2 OPERATION OVERVIEW

CONTENTS

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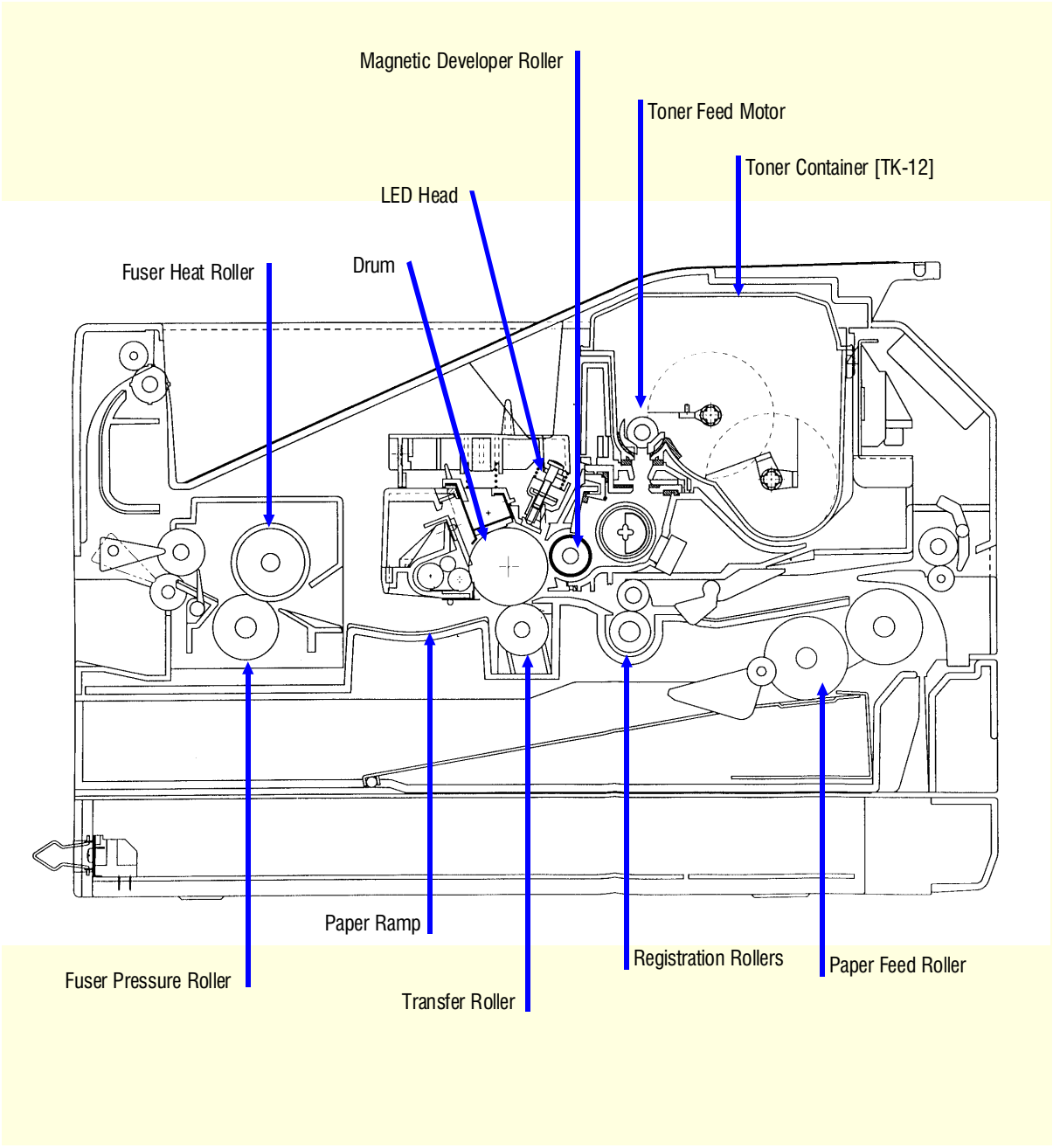
2.1. Introduction

This chapter describes how the printer receives data from the host computer, processes and prints them on paper. Section 2.2. describes the theory of the electrophotography involving those components of the LED head, drum unit, developer, etc. In later sections, an overview on the electrical circuitry, focusing on the important functions of the circuitries contained on the main logic board and the engine controller board, is provided.

2.2. Main Part Locations

Figure 2.1. below shows the printer's major components inside the printer. Details on each component are shown on the following pages.

Figure 2.1. Main Part Locations



2.3. Electrophotography System

The electrophotography is the technology used in laser and LED printers which transfers data representing texts or graphics objects into a visible image which is developed on the photosensitive drum, finally fusing on paper, using light beam. Two widely known devices that are used to generate and emit the light are laser diode and LED array (head). The printer uses the Kyocera's proprietary LED head for this purpose.

The following subsystems in the printer system constitute the main electrophotography system.

2.3.1. Electrophotography Overview

The electrophotography system includes the drum unit, developer unit, main (wire) and transfer (roller) chargers, and the eraser lamp (array).

These components comprise the electrophotography system as illustrated in Figure 2.2. These components perform a cyclic action made of seven steps as shown in Figure 2.3. This begins with the main charging as follows.

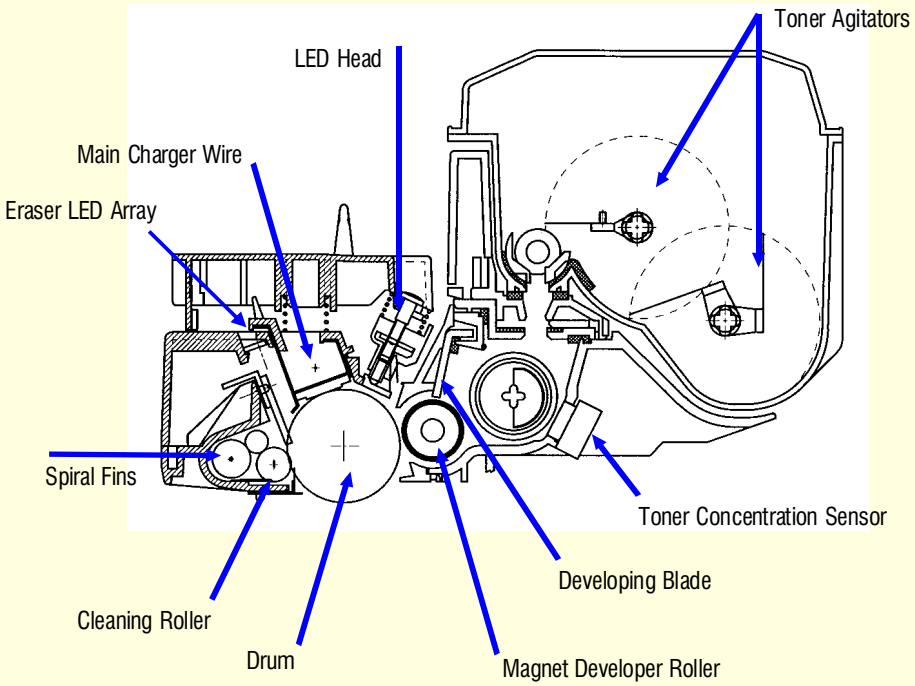


Figure 2.2. Components of electrophotography

VER 1.22

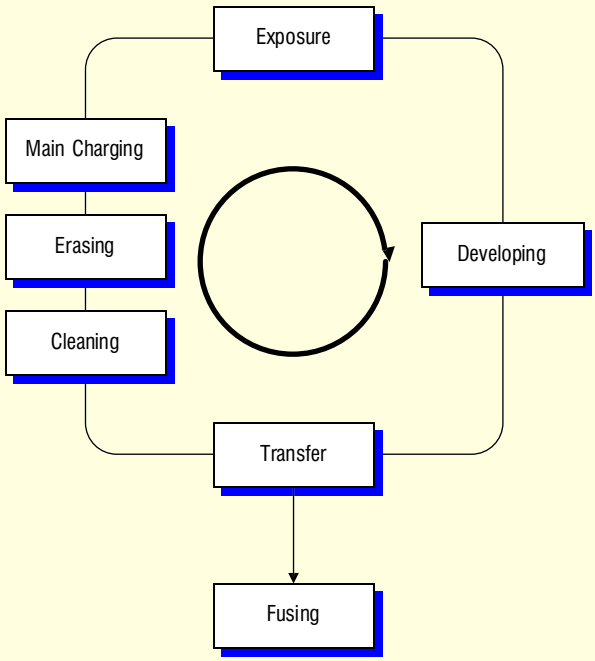


Figure 2.3. Electrophotography cycle

Step 1: Main charging:

The printer uses a long lasting amorphous silicon drum for developing image. The drum has a layer coating of amorphous silicon over a aluminum base cylinder as shown in Figure 2.4.

The amorphous silicon drum is very durable and less susceptible to the adverse effect caused by contamination on the drum itself. The drum has a flat-shaped heater fit along its inner circumference, which heats up the drum surface to a constant temperature to maintain a good print quality (approximately 45°C).

As the drum rotates in a clean (neutral) state (Figure 2.6., top), its outer surface is given a uniform electrical charge of positive (+) potential by corona charging from the main charger wire located above the drum.

Figure 2.4. Amorphous silicon drum

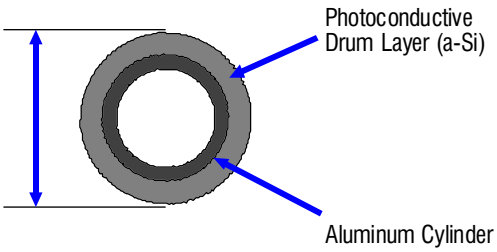
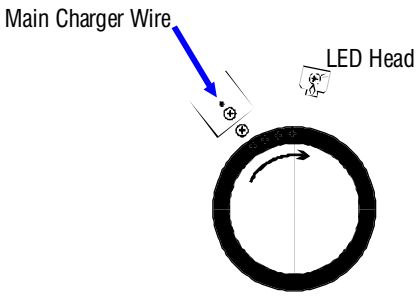


Figure 2.5. Main charging



The high-voltage (HV) board generates and applies the +6k to +7kV DC with the main charger wire (positive corotoron charging). See Figure 2.6., middle. By nature, positive corotoron charge generates much less ozone gas than negative corotron charging (used with many laser printers that use the conventional organic photo-conductive drums) does. The DC is stabilized by a zenner diode. The subsequent charge potential on the drum is approximately +300V DC. The main -charging (MCH) grid (v=+360V) located between the charging wire and the drum works to bypass the excessive current to the ground. The grid potential is optimized through adjustment of the voltage control circuit contained in the drum unit.

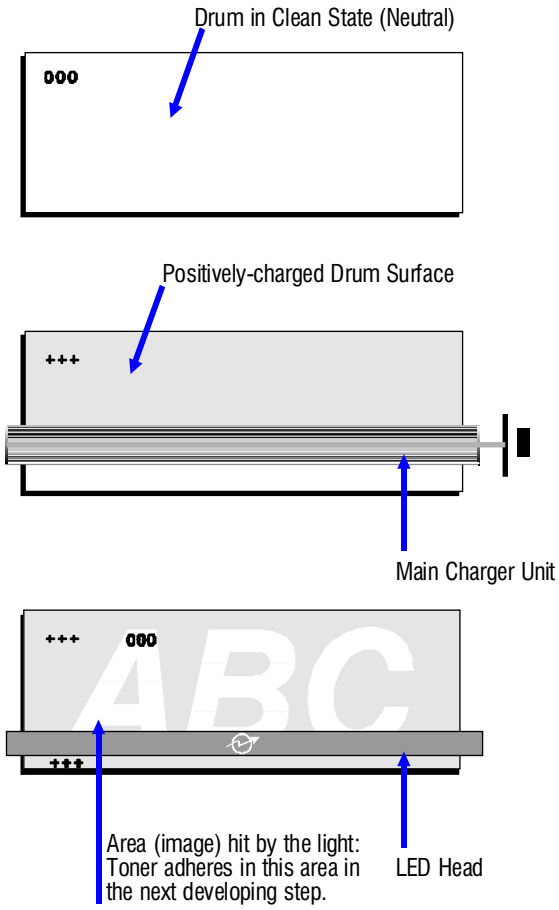
The charging wire must be cleaned periodically from time to time using the cleaning brush (MH cleaner) supplied with the printer. Cleaning the charging wire prevents print quality problem such as black streaks caused by the oxide accumulated around the charging wire.

Step 2: Exposure:

The positively-charged drum surface is then exposed to the light beam emitted by the LED head (0.55 µJ/cm2 at 685 nm). The LED head has an array of 2,560 LED chips driven dynamically by the LED driver circuit according to the computer data to be printed, and an array of lenses, running in parallel to the LED array, of the same number of the chips for focusing the LED light beam. Description on how the LED head is driven by the electrical circuit is provided later in this chapter.

When the LED head scans over the drum lengthwise, the positive charge on the drum surface which is hit by light escapes to the ground as such area becomes electrically conductive. Thus a latent image (electrically neutral area) according to the image to print is constituted on the drum as shown in Figure 2.6., bottom.

Figure 2.6. Exposure



Step 3: Developing (Development):

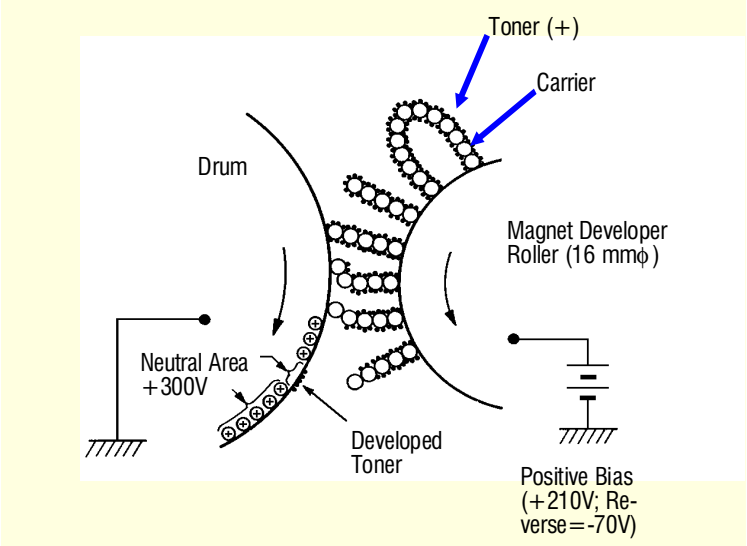
The latent image constituted on the drum in the previous step is *developed* as a visible image by applying toner over the image. The printer uses the Kyocera micro fine ceramics toner designed exclusively for use with the amorphous silicon drum. The toner, containing the drum polishing substance within itself, is mixed with the carrier powder (two ingredients of ferrite and resin carriers) held inside the developer to constitute the developing powder (or *developer* simply).

The toner is applied onto the drum to develop images in the following manner:

The developing powder, a mixture of toner and carrier powder as told above, is continuously agitated inside the developer in order that a constant concentration of the toner in reference to the carrier (*toner concentration* in short) is maintained. To achieve this, a toner concentration sensor is provided at the bottom of the developer unit which, in cooperation with the printer electronics, works to continuously monitor and maintain the optimal concentration.

The developing powder adhered by the magnetism of the magnet roller, forms brushes as shown in Figure 2.7. The tips of brushes sweep over the drum surface which the latent image is to be developed. When sweeping, the toner particles on the brush are wrested away from the brush and attracts to the electrically neutral areas (previously hit by the LED light) on the drum. Other parts on the drum which has not been exposed to the LED light so remained positive, prevents toner from adhering.

Figure 2.7. Developing

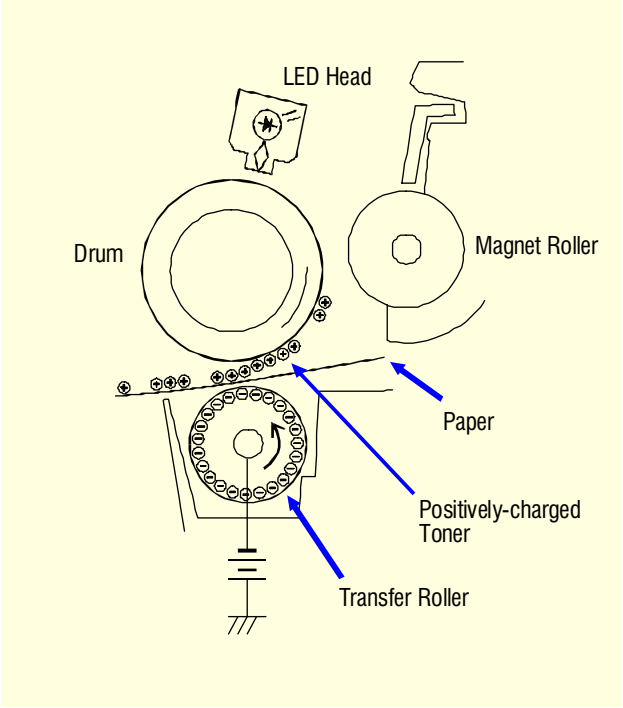


As the amount of the toner in the developing powder dwindles during printing, the toner concentration ratio lowers, the permeability sensor then requests the engine controller to feed more toner from the toner reservoir.

Step 4: Transfer:

The image developed on the drum by toner is transferred onto paper using the electric charge attraction given by the toner itself and the transfer roller. The transfer roller is negatively biased so that the positively charged toner is attracted onto the paper while it is pinched by the drum and the transfer roller. See Figure 2.8.

Figure 2.8. Transferring toner to paper

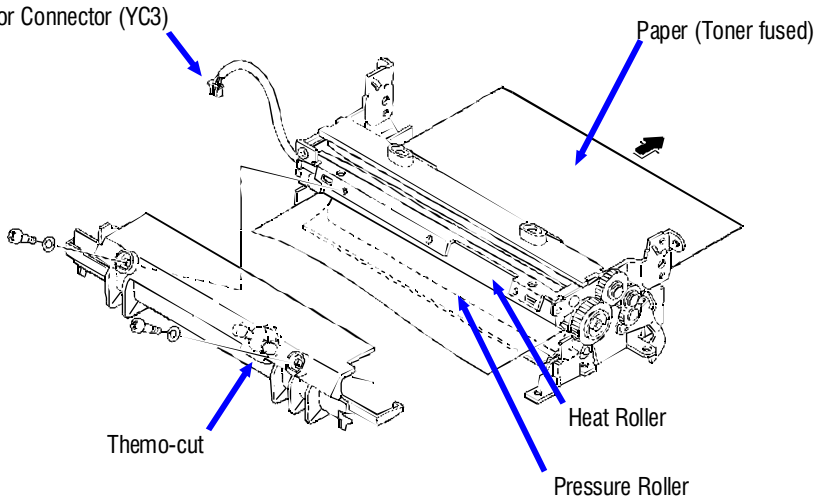


Step 5: Fusing:

See Figure 2.9. After transferring, the toner on the paper is permanently fused onto the paper as it passes through the heat roller and the pressure roller in the fuser unit. The heat roller has a 500W (FS-1550 series) or 800W heater (FS-3400 series) which is wired in series with a thermistor controlled by the engine controller to continuously preheat the heating roller at approximately 165°C (FS-1550 series) or 180°C (FS-3400 series) during the printer is idling; and at approximately 180°C (FS-1550 series) or 193°C (FS-3400 series) during printing. These temperatures on the heater roller surface are constantly monitored by the engine control circuit and a thermistor.

For safety purpose, the fuser system is protected by a thermo-cut which automatically cuts off the heater current in case of an unusually high temperature.

Figure 2.9. Fuser unit



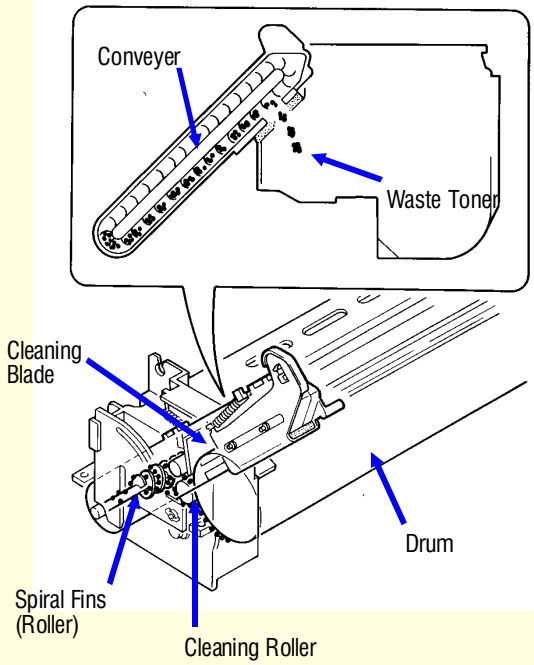
VER 1.22

Step 6: Cleaning the Drum

The toner failed to adhere to the paper in the transferring step and remaining on the drum is cleaned off of the drum by the cleaning blade which is pressed against the drum, and collected back to the waste toner reservoir inside the toner container as shown in Figure 2.10. (The cleaning blade is 77° hard and made of polyurethane rubber.)

As shown in this figure, the refresher roller located in parallel to the drum drives the toner to the spiral (fins) roller with which the belt conveyer for delivering the waste toner in the waste toner bottle is connected. The refresher roller also cleans and reconditions the drum in each cycle of processing.

Figure 2.10. Cleaning the drum



Step 7: Erasing

An electrophotography cycle concludes by returning the drum to an electrically clean (neutral) state. This is necessary as the drum has the residual positive charge in the areas not hit by the LED light in exposure step.

The remaining charge is canceled by exposing the drum to the light emitted from the eraser LED array positioned parallel to the drum, following the cleaning step. This lowers the electrical conductivity of the drum surface making the residual charge on the drum surface escape to the ground.

Figure 2.11 on next page shows the location of the eraser lamp inside the drum unit. For the diagnostics purpose of the printer, the current flowing through the eraser array is monitored by the engine controller. If the array blows, the *Call Service person E5* message is shown and printing is halted.

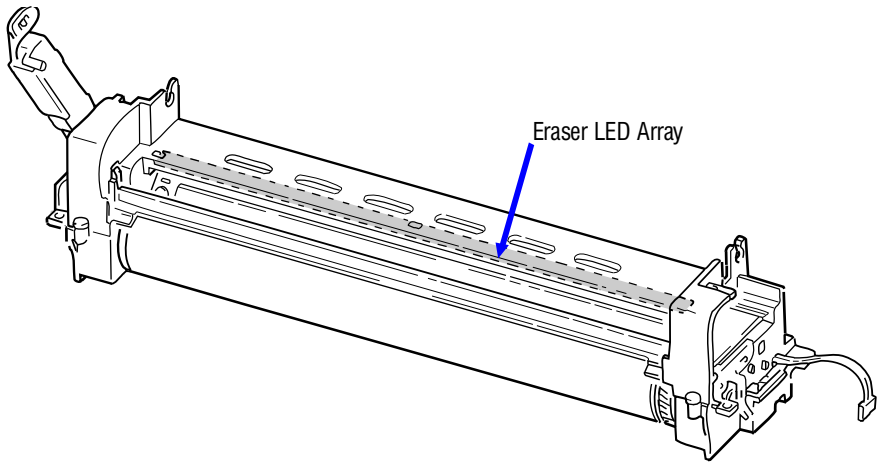


Figure 2.11.
Eraser LED array

2.4. Paper Feeding System

The paper feeding system picks up paper from the paper cassette or the manual feeding tray and feeds it to the electrophotography system for transferring and fusing image on paper, and finally delivers the printer page to the face-down or face-up tray. Figure 2.12. below shows the paper feeding path in the printer.

The paper feeding system is modularized and detachable at the printer's front for ease of maintenance. The paper feeding unit controls paper pickup, registration, and transportation of paper as commanded by the printer's engine controller CPU. Clutches and sensors are used to activate and deactivate the rollers to rotate for accomplishing these functions in complete synchronization.

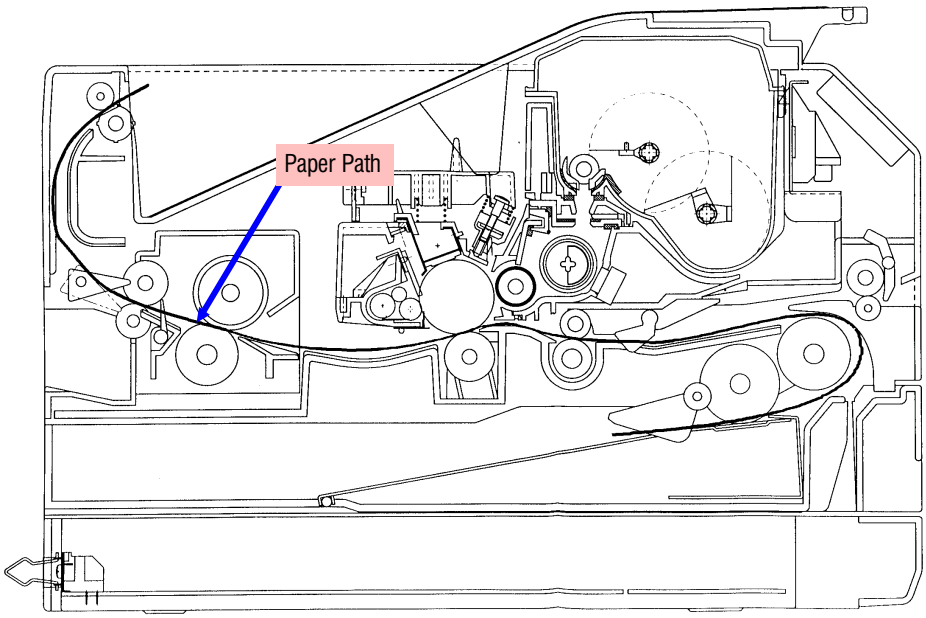


Figure 2.12.
Paper Feeding
Path

The printer can be installed with an option envelope feeder (EF-1), paper feed (PF-5), etc. Service information pertaining to these options are described in the specific option's service manuals and therefore not repeated in this manual.

The function of the paper feeding system is explained step by step below, starting from paper pickup.

2.4.1. Paper Pickup

Different pickup systems are used for automatic feeding and manual feeding.

Automatic (Cassette) Feeding

The printer recognizes the existence of paper in the cassette when the paper empty sensor above the cassette is triggered (pushed up).

Two rubber-made paper feeding tires, at the bottom of the paper feeding unit, pick up paper in the paper feeding cassette one by one. The tire revolves when the paper feeding clutch is energized as commanded by the engine controller CPU.

When the main logic controller finishes data processing, the engine controller CPU commands the paper feeding clutch to turn on. The clutch then connects the main motor power to the paper feeding tires so that the feeding tires revolve to feed the first sheet of paper in the cassette towards the registration rollers. The paper pushes up the paper feeding sensor to report the engine controller the successful paper feeding.

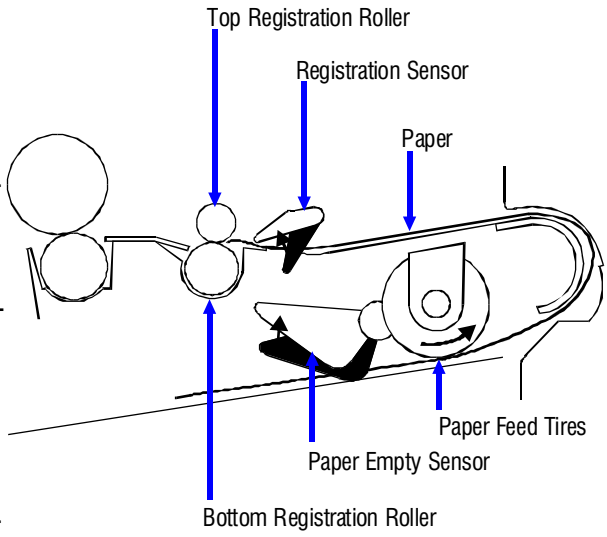
Manual Feeding

The printer recognizes the existence of paper on the manual feed tray when the manual paper sensor is pushed up.

In manual paper feeding mode, the paper placed on the manual feeding tray is drawn in when the manual feeding clutch is energized and the manual feeding roller revolves, pinching the paper with the free, lower manual feeding roller.

2.4.2. Registration

Figure 2.13. Registration



Registration ensures the alignment of the relative position of paper with the corresponding image developed on the drum when the paper is in transferring process. The printer components that serve for registration include the top [metal] registration roller, the bottom [rubber] registration roller, and the registration clutch.

See Figure 2.13: The bottom registration roller is driven by the main motor in mesh with gears and the registration clutch, and in turn drives the top registration roller. As the top of the paper reaches the registration rollers, the engine controller CPU activates the registration clutch so that it yields transferring the driving power from the motor to the bottom registration roller, detaining paper just before the rollers so that the paper *buckles* momentarily (because the paper feeding tires are still driving the paper forward). This buckling straightens the paper and cancels skewing that may have occurred when the paper left the paper feed cassette.

When the main logic controller decides to begin printing, the registration clutch transfers the driving power from the motor to the bottom registration roller and subsequently the top registration roller: The paper is pinched by the two rollers and fed forward to the drum for transferring image.

During paper is being fed, the engine controller CPU watches the paper clearing the registration sensor. If the registration sensor does not reset within the predetermined period of duration, the engine controller concedes the occurrence of a paper jam, then the engine controller reports the jam to the main logic controller which in turn displays the Paper jam message on the message display and halts printing.

The two paper sensors discussed above are also used for identification of the paper size in the paper cassette and the size of the paper actually being fed in the printer. Details including the timings used for this purpose is given in *Appendix A, Engine Timing Charts.*

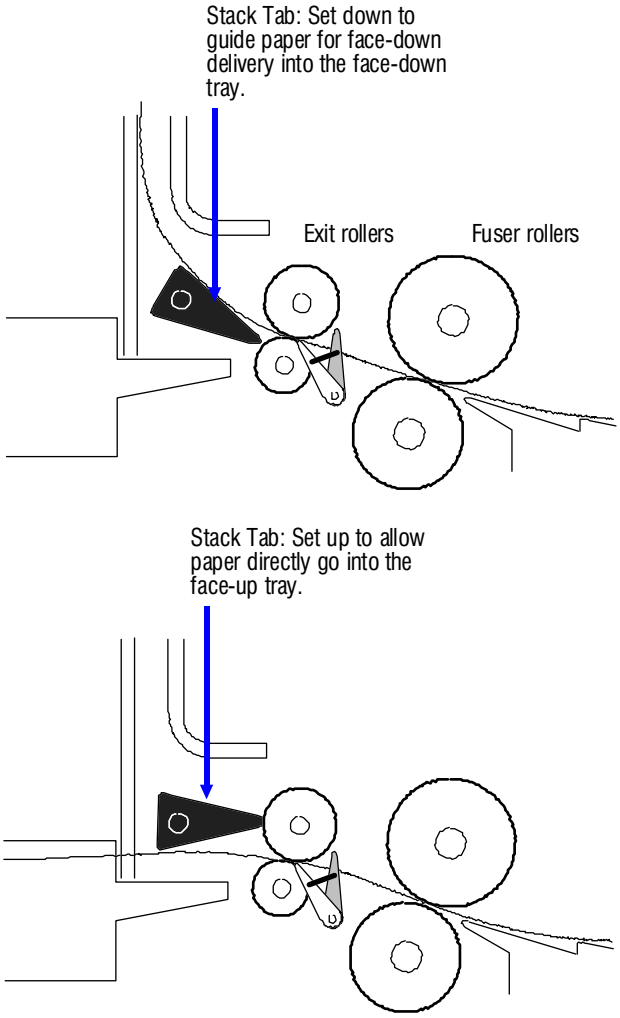
2.4.3. Stack Selection

Figure 2.14. Stack Selection

Whether to deliver the printed pages in face-down (correct order) or face-up (reverse order) stack is determined as shown in Figure 2.14.

The paper is guided to the stack selection tab by the exit rollers after leaving the fuser rollers.

As the engine controller accepts command for changing the stack (via the control panel key or using STAK command), the solenoid located at one end of the stack selection tab is energized to flat the tab to route the paper in the commanded receiving tray.



2.5. Electrical System Overview

This section provides explanation on the printer's engine electrical system. The main logic controller system is separately discussed in chapter 3.

Figure 2.15. on next page shows the entire wiring diagrams of the printer including all circuit boards and electrical modules.

2.5.1. Board Identifications

Following is a list of all boards and ID codes (KP-#). The board ID code is printed on the circuit board.

Table 2.1. Boards

Board ID*	Board Description
KP-445	Main logic controller, FS-1550/A
KP-470	Main logic controller, FS-3400/A
KP-485	Main logic controller, FS-1550+, FS-3400+
KP-371	Engine controller
KP-372	Wiring liaison for FS-1550 series
KP-477	Wiring lisison for FS-3400 series
KP-418	AC power, 120V AC ver.
KP-373	AC power, 240V AC ver.
KP-420	LED head driver (mtd.)
KP-392	Developer bias
KP-399	Drum zener diode
KP-244	Manual feed sensor
KP-391	Paper sensor
KP-341	Envelope feeder sensor

*The board ID is followed by a revision code (A, B, etc.) which may vary depending on design revision.

2.5.2. Engine Controller Overview

The engine controller is included in KP-371 board. It provides timing control over drum revolution, paper feeding, fuser rollers revolution, etc. Temperature is maintained for consistency and stability on the drum and the fuser by the engine controller.

Figure 2.15. Printer Wiring Diagram

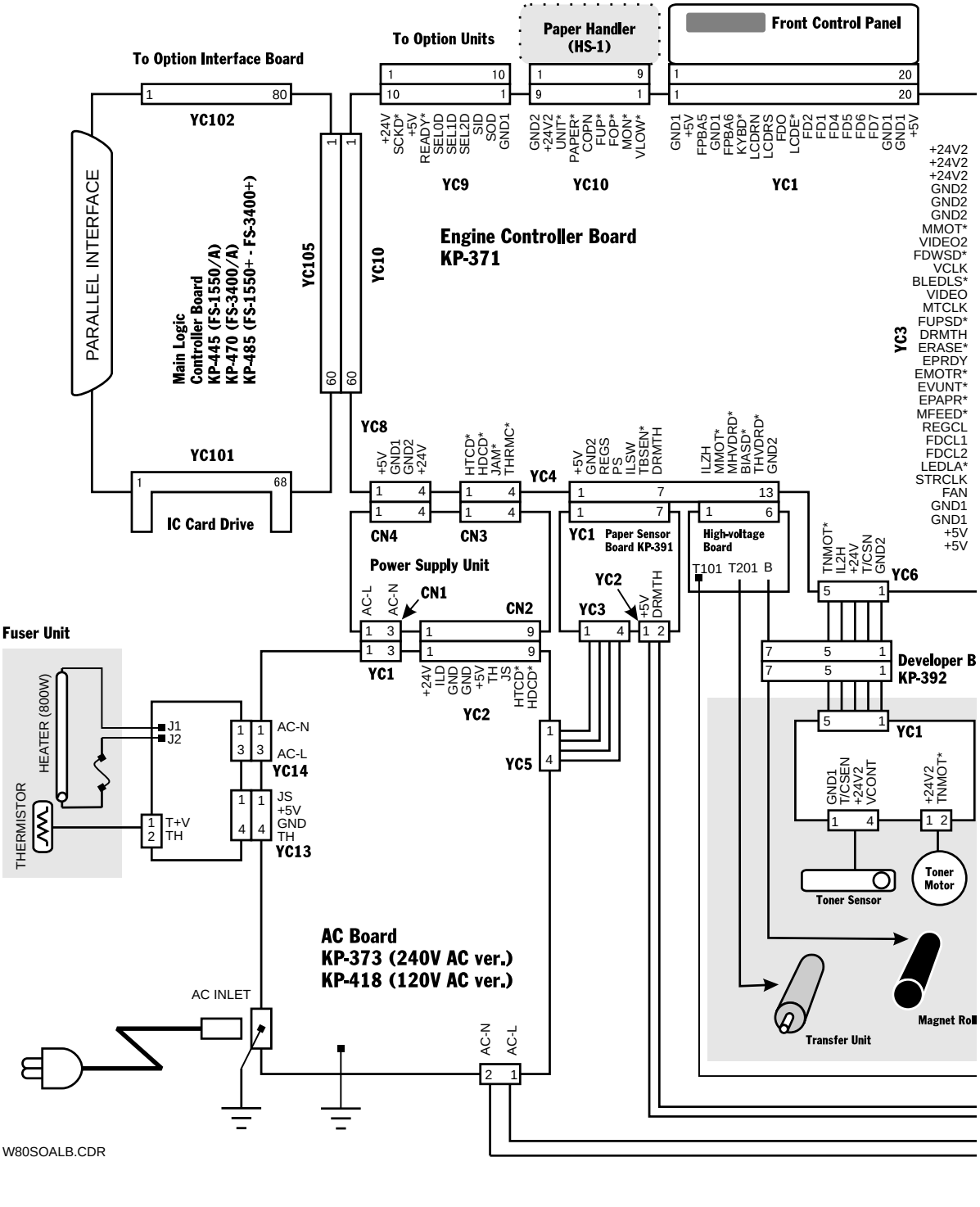


Figure 2.15. Continued

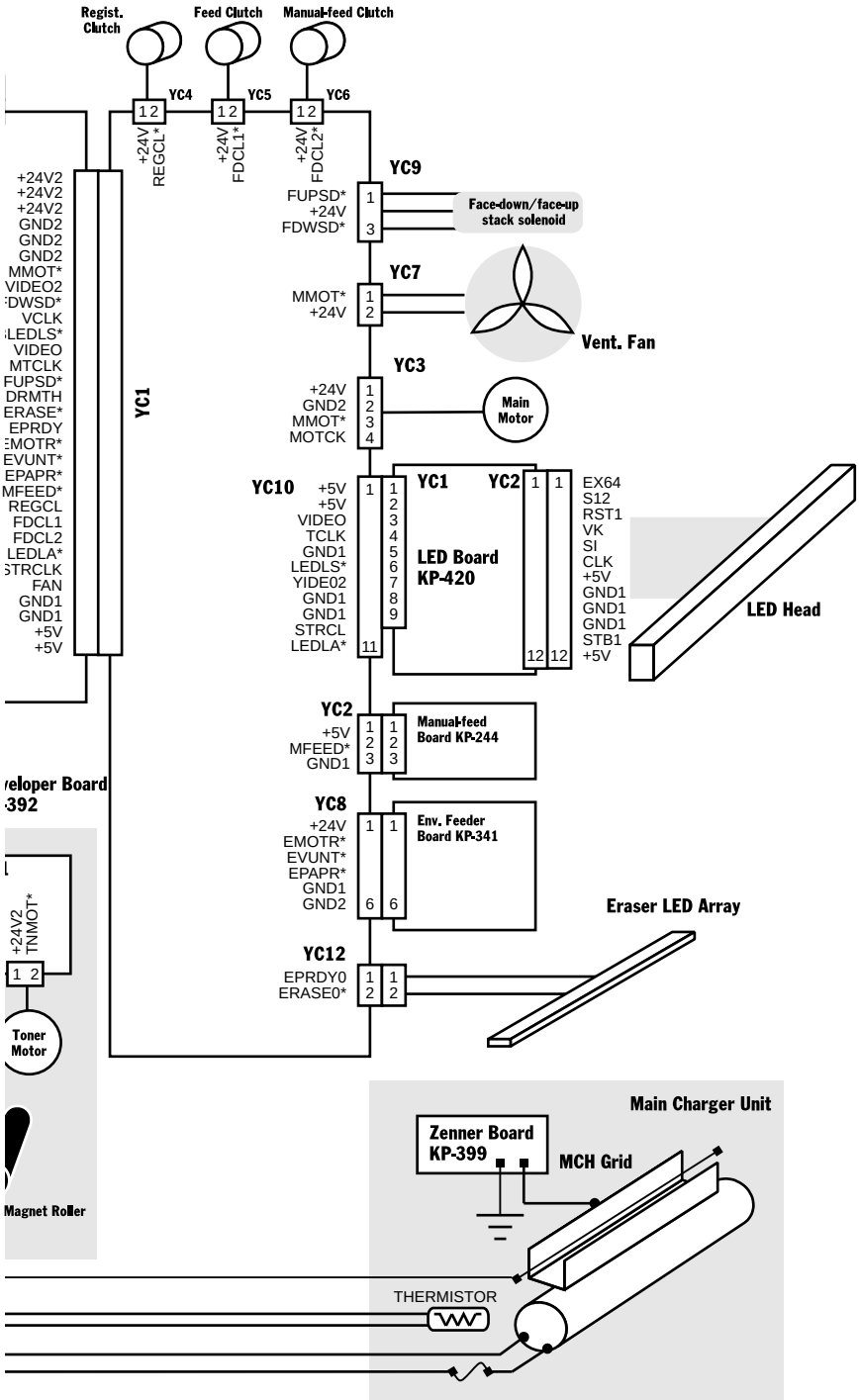


Figure 2.16. on next page illustrates the engine board. Figure 2.17. is a simplified block diagram of the engine controller system. The heart of the engine controller is an 8-bit microprocessor, μPD78002.

On the following pages, operating information on following segments of the engine controller circuit are discussed.

- Engine controller CPU (μPD78002)
- Fuser heater controller
- Drum heater controller
- Eraser controller
- Front panel controller
- Toner motor controller
- Main motor controller
- LED head driver

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Figure 2.16. Engine Controller (KP-371) Board Layout

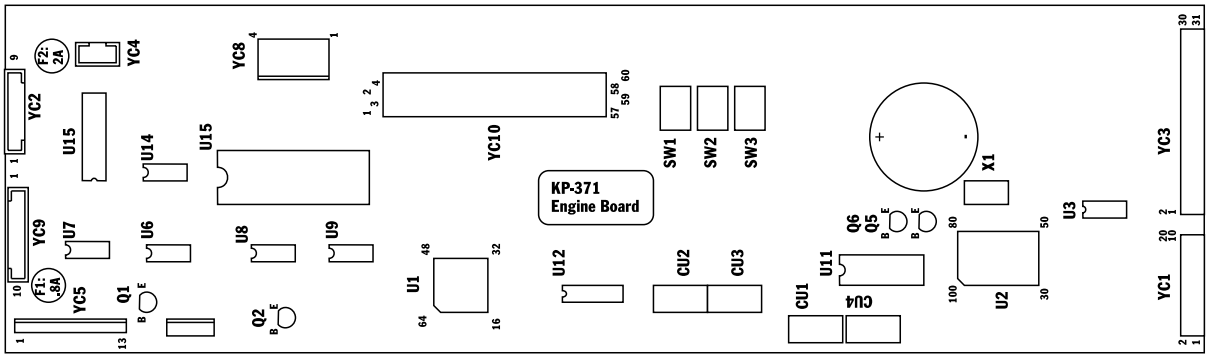
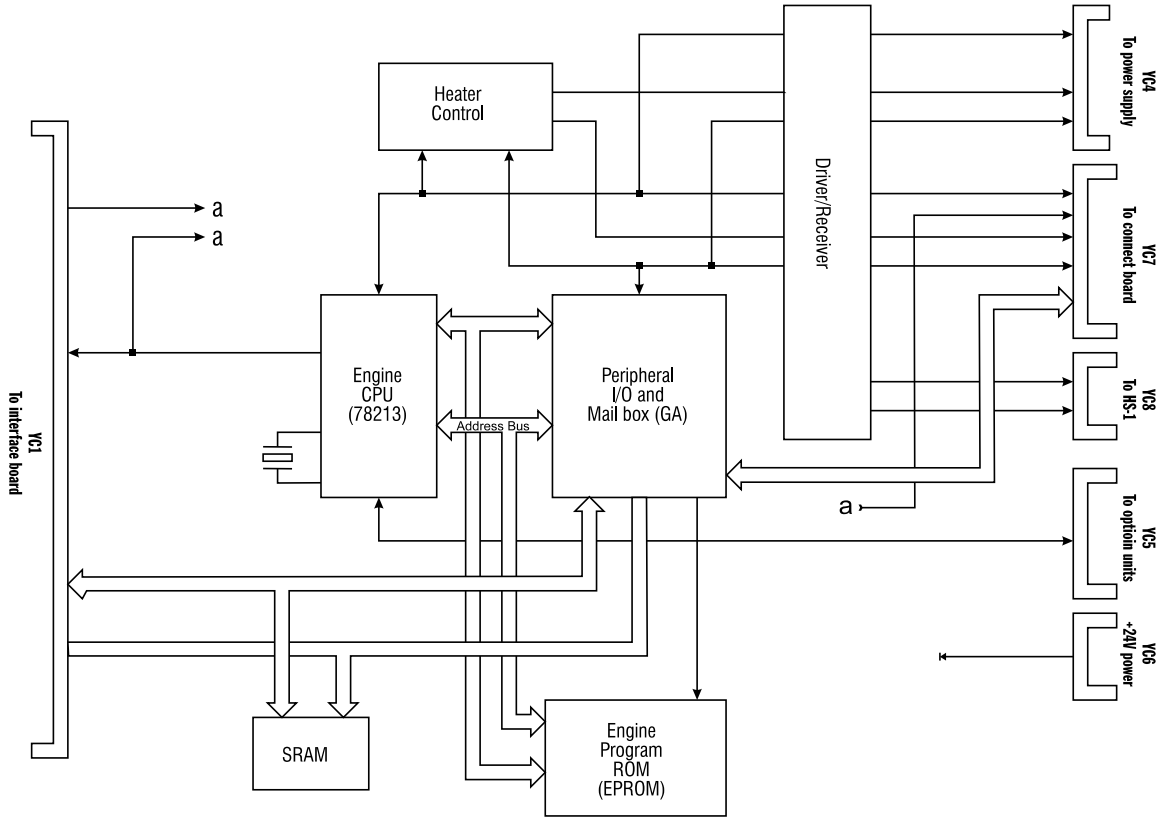


Figure 2.17. Engine Controller Block Diagram



2.5.3. Engine Controller CPU

µ PD78002 (Figure 2.18.) is a one-chip microprocessor which includes 16 k by 8 -bit ROMs and 512 by 8-bit RAMs. It uses multiple purpose input/output ports for communicating with the main logic controller CPU. Table 2.2. lists all port assignments.

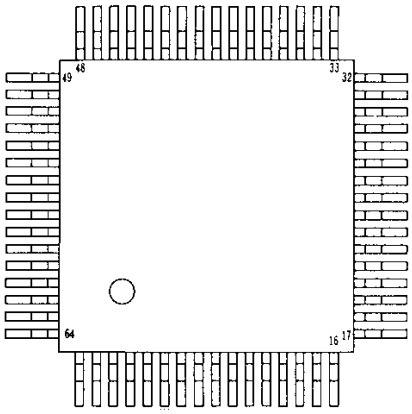


Figure 2.18.
Engine CPU
(78002GC)

Table 2.2. Engine CPU Port Assignment

Pin #	Pt. #	Signal	Function	Input/Output
45	P04	$\overline{\text{TTSEN}}$	Fuser heater control, L: Heater is on.	Input
39	P03	$\overline{\text{DTSEN}}$	Drum heater control, L: Heater is on.	Input
38	P02	COUNT	Total page counter, H: One count	--
37	P01	$\overline{\text{CNTIR}}$	Controller init. L:	Input
36	P00	BMTCLK	Main motor clock (Interrupt)	Input
54	P17	$\overline{\text{FUP}}$	HS-1 sensing, L: Installed	Output
53	P16	$\overline{\text{FOP}}$	HS-1 sensing, L: Installed	Output
52	P15	CPRDY	Controller power ready, H: Ready	Input
51	P14	$\overline{\text{VSYNC}}$	Vertical sync. L: Synchronized	Input
50	P13	$\overline{\text{PRINT}}$	Main controller board, L:	Input
49	P12	LEDE	LED head drive, H: Driving	Output
48	P11	$\overline{\text{RDY}}$	Main controller board, L:	Output
47	P10	$\overline{\text{VSREQ}}$	Vertical sync. request L: Requesting	Output
64	P27	$\overline{\text{SCK}}$	Option unit,L:	Output
63	P26	SO	Option, H:	Output
62	P25	SI	Option, H:	Input
61	P24	HEATT	Heater, H:	Output
60	P23	HEATD	Drum, H:	Output
59	P22	SELI2	Option, H:	Output
58	P21	SELI1	Option, H:	Output

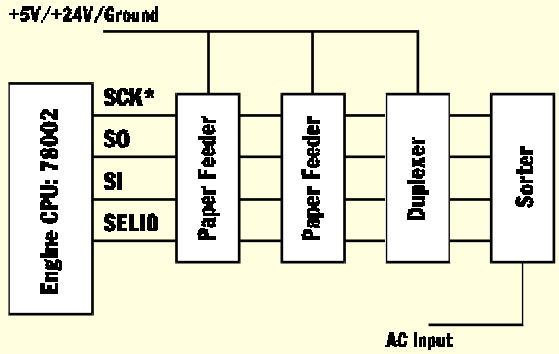
Pin #	Pt. #	Signal	Function	Input/Output
57	P20	SELI0	Option, H:	Output
8	P37	EUSEL	Native switch, H: European (A4)	Input
7	P36	TOMER	Toner motor, H: On	Input
6	P35	$\overline{\text{DS/CMER}}$	Drum, L:	Input
5	P34	$\overline{\text{TTMER}}$	Heater, L:	Input
4	P33	MHVDR	Main high-voltage drive, H: On	Output
3	P32	THVDR	Transfer high-voltage drive, H: On	Output
2	P31	BIAS	Developer bias drive, H: On	Output
1	P30	THSBY	Fuser temp. switch, H: Standby (low)	Output
30	P63	SW1	Paper cassette size, see table 2.4.	Input
29	P62	SW2		Input
28	P61	SW3		Input
27	P60	--	Unused	Input
9	--	GND	Ground	--
10--17	--	AD0--AD7	Address/data bus	Input/Output
18--23	--	A8--13	Address	Output
24	--	GND	Ground	--
25	--	A14	Address	Output
26	--	A15	Address	Output
31	--	$\overline{\text{RD}}$	Read	Output
32	--	$\overline{\text{WR}}$	Write	Output
33	--	$\overline{\text{WAIT}}$	Wait	Input
34	--	ASTB	Address strobe output	Output
35	--	$\overline{\text{RES}}$	Reset	Input
40	--	VCC		--
41	--	X2	Clock input	Input
42	--	X1	Clock input	Input
43	--	IC0	Fixed to the ground	Input
44	--	TP1	Test pin	Output
46	--	IC1	Fixed to the ground	Input
55	--	IC2	Fixed to V_{CC}	Input
56	--	IC3	Fixed to the ground	Input

Table 2.3. Engine Gate Array Pin Assignments

Pin #	Pt. #	Signal	Function	Input/Output
1--6	--	ECA5--0	Main board CPU address	Input
7	--	$\overline{\text{DSMCS}}$	Chip select for internal mail box	Input
8	--	$\overline{\text{DSOE}}$	Read for internal mail box	Input
9	--	$\overline{\text{DSWE}}$	Write for internal mail box	Input
10	--	GND	Ground	--
11--14	--	D31--28	Main board CPU data bus	Input
15	--	GND	Ground	--
16--19	--	D27--24	Main board CPU data bus	Input
20	--	VCC	Vcc	--
21	--	$\overline{\text{RES}}$	Reset	Input
22	--	$\overline{\text{DSNRY}}$	Data strobe acknowledge	Output
23	--	GND	Ground	--
28	--	HEGLIB	Selection of engine or option I/F board	Input
33	--	GND	Ground	--
34	--	$\overline{\text{ENABLE}}$	Front panel enable	Output
35	--	LCDRW	Front panel read/write	Output
36--39	--	FD7--4	Front panel data bus	Input/Output
40	--	GND	Ground	--
41	--	VCC	Vcc	--
42--45	--	FD3--0	Front panel data bus	Input/Output
46	--	GND	Ground	--
55	--	VCC	Vcc	--
64	--	X2	Clock output	Output
65	--	X1	Clock output	Output
66	--	GND	Ground	--
67	--	CLOCK0	Clock divisor output	Output
68	--	VCC	Vcc	--
69	--	XTO	Crystal oscillator input	Input
70	--	XTI	Crystal oscillator input	Input
71	--	GND	Ground	--
72--75	--	A15--12	Engine CPU address	Input
76	--	$\overline{\text{WAIT}}$	Wait	Output
77	--	$\overline{\text{WR}}$	Engine CPU write	Input
78	--	$\overline{\text{RD}}$	Engine CPU read	Input
79	--	ASTB	Engine CPU address strobe	Input
80	--	$\overline{\text{RES}}$	Reset	Input
81, 90	--	GND	Ground	--
91	--	VCC	Vcc	--
92--99	--	AD7--0	Engine CPU address/data bus	Input/Output
100	--	GND	Ground	--
82	PA7	$\overline{\text{JAMO}}$	Paper jam sensor, L: Jam	Input
83	PA6	JAMR	Registration sensor, L: No paper	Input

Pin #	Pt. #	Signal	Function	Input/Output
84	PA5	$\overline{\text{MMOT}}$	Main motor drive, L: Motor on	Output
85	PA4	$\overline{\text{ERASE}}$	Eraser drive, L: Eraser on	Output
86	PA3	TMOTD	Toner motor drive, H: Toner motor on	Output
87	PA2	$\overline{\text{FDCL2}}$	Feed clutch drive, L: Clutch on	Output
88	PA1	$\overline{\text{FDCL1}}$	Feed clutch drive, L: Clutch on	Output
89	PA0	REGCL	Registration clutch, H: Clutch on	Output
56	PB7	--	Native switch, L: FS/300 dpi	Input
57	PB6	EPRDY	Eraser ready, H: Ready	Input
58	PB5	T/CSN	Toner concentration sense	Input
59	PB4	$\overline{\text{READY}}$	Option unit ready, L: Ready	Input
60	PB3	$\overline{\text{EPAP}}$	Envelope feeder status, L: Paper in	Input
61	PB2	$\overline{\text{EUNIT}}$	Envelope feeder instal., L: Installed	Input
62	PB1	COPN	HS-1 cover status, H: Open	Input
63	PB0	$\overline{\text{MFEED}}$	Manual feed paper, H: Paper in	Input
47	PC7	--	Native switch, L: FS/300 dpi	Input
48	PC6	$\overline{\text{FAN}}$	Fan drive, L: Fan on	Output
49	PC5	$\overline{\text{FUPSD}}$	Face-up stack select, L: Face-up	Output
50	PC4	$\overline{\text{FDWSD}}$	Face-down stack select, L: Face-down	Output
51	PC3	$\overline{\text{EMOTR}}$	Envelope feeder motor, L: On	Output
52	PC2	$\overline{\text{MON}}$	HS-1 motor status, L: On	Output
53	PC1	$\overline{\text{VLOW}}$	HS-1 speed shift, L: Slow	Output
54	PC0	$\overline{\text{EGIR}}$	Engine interrupt, L: Interrupted	Output
24	PD7	--	Native switch, L: FS/300 dpi	Input
25	PD6	--	Native switch, L: FS/300 dpi	Input
26	PD5	$\overline{\text{BTBSEN}}$	Toner container installation, L: Installed	Input
27	PD4	PAPER	Paper, L: Empty	Input
29	PD3	$\overline{\text{UNIT}}$	HS-1	Input
30	PD2	$\overline{\text{HSPAP}}$	HS-1	Input
31	PD1	COV2	Top cover status, H: Close	Input
32	PD0	COV1	Feed unit (drawer) status, L: Close	Input

Figure 2.19. Option Device Selection



Port	Upper Option Feeder	Lower Option Feeder	Duplexer	Sorter	*Reset*
SELI0	L	H	L	H	H
SELI1	H	H	L	L	H
SELI2	L	L	H	H	H

Table 2.4. Cassette Size Detection

Port	A5	A4	B5	Letter	Legal	*Cassette uninstalled*
SW1 (P70)	L	L	L	H	H	H
SW2 (P71)	H	H	L	L	L	H
SW3 (P72)	L	H	H	L	H	H

Note. Any combination of port levels other than above is recognized as that the cassette is not installed.

2.5.4. Fuser Heater Controller

Figure 2.20. below shows a simplified schematic diagram for the fuser heater controller circuit.

The fuser heater controller turns the fuser heater, located coaxially inside the top fuser roller, on and off intermittently so that the surface of the roller maintains a specific, constant temperature needed to permanently fuse the toner on paper as the paper passes between the heater roller and the pressure roller which is located beneath the heater roller.

The fuser heater is directly fed with AC primary power (120V or 220 to 240V) which is supplied from the AC board (KP-373/418) at YC14, to the fuser board YC1, Comparator U8-A monitor the current flowing into the thermistor located at one end of the top roller and keeps port 04 of the engine CPU low when the thermistor is normal. According to the variance of the thermistor's resistance, as detected by the comparator, the engine CPU switches on and off the triac through its port 24, U6, U9, and Q3. In its secondary gate, the solid state relay intermittently switches the heater on and off according to Q3 so that the fuser temperature in printing is maintained constantly at approximately 185°C (FS -1550 series) or 193°C (FS-3400 series); and at approximately 165°C (FS-1550 series) or 188°C (FS-3400 series) at standby. This transition is made by transistor Q1, connected to the CPU's own signal for transition THSBY at port 3 of the engine CPU.

In the event that the thermistor is blown, comparator U8-B sends a high level TTMER signal to port 3 of the engine CPU. The CPU then halts the printer and gives the Call Service person E4 message on the printer's message display.

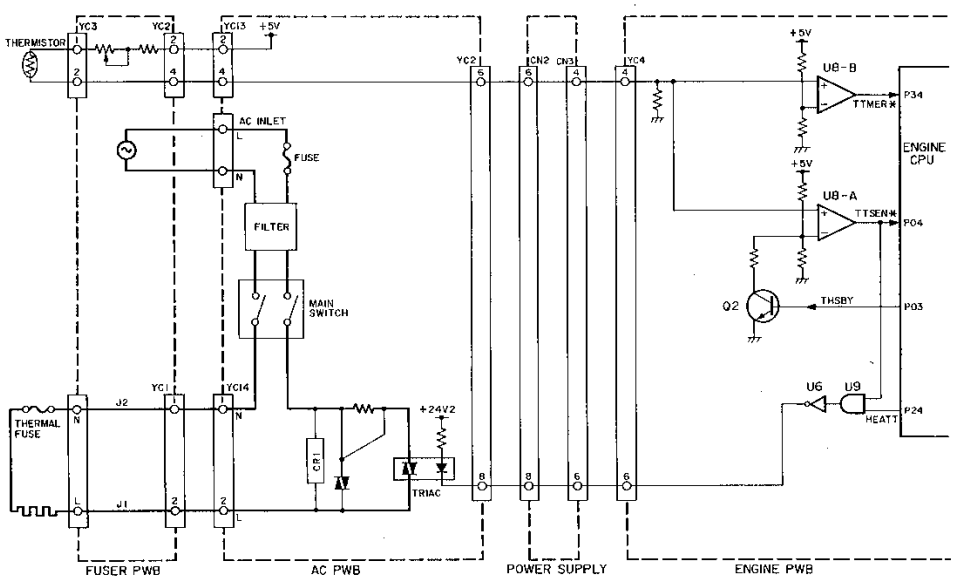


Figure 2.20. Fuser Heater Controller

The heater is forcedly turned off in case the $\overline{\text{TTSEN}}$ signal persists to be low for more than the predetermined period of time. There also is a fail-safe provision in the middle of the heater primary circuit: A thermal fuse is wired in series with the thermal cutoff which opens up the heater power if the temperature on the fuser roller comes to be extremely high.

2.5.5. Drum Heater Controller

The amorphous silicon drum needs to be in a steady state of temperature to yield good printing quality. For this purpose, the drum has a flat heater wound along the inner surface of the drum as shown below.

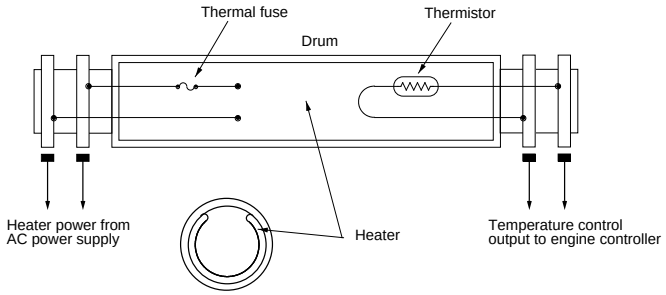
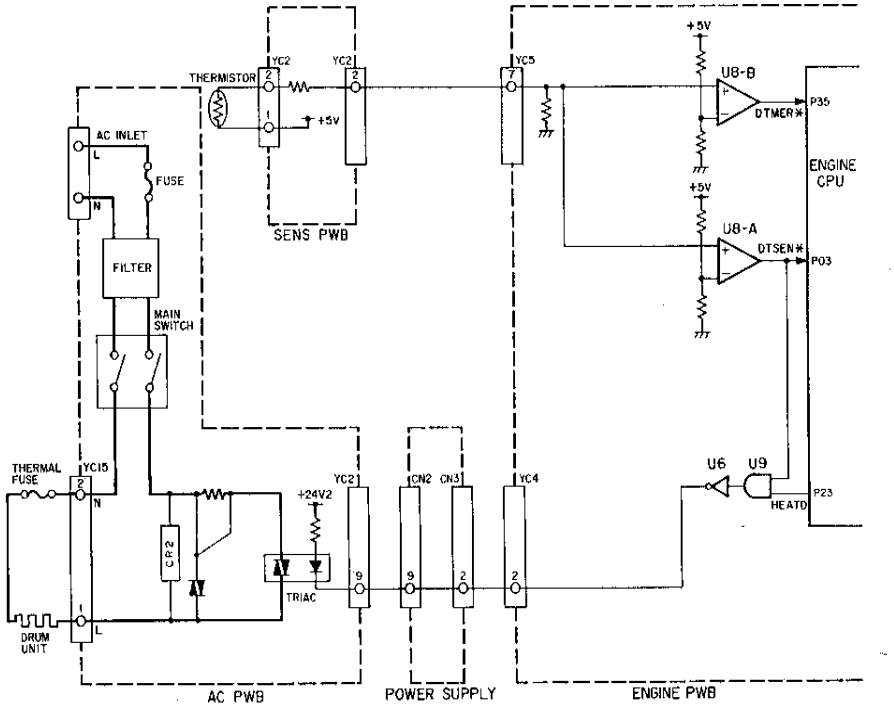


Figure 2.21. Drum Heater

Figure which follows is a simplified diagram of the drum heater controller. As seen, the drum heater controller uses the similar manner and circuitry to that of the fuser heater to keep the constant temperature, except that the drum temperature is maintained at approx. 45°C.

This circuit also features the protection device against the excessive temperature. If the $\overline{\text{DTSEN}}$ signal persists to be low for more than the predetermined period of time and the temperature exceeds approximately 60°C, the drum heater is forcedly turned off.

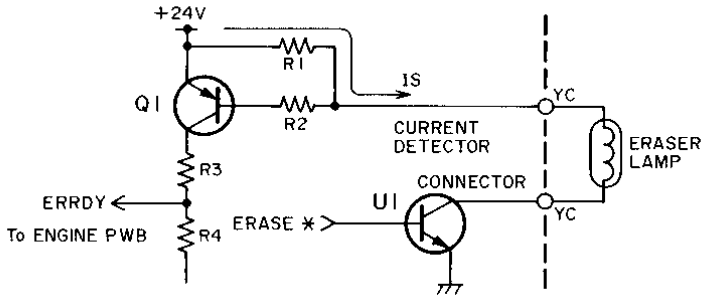
Figure 2.22. Drum Heater Controller



2.5.6. Eraser Controller

The eraser LED array is wired to the KP-372 (FS-1550 series) or KP-477 (FS -3400 series) board located at the right side of the chassis, via the drum board KP-243, finally to the engine controller board located at the bottom of the printer. In Figure 2.23, the LED array, one end of which is fed with +24 V DC, is turned on when U1 turns on to ground the other end as the engine controller sends an ERASE signal according to the cyclic photography process to erase the residual charge on the drum.

Figure 2.23. Eraser LED Control



The eraser circuit has the blow-out detector. The current detector Q1 in Figure 2.23. monitors the eraser current Is. The normal eraser current is approx. 16 mA. Should the current detector detect an abnormal current, the engine controller halts printing and let the message display to display *Call Service person E5* (eraser error).

2.5.7. Toner Motor Controller

The toner motor controller, located in the engine controller board, is simply diagrammed as follows.

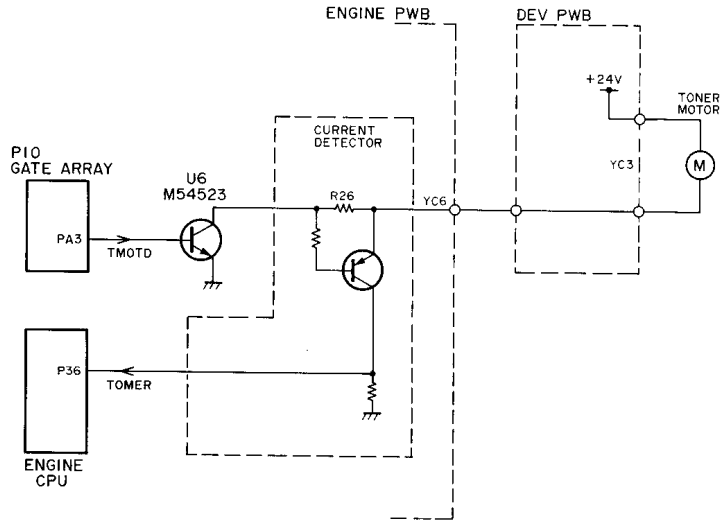


Figure 2.24. Toner Motor Controller

The peripheral-I/O (PIO) gate array feeds U6 a high-level TMOTD (toner motor driving) signal to drive the toner motor when the engine controller, by use of the toner concentration sensor at the inside bottom of the developer, determines the replenishment of the toner supply in the developer becomes necessary.

Resistor R26 is used for the current amplifier connected across the resistor to detect the possible over-current situation which could happen when the toner motor is stuck because of damage of gears, for instance. Once the current amplifier determines that the current flowing across the resistor is greater than approximately 135 mA, it reports the engine CPU using the TOMER signal. The engine CPU then halts the printer and lets the message display to show *Call Service person E9* (toner motor error).

2.5.8. Developer Toner Concentration Sensor

Figure which follows shows the toner concentration sensor circuit. The toner concentration sensor is used to determine the need for replenishment of the toner supply in the developer.

Terminal *Vdg* is connected to the engine controller. The level at *Vdg* is low when the toner concentration is normal; while, the level is high (+5V) when the toner concentration is low.

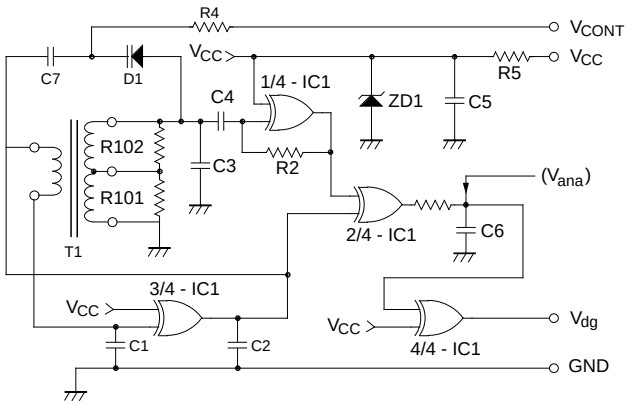


Figure 2.25. Toner Concentration Sensor

2.5.9. Front Control Panel Controller

The control panel has 12 keys, 14 LEDs, and an STN-type liquid quartz display module of two 16-character rows which are driven directly by the main logic controller with the assistance of the gate array, LZ93M28. The gate array function in key scanning and LED driving as shown in Figure 2.26.

The keys are grouped in two: SW1 through SW6 and SW7 through SW12. The main logic controller selects one of these key groups by making D1 or D2 active and by making use of U1 and the data bus.

The data necessary to light the appropriate LED are latched in U1 as the main logic controller selects LD1 through LD5, LD14, and LD15 or LD6 through LD13.

The LCD module for message display is also controlled by the main logic controller.

The message display has priority in showing messages as tabled in Table 2.5.

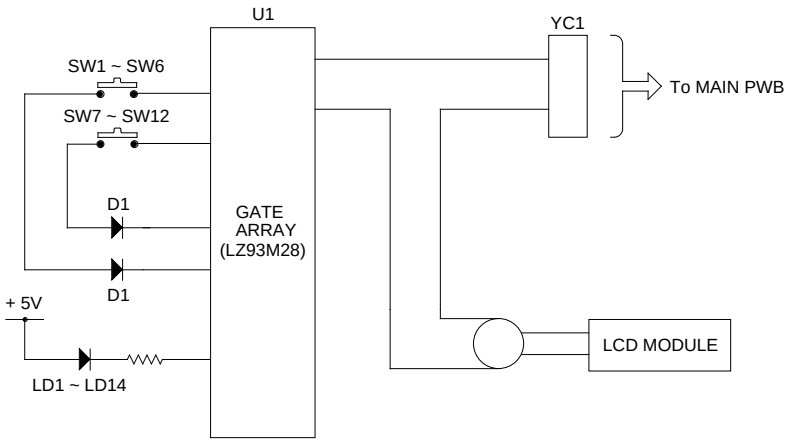


Figure 2.26. Front Control Panel Circuit

Table 2.5. Message Priorities

Priority	ON-LINE State	OFF-LINE State
High	Call service person ##: nnnn System error ... Restarting I/F occupied	
	Top cover Open	
	Paper feed unit Open	
	(Paper handler cover Open)	
	(Opt. feeder 1 rear cover Open)	
	(Opt. feeder 2 rear cover Open)	
	(Sorter unit rear cover Open)	
	(Duplex unit rear cover Open)	
	(Duplex unit front cover Open)	
	Developer unit connection error Replace Toner kit TK-12	
	Missing Toner container TK-12	
	Paper jam	
	Remove manual feed paper (Sorter paper full) (Remove Sorter paper)	
	IC-CARD error Insert again Insert the same IC card	
	Print Cancel? nnnnnnn	
	Memory overflow ... Press ON LINE Print overrun ... Press ON LINE (KPDL error ... Press ON LINE) IC-CARD error ... Press ON LINE (Opt. ROM error ... Press ON LINE)	
	Paper path error	
	Add paper	
	Self test Sleeping Heating	
	Processing Waiting FormFeed TimeOut	(Option interface error)
	(Option interface error)	Warning Low toner TK-12 Warning Low memory
	Warning Low toner TK-12 Warning Low memory	Battery error IC-CARD Format error IC-CARD Warning battery IC-CARD
	Battery error IC-CARD	Processing Waiting Formfeed Timeout
	Format error IC-CARD	
	Warning battery IC-CARD	
Low	Ready	

Table 2.6. below explains the relevancy of the front panel indicators to the messages on the message display. In this table, ON means the LED turns on; while OFF means the LED does not light. Exceptions are noted at the bottom of the table. Table 2.6. shows key operability in accordance with the current message on the message display.

Table 2.6. Messages vs. Indicators

Message	Indicators					
	ON LINE	Ready	ATTENTION	Service	Toner-empty	Paper jam
Call service person ##: nnnn	Off	Off	--	On	--	--
System error ... Restarting Paper feed unit Open Top cover open (Paper handler cover open) (Opt. feeder 1 rear cover Open) (Opt. feeder 2 rear cover Open) (Sorter unit rear cover Open) (Duplex unit rear cover Open) (Duplex unit front cover Open) Missing Toner container TK-12 IC-CARD error Insert again Insert the same IC-CARD	Off	Blink	On	Off	--	--
Remove Manual feed paper Paper path error Remove Sorter paper Sorter paper full	See *1	Off	On	Off	--	--
Replace Toner kit TK-12 Developer unit connection error	Off	Blink	--	Off	On	--
Paper jam	Off	Blink	Off	Off	--	On
Memory overflow ... Press ON LINE Print overrun ... Press ON LINE (KPDL Error ... press ON LINE) (Opt. ROM Error ... Press ON LINE) (IC-CARD error .. Press ON LINE)	Blink	On	On	Off	--	Off
Add paper	See *1	Off	See *2	Off	--	Off
Self test Heating	Off	Blink	Off	Off	--	Off
Processing Waiting FormFeed TimeOut	See *1	On	See *2	Off	--	Off
Print Cancel ? xxxxxxxxxx	Off	See *3	See *4			
I/F/ occupied	See *1	On	On	Off	--	Off
MODE SELECTing	See *1	See *3	See *2	Off	--	Off

Message	Indicators					
	ON LINE	Ready	ATTENTION	Service	Toner-empty	Paper jam
Warning Short memory (Option interface error) (Battery error IC-CARD) (Format error IC-CARD) (Warning battery IC -CARD)	See *1	On	--	Off	--	Off
Warning Low toner TK-12	See *1	On	--	Off	Blink	Off
Sleeping	Off	Off	Off	Off	Off	Off
Ready	See *1	See *1	Off	Off	Off	Off

*1: On if online; off if offline. *2: Blink if a warning is given; otherwise off. *3: Off if paper is empty; otherwise on. *4: On if an error is indicated; otherwise same as *2.

Table 2.7. Key Operability to Messages

Message	Key										
	ONLINE	STATUS	FORM FEED	FEED SEL	STACK	PAGE ORI.	COPY	MODE SEL	+/-	ENTER	CANCEL
Call service person ## System error/Restarting I/F/ occupied Paper feed unit Open Top cover Open (Opt. 1 rear cover Open) (Opt. 2 rear cover Open) (Sorter unit cover Open) (Duplexer r. cov. Open) (Duplexer f. cov. Open) (Sorter paper full) (Remove sorter paper) Dev. unit connect. error Replace toner kit TK-12 Missing toner container Remove M. feed paper Paper jam (Paper path error) (IC-CARD/Insert again) (Insert the same IC-CD) Self test Heating	No	No	No	No	No	No	No	No	No	No	No
Print Cancel?	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Add paper (Paper path error)	No	No	No	See *1	See *1	See *2	See *2	See *2	No	No	Yes

Message	Key										
	ONLINE	STATUS	FORM FEED	FEED SEL.	STACK	PAGE ORI.	COPY	MODE SEL	+/-	ENTER	CANCEL
Memory overflow ... Print overrun ... (KPDL error ...) (IC-CARD error ...) (Opt. ROM Error ...) Processing FormFeed TimeOut	Yes	No	No	No	No	No	No	No	No	No	Yes
Waiting	Yes	No	Yes	No	No	No	No	No	No	No	Yes
Warning Short memory Warn. low toner TK-12 (Option interface error) (Battery error IC-CARD) (Format error IC-CARD) (Warning battery IC-CD)	Same as FormFeed TimeOut, Processingm and Waiting, if the printer is off-line in printing; otherwise same as Ready.										
Sleeping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ready	Yes	Yes	See *3	Yes	Yes	Yes	Yes	Yes	No	No	No
MODE SELECTing	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes

*1: No during the main motor is running; otherwise Yes. *2: No during printing or warming up; otherwise Yes. *3: Enables automatic macro overlay if the current emulation is HP LaserJet IV. The PRESCRIBE automatic macro overlay overrides the HP's, however.

2.5.10. Main Motor Controller

The main motor is a 3-phase, DC brushless motor driven by a single chip IC including the drivers and speed controller circuit. The controller is used to maintain the constant revolution of the main motor by using the driving signals achieved by dividing the FG pulse of 405.42 Hz (FS-1550 series) or 637 Hz (FS -3400 series) and a crystal oscillator of 3.3212 MHz (FS-1550 series) or 5.2224 MHz (FS-3400 series). The main motor clock is used for paper transportation timings. The motor driver IC also includes drivers for producing signals of U phase, V phase, and W phase, in sequence, that are used to revolve the main motor.

Refer to Figure 2.27. The main motor is turned on when the signal at pin #25 (MMOT) of CN3 becomes low. As the revolution of the main motor has reached the predetermined rate, pin #19 (MOTCK) of CN3 gives a 405.42 Hz (FS-1550 series) or 637 Hz (FS-3400 series) square wave which is in turn fed to the engine CPU to be used as the timing signal in, for example, determining the correct position of the paper, energizing clutches, etc. If the engine CPU fails to detect this signal within the predetermined period of time, the printer indicates *Call Service person E1* (main motor error) and stops printing.

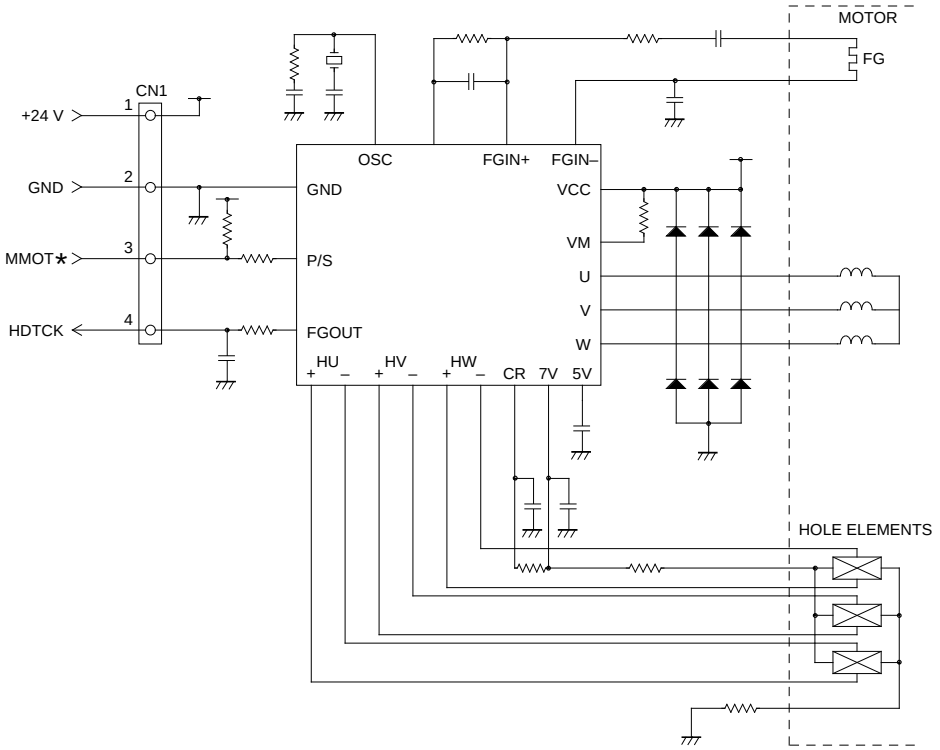


Figure 2.27. Main Motor Driver

2.5.11. LED Head Driver

Figure below shows the block diagram of the LED head drivers mounted on the glass-printed-circuit board. The LED head uses forty (40) one-chop 64-bit LED chips (64 bits × 40 blocks = 2560 bits). In this figure, the driving current for the LED chips flows from both source driver #1 and source driver #2 to ensure an even current supply to overcome the resistance of the board.

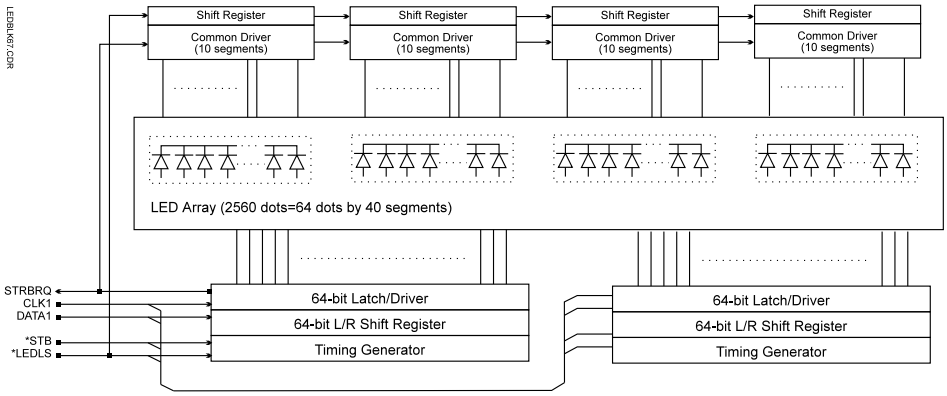


Figure 2.28. LED Head Driver

The source driver has the internal segments as shown in the figure below. Each time the video data come into the 32-bit shift register, the driver moves it into a 64-bit latch, then drives the source driver.

The common driver IC includes 10-bit common drivers as shown here. Four ICs including this common driver are subordinately connected to drive the 40 LED chips.

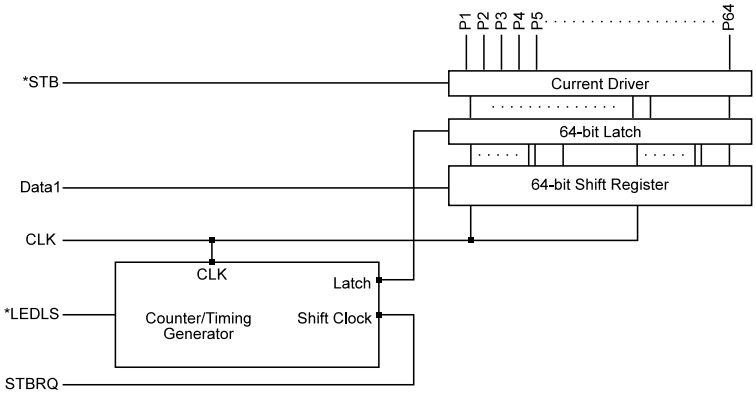


Figure 2.29. Source Driver for LED Head

The least significant bit of the common driver shift register is given a 1 as a *LEDLS signal arrives the controller in the IC. (The *LEDLS signal can be referred to as the synchronization signal in laser printers.) An LED segment is selectively driven when the 1 in the shift register is read in 64-bit configuration. The LED segment does not flash if a 64-bit input is made right after a *LEDLS; the first block of the LED chips flashes when the next 64 -bit input is being made.

Figure 2.31. shows all singlas used for the LED head driver. Figure 2.32. on next page is the timing table for driving the LED head.

The meaning of theses signals and timings are explained in the following table.

Figure 2.30. Common Driver for LED Head

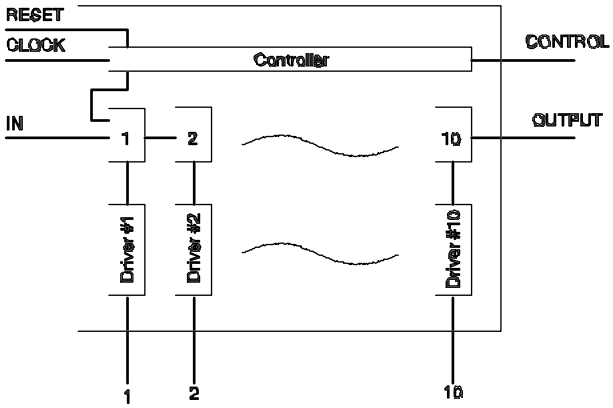


Figure 2.31. Signals used for LED Head

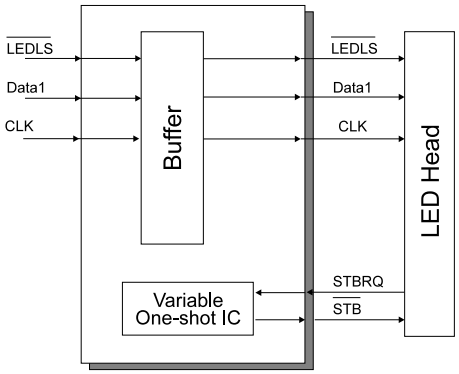
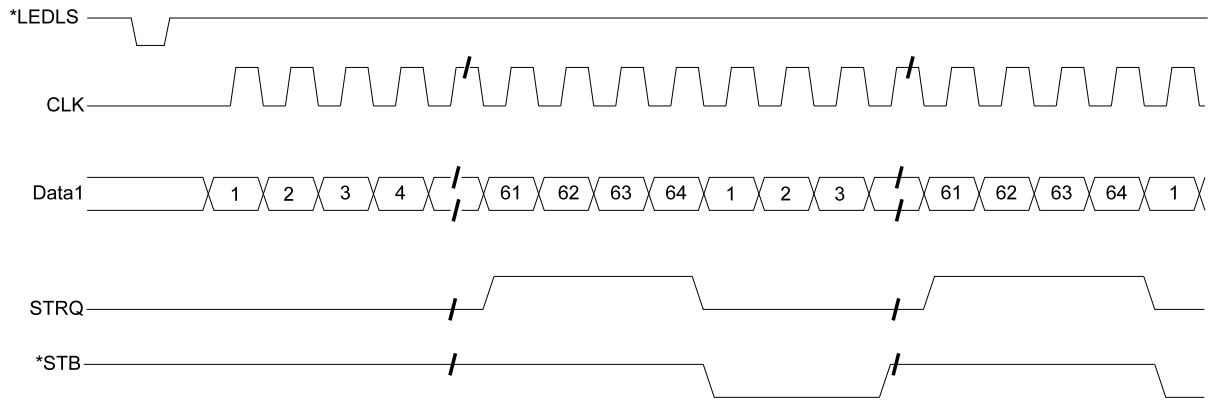


Figure 2.32. LED Head Signal Timings



Signal	Meaning
*LEDLS	The horizontal synchro signal that resets the logic circuit for the LED head.
CLK	The clock-synchronizing signal for video data.
Data1	Video data.
STRQ	The request for a strobe input. Means that the LED head is ready when this is L.
*STB	The triggering signal for the LED head to light. Adjusts for the LED luminosity.