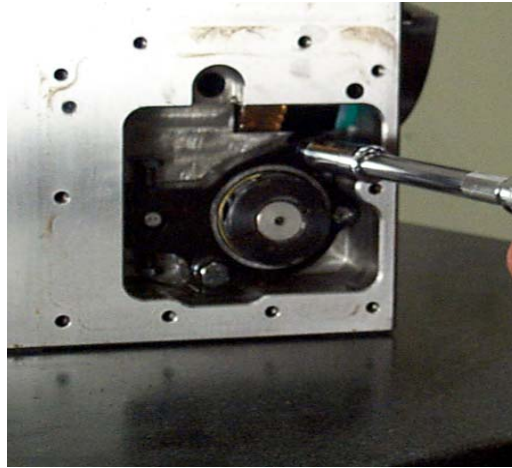


Figure 8-4: Loosen Bolts Holding Worm Pivot Plate

4. The pivot adjustment screws should be set to zero (pivot plate resting on pin A) before starting the adjustment procedure.

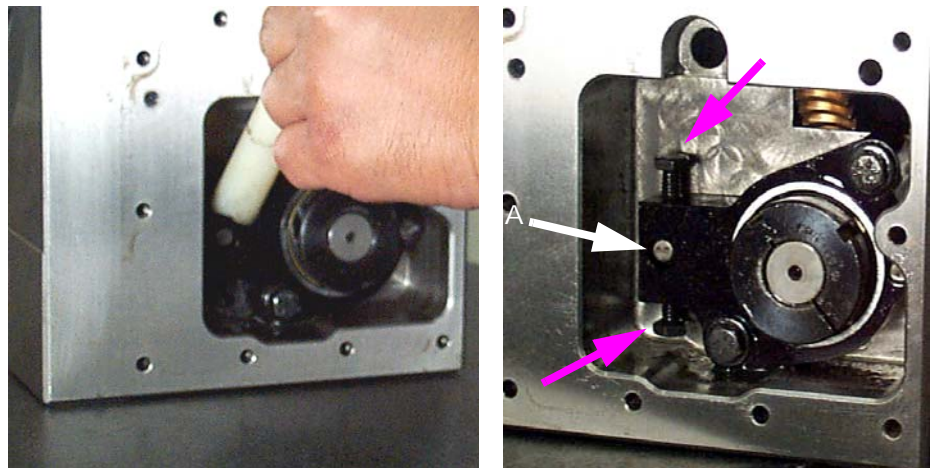


Figure 8-5: Set Pivot Adjustment Screws to Zero

- Turn the top pivot adjusting screw one turn on the side opposite of the motor. Turn the screw on the motor side two turns. (A turn for this procedure is as far as the wrench will move from one side of the pocket to the opposite side).

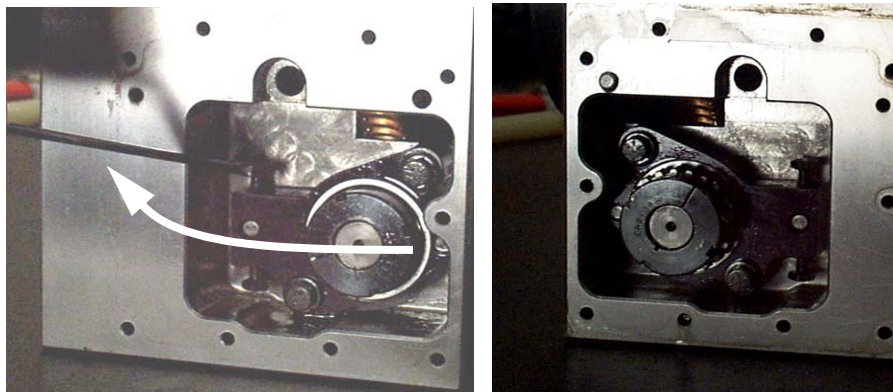


Figure 8-6: Turn Top Pivot Adjusting Screw and Screw on Motor Side

- Set an indicator on a stand. Zero the indicator on the worm pivot plate of the side opposite the motor.



Figure 8-7: Zero Indicator on Worm Pivot Plate

7. Move the indicator to the opposite side and take a reading off of the motor side pivot plate. Adjust the motor side pivot plate so that it is $+0.001$ or -0.0002 ($+0.0254\text{mm}$ or -0.0508mm).

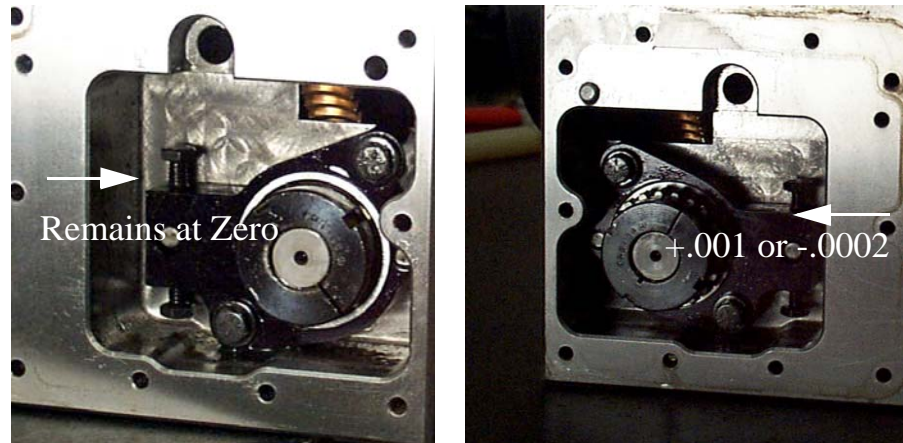


Figure 8-8: Move Indicator and Take Reading

8. Keep checking that the pivot plate on the side opposite the motor stays at zero, adjust back to zero if required. Continue adjusting and checking pivot plate heights until the plates are adjusted.
9. Tighten pivot plate bolts until snug.

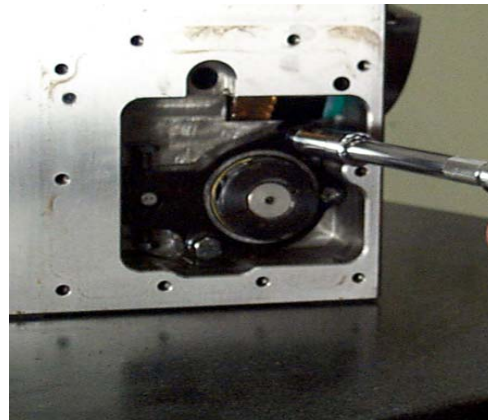


Figure 8-9: Tighten Pivot Plate Bolts

10. Tighten adjustment bolts until they are touching the pin, do not tighten beyond just touching the pin.

11. Install motor plate o-ring and set motor on housing with two bolts at opposite corners.

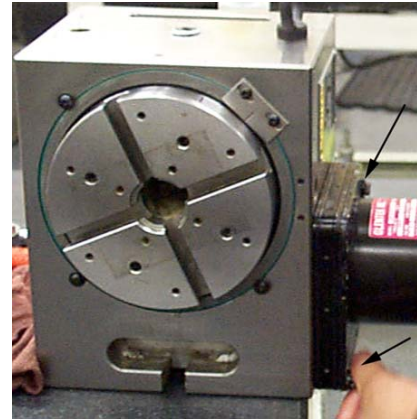


Figure 8-10: Install Motor Plate O-Ring and Set on Housing

12. Connect power leads to the motor.
13. Listen to the operation of worm gear. Any knocking or banging indicates a bad gear adjustment on the worm or motor gear. Exit the program and enter the JOG mode.
14. Place an indicator on the face of the chuck, near the outer edge of the chuck as shown.

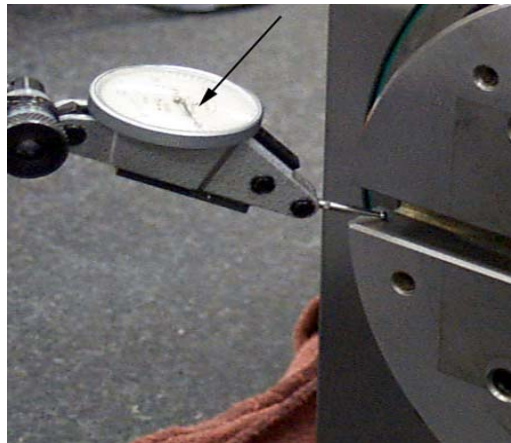


Figure 8-11: Place Indicator on Face of Chuck

15. Zero the indicator and jog the axis in each direction returning to the initial position. The indicator should not be more than +/- .0001" (0.0508mm) from zero. If the indication exceeds this, continue with the next step to determine the cause of backlash error.

16. Zero the indicator. Using a flat aluminum plate in the slots of the chuck, place force up and down on the plate. If there is movement indicated, the worm gear adjustment is off. If there is no movement the motor gear backlash is the cause.



Figure 8-12: Place Force on Plate

17. To correct worm gear backlash, adjust the worm gear backlash on the exposed side of the housing with adjusting bolts until indicator moves less than .002" (0.508mm) when the plate is pressed.

8.2 MAINTENANCE

8.2.1 GEAR OIL

The gear oil is the primary concern in rotary table maintenance. The oil should be changed every six to twelve months, depending on usage.

1. Remove the 1/8-27 NPT plug from the cover plate opposite the motor.
2. To allow the oil to flow more freely, wipe off any chips and dirt from the top of the rotary table and remove the 1/2-14 NPT plug. (No lubrication maintenance is required for the VH-5C.)

As a replacement oil use:

MOBILGEAR 626

LUBRICATION OIL

ISO VG 68

3. Replace the 1/8-27 NPT plug using teflon tape.
4. Using a funnel, fill the rotary table with the recommended oil or an approved equivalent gear oil through the top of the unit. Fill to the line on the sight glass, approximately 48 fl. oz.
5. Replace the top plug using teflon tape.

8.2.2 COOLANT

Some types of coolant have a tendency to swell the motor cover gasket and attack the sealing compound. If this occurs, we recommend switching coolants. Wynns 941 has shown to be a satisfactory coolant.

8.2.3 FACE PLATE

The rotary table face plate and any tooling must be free from chips and dings. Stone both surfaces and wipe clean.

8.2.4 SERIALIZED MATCHED SETS

Rotary tables heads and tailstocks are serialized. FADAL maintains a record of the center line height of all serialized heads and tailstocks. If a customer desires at a later date to purchase a matching component, this may be easily accomplished.

8.3 A & B AXIS SETUP

Follow the next procedure:

1. Power off the machine. Install the A & B axis drive inside the cabinet and install the A axis rotary table.

- Hardware:

- A axis drive for VH165
A06B-6114-H103 SERVO AMP SVM1-20i
- A&B axis drive for TR165 (Requires Package SCL-1)
A06B-6114-H205 SERVO AMP SVM2-20/20-i
- A axis drive for V300 (Requires package SCL-1)
A06-6114-H103 SERVO AMP SVM1-20i
- A axis drive for ROT-SMW-1XX
A06B--6114-H103 SERVO AMP SVM1-20i
- A axis drive for ROT-SMW-2XX
A06B-6114-H103 SERVO AMP SVM1-20i

- Connect the wire according the wire diagram page E600

2. Turn ON/OFF A & B axis.

- Press MDI key on the operator panel
- Press PROGRAM on the MDI panel
- Press MDI soft key below the LCD screen
- Input M85 (M85 turn on A axis, M86 turn off A axis, M87 turn on B axis, M88 turn off B axis)
- Press EOB key on the MDI panel
- Press INSERT key
- Press CYCLE START
- Wait until this command is complete
- Turn off the control
- Turn on the control
- Use JOG function to check if the A axis is working

** Repeat above steps to use M86 to turn off A axis, M87 turn on B axis, M88 turn off B axis.

3. Input the pitch compensation

** Input the data inside of program

** O4014 is for A axis, O4015 is for B axis

** To change the #100 variable to setup different rotary table, default value is for VH165, TR165

- Input the survey data inside of program
- Change the value of #100 of Program O4014/O4015 according the rotary type
- Run Program O1014/O1015
- Turn off the CNC power
- Turn on the CNC power

- Reference all the axes
- Double check the pitch compensation data if necessary

```

O4014(PITCH_A_SETUP)
(*STEPOVER=10 FOR V300
(*STEPOVER=20 FOR VH65, TR65
(*N3605 BITO=0.UNIDIRECTIONAL PITCH COMP.
(*N3620 p4R600
(*N3621 p4R600
(*N3622 p4R618
(*N3623 p4R10
(*N3624 p4R10000
(*N3625 p4R360000
(*N3626 p4R0
(*N3627 p4R0
M0
N10#100=0 (0=TR65 or VH65, 1=V300)
(*SETUP ROTARY TABLE TYPE INTO ABOVE
M0
N20 IF [#100 EQ 0] GOTO60
(*STEPOVER=10
G10L50
N10600 R0
N10601 R0
N10602 R0
N10603 R0
N10604 R0
N10605 R0
N10606 R0
N10607 R0
N10608 R0
N10609 R0
N10610 R0
N10611 R0
N10612 R0
N10613 R0
N10614 R0
N10615 R0
N10616 R0
N10617 R0
N10618 R0
N10619 R0
N10620 R0
N10621 R0
N10622 R0
N10623 R0

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N10624 R0
N10625 R0
N10626 R0
N10627 R0
N10628 R0
N10629 R0
N10630 R0
N10631 R0
N10632 R0
N10633 R0
N10634 R0
N10635 R0
N10636 R0
N3620 P4R600
N3621 P4R600
N3622 P4R636
N3623 P4R10
N3624 P4R10000
N3625 P4R360000
N3626 P4R0
N3627 P4R0
G11
GOTO70
N60
(*STEPOVER=20DEGREE
G10L50
N10600 R0
N10601 R0
N10602 R0
N10603 R0
N10604 R0
N10605 R0
N10606 R0
N10607 R0
N10608 R0
N10609 R0
N10610 R0
N10611 R0
N10612 R0
N10613 R0
N10614 R0
N10615 R0
N10616 R0
N10617 R0
N10618 R0
N3620 P4R600

N3621 P4R600
 N3622 P4R618
 N3623 P4R10
 N3624 P4R20000
 N3625 P4R360000
 N3626 P4R0
 N3627 P4R0
 N70M30

%

4. Make a cold start for A & B axis

- Press MDI key on the operator panel
- Press SYSTEM key on the MDI
- Press PARAM soft key on LCD
- Input 1850
- Press NO.SRH soft key on LCD, the backlash parameter will be displayed (No.1850)
- Use the cursor move the related axis, and input the correct data as following:

Cold start data = C (the data from rotary room, Metric) x 10

Parameter:1850

A _____
 B _____

- According the regular cold start procedure to make cold start for 4th and 5th axis
- Double check the cold start position
 - Reference A &B axis
 - Use indicator to check the A axis level according the table
 - Redo the cold start setup according the cold start setup procedure

5. Input the backlash to the parameter

- Press MDI key on the operator panel
- Press SYSTEM key on the MDI
- Press PARAM soft key on LCD
- Input 1851
- Press NO.SRH soft key on LCD, the backlash parameter will be displayed (No.1851)
- Use the cursor move the related axis, and input the correct data as following:

Backlash Data = D (the data from rotary room, Metric) x 10

Parameter:1851

A _____
 B _____

6. Check the A & B axis brake
 - Install the indicator on the table and touch the chuck of the A axis
 - Use M code to brake/release the A & B axis and check if the A & B axis is off from the original position.

M60 ---- A axis brake
 M61 ---- A axis release
 M62 ---- B axis brake
 M63 ---- B axis release

- Change the timer of A & B axis if the position is off through the previous step.

Steps to change the PMC timer:

- Press MDI
- Press SYSTEM on the MDI panel
- Press PARAM soft key
- Press PMC soft key
- Press PMCPRM soft key
- Press TIMER soft key, then you can see all the timer table as above
- Use PAGE DOWN and PAGE UP to go to different page
- Use cursor move to the Timer number which we need to change
- Input the timer data
- Press INPUT
- Timer Data is input

Table 8-1: Timer

TIMER NO.	T ADDRESS	T DATA	DESCRIPTION
50	T0098	496	M60 Delay A axis Servo Off after Motor Brake applied
51	T0100	496	Delay M60 FIN after Servo Off applied, set if required
52	T0102	496	M61 Delay A axis Brake Release after Servo On applied
53	T0104	496	Delay M61 FIN after Brake Released, set if required
54	T0106	496	M62 Delay B axis Servo Off after Motor Brake applied
55	T0108	496	Delay M62 Fin after Servo off applied, set if required
56	T0110	496	M63 Delay A axis Brake Release after Servo On applied
57	T0112	496	Delay M63 FIN after Brake Released, set if required

8.4 DIGITAL AXIS DRIVE SYSTEM

8.4.1 SETUP BACKLASH PROCEDURE

***Prepare: In MDI mode, input G21 to change machine to Metric display.

Follow the next procedure:

1. Reference all the axes.

Push Reference mode key and select reference mode, then push X/Y/Z key to move X/Y/Z axis to zero position. CNC screen will display XoYoZo.

2. Find out machine backlash manually. Record the backlash as data "A"

3. Input the backlash to the parameter

- Press [MDI] key on the operator panel
- Press [SYSTEM] key on the MDI
- Press [PARAM] soft key on LCD
- Input 1851
- Press [NO.SRH] soft key on LCD, the backlash parameter will be displayed (No.1851)
- Use the cursor to move the related axis, and input the correct data as following

$$\text{Backlash Data B} = \text{A(Metric)} \times 10000$$

Parameter:1851

X_____

Y_____

Z_____

A_____

B_____

4. Reference all the axes

Push Reference mode key and select reference mode, then push X/Y/Z key to move X/Y/Z axis to zero position. CNC screen will display X0Y0Z0.

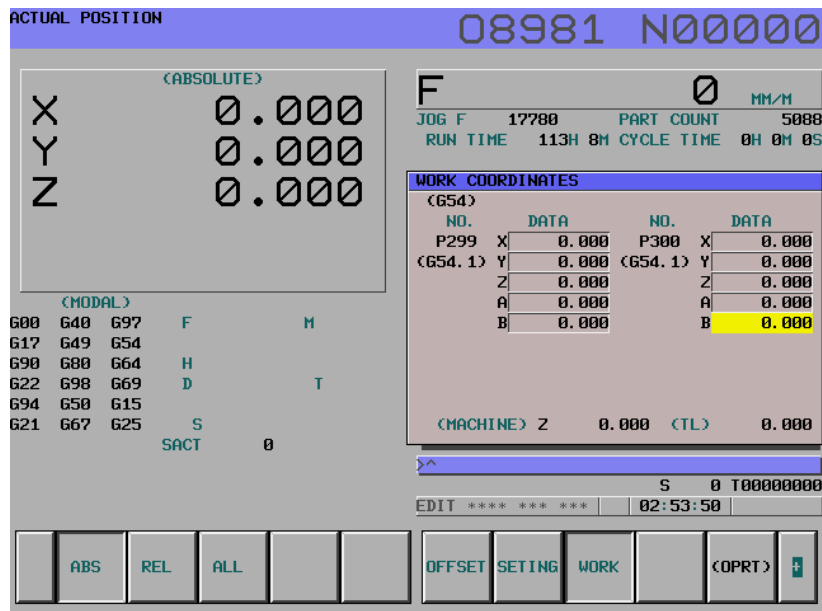
5. Repeat steps 2 and 3 for all the axes

6. Backlash setup is finished.

8.4.2 WORK COORDINATE SETUP

FANUC Software option related with work coordinator procedure:

1. Update the software option from EZOPT disk according to Fanuc software option installation procedure. (See Options Setup, Section 6.0)
2. Cycle the CNC power.
3. Following the procedure go to the next screen
 - press [OFFSET/SETTING] key on the MDI panel
 - press the [WORK] soft key on the LCD screen
 - press [PAGE UP] key once on the MDI panel
4. Check the following screen on the CNC. If G54 P299/P300 coordinator is displayed, the software installation is successful. Otherwise, repeat all the steps all over again.



8.4.3 CONTROL AXIS DETACH SETUP

Fanuc software option related with control axis detach.

Follow the next steps to detach the software function with 4th /5th axis.

1. Update the software option from EZOPT disk according to Fanuc software S/W option installation procedure.(See Options Setup, Section 6.0)
2. Cycle the CNC power.
3. According the procedure, chek the following screen.
 - press [SYSTEM] key on the MDI panel

- press [PMC] soft key on the LCD screen
- press [PMCDGN] soft key on the LCD screen
- press [STATUS] soft key on the LCD screen
- input [F110] from the MDI panel
- press [SEARCH] soft key on the LCD screen

4. Check the following screen on the CNC. If the row of **F110** is same as the following picture, software installation is successful. Otherwise, repeat the steps all over again.

PMC SIGNAL STATUS		OVERRIDE						PMC RUN	
ADDRESS	7	6	5	4	3	2	1	0	
				MDTCH5	MDTCH4				
F0110	.	.	.	I	I	.	.	.	
F0111	
F0112	.	.	.	I	I	I	I	I	
F0113	
F0114	
F0115	
F0116	
F0117	
[F0110	:	:	:	:	:	:	:	I	

SEARCH				FORCE						
--------	--	--	--	-------	--	--	--	--	--	--

9.0 PALLET CHANGER

9.1 INSTALLATION OF PALLET CHANGER

1. The left, front, lower edge of the base must be a minimum of 2" from the floor. Level the machine on the 1.5" leveling pads that were shipped with the machine (see the Fadal Maintenance Manual Pre-Installation/Installation Section for documentation on leveling the VMC).
2. Verify that the X and Y axis cold start positions are correct. The X axis must travel to X-20" and the Y axis must travel to Y-10" and Y+10". Cold start the machine.
3. Enter the Parameters page and select the Pallet Changer.
 - a. At the ENTER NEXT COMMAND screen, type SETP and press the ENTER button.
 - b. Press the SPACE BAR to select the second page.
 - c. Press the D button, to page down to the PALLET category. Select the number 2, which answers yes to the question "Do you have a Pallet Changer". Press the ENTER button and then press the MANUAL button to exit the Parameters page.
4. Verify that the rail support bolts on the Pallet Receiver are installed and are all the way up.



Figure 9-1 Verify Rail Support Bolts are Installed and All the Way Up

5. Verify that the rails and the bolts are high enough to clear the VMC sheetmetal. If not, adjust the Pallet Receiver legs clockwise to raise the level of the support rails.
6. Move the VMC table to X=-20" and Y=10".
7. Open the Pallet Changer door using the UTILITIES command.
 - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
 - b. Select option #5 PALLET CHANGER.
 - c. Select option #4 SERVICE UTILITY.
 - d. Select option #2 OPEN/CLOSE DOOR.

- 8) Slide the Pallet Changer receiver base into position. Line up the floor plate rails with the bolt holes on the main casting base.

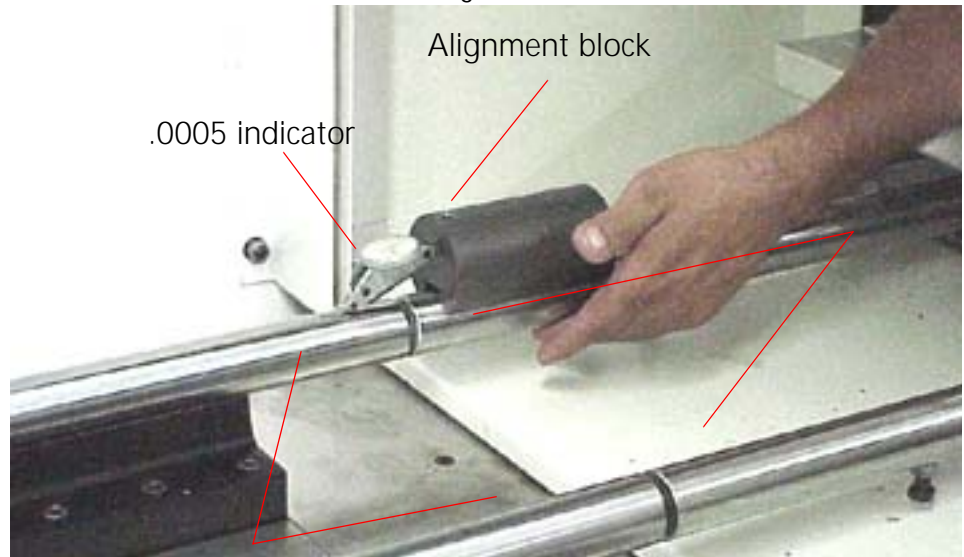


Figure 9-2 Slide Pallet Changer Receiver Base into Position

9. Install the bolts for the floor plate rails. Check the alignment visually. Tighten the bolts and then break them loose.
10. Level the receiver base. After leveling, verify the gap between the receiver rails and the machine rails is .100" - .200" and the up and down alignment is also .100" - .200".
11. To align the rails side to side, move the receiver base left or right until the receiver and machine rails are aligned within .100" - .200".
12. Place the Alignment block on the receiver rail and the .0005" indicator on the machine rail and slide the adjustment block toward the machine. The indicator will move, indicating the up and down alignment of the rails. Adjust the receiver base legs to bring the up and down alignment of the receiver and machine rails to within .003".
13. Place the Alignment block on the receiver rail and the indicator on the machine rail and rotate the adjustment block to the side. The indicator will move, indicating the side to side alignment of the rails. Move the receiver base to bring the side to side alignment within .002". Check all four rails. If one rail is out of tolerance and cannot be adjusted to within tolerance, the machine or receiver rail may need to be replaced.
14. Tighten the bolts on the receiver base legs. After tightening the bolts, perform a check on the alignment by using steps 12 and 13. Re-adjust if necessary.
15. Remove the pallet shipping brackets.

16. Move pallet A onto the machine by hand. Check for a smooth transition. If binding occurs, return the pallet to the receiver and check the alignment (Steps 12 and 13).
17. Once the A pallet travels across the rails smoothly, return it to the receiver and perform the same check on the B pallet.
18. Remove the pallet arm safety cover.



Figure 9-3 Remove Pallet Arm Safety Cover

19. Loosen the 5/16" socket head pallet arm bolt. The pallet changer arm will drop down. Swing the arm out of the path of the pallet.
20. Release the clamp.
 - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
 - b. Select option #5 PALLET CHANGER.
 - c. Select option #4 SERVICE UTILITY.
 - d. Select option #1 Clamp/Unclamp.

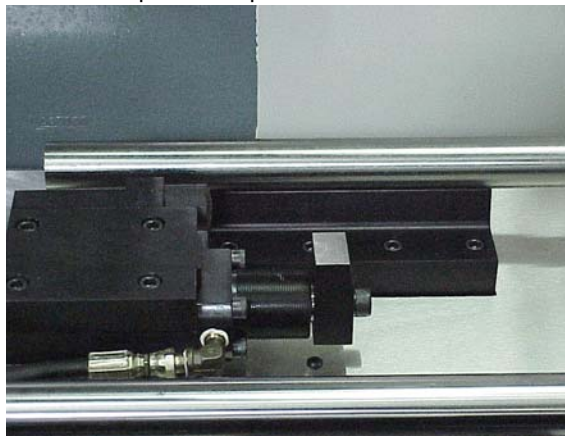


Figure 9-4 Release the Clamp

21. Pull pallet A all the way on to the machine table and use the instructions in step #20 to clamp the table in place.
22. Position the Pallet Changer Arm roller into the slot of the pallet. Place the roller half way into the slot. The arm should be flush with the top of the pivot pin.

23. Tighten the 5/16" socket head pallet arm bolt to 35-40 foot pounds.
24. Store pallet A.
 - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
 - b. Select option #5 PALLET CHANGER
 - c. Select option #4 SERVICE UTILITY
 - d. Select option #3 Store Pallet
25. If the pallet moves smoothly, tighten the rail slide bolts that are connected to the base.
26. Check pallet A and verify that the pallet is resting properly on the receiver roller. If the pallet is not resting properly on the roller, then adjust the pallet stop block position on the pallet.
 - a. Remove the cover over the roller.
 - Remove the two 5/16" hex head bolts that are holding the cover in place.
 - Remove the cover.
 - b. Loosen the two 9/16" hex head bolts that are located underneath the pallet stop block.
 - c. Slide the stop block until it rests properly over the roller.

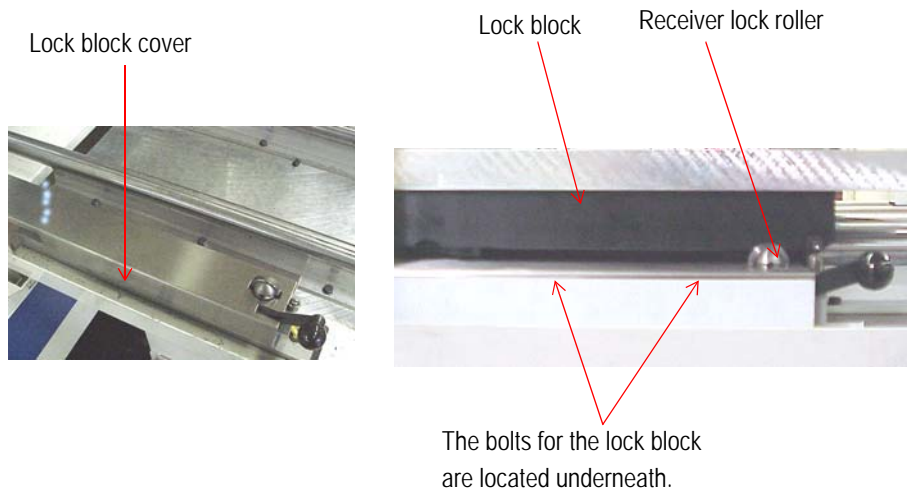


Figure 9-5 Remove Cover; Loosen Bolts; Slide Stop Block Over Roller

27. Jog the table back to pallet B and load pallet B.
 - a. In the ENTER NEXT COMMAND mode, type UT and press the ENTER button.
 - b. Select option #5 PALLET CHANGER; press the ENTER button.
 - c. Select option #4 SERVICE UTILITY; press the ENTER button.
 - d. Select option #8 JOG.
 - e. Press the JOG key on the keypad and jog the Y-axis to Y= -10.

- f. Verify that the arm is lined up with the groove in pallet B. If the arm is not lined up with the groove, move the pallet forward or backward to allow the arm to enter the groove.
 - g. Press the manual button to return to the utility menu. Press Option #4 LOAD PALLET.
28. If pallet B loaded smoothly, store pallet B and verify that the pallet stop block is resting properly on the roller. If the pallet is not resting properly on the receiver roller, adjust the positioning (refer to step #26).
29. Drill holes in the concrete through the holes in the receiver base legs. Install the mounting bolts and tighten.
30. Verify the alignment, by performing several pallet changes using the utilities menu.
31. Adjust the pallet rail support bolts down until they touch the sheetmetal. Tighten the lock nut.

9.2 INSTALLATION OF LIGHT CURTAIN

1. Attach the front and rear base plates to the pallet receiver (A).
2. Fasten the front and back light curtain mirror assemblies to the front and rear base plates. Verify that both mirrors are level (B).
3. Attach the receiver and transmitter. Align the receiver and transmitter to the mirror heights (C).
4. Attach the controller junction box onto the pallet changer base. Plug the transmitter and receiver cables into the junction box (D).
5. Connect the controller junction box to the 2100-3 board for 120V power.

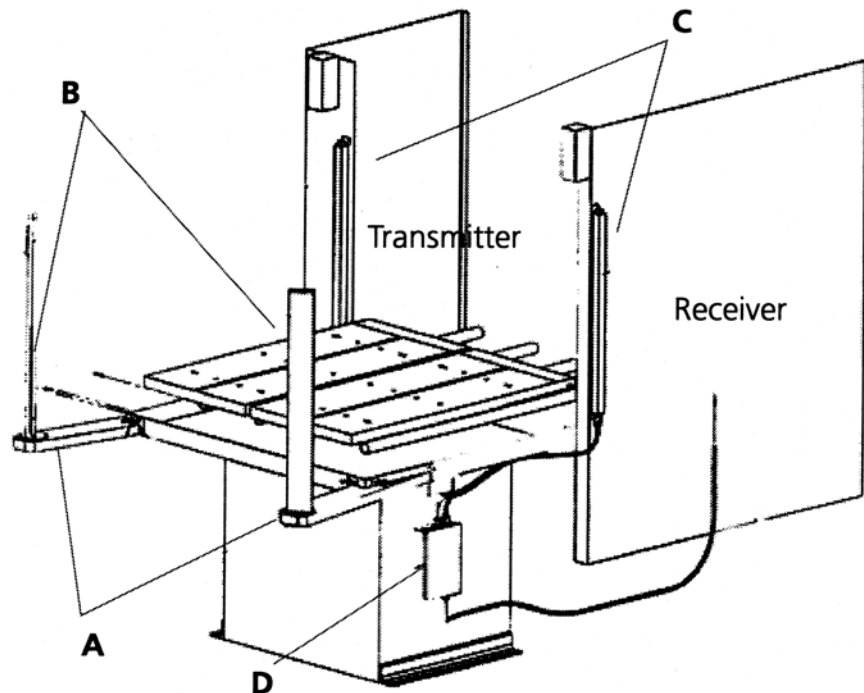


Figure 9-6 Connect Controller Junction Box to 2100-3 Board

- | | |
|-------------------------------------|-----------------------------|
| A= Front and rear base plates | C= Transmitter and Receiver |
| B= Front and rear mirror assemblies | D= Junction box |

9.2.1 MIRROR ALIGNMENT



NOTE

The transmitter has two lights (one red and one green) located at the top end of the unit. They represent a good alignment (green light) or a bad alignment (red light). There must not be any obstructions within the light curtain while the alignment is being set. Obstructions may keep the transmitter from aligning properly with the receiver.

1. Stand next to the transmitter of the light curtain and look into mirror #1.
2. Adjust mirror #1 until the mirror #2 can be seen.

3. Adjust mirror #2 until the receiver can be seen when looking in mirror #1.
4. Repeat the above steps while standing on the receiver side. If the mirrors are aligned properly, the transmitter will be viewed while looking in mirror #2 from the receiver side.
5. After the alignment has been set, look at the lights on the transmitter. The green light will be illuminated if the alignment is correct. If the alignment is incorrect, the red light will be illuminated.
6. If the red light is illuminated, repeat steps 1-5. Also, try adjusting the receiver or transmitter.

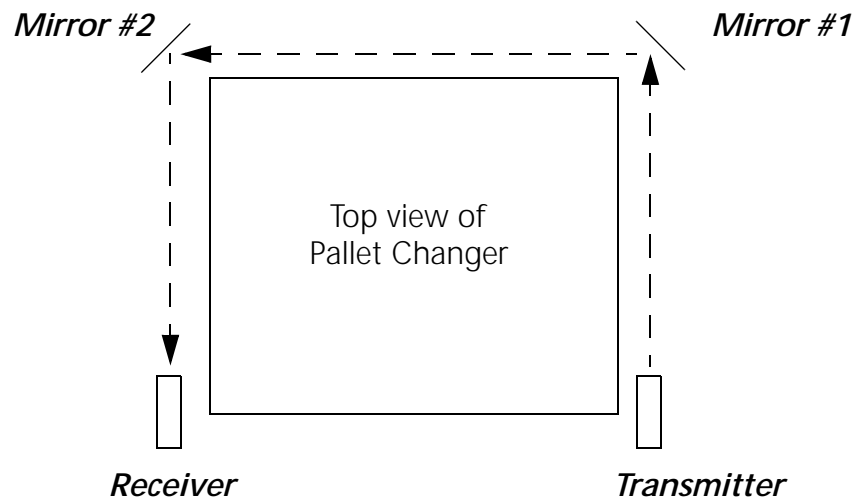


Figure 9-7 Mirror Alignment

9.3 SETTING THE SENSOR ON THE 1840 BOARD

9.3.1 PURPOSE

During a pallet change, the table will move to the table limits. If there is anything blocking the progress of the Y-axis, the current of the motor will be too high. The 1840 board senses when the Y-axis motor is receiving too much current and will inhibit the pallet operation.



WARNING!

This procedure is for DC machines only. AC machines monitor motor overload through the axis controller card.

1. Install the 1840 board into the VMC.
2. Power on the VMC.
3. Enter the ENTER NEXT COMMAND mode and enter a program for testing the sensor.
 - a. Type PR and press the ENTER button.
 - b. Select option #3 START A NEW PROGRAM.
 - c. Type a program number that is not currently in the system and press the ENTER button.
 - d. Select option #6 EXIT.
 - e. Type IN and press the ENTER button.
 - f. Enter the following program:


```
N1 M49 F150. G1 G91
N2 Y5.
N3 Y-5.
N4 M99P1
```
4. Start the program. Press the AUTO button to start the program running.
5. On the 1840 board, turn the pot clockwise until the red LED is on continuously.
6. Turn the pot counterclockwise until the LED gives one solid blink once at the end of each move.
7. Stop the program.
 - a. Press the SLIDE HOLD button.
 - b. Press the MANUAL button.

8. Make a pallet change In the MANUAL DATA INPUT mode (do not make a pallet change from the UTILITIES menu; a pallet change from the UTILITIES menu does not utilize all of the functions of a complete pallet change).

In the MANUAL DATA INPUT mode:

- a. Turn the Rapid travel 3-position switch to 100%.
 - b. Type M31.
 - c. Press the ENTER BUTTON.
9. If the INHIBIT message is displayed on the monitor, repeat steps #3-#8.

9.4 OPERATION

The pallet changer may be operated within the program or by use of the UT (Utilities) command.

9.4.1 PALLETS

There are 2 pallets on the pallet changer. They are identified as Pallet A and Pallet B. Pallet A is the closest pallet to the operator.

There are 3 positions for the pallets: loaded, stored, and working.

- The **loaded** position is when the pallet is locked onto the table with the hydraulic clamp.
 - The **stored** position is when the pallet is ready to be loaded onto the table.
 - The **working** position is when the pallet is released from the stored position. The pallet must be moved to this position manually. Push the release lever down, to pull the table to the working position.
1. The pallets move on rails with circular bearings.
 2. The pallet is locked in place on the table with a hydraulic clamp.
 3. The clamp is released with program coding of a pallet change or through the utility menu.

9.4.2 M-FUNCTIONS

There are 3 M-Functions that may be used to operate the pallet changer:

- **M31 Exchange Pallets** - This function performs a pallet exchange. The pallet changer will store the current pallet and load the other pallet.
- **M32 Store and Load Pallet A** - This function is used when only pallet A is to be utilized. This exchange is performed the same as the M31 function. When pallet A is on the table, it is placed in the stored position. The machine will enter the waiting state, while the operator changes parts. When the START button is pressed, pallet A is loaded.

9.5 MAINTENANCE SCHEDULE

9.5.1 EACH PART CYCLE

1. Use an M20 in the program to make it automatic. Frequent washing out of chips prevents them from building up into difficult-to-remove piles.
2. Blow away any chips that may lodge underneath Pallet in Hydraulic Arm groove.

9.5.2 DAILY MAINTENANCE

1. Put both Pallets away onto stand. Put tool in spindle. Wash down interior with coolant hose nozzle, using care to keep splash away from Automatic Tool Changer, Head assembly, or any wiring connections.
2. Clean chips from trough behind Table and Saddle, and on Sliding.
3. Guard, and inspect between front Y-axis way cover and front of machine for chip buildup.
4. Remove screen/tank cover over fluid tank, and clean screen protecting pumps.
5. Using tool, check for any chip buildup in tank ahead of screen.
6. Check tank reservoir fluid level, and refill as necessary.
7. Check Waylube level, refill with Castrol Magna BD68, Shell Tonna V68, or Mobil Vactra #2.
8. Check for air pressure. Single regulators should be set for 80PSI. Dual regulators should be set at 80PSI on the left gauge, and 90-100PSI maximum on the right gauge.
9. Move X-axis to either side, and flip over outer X-axis way cover. Inspect for chip buildup, and clean. Check for waylube presence on both X-axis ways. Inspect Z-axis and Y-axis as well.
10. Check pressures/vacuum on Coolant-Thru pump filter and replace filter, if necessary.

9.5.3 WEEKLY MAINTENANCE

1. Check Hydraulic Fluid level for Pallet Clamp on top of machine. Use Mobil DTE Heavy Medium.
2. Remove Hydraulic Arm pump cover, and inspect Hydraulic Arm system, refilling fluid if necessary.
3. Check Hydraulic Arm chain tension by push/pull on arm.
4. Remove Head Cover, and inspect fluid lines for Hi/Lo Idler assembly, refilling, if necessary.

9.5.4 MONTHLY
MAINTENANCE

5. Remove all tools from tool changer, and clean out any chip buildup found. When returning tools to ATC, inspect retention ring tension on tool holders for excessive looseness, replacing rings, if necessary.
 6. Disconnect front Y-axis way cover from saddle, and check for chip buildup.
 7. Inspect under Y-axis motor for chips, and clear out drain ports under Y-axis ways nearest the column.
-
1. Carefully remove pallets, and grease rail bearings, using care not to damage lip seals.
 2. Remove spindle motor top filter cover, and inspect filter. Replace, if necessary.
 3. Inspect Pallet Roller latch system for both Pallets on stand.
 4. Check Pallet Lift Door for smooth operation.
 5. Inspect Chiller cabinet for low fluid in container, should be 1/2 to 3/4 full.
 6. Inspect Chiller recirculation pump filter, and clean as needed.
 7. Blow air into top of Chiller louvers to clear out dirt collecting on condenser.
 8. At bottom of rear cabinet, remove fan filter screen and clean.
 9. Inspect front door rollers, tightening as necessary.
 10. Check door interlock system for proper operation.
 11. Remove head cover and inspect belts, and check for any Coolant-thru system leaks.
 12. Inspect all cables, hoses, and tubing for looseness, or damage.

9.6 MIDACO PALLET CHANGER

9.6.1 REQUIREMENTS

Power requirements

The pallet changer requires a 230V/Single Phase/30AMP power feed. The power is to be connected to the top of the power disconnect located in the pallet changer's electrical enclosure. The control panel is located inside the pallet shuttle. Release the two latches on the side of the shuttle to access the electrical enclosure. The power disconnect is in the upper right hand corner of the black electrical enclosure. Your power source must satisfy all local and national electrical codes. The power cable must NOT lie on the floor, but be wire-tied to the underside of the pallet shuttle. Install the power cable in a location that does not interfere with the operator and is NOT exposed to any traffic in your shop.

CNC Interface (M-Codes)

Two dedicated "M" functions with dry contacts that are M-Fin cancelable are required.

Air Supply requirements

The pallet changer requires a dry air supply of 12.5CFM at 100 P.S.I. during a pallet change. The minimum air requirement for your pallet load will vary with weight. The pallet may not unclamp if the proper air supply is not available. The air pressure may be increased to a maximum of 120 PSI. This requires a 3/8" I.D or larger compressed air supply line with 1/4" NPT fitting.

9.6.2 MAINTENANCE

The following is a list of required maintenance for the pallet changer. These procedures must be followed in order to keep your machine in good working condition.

Daily

1. Clean all of the chips off the receiver, and the machine tool's table. Check under the draw plate and remove any chip build-up there. Also, check for and remove any chips on the underside of the pallets and pallet rails.
2. Clean the chips off of the shuttle bed and rails.

Weekly

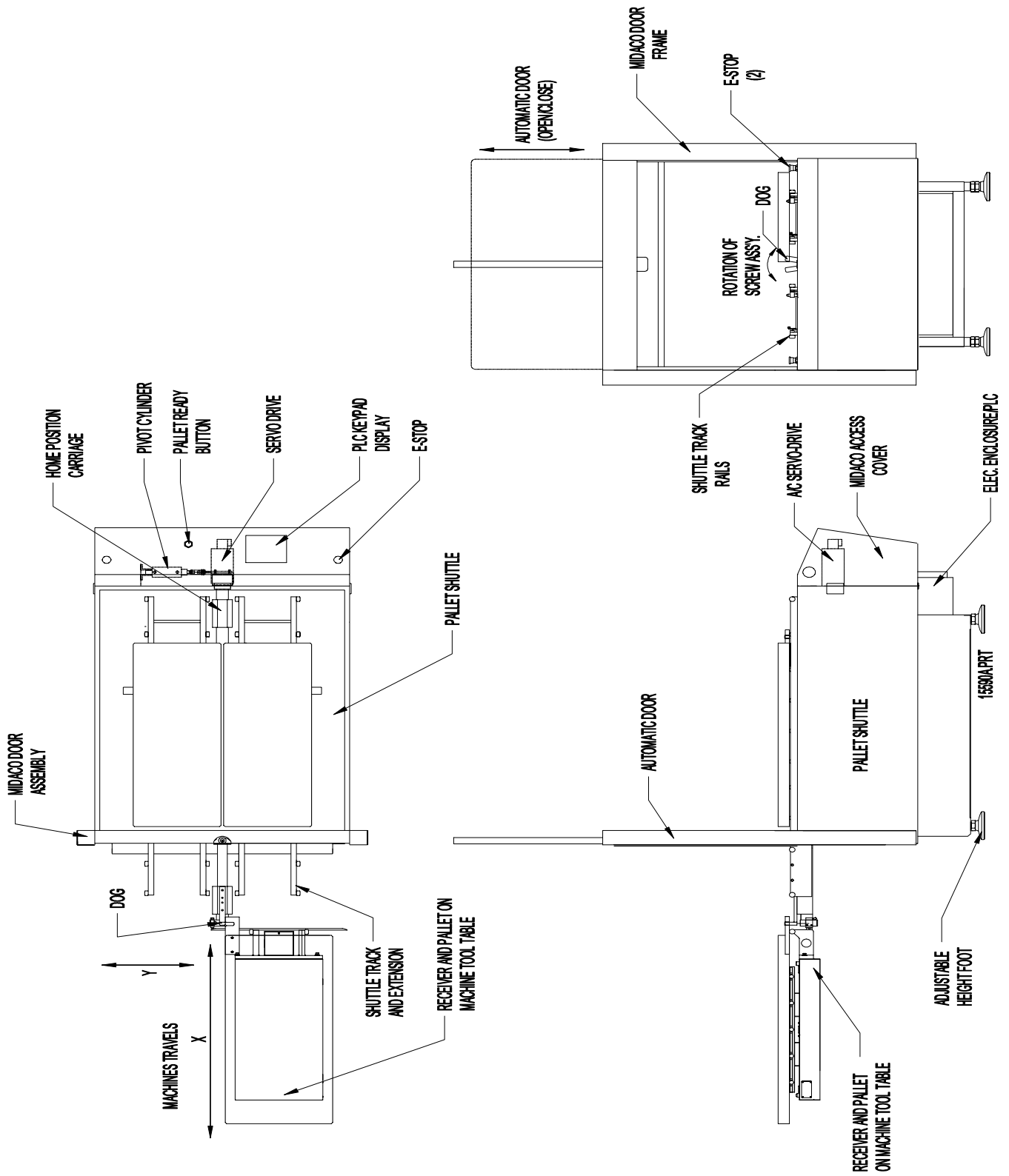
1. Check the air supply to make sure air is dry, and free of contaminates.
2. Clean exterior surfaces using a mild cleaner; do not use solvents.

Monthly

1. Check the air pressure level. Maintain a constant supply of 90-120 PSI.
2. Check the cam followers to make sure they move freely.

For more detailed information see Midaco Pallet Changer Servo Drive Manual.

2.6.3 PALLET



10.0 SPINDLE DRIVE SYSTEMS

10.1 BELT DRIVE SYSTEMS

10.1.1 POSI-DRIVE BELT SYSTEM

The Posi-Drive Belt System features two belts that run on a 1-2 and 2-1 reduction pulley arrangement.

Spindle Belts Replacement on Auto Hi/low System

The spindle drive belts are Gates 315K10. Gates manufactures the belts to Fadal specification. When replacing the spindle belts, use only the belts supplied by Fadal Machining Centers. The belts supplied by Fadal are sized.

The following steps are for replacing the belts on the auto HI/LOW spindle:

1. Verify that the VMC is aligned with the cold start indicators.
2. Power off the VMC and lock out the main disconnect.
3. Disconnect the air supply from the VMC.
4. Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head Cover. Cut all the wire ties holding the air lines and wires in place.
5. The Auto Hi/Low pistons need to be released. Determine which piston is applying force on the belts, the upper piston is the low speed belt piston the lower piston is the high speed belt piston. To release the actuator, push the check valve into the actuator. With the check valve released, pull the idler away from the belts.

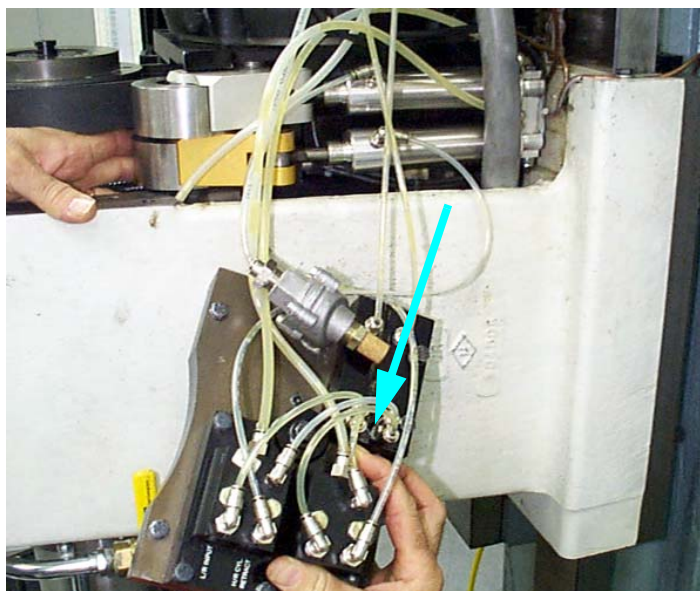


Figure 10-1: Release Check Valve and Pull Idler Away from the Belts

6. Remove six each of the 1/4" hex bolts holding the Drawbar Cylinder assembly.

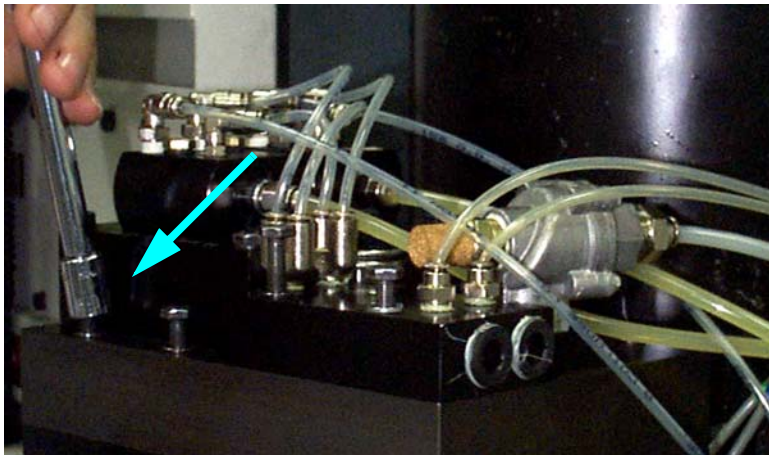


Figure 10-2: Remove Hex Bolts Holding Drawbar Cylinder Assembly

7. Remove the Drawbar Cylinder assembly.
8. Disconnect the Orientation Bridge/Drawbar hall effect sensor 6 pin molex connector. Disconnect air line to the Orientation piston.

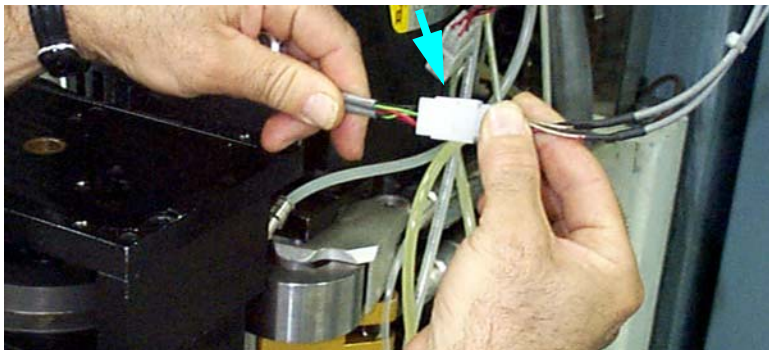


Figure 10-3: Disconnect Orientation Bridge/Drawbar

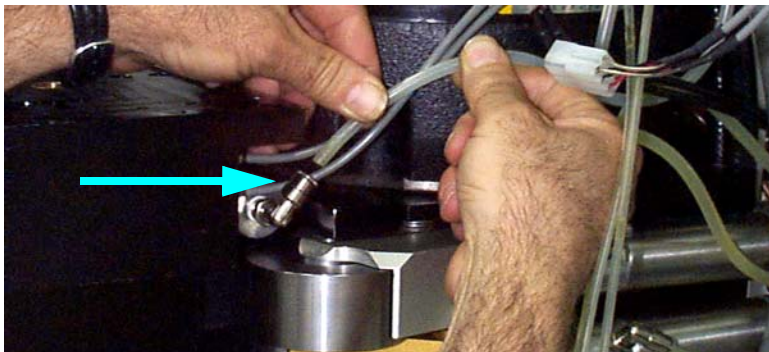


Figure 10-4: Disconnect Air Line to Orientation Piston

9. Remove three each of the 3/8" socket head cap screws holding the Orientation Bridge assembly.

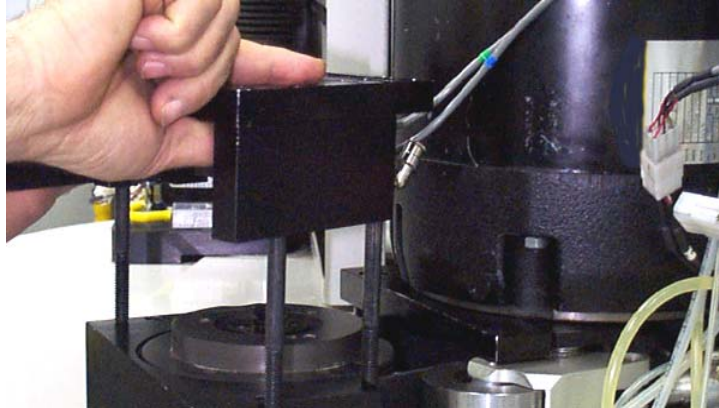


Figure 10-5: Remove Socket Head Cap Screws

10. Remove the Orientation Bridge assembly and front belt guide.

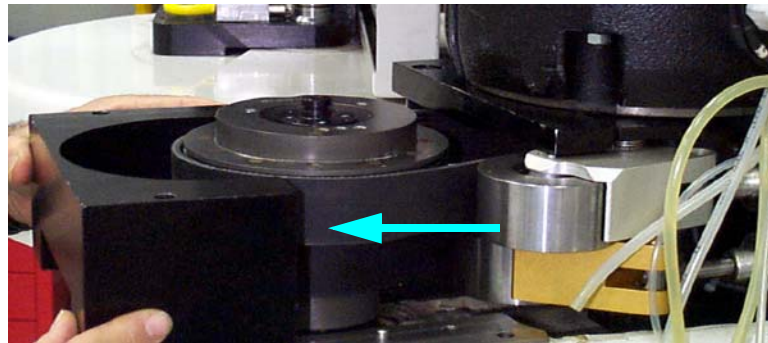


Figure 10-6: Remove Orientation Bridge Assembly & Front Belt Guide

11. Remove the Core Cover located on the bottom of the head.
12. Remove both of the 1/2" bolts to the rear belt guide, as well as the left 1/2" Spindle motor bolt.

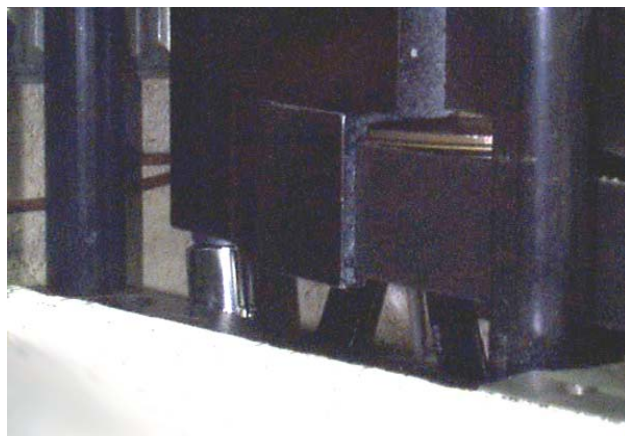


Figure 10-7: Remove Bolts to Rear Belt Guide



Figure 10-8: Remove Spindle Motor Bolt

13. Swing the spindle motor forward and remove the rear beltguide from the left side.

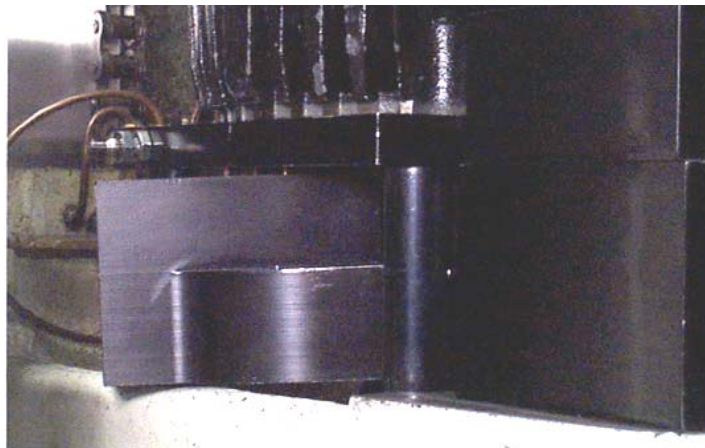


Figure 10-9: Remove Rear Belt Guide

14. Remove the 2 spindle drive belts.
15. Replace the 2 spindle drive belts. Reassemble using the previous steps in reverse order.

10.1.2 MOTOR PLATE
TENSIONER CABLE

Machines equipped with a motor plate tensioner cable system (10K), as shown in the figure below, will need adjusting when belts are replaced.

Adjustment procedure:

1. Disconnect the air supply from the machine. Remove the tension from the belts. Use either a dial indicator or a travel indicator.



Hex head bolt

Figure 10-10: Place Indicator

2. Once the indicator is in place, you will need two 9/16" open end wrenches to tighten and lock the cable tensioner screw.
3. Zero the indicator and slowly turn the 3/8" hex head bolt.
4. Adjust the screw until the plate moves .002 to .005 on the indicator.
5. After adjusting, lock down the 3/8" jam nut with the other wrench while holding the adjuster screw. Watch the indicator to verify that there is no movement.

10.2 HYDRAULIC HI/LOW SYSTEM

The hydraulic hi/low system requires very little maintenance. It is an air over oil system with check valves. Periodically check that you can see fluid in the 1/4 inch lines that go to the rear of the cylinder. If the lines have an excessive amount of bubbles then it is an indication that the oil level is low.

Filling

1. Remove the head cover.
2. Disconnect the air supply from the machine.
3. With the air source disconnected one actuator will still be engaged. To release the actuator, push the check valve into the actuator.
4. With the check valve released, pull the idler away from the belts.
5. Remove the 1/4"line that goes to the rear of the cylinder and fill with Mobil DTE heavy medium oil.
6. The reservoir is full when oil enters the 5/32 line on the actuator.



WARNING!

DO NOT allow an excessive amount of oil to flow into the separator.

7. Reattach the 1/4"line to the fitting on the cylinder.
8. Repeat the above steps for the other range.
9. Reconnect the air supply to the machine.



WARNING!

Verify that the oil lines are secure.

10. In MDI, cycle between the high and low ranges about 10 times. This will fill the cylinders.

MDI Example

Type:

MD,ENTER

S.1, ENTER

S.2, ENTER

Repeat the S.1 and S.2 to continue switching ranges.

10.2.1 7,500 RPM POLY CHAIN BELT

This system features a single belt that runs on a 1-1 pulley arrangement.

Spindle Belt Replacement

The spindle drive belt is a Gates Poly-chain. Gates manufactures the belt to Fadal specification. When replacing the spindle belt, use only the belts supplied by Fadal Machining Centers.

1. Verify that the VMC is aligned with the cold start indicators.
2. Power off the VMC and lock out the main disconnect.
3. Disconnect the air supply from the VMC.
4. Remove four each of the 1/4" cap bolts on the Head Cover and remove the Head cover.
5. Cut all the wire ties holding the air lines and wires in place. Disconnect the 1/4" assembly.

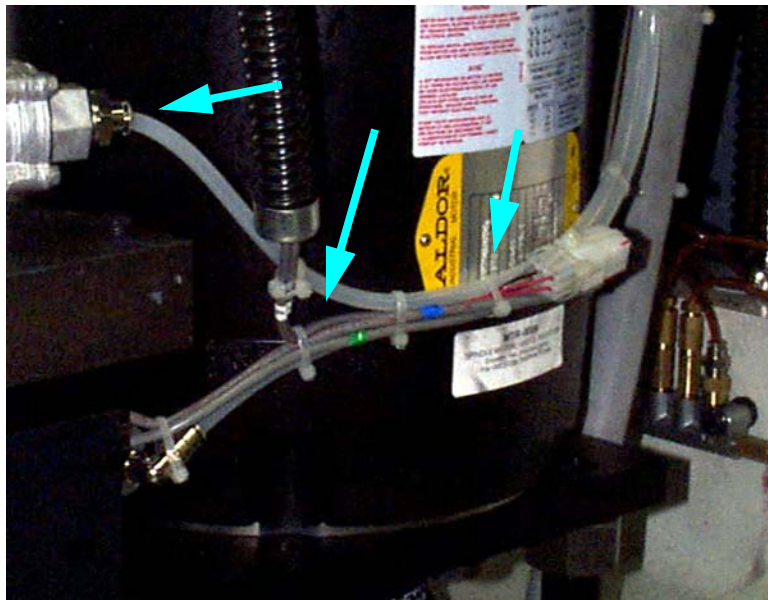


Figure 10-11: Cut Wire Ties Holding Air Lines and Wires

6. Remove each of the six 1/4" hex bolts to the Drawbar assembly.

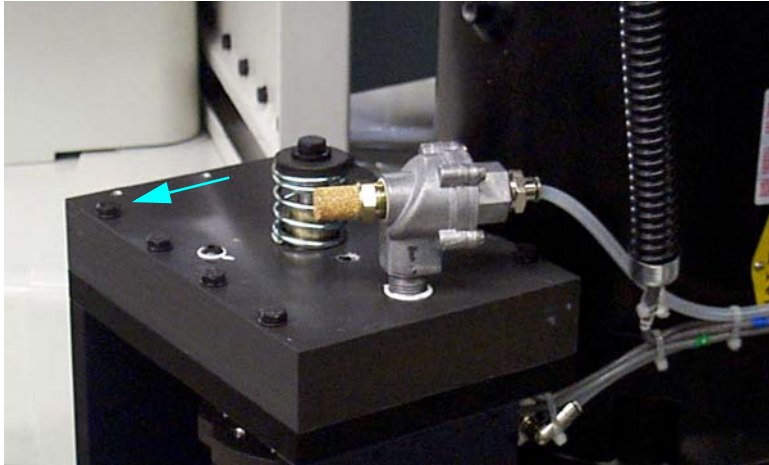


Figure 10-12: Remove Hex Bolts to Drawbar Assembly

7. Remove the Drawbar assembly.
8. Remove each of the four 3/8" cap bolts to the Orientation Bridge assembly.

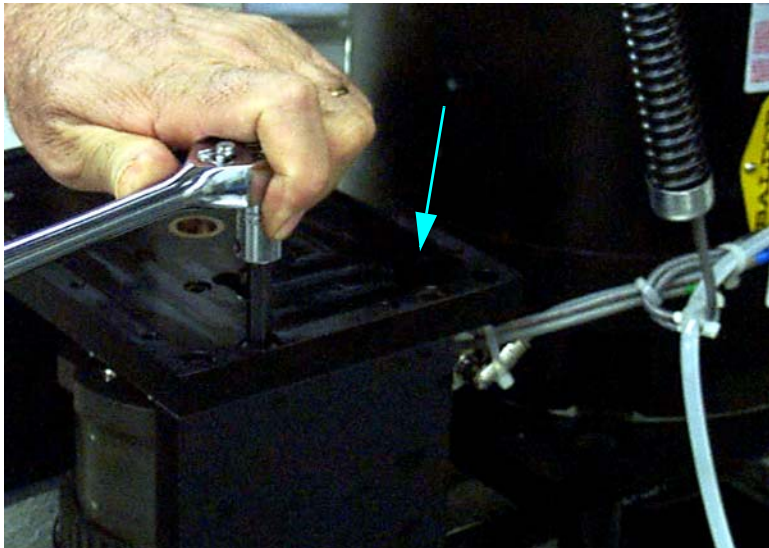


Figure 10-13: Remove Cap Bolts to Orientation Bridge Assembly

9. Remove the Orientation Bridge.

10. Loosen each of the two 1/2" hex bolts to the Spindle motor.

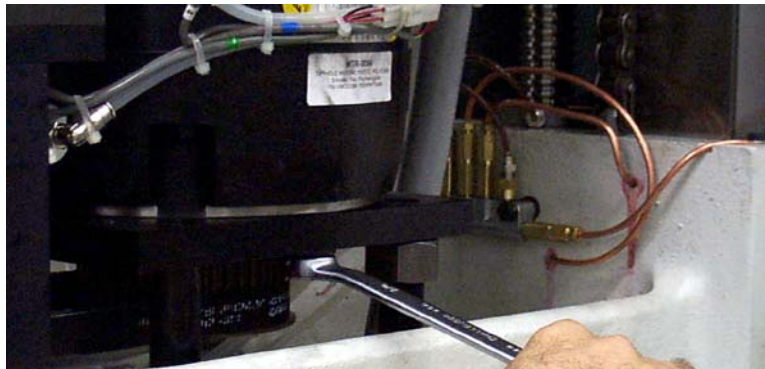


Figure 10-14: Loosen Hex Bolts to Spindle Motor

11. Swing the Spindle motor forward.
12. Remove the Spindle drive belt.
13. Install the new Spindle drive belt.
14. Mount a Mag base with an indicator on the head and touch off the top-front edge of the spindle pulley.
15. Set a zero reading while there is NO belt tension, then push back on the Spindle motor until about .0005" of deflection is seen on the indicator.
16. Tighten two each of the 1/2" hex bolts to the Spindle motor.
17. Verify that the reading has not changed.



NOTE

If the belt tension is too tight, then vibration will appear at the tool tip, and a poor finish may result.

18. Reassemble using the previous steps in reverse order.

10.3 TOOLS STICKING IN THE SPINDLE DURING A CHANGE CYCLE

There are many different solutions to problems leading to sticking tools, and although most machines experiencing a sticking tool problem will exhibit only one or two of these symptoms, it is better to check out all of them in each case. Inspection and elimination of the items on this list ensures a complete resolution to the problem.

10.3.1 AIR SUPPLY PRESSURE

Minimum air pressure from the building to the machine must be greater than 80 PSI, or 5.5 Bar. The supply volume must be adequate enough to not drop more than 5 PSI during a tool change cycle. Check for restrictions in the building plumbing, air filtration system, regulator bowl, lack of a closed loop in air supply plumbing around the shop, or excessive water in the air supply. A good test for inadequate volume is the observation of large pressure drops during a tool change cycle, or when other machinery in the shop uses air. Those machines with dual regulators should have the main regulator on the right side set no greater than 120 PSI (8 bar), and the secondary regulator at 70-80 PSI (5-5.5 bar). The main regulator feeds the Drawbar Cylinder, and its output force is computed at 100 PSI, for example, 38 square inches x 100 pounds per square inch or 3800 pounds pushing force. An increase of pressure to the Drawbar Cylinder proportionately increases Drawbar force at a factor of 38:1.



Figure 10-15: Dual Air Regulator Set at 80 psi and 120 psi

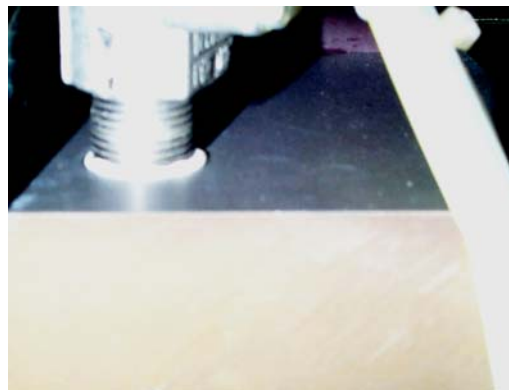


Figure 10-16: Exhaust Valve Pipe Nipples

10.3.2 DRAWBAR CYLINDER HALL EFFECTS SWITCH

Tool "Popping" can be reduced on machines equipped with Drawbar Cylinder Hall Effects switches, by checking the adjustment on the switch. If the switch is up too high, then the Z-axis may start up prematurely in the Tool Extraction cycle, wrenching the tool out of the spindle. Note that there is a new parameter in SETP labelled "Do you have Air Valve feedback?" This does not mean that electric signals are returning to the control from the air valve. It means that there could be Hall Effects switches on the Idlers and Drawbar Cylinder, and if so, the answer would be "YES". To answer "NO" might mean that the control will ignore any such feedback and Z-axis may lift off the tool prematurely.

10.3.3 INSUFFICIENT AIR VOLUME: MAC IN-LINE VALVE

In some cases, the rear MAC In-Line valve that delivers air to the Drawbar Cylinder may have reduced output by volume. There have been cases of 40% reduction in airflow when this valve experiences a failure. This condition will not allow the Drawbar Cylinder to fill fast enough to provide enough impact to operate properly. A simple test is to swap the valve with another in the manifold and retest.

10.3.4 AIR LEAKS: EXHAUST VALVE

Inside the Exhaust Valve on top of the Drawbar Cylinder is a diaphragm valve/seat. A tiny pinhole leak in the diaphragm will cause the valve to leak out the exhaust and not fill up the Drawbar Cylinder. Inspect the diaphragm visually for a rupture, and replace if necessary. Part numbers are VLV-0032 and VLV-0033 for repair kits, the large valve style or the small valve style, respectively.

10.3.5 AIR LEAKS: EXHAUST VALVE NIPPLE

The pipe nipple that attaches the Exhaust Valve to the Drawbar Cylinder Housing may be cracked from overtightening, and then leak. Inspect and replace, if necessary.

10.3.6 AIR LEAKS: DRAWBAR CYLINDER BUSHING

Test for an air leak with soapy water sprayed around the air lines. The bronze bushing that guides the Drawbar Cylinder Shaft may be worn, or damaged, or too rough internally to prevent premature wear to the O-ring around the shaft. Disassemble the Drawbar Cylinder and inspect/replace the O-ring and bushing. A new bushing design will be available soon to not only house a second O-ring, but provide a smoother surface to reduce O-ring wear. It will be retrofittable to all earlier Drawbar Cylinders. It has been included in the Sticking Tool Retrofit kit listed on the last page.

10.3.7 AIR LEAKS: DRAWBAR CYLINDER PLATE

Another source of air leaks can be from the large O-ring around the Drawbar Cylinder Plate, and to discover this will require disassembly and inspection. The Drawbar Cylinder Plate itself can be cracked or distorted. When reassembling, please note the

	correct location of the magnet for the Hall Effects switch, and avoid cutting the large O-ring accidentally.
10.3.8 AIR LEAKS: HYDRAULIC ACTUA- TOR ASSEMBLY BOLTS	Two of the 1/4-20 bolts used to mount the Hydraulic Actuator assembly penetrate the Drawbar Cylinder housing, and may not have been sealed with teflon tape adequately. Test with soapy water for air leaks, sealing the bolt threads with teflon tape.
10.3.9 AIR LEAKS; COOLANT-THRU DRAWBAR CYLINDER	<p>On Coolant-Thru Drawbar Cylinders equipped with a brass "shuttle valve" there is a port fitted to the top of the housing that was designed to feed air first to the shuttle valve, and then down the Drawbar Shaft to clear off the tool holder. The existence of this port is a leak to the Drawbar Cylinder, bleeding off air from the chamber. Earlier versions had a large port, and later versions have an orifice restricting airflow.</p> <p>A mechanical air valve can be installed to draw air for the shuttle valve back at the main regulator, instead of from the Drawbar Cylinder. Contact the Fadal Parts Department for details.</p>
10.3.10 ORIENTATION BRIDGE "LIFTING"	When the Drawbar Cylinder pushes downward with 3000 to 4000 pounds force, and meets resistance in extracting the tool, an upward force is created that wants to "lift" the Orientation bridge up from the head casting. The 3 bolts that hold the Bridge down to the Belt Guide resist this upward movement. During a tool change, inspect the movement upward of the Orientation Bridge. A closer inspection might reveal stripped bolt threads, distortion of the Bridge plate, damaged pockets in the Bridge plate containing the 3 bolt heads. A new design Orientation Bridge and Belt Guide will have 4 bolts holding it down, and is included in the Sticking Tools Retrofit kit listed below.
10.3.11 BLACK OXIDE TOOL HOLDERS	We recommend "Side Ground" tool holders. Those manufactured with "Crush Ground" or those with Black Oxide coated finish are more vulnerable to tool sticking problems.
10.3.12 DIRTY TOOL HOLDERS	Foreign matter on the tool holder taper, and sometimes coolant gel from evaporated coolant on the taper, will contribute some to the problem. As a test, clean the tapers thoroughly, and spray an anti-rust lubricant such as LPS-3 or Ironclad (not WD40) on the taper and retest.
10.3.13 SPRING PILOT: OVERSIZED DIAMETER	The outer diameter of the Spring Pilot, either non-locking or locking, may be too large and fit too tightly into the spindle bore. Check for score marks on the pilot, which would

indicate galling of the surface. Recently the Knock-Out Cap was redesigned to provide a capturing ridge to contain the upper points of the crown of the spring pilot. With the increased tool retention forces, we have seen some distortion of the pilot. Check the inner bore of the Spindle Rotor where the Spring Pilot is located and carefully stone any developed burrs.

10.3.14 SPRING PILOT: BALL POCKETS INCORRECT

With the Spring Pilot removed from the spindle, carefully inspect the 4 ball pockets and insert (4) BRG-0004 1/4 steel balls into them. Remount the Spider on top of them. The balls should easily retract full travel when pressed, and return under gravity force. Any binding indicates a misformed pocket. The pockets themselves should show no sign of distortion that might restrict ball travel when heavily loaded.

10.3.15 DRAWBAR SCORED

Inspect the shaft of the Drawbar itself, particularly where the Belleville springs may contact it. Should the Belleville springs twist around the Drawbar, they may shift off of their rims, and dig into the Drawbar, and resist up and down movement. The introduction of hardened flat washers every 10th Belleville spring helps prevent the stack shift. A newly designed Drawbar and Spring Pilot will be available soon that has a larger diameter shaft which should restrict the stack shift from occurring. See the Sticking Tools Retrofit kit below.

10.3.16 DAMAGED DRAWBAR

At the bottom of the Drawbar is a pocket for the Pull Stud of the tool holder, and around its perimeter are 8 holes for the 3/16 inch balls to grasp the Pull Stud. Earlier Drawbars had a deeper pocket, and CAT tools were pushed out of the spindle by the lowest rim of this pocket contacting the pull stud. Eventually the rim of the Drawbar was distorted and the balls might not retract as smoothly as expected. Later Drawbars have a shorter pocket so that the Drawbar shaft pushes on the top of the pull stud, rather than on its base. A damaged Drawbar rim might prevent the pull stud from extraction smoothly.

10.3.17 DAMAGED FLOATER

The Floater is located by two 3/16 balls in a circular track in the spindle throat. These hold the Floater steady when the Drawbar is pressed through it, and the step at the bottom of the Floater allows the 8 3/16 balls to retract out of the way to release the tool. Should the Floater be damaged in a way that allows it to move with the Drawbar, the Pull Stud cannot be extracted from the Drawbar. Replace the damaged Floater, if necessary.

10.3.18 TESTING PROCEDURE

Use the following page to measure Drawbar performance, both before inspection, and after completion of the procedures outlined in this bulletin, for comparison.

10.3.19 MEASURING
DRAWBAR PERFOR-
MANCE

In order to measure the amount of push force that the Drawbar Cylinder has upon the tool, place a tool holder into the spindle (without a tool in it) and Jog the machine **slowly** downward in Z-axis onto the SVT-0066 Pressure Gauge-3000PSI. Once the gauge begins to register after contact, press the Tool In/Out button to release the tool. Measure how much **net force** is pressed upon the tool by the Drawbar.

Use the following chart to figure the amount of force that is lost.

Drawbar Cylinder force		_____	(38 x #PSI)
Less Drawbar return spring	-	100	
Less Belleville Springs	-	800	
Net Force	=	_____	
Less Pressure Gauge reading	-	_____	
Lost Pressure Force	=	_____	

Drawbar Cylinder force is the air pressure in PSI multiplied by 38. Figuring the Drawbar return spring to be about 100 pounds, and the resistance from the Belleville Springs to be 800 pounds, we deduct 900 from the Drawbar Cylinder force. This gives us the expected Net Force.

However, it is necessary to measure with the Pressure Gauge what the Net Force **actually** is. The difference is lost forces, such as binding, friction losses, etc. A higher number Lost Pressure Force will result in Sticking Tools.

The technician should check sections 10.3.1 through 10.3.17, and the corrections should restore any missing forces and allow more of the drawbar cylinder pressure to reach the tool holder.

10.3.20 DRB-0024
 STICKING TOOLS KIT,
 10K LDB, DRB-0025
 STICKING TOOLS KIT,
 10K LDB-CT=

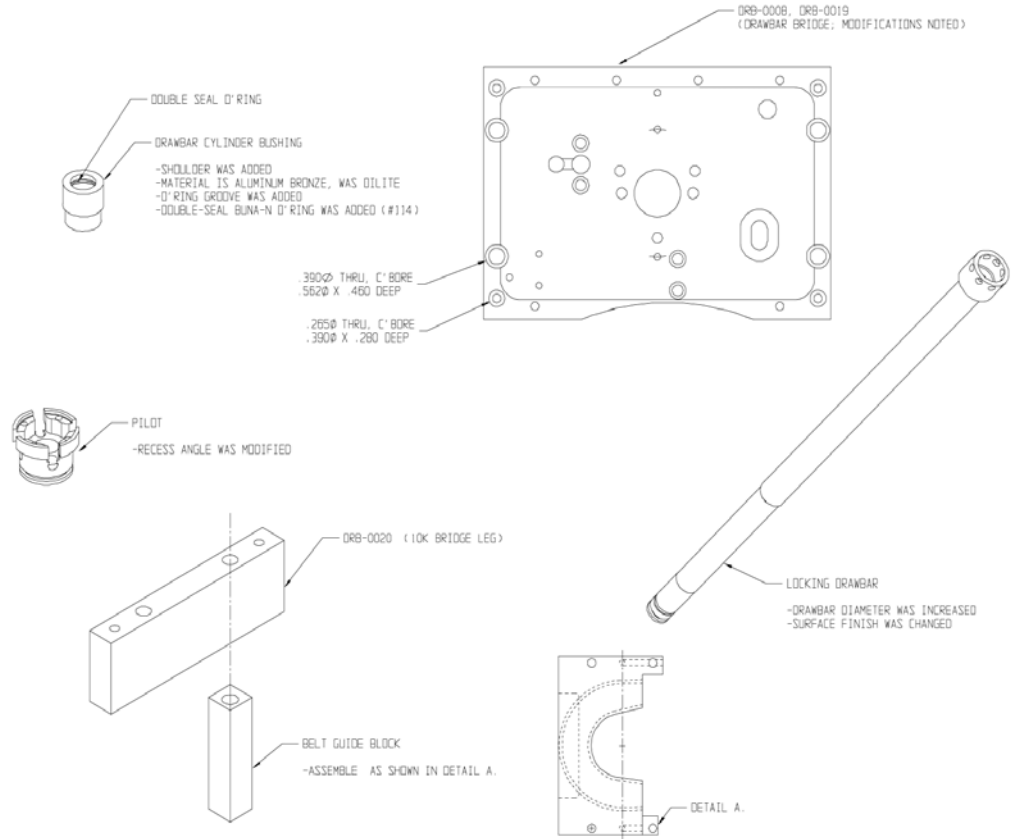


Figure 10-17: Drawbar Kit

10.4 SPINDLE DRAWBAR AND BELLEVILLE SPRING REPLACEMENT

10.4.1 DRAWBAR REMOVAL

1. Remove the Drawbar Cylinder Assembly.
2. Remove the Orientation Bridge Assembly.
3. Place a long 3/8 inch drive extension or similar item in the spindle and jog the head down until the extension is under slight tension between the drawbar and the table.



WARNING!

Do not place high tension on the extension; it only needs to support the drawbar. Place a piece of wood between the extension and the table, if needed.

4. Remove the Knock out cap (on locking drawbars only).
5. Place pilot tool on spring pilot.
6. Use wheel puller to depress the spring pilot.
7. Remove spring retainers.
8. Remove wheel puller.
9. Jog head up and remove the extension and the drawbar. Be careful not to drop the ball bearing.
10. Now remove the belleville springs or the floater.
11. To reinstall, reverse the above steps.

10.4.2 REPLACE BELLEVILLE SPRINGS

1. Remove drawbar (*See Drawbar Removal, Section 10.4.1, MAN-0121 R1*)
2. Using a spring hook or a magnet remove the belleville springs (Be sure to remove any broken pieces).
3. Install replacement springs starting with first one cupped downward and reverse every other one. The quantity will vary depending on the spindle pocket size (*See Belleville Spring Quantity Chart, Table 10-1, MAN-0121 R1*).
4. Reinstall drawbar.

10.4.3 REMOVE FLOATER

1. Remove the drawbar (See *Drawbar Removal, Section 10.4.1, MAN-0121 R1*)
2. The floater has two ball bearings that hold it in place. Using a floater removal tool or a magnet pull the ball bearing toward the center and the floater should come out. If badly damaged the floater can be difficult to remove.



NOTE

This procedure will rarely be necessary. Spindle Belleville Springs Quantity Chart

There have been many spindle and spring retainer combinations over the years. To determine the number of Belleville Springs in a spindle, three factors have to be considered: The depth of the spring pocket in the spindle, the depth of the spring retainer and the width of the Belleville springs. The following chart is a guide line for the number of springs and may vary slightly from spindle to spindle.

This chart covers the most common depths of spindles. In most cases the deeper spring retainers will use one less spring then number in the chart.

Table 10-1: Belleville Springs Quantity Chart

Spindle Type	Spindle Depth	Number Of Springs
10K Non-Locking	2.00	19
10K Non-Locking	3.00	30
10K Non-Locking	4.25	43
15K Non-Locking	4.326	44
15K Non-Locking	4.627	47
10K Locking	2.00	18
10K Locking	3.00	29
10K Locking	4.25	42
10K Locking	4.326	40
10K Locking	4.627	44

10.5 SPINDLE PRE-LOAD

10.5.1 MEASURING THE SPINDLE PRE-LOAD

1. Place a Pressure Gage (SVT-0066) on the table and align it with the Spindle nose.
2. Set an indicator on the Head and touch the indicator tip on the nose of the Spindle.
3. Jog the head (Z axis) down until the pressure gage reads 1000 pounds.
4. Zero the Indicator.
5. Jog the head (Z axis) up until it is no longer in contact with the pressure gage.
6. Depress the "Tool In Out" Button on the keyboard.
7. Release Button.
8. Read the value on the indicator.

If adjustment is necessary on a adjustable spindle then turn the spindle preload adjustment nut clockwise to tighten and counter clockwise to loosen.

Listed below are the Fadal factory recommended specifications for the various spindles.

Table 10-2: Factory Recommended Spindle Specifications

RPM Rating	Preload Setting (Deflection at 1,000 psi)	Lube Method
15,000/10,000	0014-.0017 (Can Not be adjusted)	Air/Oil
10,000	0013-.0015 (Adjustable preload)	Grease Packed
15,000	0017-.0019 (Adjustable preload)	Grease Packed

10.6 SPINDLE DUTY CYCLE

The Fadal Engineering Department in conjunction with the bearing manufacturers recommend that the following procedures be followed to increase spindle life under extreme operating conditions.

Spindles operating under 8,000 RPMs need no cool down period regardless of on time or load to the tool.

Fadal recommends that spindles operating at over 8,000 RPMs for extended periods of time should be shut down for a period of at least 20 minutes after every 5 hours of continuous operation. This will allow cooling of the races and re-lubrication of the grease lubricated bearings. The actual load to the spindle is not a factor at these higher RPMs. The time period should be monitored as closely as possible to increase spindle life.

10.7 AIR POSITIVE FLOW SYSTEM

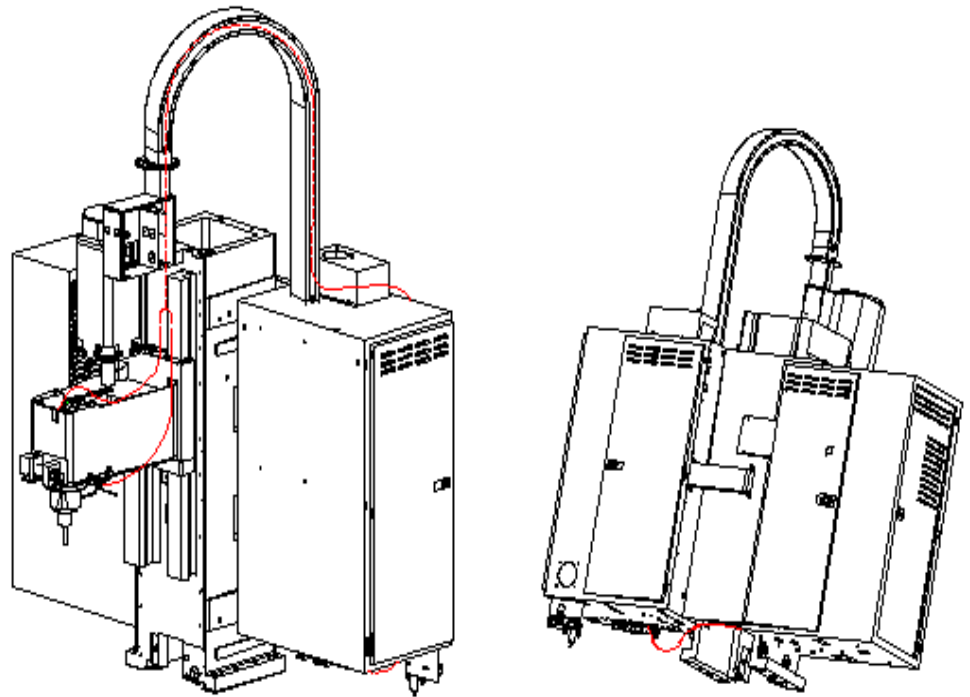


Figure 10-18: Air Positive Flow System

10.8 SPINDLES

10.8.1 10K GREASE PACKED SPINDLES

Components

The 10K grease packed spindles are self contained units.

Functional Description

These spindles are belt driven and require no maintenance. There is air supplied to the spindle on the top and bottom for positive pressure.

These spindles are self-contained, therefore they should be replaced when bad. The 10K spindle has a locking drawbar.

10.8.2 15K AIR/OIL SPINDLE

Components

The 15K air/oil system consists of a spindle, a spindle lubricating oil supply pump, a vacuum pump, a positive displacement injector (PDI) block, a coalescent filter, four pressure switches (2-15psi, 1-80psi, 1-265psi) mounted on a pressure switch manifold, an electronic control board with wire harness, and various standard plumbing parts. This spindle is also belt driven.

Functional Description

The electronic control board controls the ON time of solenoids for oil and air while monitoring:

- Supply oil pressure
- Oil reservoir level
- Supply air pressure
- Air/oil pressure to the upper and lower bearings of the spindle

The pump pressurizes oil to the PDI block. Oil pressure is monitored by an oil pressure switch. Air is supplied to the PDI block through a coalescing filter from a solenoid valve. Air pressure to the machine is monitored by an air pressure switch. The PDI block mixes air and oil. The two lines carry the air/oil mixture to the upper and lower bearings. The pressure of each line is monitored by a pressure switch. A vacuum pump is used to remove any oil that blows by the upper or lower bearings, to reduce oil leakage.

10.8.3 SPINDLE/LUBE
PUMP/CONTROL**Spindle**

Bearings	Ceramic Steel Hybrid
Lubrication	Air and oil pressure feed back control
Operating temp.	Ambient +20°F during steady state operation
Motor Power	15 HP
Max. Speed	15,000 RPM
Max. Cut	3/8"
Max. Depth of cut	3/8"
Max. Tool diameter	3/4"

Spindle Lube Pump

Lube Pump	Air and oil feed back pressure control
Oil	Mobil DTE 797 Steam Turbine Oil or equivalent
Oil Cycle	Nominal 0.025 cc/injection cycle
Oil Filtration	5 micron absolute
Air Flow	160 SCFH @ 80 psi
Air Filtration	10 micron
Venturi Vacuum Pump	9" Hg

Control Circuit

Supply voltage	120 VAC
Overload protection	2 amp (fused)

Spindle Removal

1. Verify that the VMC is aligned with the cold start indicators.
2. Power off the VMC and lockout/tagout the main disconnect.
3. Disconnect the air supply from the VMC.

4. Remove the head cover by removing the four 1/4 -20 socket head cap screws.
5. Disconnect the electrical connection to the orientation bridge assembly at the six pin connector plug.
6. Disconnect the two 1/4" air lines from the orientation bridge assembly.
7. Remove the draw bar cylinder plate by removing the six 1/4" hex head bolts and set them aside.
8. Remove the orientation bridge assembly and the front belt guide by removing the three 3/8" socket head cap screws.
9. To swing the spindle motor forward, loosen the 1/2" hex bolt on the left side of the spindle motor and loosen the two 1/2" hex bolts on the right side of the spindle motor.
10. Remove the spindle drive belt.

**WARNING!**

Use heavy duty work gloves when handling the heated spindle and pulley.

11. Using a propane torch, direct the flame at the spindle pulley for approximately 6-10 minutes while slowly rotating the spindle. Maintain an even amount of heat throughout the pulley. The spindle pulley will drop down on the spindle when it is expanded enough to remove it from the spindle.
12. Label and disconnect the upper and lower spindle cooling lines from the spindle. Disconnect the 5/32" air seal line from the lower spindle flange. This will be reused later as the air supply to the vacuum pump.
13. Loosen the upper spindle retainer clamping screw.
14. Remove the six 1/2" hex bolts and lock washers from the upper spindle retainer and lift the retainer from the spindle. Ensure that the cooling line O-ring and the spindle O-ring are removed.
15. Remove the coolant supply manifold by removing the 1/4" socket head cap screw. Move it out of the work area and support it so that the lines are not crimped.

**WARNING!**

Support the spindle with a wooden block while performing the next step.

16. Remove the six 3/8" socket head cap screws holding the spindle in the head, remove the old spindle and O-ring. Discard the used O-ring. Save the socket head cap screws.

10.8.4 COMPONENT
INSTALLATION**Regulator/ Separation Block Mounting**

The regulator should be installed at the same location that it was at when the machine was originally installed.

Installing Spindle Lubrication Pump

Mount the spindle lubrication pump plate assembly to the side of the column above the way lube pump. On older model VMCs four 1/4-20 holes may need to be drilled and tapped; use the spindle lubrication pump plate assembly as a template.

Vacuum Pump Installation

Using the vacuum pump base as a template, drill through and tap two 1/4-20 holes into the left counter weight arm on top of the column. Mount the vacuum pump to the plate.

Pressure Manifold Mounting

Mount the pressure switch manifold block on the inside bottom of the cabinet, by removing the four knockouts and drilling the necessary mounting holes.

Control Board Mounting

Mount the control board on the inside upper right side of the cabinet, by drilling the necessary holes to attach.

Solenoid Modification

1. Remove the solenoid fitting on the solenoid closest to the rear of the cabinet.
2. Install the T-fitting and 1/4" to 5/32" reducer on solenoid.

10.8.5 SPINDLE TRAM

1. Level Machine.
2. Adjust TABLE GIBS, SADDLE GIBS, and HEAD GIBS.

Watch for Turcite gibs: .0003"
Non-Turcite gibs: .0005"

3. Adjust TABLE STRAPS.
4. Adjust SADDLE STRAPS and HEAD STRAPS.

5. Above items must be checked properly or spindle tram test may be invalid.

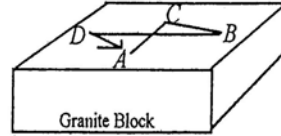


Figure 10-19: Granite Block for Spindle Tram Test

6. Establish X,Y plane by mounting an indicator in spindle. Touch off granite block at points A,B,C, and D by moving in MDI as follows:

Zero indicator at A Y-10. F75. G1(Move to C and record)
 Y5.X5. (Move to B and record)
 X-10. (Move to D and record)
 Y5.X5. (Verify zero at A)

7. Sweep indicator over the same four points by rotating spindle by hand. Check each point at E,F,G,H.

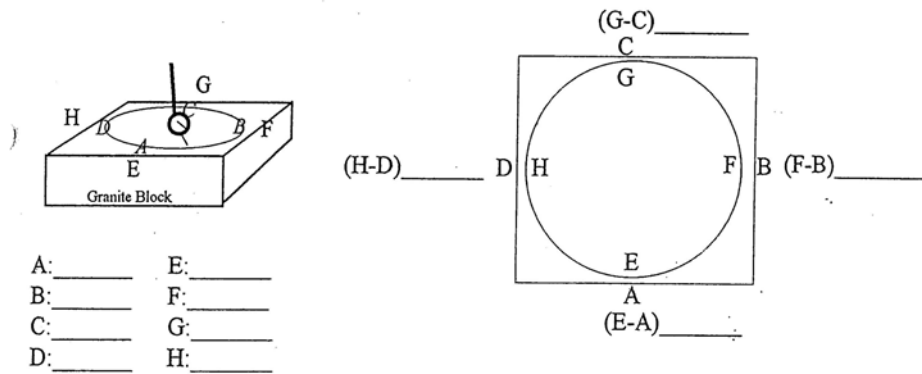


Figure 10-20: Check Points for Spindle Tram Test

10.8.6 ADJUSTING SPINDLE TRAM

If spindle is to be installed, follow this procedure. Clean all surfaces and replace O-rings. Mount spindle in head using 6 SoCap bolts. Check tram as described above. Determine which position shows the most POSITIVE error. Imagine a pointer using diagram below, and align arrow on diagram to point towards most POSITIVE direction. Loosen 6 bolts slightly, and tighten according to the diagram bolt pattern with a torque wrench. First, tighten to 25 Ft.Lb. and then to 55 Ft.Lb. Retest tram, and install upper O-Ring and clamp ring. Tighten these 6 bolts also using the following bolt pattern.

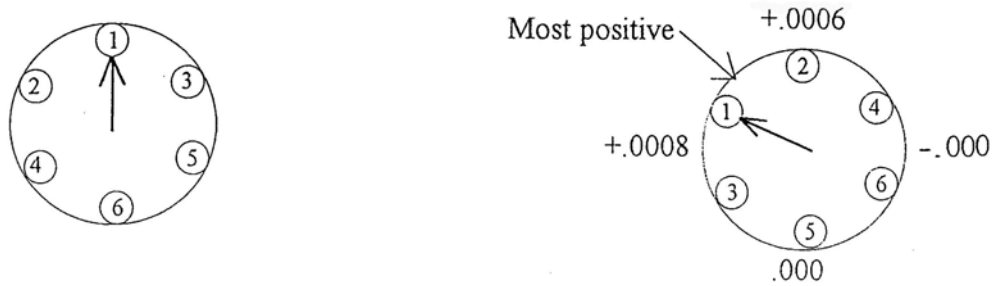


Figure 10-21: Adjusting the Spindle Tram

10.9 15K AIR/OIL SPINDLE INSTALLATION

1. Verify that the lower spindle O-ring is in good condition (not cut, torn or pinched).
2. Position the 15K spindle in the head with O-ring seal.
3. Install six socket head cap screws and evenly tighten them until they are snug. Torque the socket head cap screws in increments of 25 ft/lbs then 40 ft/lbs.
4. Place a magnetic dial indicator base on the spindle. Check the run out on a true plate. The run out should be less than .0005"(.0127mm).
5. Shim the spindle if necessary to achieve a proper run out specification.
6. Verify that the upper spindle retainer O-rings are in good condition (not cut, torn or pinched).
7. Align the upper spindle retaining ring with the cooling passage. Lightly cover the hex head bolts with gasket sealing compound and evenly tighten them until snug. Torque the hex head bolts to 30 ft/lbs.
8. Snugly tighten the retainer ring clamping screw.
9. Using a propane torch, direct the flame at the spindle pulley for approximately 5 minutes. Maintain an even amount of heat throughout the spindle pulley.



WARNING!

Use heavy duty work gloves when handling the heated spindle and spindle pulley.

10. While the spindle pulley is heating, place the spindle pulley locating spacer (part # SVT-0096) on the ground surfaces of the head.
11. Find the orientation mark on the top of the spindle housing and position the spindle so that the orientation mark is toward the front of the VMC. Secure the spindle so that it will not rotate when installing the spindle pulley.
12. Place the spindle pulley on the spindle so that it rests on the locating spacer, at the same time align the orientation marks of the spindle and the spindle pulley.
13. Allow the spindle pulley to cool to the touch before continuing with the assembly.
14. Install the spindle drive belt.
15. Place a dial indicator against the top front edge of the pulley and set it at zero.
16. Swing the spindle motor towards the rear of the machine until the dial indicator reads .0003" (.0076mm).



WARNING!

Do not adjust the belt tension more than the recommended deflection.

17. Tighten the 1/2" hex bolt on the left side of the spindle motor and the two 1/2" hex bolts on the right side of the spindle motor.

10.9.1 PLUMBING
SPINDLE

18. Install the orientation bridge assembly and front belt guide with the three 3/8" socket head cap screws, and tighten them snugly.
19. Install the draw bar cylinder plate with the six hex head bolts, and tighten the bolts.
20. Connect the six pin connector plug into the orientation bridge assembly.
21. Connect the two 1/4" air lines to the orientation bridge.
22. Connect the coolant lines removed from the old spindle to the upper and lower connections on the new spindle.

1. Pull four 5/32" air lines from the back of the machine up through the cable ways to a point just above the head next to the motor mounts. Leave a portion of the lines coiled for extra.

**NOTE**

Check the machine for the High/Low option 5/32" lines. If these lines are present they can be used instead of pulling the new lines through the cable ways. Label these lines as 21, 22, 25 and 26 if used.

2. Pull the 5/32" air seal line previously removed from the old spindle up through the cable way. Connect it to the fitting (32) on the vacuum pump.
3. Insert three 5/32" lines in 3 foot lengths into the fittings located on the lower spindle flange. The three lines are the inlet line stamped "AIR/OIL IN" (23), the exhaust line stamped "AIR OUT" (29), and the vacuum line stamped "VACUUM" (27).
4. Cover the two lines (23, 27) with 1/4" nylon tubing from the fittings to the point where they enter the head.
5. Feed the line from the fitting on the lower flange stamped with "AIR/OIL IN" (23) up through the head to where the four lines are located next to the motor mount.
6. Insert three 5/32" lines in 3 foot lengths into the three fittings located on the upper bearing retainer just below the pulley. The three lines are the inlet line stamped "AIR/OIL IN" (24), the exhaust line stamped "AIR OUT" (30), and the vacuum line stamped "VAC/AIR" (28).
7. Feed the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, into the head and up along side the other lines from the lower flange.
8. The four lines coming to the head from the back of the machine are two PDI lines (21, 22) and two Pressure switch lines (25, 26). Be sure to keep these lines labeled.
9. Connect one air/oil PDI line (21) and one pressure switch line (25) to the double end of the Y-fitting.

10. Connect the inlet line, stamped "AIR/OIL IN" (23) on the lower flange, to the single end of the Y-fitting.
11. Connect the other air/oil PDI line (22) and the other pressure switch line (26) to the double end of the second Y-fitting.
12. Connect the inlet line, stamped "AIR/OIL IN" (24) on the upper bearing retainer, to the single end of the Y-fitting.
13. Feed the two outlet lines, one from the lower flange Stamped "AIR OUT" (29) and one from the upper bearing retainer stamped "AIR OUT" (30), into the inside of the head and fasten them to any hose with a nylon wire tie. These two lines are the exhaust lines.
14. Verify that a 5-in-line valve system or air-seal valve is installed on the machine. If they currently do not exist on the machine, order and install part number VLV-0006.
15. Feed the lower vacuum line (27) up through the head to the vacuum pump and connect it to the Y-fitting (27) on the vacuum pump.
16. Feed the upper vacuum line (28) along the top of the head to the vacuum pump and connect it to the fitting (28) on the vacuum pump.
17. Verify that all plumbing lines are installed correctly. Secure loose lines as necessary with nylon wire ties.

10.9.2 INSTALL COMPONENT PLUMBING

1. Complete the installation of all lines for the air supplies, oil supply lines and pressure feed back lines.
2. Before filling the spindle lubrication pump with the recommended oil (Mobil DTE 797 Steam Turbine Oil), remove the reservoir and inspect the float on the level switch. The cutaway ridge on the float should be on top. Remove the float and reverse it if the ridge is on the bottom of the float.

Start Up After Installation

1. Fill the reservoir on the spindle lube tank with Mobil DTE 797 ISOVG32 oil or equivalent. Any other viscosity oil will cause damage to the spindle.
2. Check the wiring on the circuit control board.
3. Plug in the air supply line to the machine and set the regulators to 80 psi for the left regulator and 120 psi for the right regulator.
4. Remove the oil pressure line from the oil pressure switch fitting on the pressure switch manifold. Hold the line over a collecting container. Prime the spindle lubricating pump by depressing the solenoid button with a small screwdriver until all air bubbles are removed from the oil pressure line.

**NOTE**

Observe the color of the oil coming out of the oil pressure line. If the color is DARK BROWN, there is way lube oil in the pump. Prime the line until the way lube oil is flushed out. The spindle oil color is LIGHT YELLOW, prime the oil pressure line until the oil coming out is this color.

5. Replace the oil pressure line at the oil pressure switch fitting.
6. Press the reset button on the control board and observe the LED lights (if any lights are illuminated then take the action necessary to correct the condition).
7. Prime the PDI block with the spindle inlet lines at the Y-fitting on the head disconnected. Prime until oil is seen flowing through both of the 5/32" lines coming out of the PDI block. Prime by pressing the spindle lubrication pump solenoid button with a small screwdriver. Press it for 10 seconds and release it for 10 seconds and repeat until oil flow is satisfactory. Priming can only be done while the air is flowing to the spindle. If air is not flowing then press and release the reset button. This will provide 2 minutes of air flow.
8. After priming the PDI block, run the spindle at 10,000 RPM and monitor the temperature for 20 minutes. If the temperature is high, check the PDI block operation.
9. Run the spindle at 15,000 RPM and monitor the temperature. The spindle temperature should be below 100°F after one-half hour. This is the steady-state temperature of the spindle.
10. If the temperature exceeds this specification, verify the oil line connections and the oiling cycle.

10.10 40 TAPER BT & CAT PULL STUDS

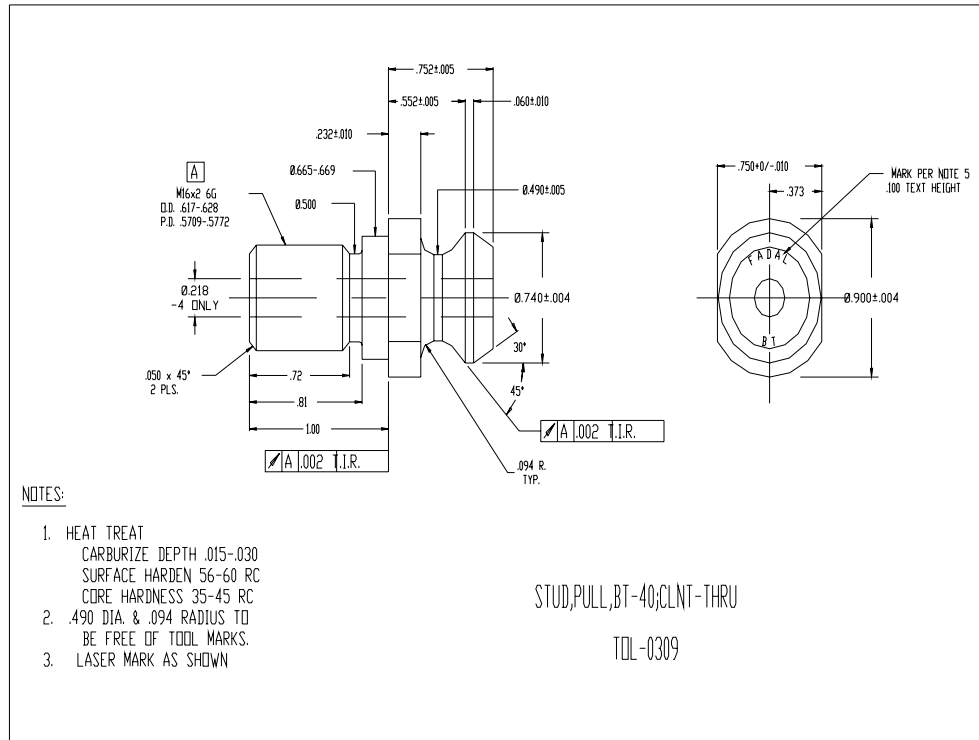


Figure 10-22: 40-Taper BT & CAT Pull Studs

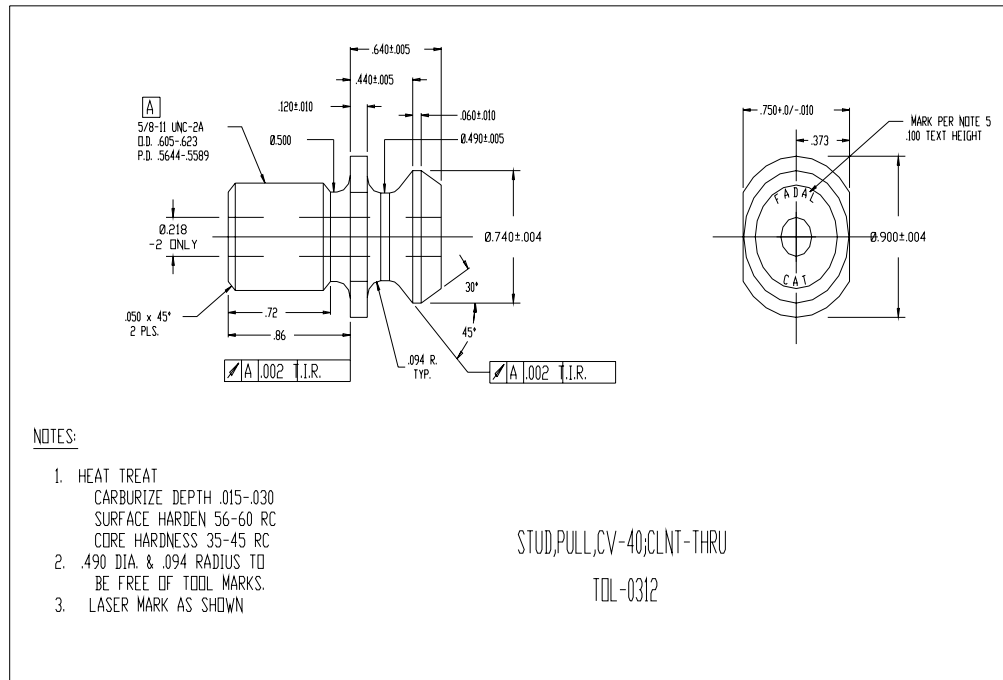


Figure 10-23: 40-Taper BT & CAT Pull Studs

11.0 FUSES

Before replacing a blown fuse, it is necessary to locate and remove the cause of the blown fuse.

For this reason, only those personnel who have received approved safety and maintenance training may perform this work.

WARNING!

Before starting the replacement of a fuse, remove the cause of the fuse butn-out. Accordingly, the replacement should be performed by a person fully trained in maintenance of safety. When replacing a fuse with the cabinet open, be careful not to touch the high-voltage circuits. Touching an uncovered high-voltage circuit presents an extremely dangerous electric shock hazard.

11.1 REPLACING THE
FUSE OF LCD UNIT

Mounting position of the fuse

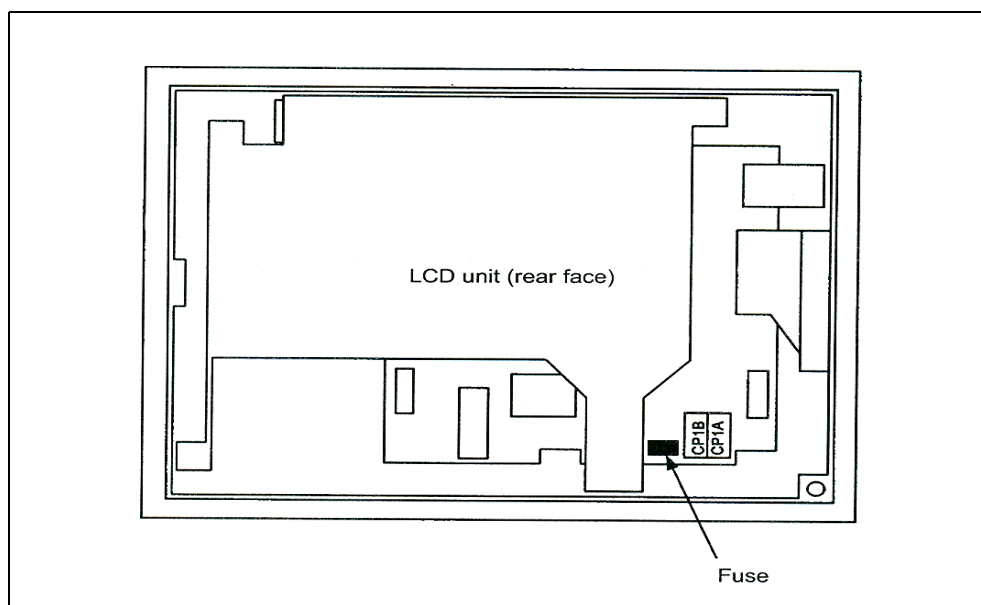


Figure 11-1: Fuse of LCD unit

- Information of the fuse
Ordering information: A02B-0265-K101
Rating: 2.0 A
Individual information: A60L-0001-0290#LM20C

11.2 PANEL FUSES

Fuses are *GMA-1, GMA-2, GMA-3, GMA-5.*

Location

Table 11-1: Panel Fuses

TERMINAL BLOCK	POSITION	FUSE
T.B.1	180F1	24V 5AMP
	180F2	24V 3AMP
	180F3	24V 1AMP
	180F4	24V 5AMP
T.B.3	170FU1	120V 2AMP
	170FU2	120V 2AMP
	170FU3	120V 2AMP
	173FU1	120V 3AMP
T.B.4	850FU1	24V 1AMP
	850FU2	24V 1AMP
	850FU3	24V 1AMP
	850FU4	24V 1AMP
	850FU5	24V 1AMP
	850FU6	24V 1AMP
	850FU7	24V 1AMP
	850FU8	24V 1AMP
	851FU1	24V 1AMP
	851FU2	24V 1AMP
	851FU3	24V 1AMP
	851FU4	24V 1AMP
	851FU5	24V 1AMP
	851FU6	24V 1AMP
	851FU7	24V 1AMP
	851FU8	24V 1AMP
	852FU1	24V 1AMP
	852FU2	24V 1AMP
	852FU3	24V 1AMP
	852FU4	24V 1AMP
	852FU5	24V 1AMP
	852FU6	24V 1AMP
	852FU7	24V 1AMP
	852FU8	24V 1AMP
	853FU1	24V 2AMP
	853FU2	24V 2AMP
	853FU3	24V 2AMP
	853FU4	24V 2AMP

Table 11-1: (Continued) Panel Fuses

TERMINAL BLOCK	POSITION	FUSE
T.B 4 (cont)	853FU5	24V 5AMP
	853FU6	24V 5AMP
	853FU7	24V 5AMP
	853FU8	24V 5AMP
	854FU1	24V 2AMP
	854FU2	24V 2AMP
	854FU3	24V 2AMP
	854FU4	24V 2AMP
	854FU5	24V 2AMP
	854FU6	24V 2AMP
	854FU7	24V 2AMP
	854FU8	24V 2AMP
	855FU1	24V 2AMP
	855FU2	24V 2AMP
	855FU3	24V 2AMP
	855FU4	24V 2AMP
	855FU5	24V 2AMP
	855FU6	24V 2AMP
	855FU7	24V 2AMP
	855FU8	24V 2AMP
	856FU1	24V 2AMP
	856FU2	24V 2AMP
	856FU3	24V 2AMP
	856FU4	24V 2AMP
	856FU5	24V 2AMP
	856FU6	24V 2AMP
	856FU7	24V 2AMP
	856FU8	24V 2AMP
	857FU1	24V 2AMP
	857FU2	24V 2AMP
	857FU3	24V 2AMP
	857FU4	24V 2AMP
857FU5	24V 2AMP	
857FU6	24V 2AMP	
857FU7	24V 2AMP	
857FU8	24V 2AMP	

11.3 REPLACING THE FUSE OF THE CONTROL UNIT

Mounting position of the fuse of the control unit

The fuse of the control unit is mounted on the main CPU board.

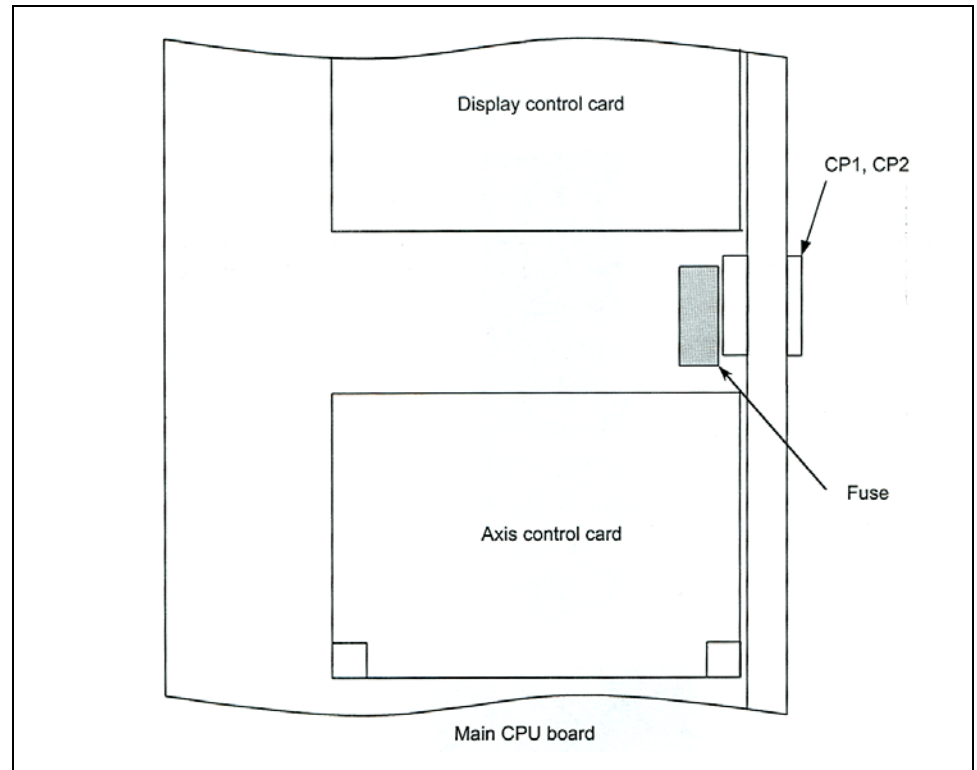


Figure 11-2: Fuse of the control unit

11.4 REPLACING FUSES ON VARIOUS UNITS

Fuse mounting location on the connector panel I/O modules

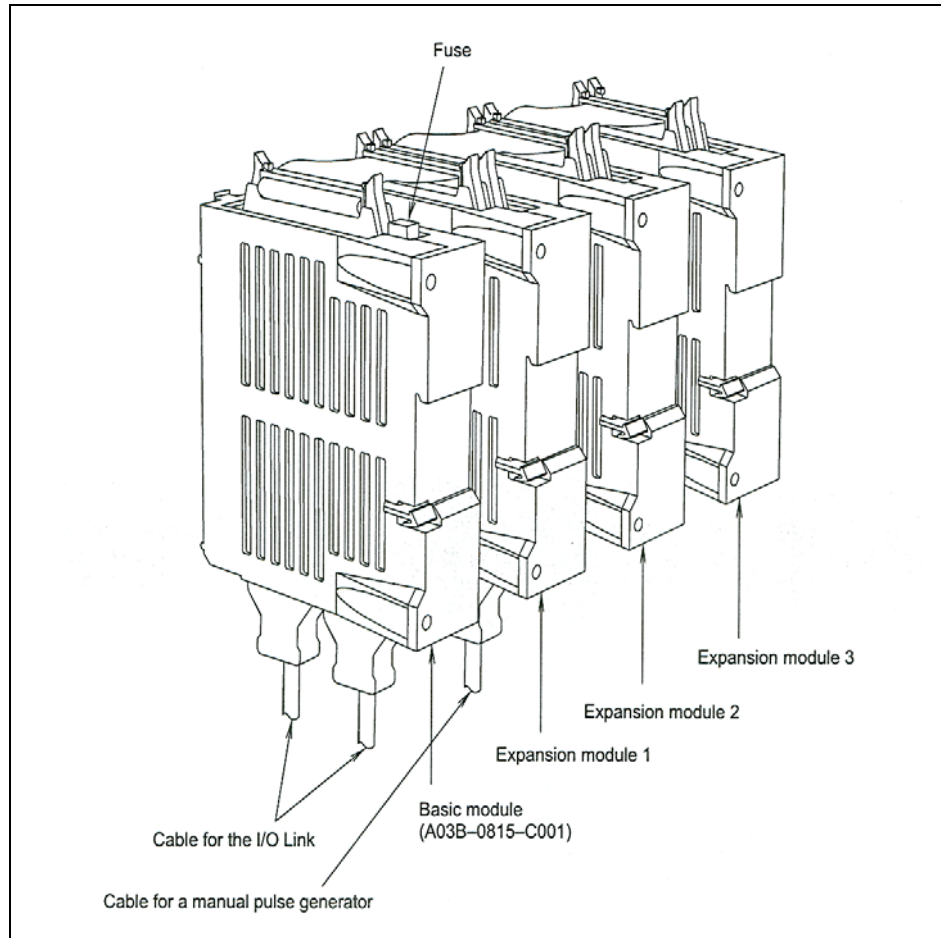


Figure 11-3: Fuses on various units



NOTE

No fuse is provided on the expansion modules. A fuse is provided on the basic module only.

Fuse mounting location on the operator's panel I/O modules

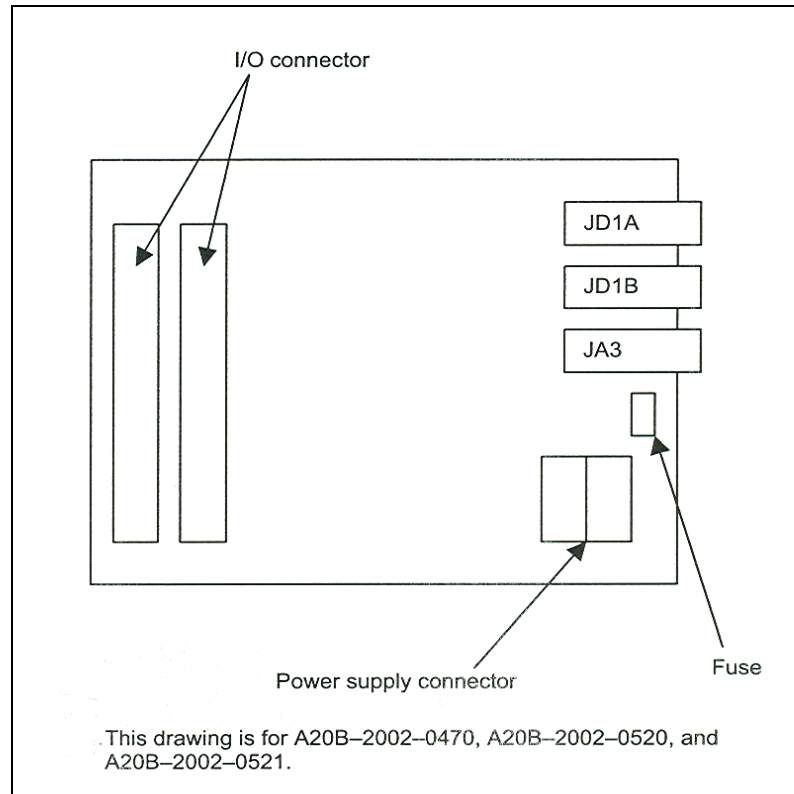


Figure 11-4: Fuse on the operator's panel

Fuse mounting location on the operator's panel connection units

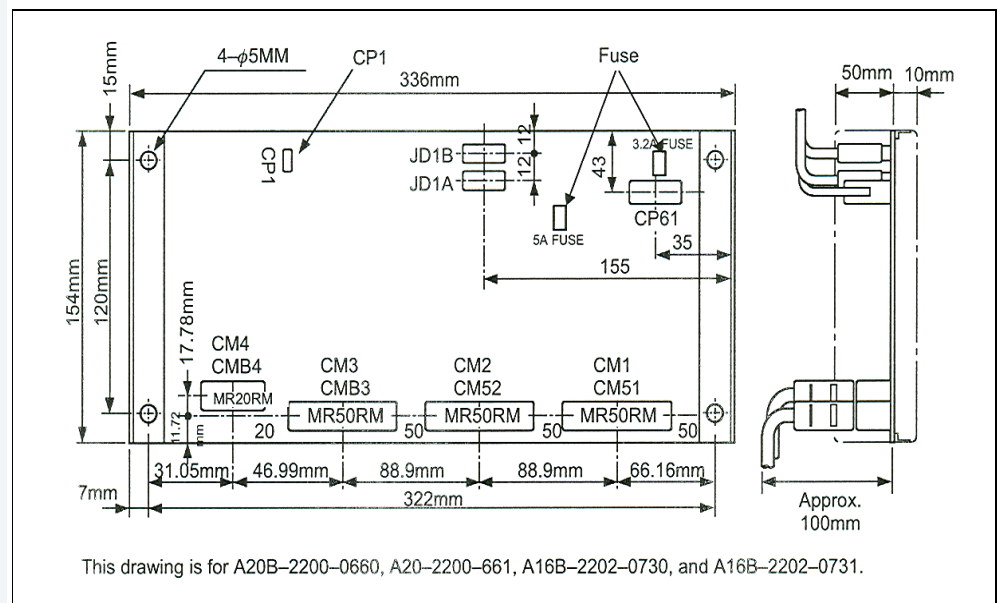


Figure 11-5: Fuse on the operator's panel

Fuse mounting locations on the machine operator's panel interface unit

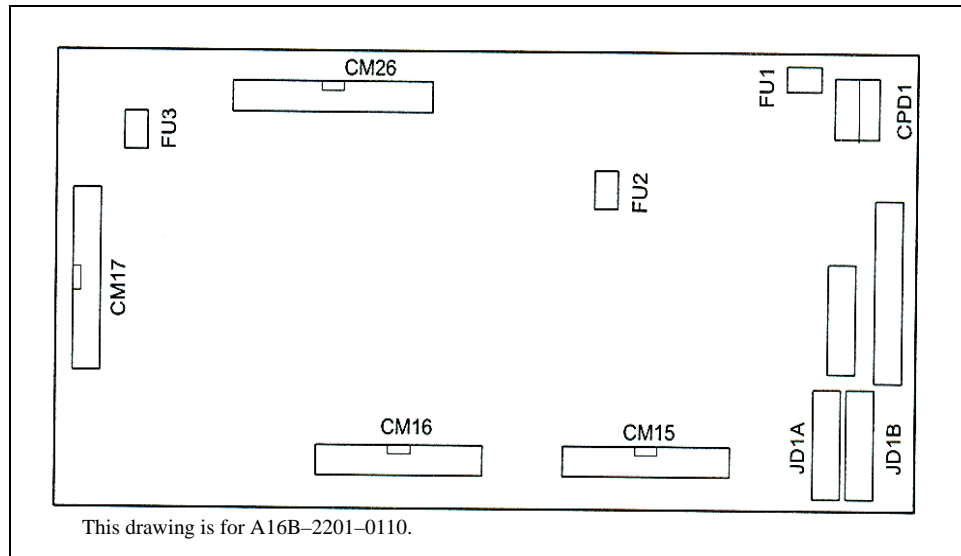


Figure 11-6: Fuse on the machine operator's panel

FU1: Fuse for +24V (for protection of general-purpose DO and the power supply of this printed circuit board)

FU2: Fuse for +5V (for protection of the IC power supply and manual pulse generator)

FU3: Fuse for +5E (for protection of general-purpose DI)



NOTE

FU2 is not mounted with Edition 05A and later.

Fuse mounting location on the distributed I/O machine operator's panels

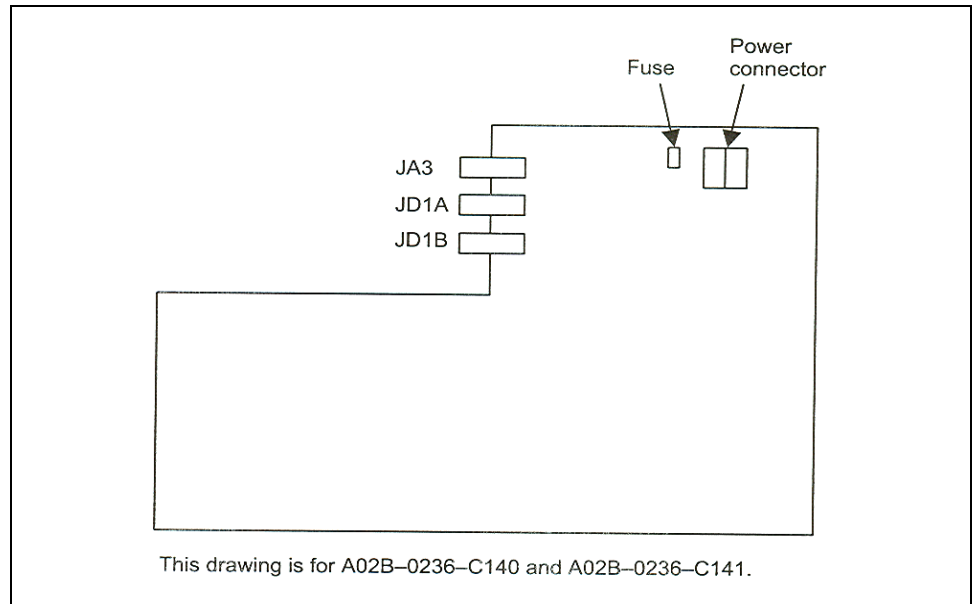


Figure 11-7: Fuse the distributed I/O panel

Fuse mounting location on the separate detector interface unit

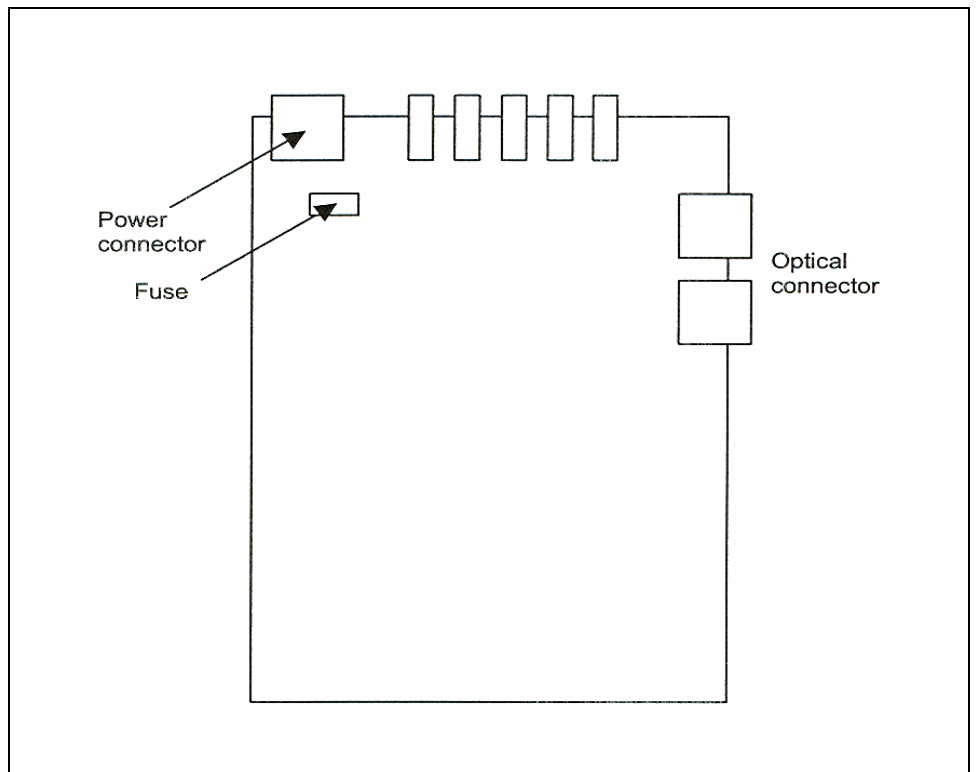
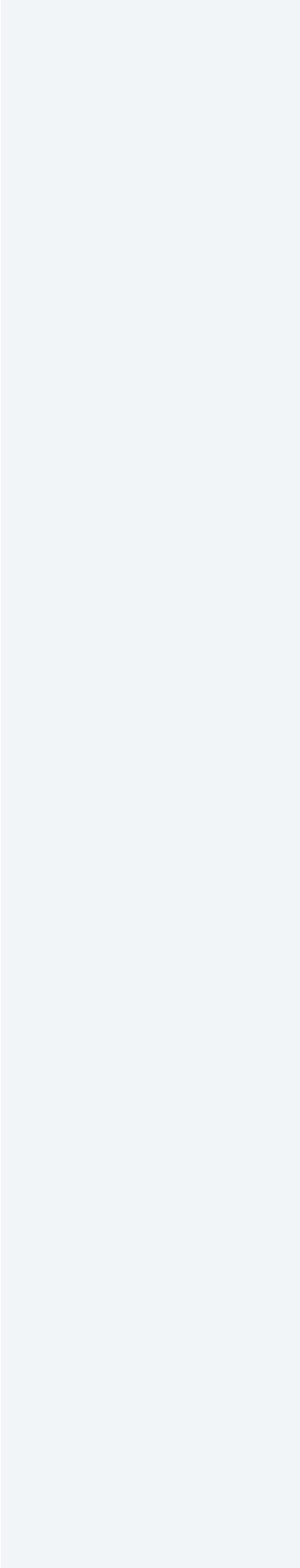


Figure 11-8: Fuse on the separate ditector



12.0 GENERAL INFORMATION

12.1 HELPFUL FORMULAS

12.1.1 TEMPERATURE

Degrees Fahrenheit (F) = $(9/5 \times \text{degrees C}) + 32$

Degrees Celsius (C) = $5/9 \times (\text{degrees F} - 32)$

12.1.2 CONVERSION FACTORS

Inch (in) = millimeter $\times 0.03937$

Inch (in) = centimeter $\times 0.3937$

Millimeter (mm) = inch $\times 25.4$

Centimeter (cm) = inch $\times 2.54$

Liter = gallon (U.S.) $\times 3.7854$

Gallon (U.S.) = liter $\times 0.2642$

Bar = Pounds per Square Inch (psi) $\times 0.0689$

Pounds per Square Inch (psi) = Bar $\times 14.5$

Newton-metre (N/m) = pound/foot $\times 14.5939$

Pound/foot = Newton-metre (N/m) $\times 0.0685$

Newton-metre (N/m) = ounce-inch $\times 0.00706$

Ounce-inch = newton-metre (N/m) $\times 0.1416$

12.1.3 ELECTRICAL REFERENCES

Formulas from Ohm's Law

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

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

Volts (E) = Amperes (I) \times Resistance (R)

Single-Phase

Kilovolt-Amperes (KVA) = (Volts \times Amperes) / 1000

12.1.4 EXPANSION
COEFFICIENTS

Three-Phase

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

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.

12.2 THERMAL EXPANSION

12.2.1 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.

12.2.2 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.

12.2.3 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.

12.2.4 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).

12.2.5 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.

12.2.6 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.

12.2.7 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.

12.2.8 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.

12.3 NON-UNIFORM EXPANSION

12.3.1 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.

12.3.2 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.

12.3.3 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.

12.4 SOLVING THE THERMAL EXPANSION PROBLEM

12.4.1 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.

12.4.2 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.

12.5 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.

12.6 VMC MAINTENANCE

12.6.1 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.

12.6.2 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.

12.6.3 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.

12.6.4 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 Thru Spindle

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 machine's 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 remembered at any time during the machining cycle.

12.6.5 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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