MODEL 1108®
REGISTER CONTROL SYSTEM

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MODEL 1108® REGISTRATION CONTROL SYSTEM

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1.0 THEORY OF OPERATION

The Model 1108 Register Control System controls the knife of a cutter to ensure continuous in-register processing of web materials. The registration mark (watermarked, printed, etc.) is photoelectronically detected in the moving web by a detection head (***Figure 1***) that utilizes a phototransistor in conjunction with a lighting technique that enhances the visibility of the mark.

Figure 1 – Detection Head

Reliable detection of the registration mark is the most important aspect of registration control. Once the registration mark is detected, it may be compared to the anticipated future cut-line of the knife to determine whether the material is being cut in-register.

The future cut-line is an imaginary cut-line the Register Control Computer calculates in relationship to the detection head used to detect the registration mark. Because the mark must be detected sufficiently ahead of the cutter knife to maximize knife correction time available, the future cut-line must be calculated to offset the difference between the knife and the detection head. The future cut-line is determined by electronically encoding the movement of the web in relationship to the rotation of the cutter knife. The future cut-line is then positionally synchronized with the detection head by mathematically accounting for the distance between the detection head and the cutter knife in terms of the sheet length being cut. Thus, the future cut-line is a signal that occurs when the location of a future cut-line passes under the detection head. This signal is then logically compared against the detection of the registration mark to determine if the cutter is in synchronization or needs correction.

When the location of the future cut-line has been determined in relationship to the registration mark (ahead, behind, in-sync); an appropriate signal will be sent to the drive circuitry of the correction motor to ensure that the actual cut-line falls at the registration mark. The correction motor is used to advance or retard the variable knife drive, such as a PIV or similar. A speed correction circuit has been supplied to compensate for variation in processing speeds (***Figure 2***).

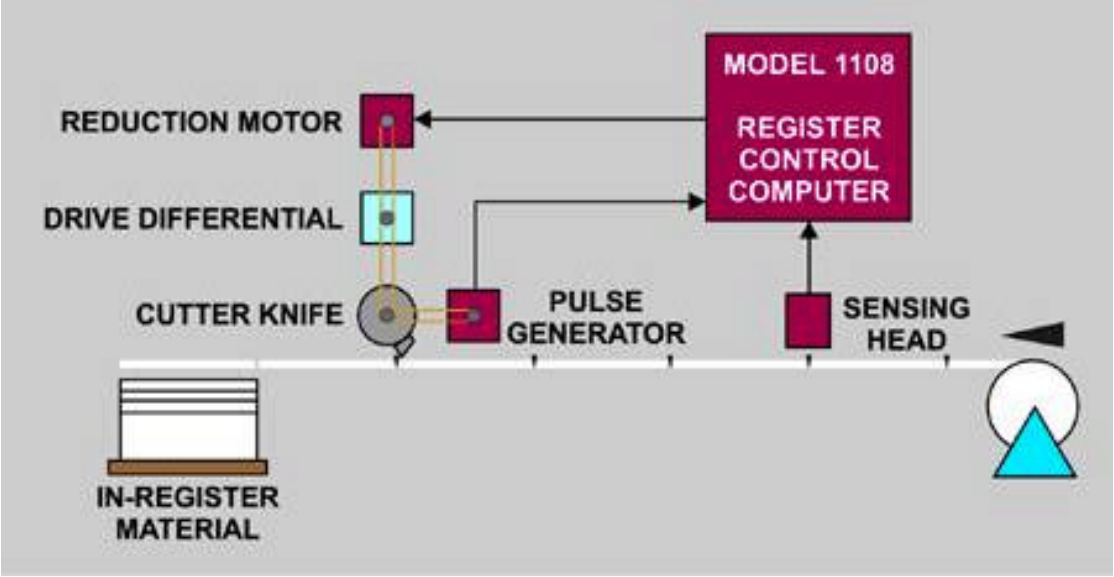

Figure 2 – Methodology of Watermark Detection

2.0 DESCRIPTION OF COMPONENTS

2.1 Detection Head and Light Source

The Detection Head (***Figure 3***) is used to detect the registration mark in the web. The head is a fabricated aluminum housing containing three phototransistors (***Figure 4***) and their related amplifiers. The phototransistors are photoelectric detectors that are used to detect the registration mark by monitoring the intensity of the near infrared light transmitted through the web of material. The phototransistors "view" the web through an aperture that reduces the field-of-view of each to 1/32" in the machine direction by 3/8" in the cross machine direction. The aperture (***Figure 5***) is used to enhance detection of the registration mark by reducing the amount of formation noise detected by the phototransistors; improving the signal-to-noise ratio for detection of the mark.

Figure 3 – Watermark Detection Head

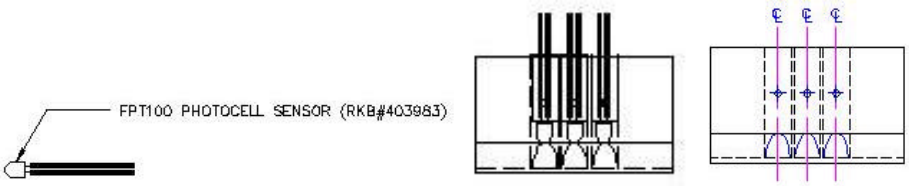

Figure 4 – Three phototransistors in sensing head

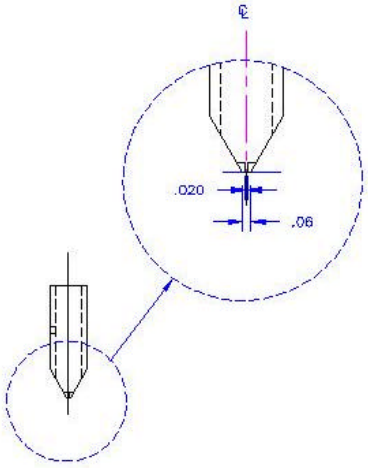

Figure 5 – Sensing Head Aperture

When a registration mark passes through the field-of-view of the Detection Head, the intensity of the infrared light transmitted through the web is distinctly altered. The distinct change in the infrared transmission will result in an analog signal that is amplified and converted to a digital pulse (***Figure 6***) before being output to the Registration Module in the Control Cabinet.

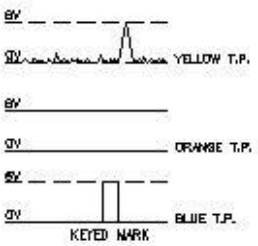

Figure 6 – Signal (Analog to Digital)

The infra-red light used for the detection of the registration mark is produced by a 12 volt filament lamp driven with direct current and housed in an aluminum fabricated Light Source Assembly (***Figure 7***). The assembly is located opposite the Detection Head on the other side of the web of material.

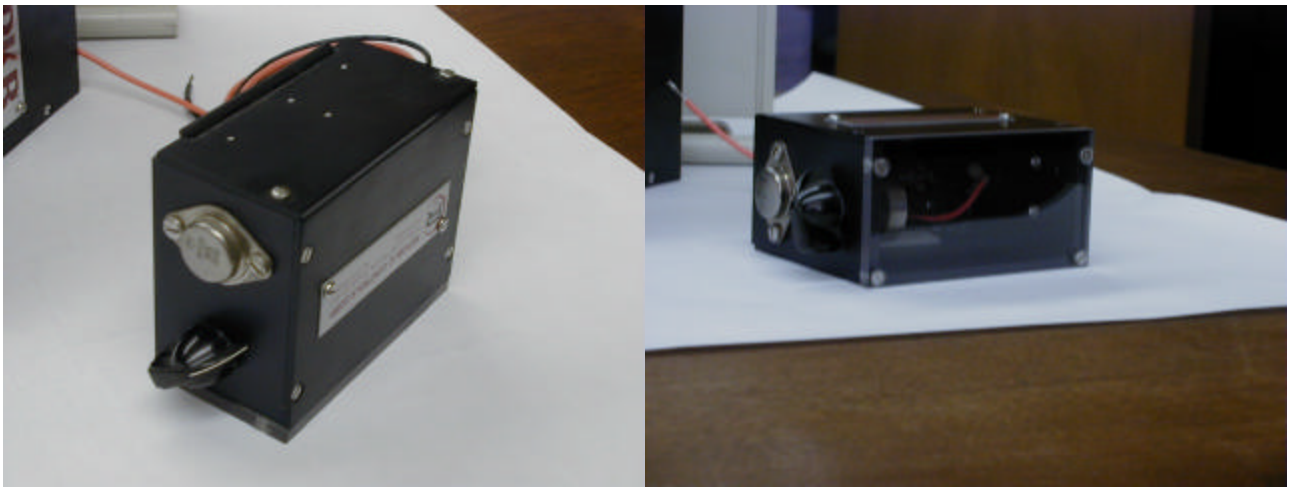

Figure 7 – Light Source Assembly

2.2 Correction Motor

The Correction Motor used to advance and retard the rotation of the cutter knife, should be a 1/2 horse power direct current electric motor. The motor controls the knife through control of the cutter knife drum differential variable drive. A gear reducer may be used with the motor to assist in power transmission.

2.3 Control Cabinet

2.3.1 Low Voltage Power Supply

A +/-15 volt direct current power supply is chassis mounted in the cabinet to provide a continuous 1.5 amp, +/-15 VDC power supply. This power is used to drive all logic electronics and the 12 volt infrared source lamp used for the detection of the registration mark (***Figure 8a&8b***).

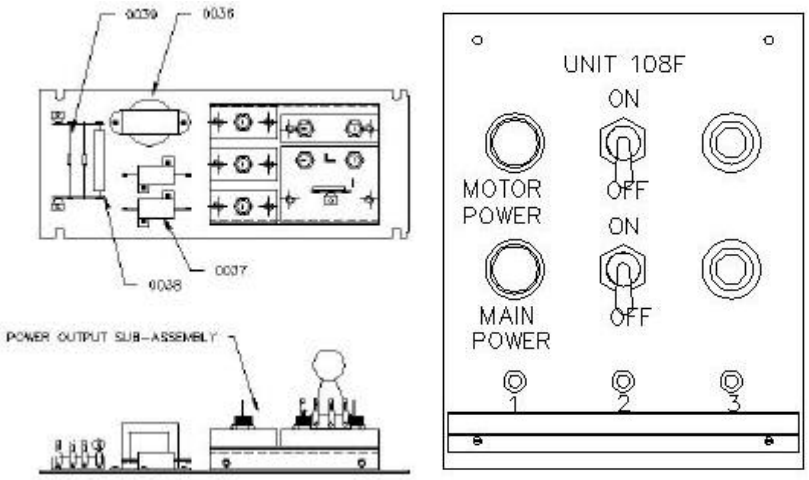

Figure 8a – Low Voltage Power Supply Assy

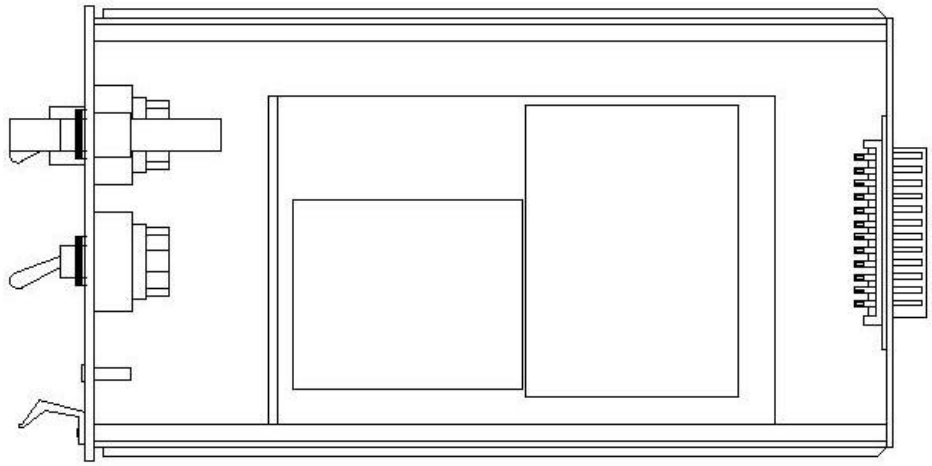

Figure 8b – Low Voltage Power Supply Assy

2.3.2 Sheet Length Unit

This rack mounted, printed circuit board is used to set the desired sheet length so that the future cut-line can be properly determined (***Figure 9***).

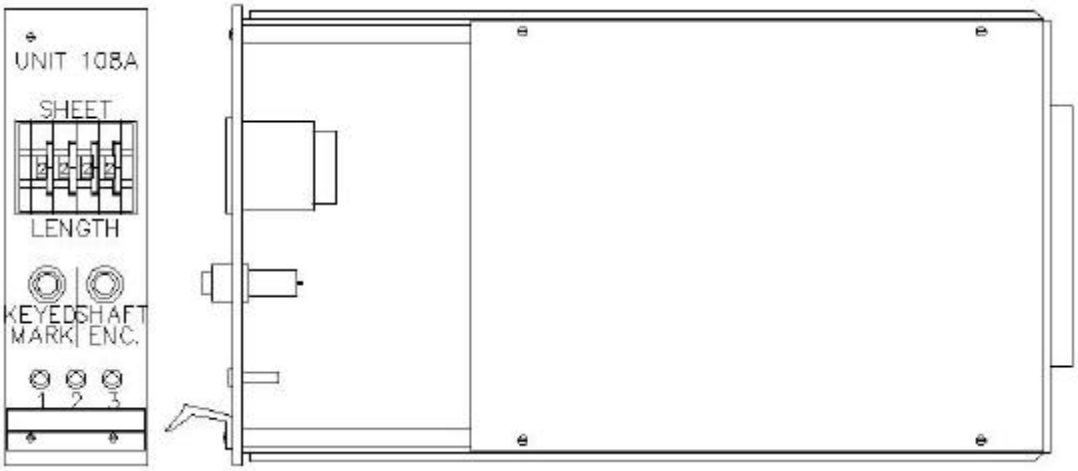

Figure 9 – Sheet Length Control Module

2.3.3 Register Control Module

This rack mounted, printed circuit board is used to generate the future cut-line, compare the registration mark location to the future cut-line and then determine whether the cutter knife needs to be advanced, retarded or held constant (***Figure 10***).

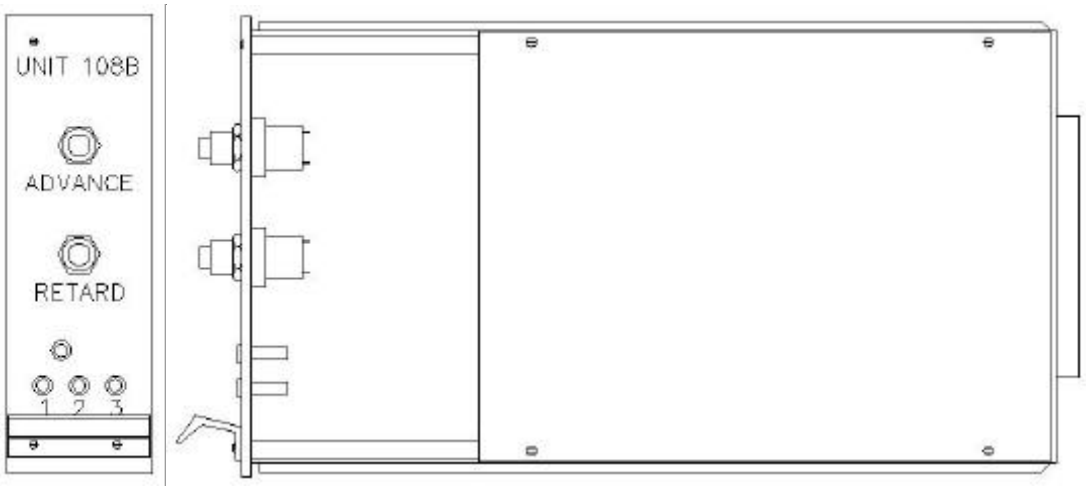

Figure 10 – Register Control Module

2.3.4 Analog Control Unit

This rack mounted printed circuit board receives a message from the correction motor that it is in motion. The Analog Control Unit also outputs a signal to the SCR Control Unit to adapt correction speed to cutter operation speed (***Figure 11***).

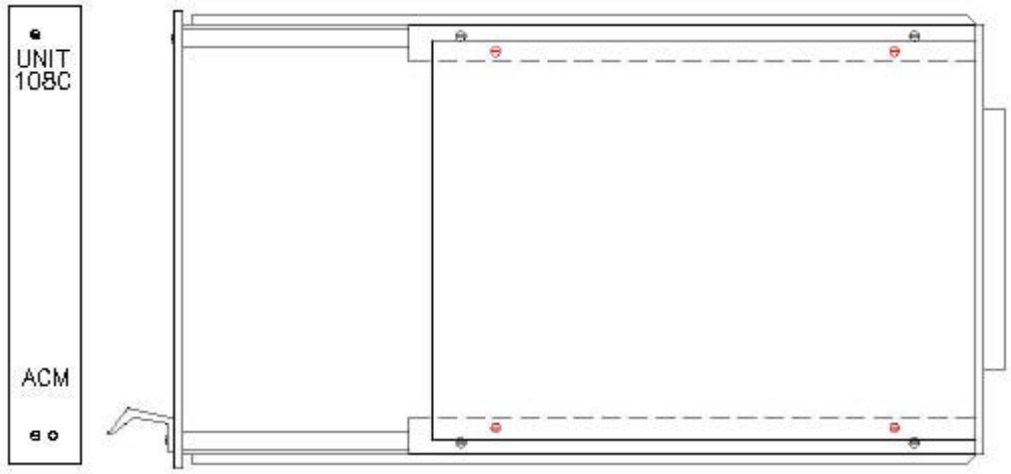

Figure 11 – Analog Control Module

2.3.5 Logic Control Unit

This rack mounted printed circuit board receives the knife control command from the Register control Unit and outputs a command to the Motor Control Unit. When a command has been output to the Motor Control Unit, the Logic Control Unit inhibits all other signals to the Motor Control Unit (***Figure 12***).

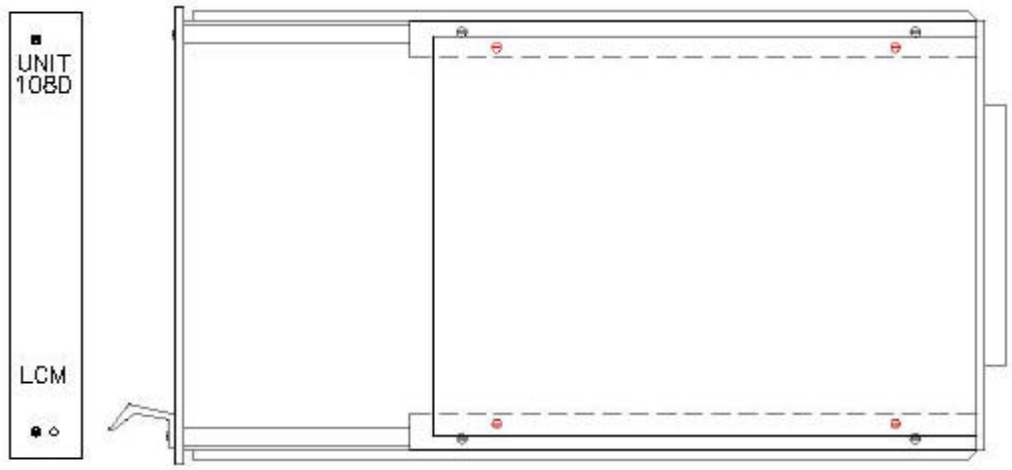

Figure 12 – Logic Control Module

2.3.6 SCR Control Unit

The SCR Control Unit is a rack mounted printed circuit board which regulates the voltages used for driving the correction motor. The SCR Control Unit receives signals from the Analog Control Unit that affects the SCR output in relationship to web processing speed. Thus, the SCR Control Unit is used to vary the speed at which correction is performed (***Figure 13***).

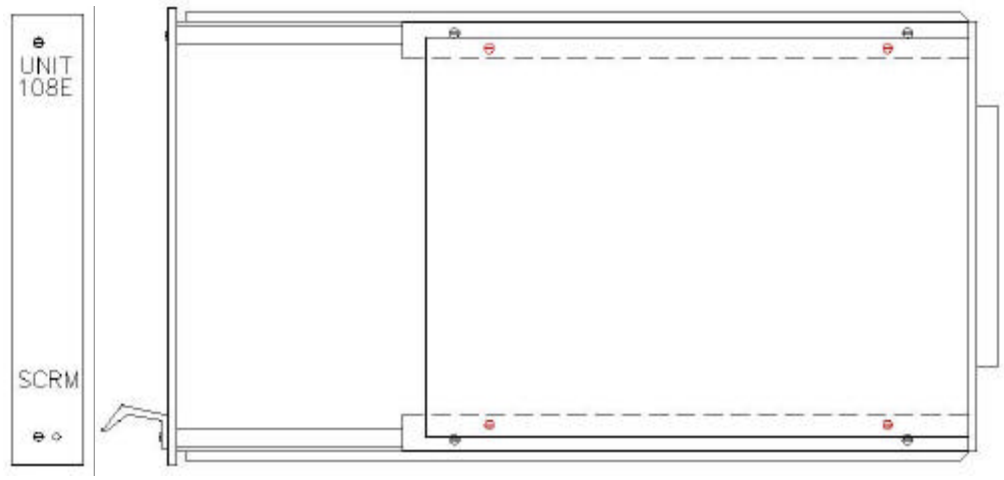

Figure 13 – SCR Control Module

2.3.7 Motor Control Unit

This rack-mounted assembly contains the circuitry and relays used to switch polarity of the correction motor drive voltage. By controlling the polarity of the motor drive circuitry the direction of rotation of the correction motor may be controlled; thus, enabling an advance or retard of the cutter knife. The Motor Control Unit also drives the in-sync, advance and retard indicator lamps on the front of the control cabinet (***Figure 14***).

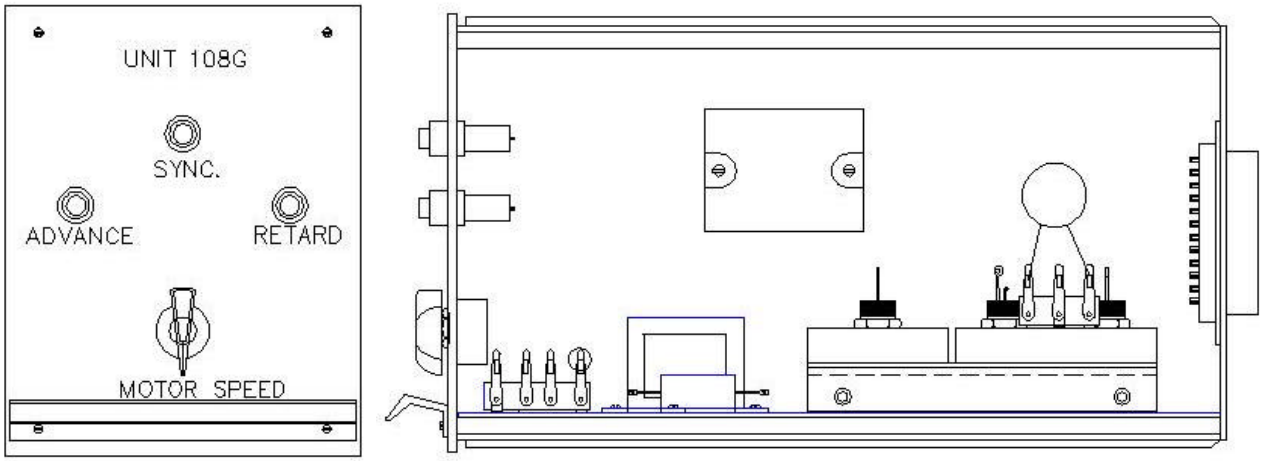

Figure 14 – Motor Control Module

2.4 Pulse Generating Shaft Encoder

The pulse generating shaft encoder supplies the electronic pulses required for measurement of the knife and web speed. The encoder is tied to the cutter knife with a timing belt and pulleys to provide a 1:1 revolution of knife to revolution of encoder ratio. The shaft encoder is an opto-electronic device housed in an industrial weight aluminum housing with a flexible coupled shaft. The encoder provides two signal channels. One channel provides a single 15-volt pulse for each revolution (the marker pulse). The other channel provides 1000, 15 volt pulses for each revolution. The shaft encoder is set so that the marker pulse is output when the knife is halfway through a cut.

3.0 INSTALLATION INSTRUCTIONS

3.1 Detection Head and Light Source

Refer to drawing C108608 in this manual for positional information for installation of the Detection Head and its related Light Source (***Figure 15***). The wiring interconnection instructions included in the Wiring Instructions and System Drawings section of this manual describe the necessary electronic interconnection to the Detection Head. The infrared lamp in the Light Source is driven by 12-15 VDC supply that may be taken off of the power supply in the Control Cabinet. Crimp connectors on to the lamp holder perform interconnection to the lamp.

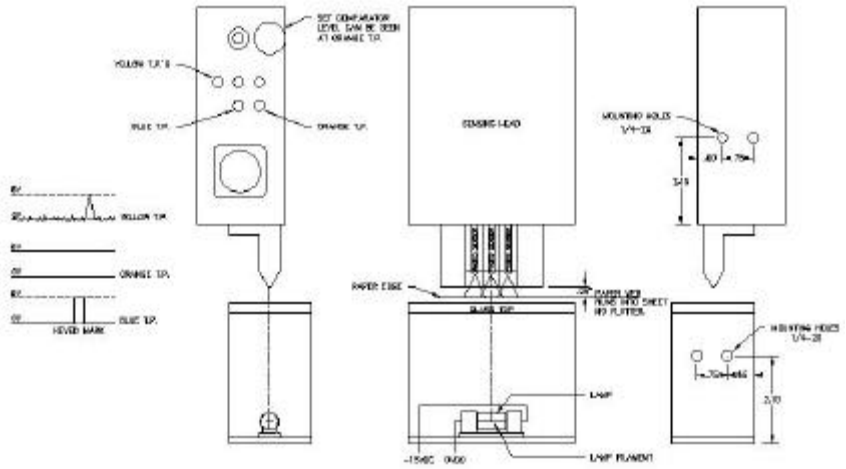

Figure 15 – Watermark/Light Source Placement to one another

Once the Detection Head has been electronically interconnected and the entire system is operational, the Detection Head detection threshold must be adjusted for proper detection of the registration mark. The Detection Head has an adjustable detection threshold (***Figure 16***) which represents the voltage level a signal created by the passing of a registration mark must exceed to be detected and converted into a digital pulse which is sent to the Control Cabinet. Instructions for proper adjustment of the detection threshold are provided in the Operation and Maintenance portions of this manual.

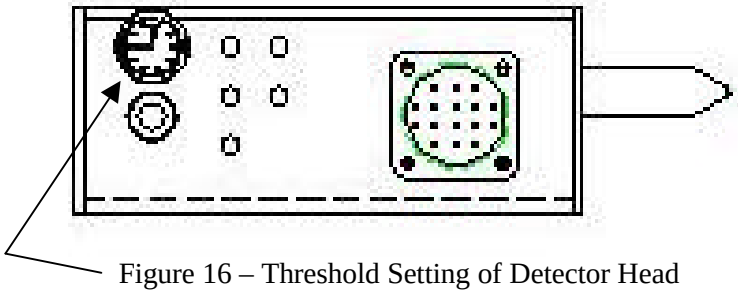

Figure 16 – Threshold Setting of Detector Head

3.2 Correction Motor

The correction motor may be tied to your variable knife drive in any fashion in accordance with your standard industrial practices.

3.3 Setting the Computer

In order for the Model 1108 system to operate properly, the distance between the cutter knife and the Detection Head must be carefully coded into the Register Control Module. If this distance is not coded correctly, an improper future cut-line location will be calculated causing the system to locate the knife at a consistent offset from the registration mark.

Inside the Register Control Module, you will find DIP switches on the printed circuit board. These switches are binary switches that represent the BCD equivalent of four decimal digits. These decimal digits represent inches up to 1599 with a single decimal tenths digit or 1599.9.

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Carefully measure the distance from the bed knife to the aperture of the Detection Head. Accurate measurement of this distance is of primary importance to the proper operation of the unit.

To code-in the distance between the knife and the Detection Head via the binary DIPswitches follow the example shown below. Keep in mind that the switch at Z3 represents the most significant digits or largest numbers. See assembly drawing D112203 to familiarize yourself with the orientation of the DIPswitches in relationship to the remainder of the circuit.

DIP SWITCH ARRANGEMENT

Z3			Z1		
ON	1248	1248	ON	1248	1248
OFF	1234	5678	OFF	1234	5678
	B	A		D	C

TO SET A DISTANCE OF 213.7 INCHES:

The binary equivalent of:

2 (0010) is set at A (Switch 6)
1 (0001) is set at B (Switch 1)
3 (0011) is set at C (Switches 5 and 6)
7 (0111) is set at D (Switches 1,2 and 3)

For Example:

Z3-1	ON	Z1-1	ON
Z3-2	OFF	Z1-2	ON
Z3-3	OFF	Z1-3	ON
Z3-4	OFF	Z1-4	OFF
Z3-5	OFF	Z1-5	ON
Z3-6	ON	Z1-6	ON
Z3-7	OFF	Z1-7	OFF
Z3-8	OFF	Z1-8	OFF

The binary equivalents of numbers are:

DECIMAL	BINARY	DIP SWITCH SEGMENT
0	0000	OFF,OFF,OFF,OFF
1	0001	OFF,OFF,OFF,ON
2	0010	OFF,OFF,ON,OFF
3	0011	OFF,OFF,ON,ON
4	0100	OFF,ON,OFF,OFF
5	0101	OFF,ON,OFF,ON
6	0110	OFF,ON,ON,OFF
7	0111	OFF,ON,ON,ON
8	1000	ON,OFF,OFF,OFF
9	1001	ON,OFF,OFF,ON

3.4 Shaft Encoder

A pulse generating shaft encoder has been supplied which will be used to determine location and speed of the cutter knife. The encoder is essential to the registration calculation and it must be installed properly to ensure proper operation of the Model 1108 system (***Figure 17***).

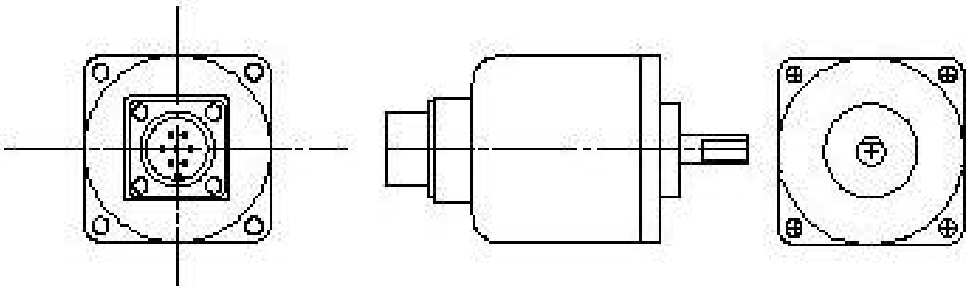

Figure 17 – Shaft Encoder

3.4.1 Driving the Encoder

The shaft encoder, similar to a tachometer, must be driven by the cutter knife and geared to provide a 1:1 ratio (1 revolution of the cutter knife to 1 revolution of the shaft encoder). Any suitable arrangement, jackshaft with flexible coupling, timing belt and pulley, etc. is acceptable. If a timing belt pulley arrangement is used for installation of the encoder, it is important to avoid tension on the timing belt. Tension on the timing belt may damage the shaft encoder.

3.4.2 Setting the Marker Pulse

The shaft encoder provides two output lines; the marker pulse (1 pulse/rev.) and one line of 1000 pulses per revolution. The marker pulse is to correlate with the cutter knife crossing the bed knife, thus cutting a sheet. To set the marker pulse, manually turn the knife until the center of the knife is "in contact" with the center of the bed knife. By setting the knife in this manner you will be set to the middle of the shear period of the knife. Once the cutter knife is properly positioned, loosen the setscrew on the pulley or coupling attached to the shaft of the encoder. After the pulley or coupling is loosened, use an oscilloscope to monitor the marker pulse output (pin F) and rotate the shaft of the encoder until the marker pulse goes HIGH. The pulse is very narrow so it may take a bit of trial and error until you can stop rotation of the encoder shaft in the middle of the marker pulse. When you have the shaft encoder shaft in the proper position where the marker pulse remains HIGH, tighten the setscrew on the pulley or coupling. As you are tightening the setscrew, slight movement of the encoder shaft may occur which will cause the marker pulse to go LOW. Do not be concerned with this slight movement.

To check the setting of the marker pulse, manually turn the cutter knife drum and monitor the marker pulse output to ensure that it coincides with the cut of the knife.

4.0 OPERATION INSTRUCTIONS

4.1 Master Power

The ON/OFF toggle switch on the front of the Control Console acts as the master power switch to the power supply of the Model 1108 system. When this toggle switch is at the ON position, all system logic electronics are operational, the low voltage power supply is operative activating the Detection Head and Light Source, and the Correction Motor switching circuitry is functional (***Figure 18***).

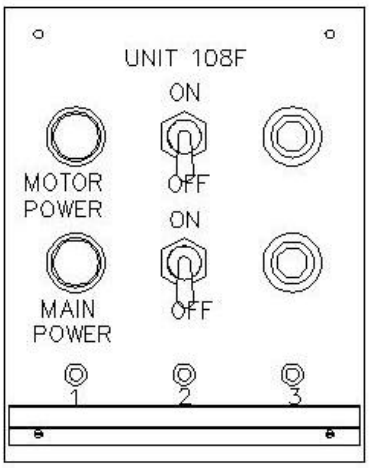

Figure 18 – Power Position Switches

4.2 Correction Motor Speed Control

A knob located on the front of the Motor Control Module controls the speed of the correction motor, thus affecting the speed of knife correction. In the manual mode, the speed of the correction motor must be manually set by visually monitoring the accuracy of the knife correction and controlling the motor speed until the knife is effectively being corrected and the cut line occurs at the registration mark.

4.3 Setting the Sheet Length

The sheet length being cut must be manually entered into the computer via the Sheet Length digital thumb switches located on the front of the Sheet Length Unit (***Figure 19***). The sheet length is displayed with four digits; two digits for complete inches and two for fractional inches at a resolution of 1/100th of an inch. For example a sheet length of 45.25 inches would appear as 4525 on the digital thumb switches. To set the sheet length, measure the distance between the "bug marks" on the sheet at the water mark detector. The distance should be measured to .01 in. Enter this number on the thumbwheel switches on the front of the Sheet Length Unit.

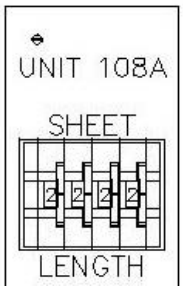

Figure 19 – Sheet Length Digital Thumb Switches

4.4 Manual Advance and Retard

The correction motor may be manually controlled, or the knife may be advanced or retarded via the two push buttons located on the front of the Register Control Module marked ADVANCE and RETARD (***Figure 20***). You may find it advantageous to manually control the knife when first starting production of a roll until the cut-line is relatively close to the registration mark. At this time, the system can complete knife correction automatically. We believe that this procedure will reduce the time necessary to get cutting in register; thus reducing waste at the start of each new roll of material. Operation of these switches drives motor at full speed.

Figure 20 - Pushbuttons

4.5 Operation Indicators

Each time a registration mark is detected by the Detection Head, a calculation is performed by the Model 1108 system that determines whether the knife needs to be corrected. Each time the resultant of this calculation occurs, an indicator on the Motor Control Unit will be illuminated to signal the action that is to be taken. One of these three indicators; ADVANCE, RETARD or IN-SYNC will be illuminated each time a registration mark is detected. These indicator lights will also display knife movement during manual override of the correction motor drive.

4.6 Setting the Threshold of the Detection Head

The detection threshold of the Detection Head must be normally set for proper detection of the registration mark. The detection threshold represents the voltage level the signal created by the passing of the registration mark must exceed in order to be detected and converted into a digital 12 VDC pulse which may be used by the registration computer.

The output of each of the three photodetectors in the Detection Head may be monitored with an oscilloscope at each of the three blue test points located on the Detection Head. Each blue test point corresponds to a single photodetector. As a registration mark passes under the Detection Head, a signal will be produced that will appear as a "spike". The detection threshold may be monitored at the orange test point on the Detection Head. The potentiometer on the head controls the voltage level of the detection threshold. Set the detection threshold at a voltage level that the "spikes" created by the registration marks consistently exceeds, but at a level which will not be exceeded by random formation noise in the sheet of material.

Thus, the detection threshold should be set at a voltage level between the average signal "spikes" created by the registration marks and the level of highest random noise. This setting will ensure that all registration marks are detected, but that there are no false signals created by formation noise. When a "spike" exceeds the detection threshold, an LED, indicator is momentarily illuminated signaling the detection of a registration mark (***Figure 21***).

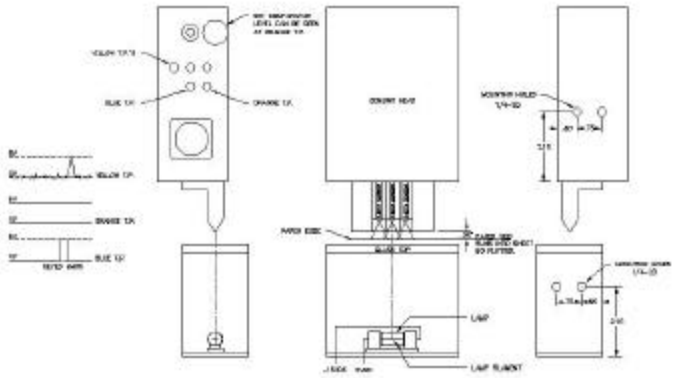

Figure 21 – Detection Threshold of Sensing Unit

5.0 MAINTENANCE INSTRUCTIONS

5.1 Periodic and Routine Maintenance

5.1.1 Infra-red Lamp Replacement

The infrared lamp in the Light Source Assembly will require periodic replacement. To remove the lamp, pull the lamp out of the snap-in holder with fuse pullers or similar. To install, simply snap-in to the lamp holder in the same manner as inserting a fuse.

5.1.2 Cleaning the Detection Head

The inspection aperture on the Detection Head will require regular cleaning to remove dust and other debris from the narrow aperture. A soft brush or light air jet will be sufficient for this purpose. Do not use high air pressure or water for cleaning the Detection Head.

5.1.3 Timing and Drive Belts

The belt used to transmit power from the correction motor and the timing belt used to drive the shaft encoder should be checked regularly for wear, alignment and tension. The timing belt on the encoder pulley should be drawn just tight enough to reliably drive the encoder. A tight draw on the encoder belt may result in damage to the encoder. If the encoder belt requires replacement, the encoder will have to be resynchronized with the knife drum. Refer to the shaft encoder installation instructions in this manual for re-synchronizing the encoder. The drive belt tied to the correction motor is to be serviced in accordance with standard industrial practice for belts of this nature.

5.1.4 Setting the Detection Head

The Detection Head will require adjustment to ensure proper detection of the registration marks. Instructions for setting the detection threshold for proper detection of the registration mark may be found in the operation instruction portion of this manual.

5.2 Troubleshooting Guide

5.2.1 Erratic/Lack of Detection of Registration Mark

1. Improperly Located Detection Head: The Detection Head may not be properly located over the location of the registration mark, resulting in only partial or complete lack of detection of the mark.

2. Blocked Inspection Aperture: The narrow aperture on the Detection Head may be blocked with dust or debris that could compromise the reliability of detection of the mark.

3. Failure of Source Lamp: The small infrared source lamp may have failed, thus inhibiting the ability of the Detection Head to detect the registration mark.

4. Poor Threshold Setting: The detection threshold in the Detection Head may require adjustment to improve detection of the registration mark. See operation instructions for this procedure.

5. Poor Watermark.

5.2.2 Offset and Over Knife Correction

1. Improper Sheet Length: The sheet length coded into the Model 1108 system may not accurately reflect the actual sheet length being cut.

2. Correction Motor Speed: The speed of the correction motor may need adjustment due to changes in web processing speed.

3. Improper Distance, Knife to Detection Head: The distance measured and coded into the Register Control Module may not accurately reflect the actual distance from the bed knives to the registration mark Detection Head. See Installation Instructions of this manual.

5.2.3 Unreliable/Irregular Knife Correction

1. Poor Detection Threshold Setting: The detection threshold in the Detection Head may be improperly set resulting in false signals due to formation noise in web of material or unreliable detection of the registration mark.

2. Poor Shaft Encoder Drive: The shaft encoder marker pulse may not be properly aligned with the cutter knife or the timing belt may be jumping or vibrating leading to inaccurate encoding on the movement of the knife drum.

3. Poor Correction Motor Drive: The belt which transmits power from the correction motor may be slipping or operating improperly. The drive circuitry of the correction motor, namely the polarity switching relays, may be experiencing switching difficulties.

4. Component Failure: Component failure in the computer resulting in the improper calculation of the future cut-line, registration mark comparator circuitry or similar may have occurred.

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APPENDIX A

DRAWING LIST

ITEM NUMBER	DRAWING NUMBER	DWG/MFG PART # REF DES./DESCRIP
0001	PL107718	Model 1108 Parts List
0002	D107718	Model 1108 System Layout
0003	D112263 Sht.1	Model 1108 System Approval Drawing
0004	D112263 Sht.2	Model 1108 System Approval Drawing
0005	D112263 sht.3	Model 1108 System Approval Drawing
0006	C112208	Model 1108 Block Diagram
0007	C112264	Model 1108 Cabling Diagram
0008	D113338	Model 1108 Rack Wiring Diagram
0009	A113337 Sht.1	Model 1108 Field Wiring List
0010	A113337 Sht.2	Model 1108 Field Wiring List
0011	PL112242	Cabinet Rack Parts List
0012	D112242	Cabinet Rack Assembly Drawing
0013	D113340	Cabinet Rack Assembly Interconnection Drawing
0014	PL112217	Sheet Length Module Parts List
0015	C112217	Sheet Length Module Drawing
0016	PL112206	Sheet Length Module Schematic Parts List
0017	D112202A	Sheet Length Module Schematic Drawing
0018	PL112216	Register Control Module Parts List
0019	C112216	Register Control Module Drawing
0020	PL112203	Register Control Module Schematic Parts List
0021	D112197	Register Control Module Schematic Drawing
0022	PL112220	Analog Control Module Parts List
0023	C112220	Analog Control Module Drawing
0024	PL112205	Analog Control Module Schematic Parts List
0025	D112205	Analog Control Module Schematic Drawing
0026	PL112222	Logic Control Module Parts List
0027	C112222	Logic Control Module Drawing
0028	C107573	Logic Control Module Schematic Assembly
0029	D107574	Logic Control Module Schematic Drawing
0030	PL112240	SCR Control Module Parts List
0031	C112240	SCR Control Module Drawing
0032	C107575	SCR Control Module Schematic Assembly
0033	C107576	SCR Control Module Schematic Drawing
0034	PL112213	Power Supply Module Parts List
0035	D112213	Power Supply Module Drawing
0036		
0037	C108656	Power Supply Module Schematic Drawing
0038	PL112210	Motor Relay Module Parts List

0039	D112210	Motor Relay Module Drawing
0040	C113341	Motor Relay Module Schematic Drawing
0041	PL112215	Motor Control Module Parts List
0042	D112215	Motor Control Module Drawing
0043	D113342	Motor Control Module Schematic Drawing
0044	PL112254	Motor Control Sub Assy Parts List
0045	B112254	Motor Control Sub Assy Drawing
0046		
0047	PL104457	Power Supply Sub Assy Parts List
0048	B104457	Power Supply Sub Assy Drawing
0049		
0050	C108608	Watermark Head/Light Source Layout Drawing
0051	PL112204	Watermark Detection Head Parts List
0052	C110556	Watermark Detection Head Schematic
0053	C112204	Watermark Detection Head Drawing
0054	B112207	Watermark Detection Head Wiring
0055	PL112274	Watermark Det. Head Aperture Parts List
0056	B112274	Watermark Det. Head Aperture Drawing
0057	PL108789	Lamp Housing Parts List
0058	C108789	Lamp Housing Drawing
0059	B109382	Lamp Housing Schematic Drawing
0060	B113339	Shaft Encoder Drawing

MODEL 1108® REGISTRATION CONTROL SYSTEM

APPENDIX B

SPARE PARTS LIST

ITEM NUMBER	MFG CODE	DWG/MFG PART # REF DES./DESCRIP	ORDERING CODE
0001	PM	SHAFT ENCODER	404142
0002	PM	PULLEY, 20XL037	401813
0003	PM	BELT, KAMAN 180XL 037	401854
0004	ME	WATER MARK DETECTOR ASSEMBLY	401996
0005	ME	LAMP HOUSING WATER MARK DETECTOR	404070
0006	PE	LAMP (12V-3W) #LLB256	401946
0007	PE	TRANSFORMER 166C50	401040
0008	PE	RESISTOR .50 Ohm 25W	402102
0009	ME	D112205 ANALOG CONTROL MODULE BRD.	404071
0010	ME	C107574 LOGIC CONTROL MODULE BRD.	403384
0011	ME	D107576 SCR CONTROL MODULE BRD.	403385
0012	PE	CONNECTOR EB82-A225G2\225-22222-101	400153
0013	PE	CONNECTOR WDI 26-4200-24S	401805
0014	PE	CONNECTOR WPI 26-4100-24P	404063
0015	PE	TRANSFORMER 171C	401044
0016	PE	TRANSFORMER 193V	401043
0017	PE	LAMP SOCKET "LEVITRON"19062	404021
0018	PE	BRIDGE RECTIFIER ECG5344	403096
0019	PE	THUMBSWITCH ASSEMBLY	404072
0020	PE	LAMPHOLDER ASSEMBLY	404073
0021	ME	D112206 SHEET LENGTH MODULE BOARD	404074
0022	PE	SWITCH 10-9	400970
0023	ME	D112203 REGISTER CONTROL MODULE BOARD	404075
0024	PE	LAMP 249-7871-3331-504 (RED)	400930
0025	PE	LAMP 249-7971-3332-504 (GREEN)	400932
0026	PE	LAMP 249-8071-3333-504 (AMBER)	400931
0027	PE	POTENTIOMETER\KNOB ASSEMBLY	404076
0028	PE	LAMPHOLDER & LENS ASSEMBLY	403802
0029	PE	TOGGLE SWITCH JBT 52235	400650
0030	PE	FUSE HOLDER ASSEMBLY	404077
0031	PE	POWER SUPPLY HBB15-1.5A	401851
0032	PE	RESISTOR OHMI 2500 Ohm 11W	401196
0033	PE	RECTIFIER, BRIDGE	400927
0034	ME	SCR C228DX1500	401260
0035	PE	V420LA40B ARC SUPPRESSOR	401263
0036	ME	MOTOR CONTROL MODULE	402218
0037	ME	POWER SUPPLY MODULE	402219
0038	PE	POTENTIOMETER/KNOB ASSY	404076
0039	PE	HOLDER FUSE ASSEMBLY	404077

APPENDIX C

DRAWINGS, SCHEMATICS
and
PARTS LISTS