FACSIMILE TRANSMISSION

ETI 2506 - TELECOMMUNICATION

Monday, 15 February 2016

WHERE ARE WE IN THE SYLLABUS?

ETI 2506 Telecommunication Systems

Prerequisites
ETI 2301 Computer Networks

Purpose
The aim of this course is to enable the student to;
1. understand evolution of telephony
2. understand structure of basic transmission systems and network topologies

Learning Outcomes
At the end of this course, the student should be able to;
1. apply knowledge of telephony in telecommunication systems

Course Description
Evolution of the fixed line telephony, analog to digital, relay switched to stored program controlled switching, manual PBX to private automatic branch exchange(PABX), analog to ISDN and DSL, non-cellular mobile phone systems, cordless phones (DECT). System structure: Basic transmission system. Types of switching: circuit switching, message switching and packet. Network topologies, exclusive and multiparty lines; signaling methods; signaling No. 7 protocol. Call types: local, trunk and international, automatic multi-exchange connection and inter-exchange signaling. Terminal Equipment: Telephone set (receiver and transmitter), telex, facsimile, computer. Traffic modeling and dimensioning: queuing theory, Erlang traffic theory. Use of traffic tables in capacity design of telephone network systems.

WHAT IS FACSIMILE?

- Facsimile (FAX) makes copies of a document over a telecommunication channel anywhere in the world at the same speed as the one the originating fax scans.

HISTORY OF THE FACSIMILE MACHINE

- **In 1843**, The first fax machine was invented by Scottish mechanic and inventor Alexander Bain.
- **In 1850**, a London inventor named F. C. Blakewell received a patent what he called a "copying telegraph".
- **In 1860**, a fax machine called the Pantelegraph sent the first fax between Paris and Lyon. The Pantelegraph was invented Giovanni Caselli.
- **In 1902**, Dr Arthur Korn invented an improved and practical fax, the photoelectric system.
- **In 1924**, the telephotography machine (a type of fax machine) was used to send political convention photos long distance for newspaper publication. It was developed by the American Telephone & Telegraph Company (AT&T).
- **In 1926**, RCA invented the Radiophoto that faxed by using radio broadcasting technology.
- **On March 4, 1955**, the first radio fax transmission was sent across the Atlantic.
- **In 1964,** Xerox Corporation introduced (and patented) what many consider to be the first commercialized version of the modern fax machine, under the name (LDX) or Long Distance Xerography.

FACSIMILE STANDARDS

1. Like telephones, all faxes comply to standards set by the International Telecommunications Union division for Telecommunications.
2. The Specific recommendation for Facsimile is ITU-T Rec. T.4 and is ITU-T Rec. T.30.
3. The recommendation defines the characteristics of facsimile terminals which enable documents to be transmitted on:
   a) the general switched telephone network,
   b) international leased circuits
   c) the Integrated Services Digital Network (ISDN).

ASCII TABLE

Table ASCII -I

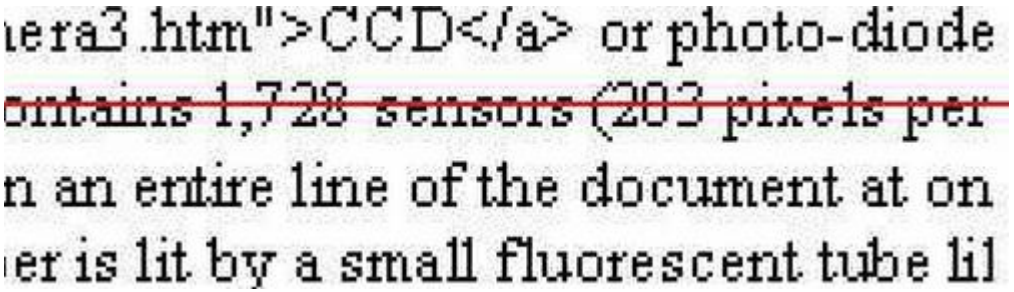
Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Ch
0	00	Null	32	20	Space	64	40	@	96	60	`
1	01	Start of heading	33	21	!	65	41	A	97	61	a
2	02	Start of text	34	22	"	66	42	B	98	62	b
3	03	End of text	35	23	#	67	43	C	99	63	c
4	04	End of transmit	36	24	$	68	44	D	100	64	d
5	05	Enquiry	37	25	%	69	45	E	101	65	e
6	06	Acknowledge	38	26	&	70	46	F	102	66	f
7	07	Audible bell	39	27	'	71	47	G	103	67	g
8	08	Backspace	40	28	(	72	48	H	104	68	h
9	09	Horizontal tab	41	29	)	73	49	I	105	69	i
10	0A	Line feed	42	2A	*	74	4A	J	106	6A	j
11	0B	Vertical tab	43	2B	+	75	4B	K	107	6B	k
12	0C	Form feed	44	2C	,	76	4C	L	108	6C	l
13	0D	Carriage return	45	2D	-	77	4D	M	109	6D	m
14	0E	Shift out	46	2E	.	78	4E	N	110	6E	n
15	0F	Shift in	47	2F	/	79	4F	O	111	6F	o
16	10	Data link escape	48	30	0	80	50	P	112	70	p
17	11	Device control 1	49	31	1	81	51	Q	113	71	q
18	12	Device control 2	50	32	2	82	52	R	114	72	r
19	13	Device control 3	51	33	3	83	53	S	115	73	s
20	14	Device control 4	52	34	4	84	54	T	116	74	t
21	15	Neg. acknowledge	53	35	5	85	55	U	117	75	u
22	16	Synchronous idle	54	36	6	86	56	V	118	76	v
23	17	End trans. block	55	37	7	87	57	W	119	77	w
24	18	Cancel	56	38	8	88	58	X	120	78	x
25	19	End of medium	57	39	9	89	59	Y	121	79	y
26	1A	Substitution	58	3A	:	90	5A	Z	122	7A	z

BASIC CONCEPT

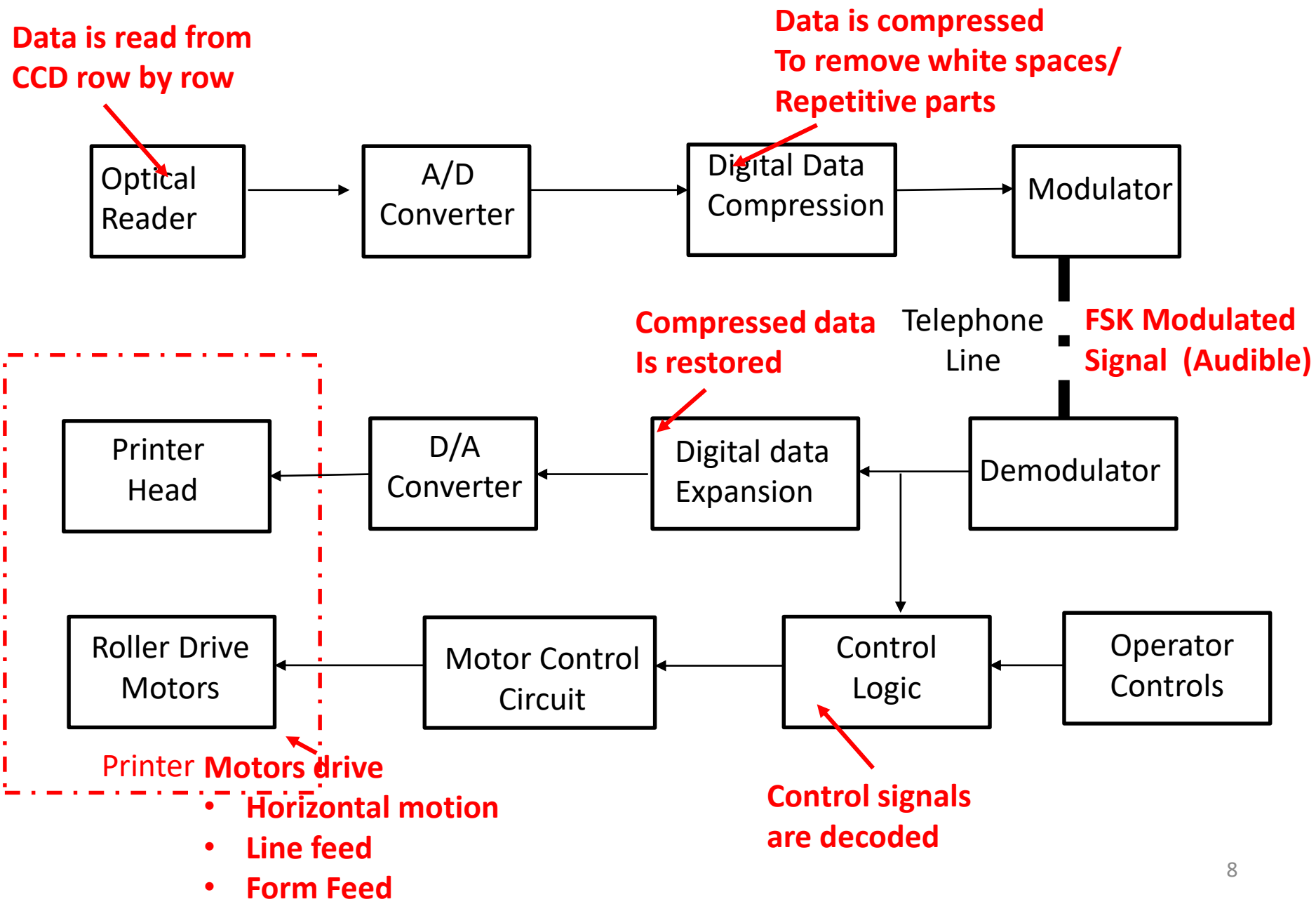
1. At the sending end, there an **optical sensor** which read the paper. Usually, a modern fax machine also has a paper-feed mechanism so that it is easy to send multi-page faxes.

2. The white and black spots that the optical sensor reads are encoded they can travel through a phone line.

3. At the receiving end, the information is decoded and sent to the printer which **marks** the paper with black (or colour) dots (or prints).



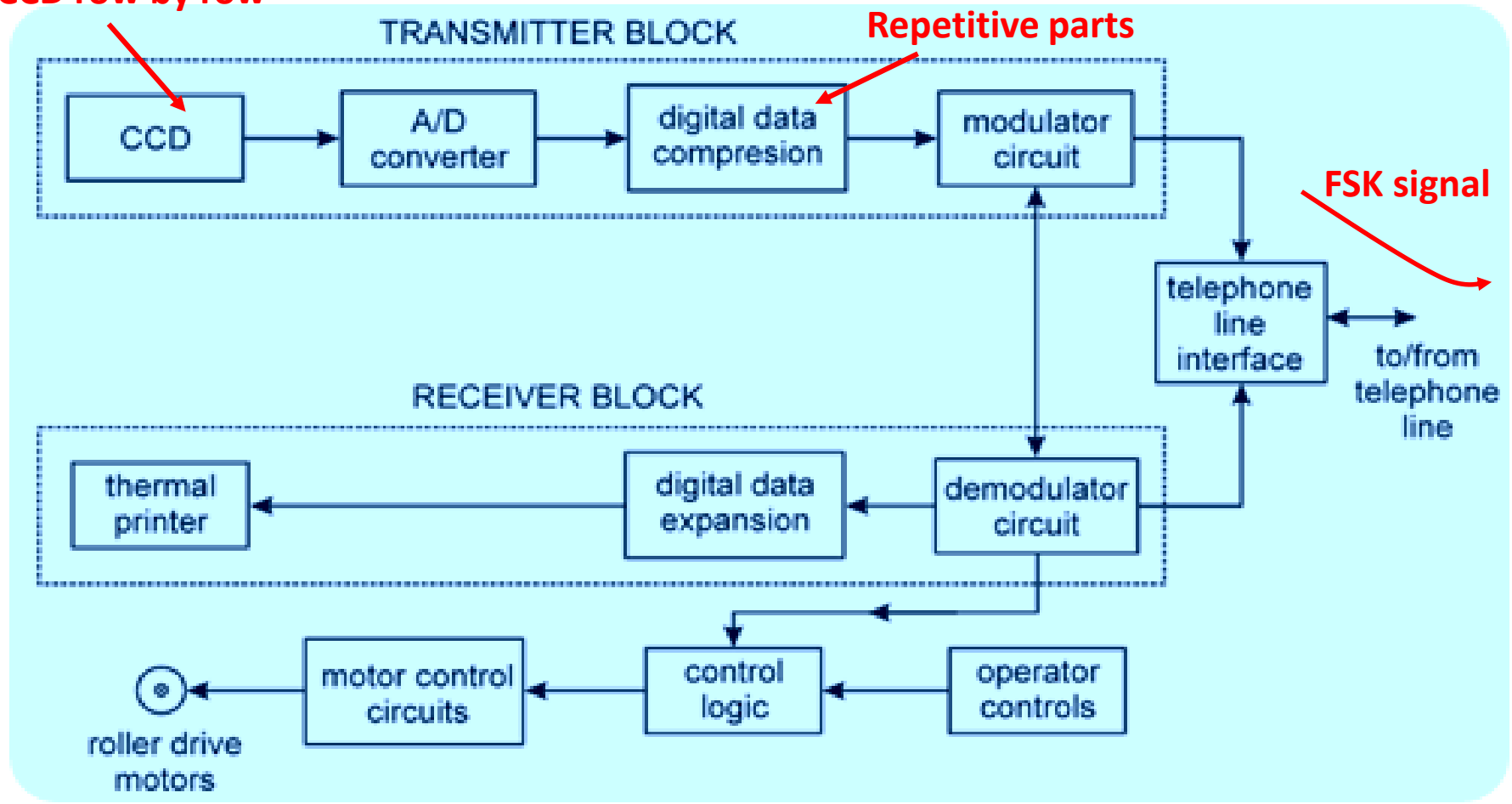
FAX BLOCK DIAGRAM



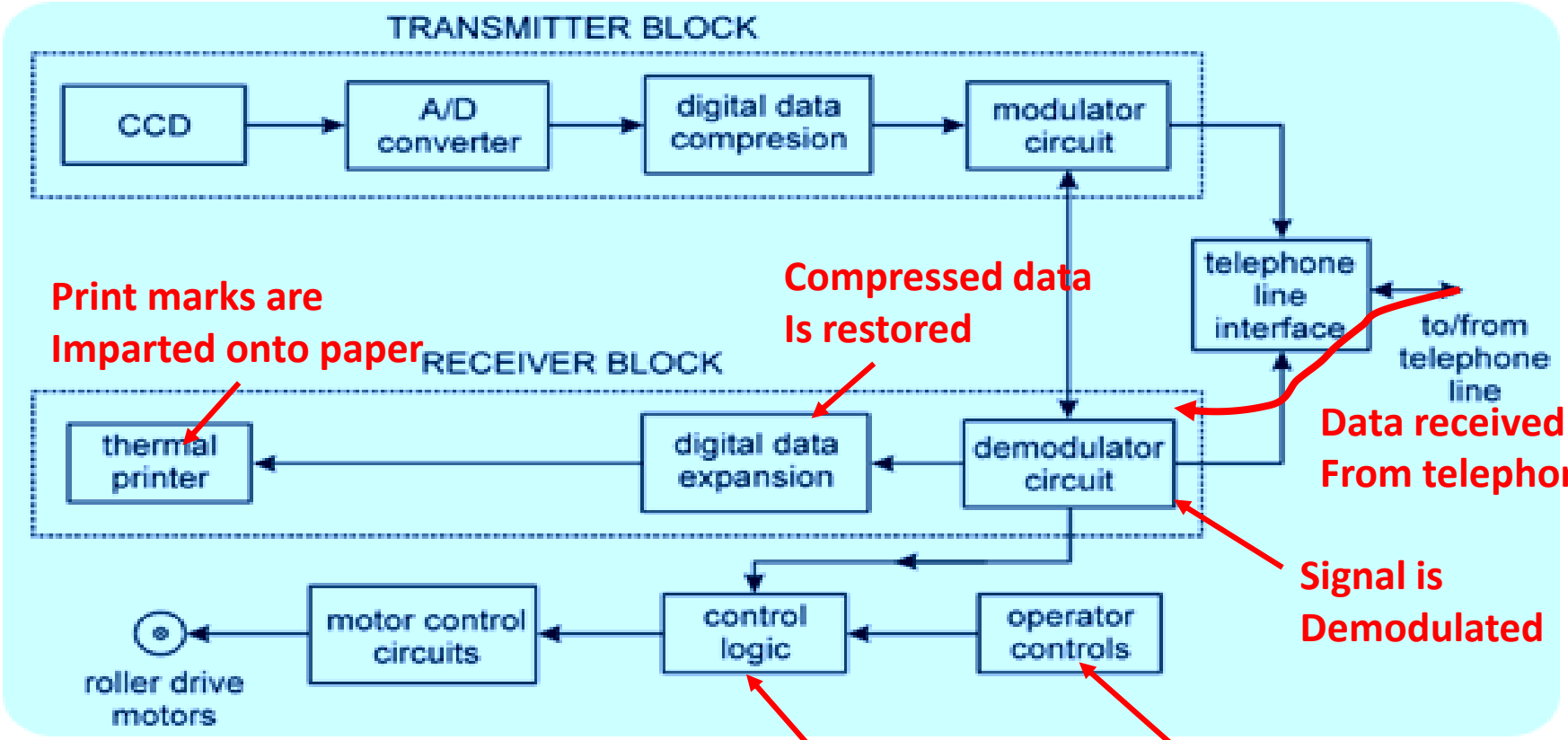
FAX TRANSMITTER

Data is read from
CCD row by row

Data is compressed
To remove white spaces/
Repetitive parts



FAX RECEIVER



Print marks are Imparted onto paper

Compressed data Is restored

Data received From telephone line

Signal is Demodulated

Motors drive

- **Horizontal motion**
- **Line feed**
- **Form Feed**

Control signals are decoded

Human Operator can manually control:

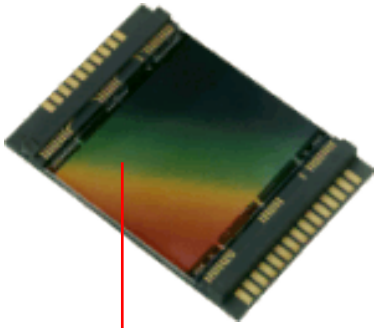
- **Line feed (LF)**
- **Form Feed (FF)**

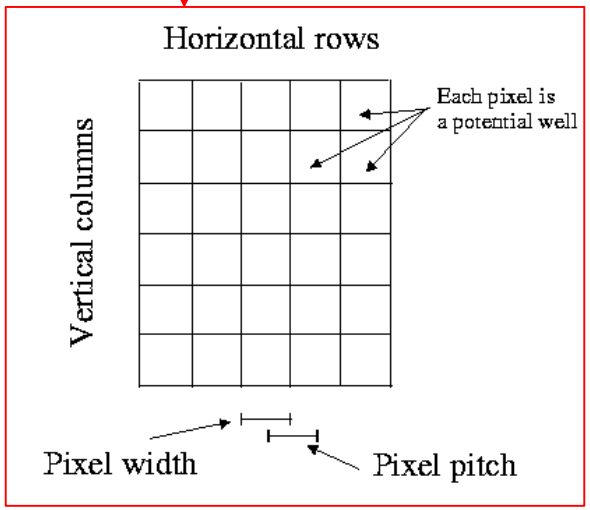
MODULATION SCHEMES

ITU Standard	Released Date	Data Rates (bit/s)	Modulation Method
V.27	1988	4800, 2400	PSK
V.29	1988	9600, 7200, 4800	QAM
V.17	1991	14,400; 12,000; 9600; 7200	TCM Trellis Coded Modulation
V.34	1994	28,800	QAM
V.34bis	1998	33,600	QAM
ISDN		64,000	PCM

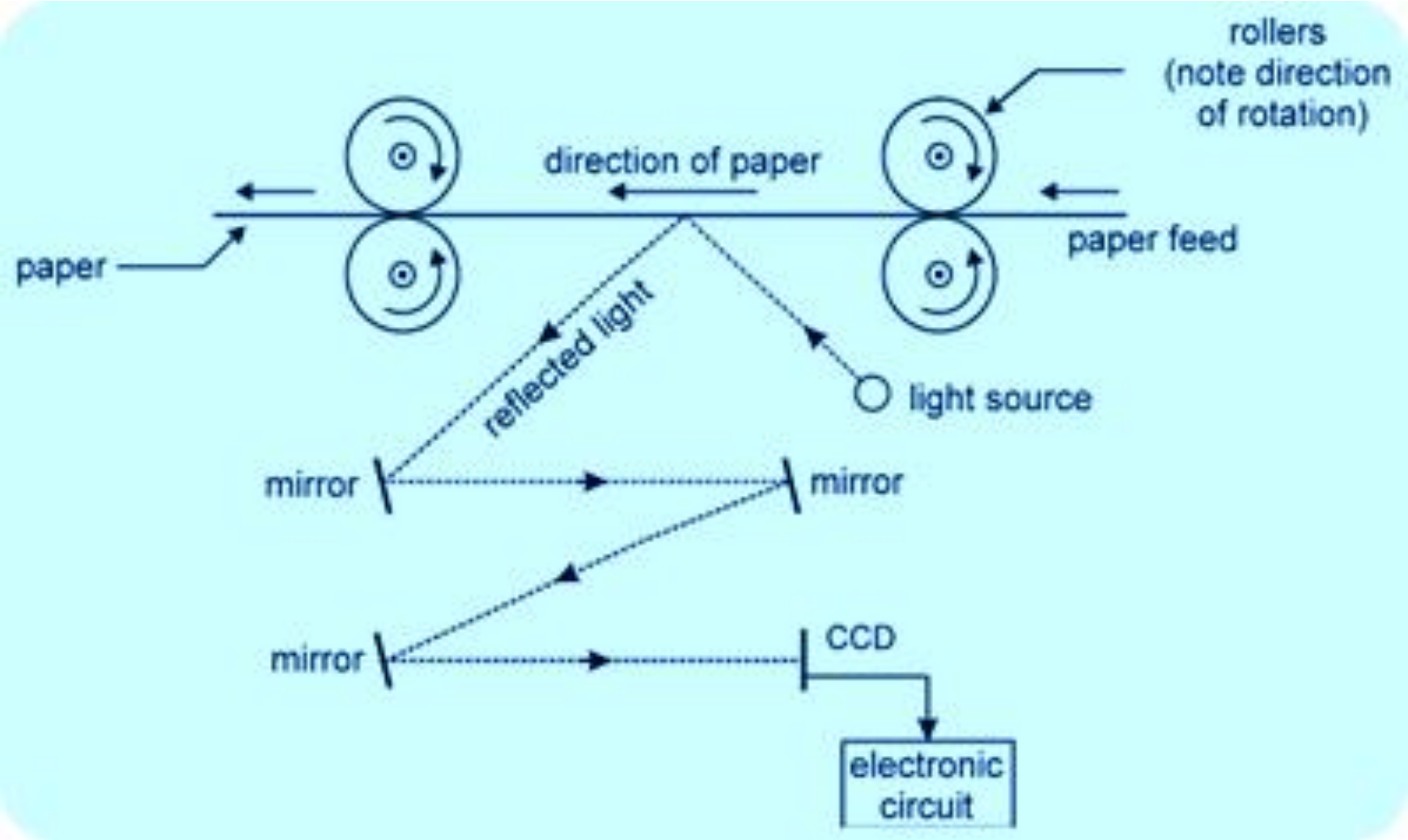
CHARGE-COUPLED DEVICE (CCD)

1. The CCD is a special integrated circuit consisting of a flat, two dimensional array of small light detectors referred to as pixels.
2. Each pixel acts like a bucket for electrons.
3. A CCD pixel acquires data as light or electrical charge.
4. During an exposure, each pixel fills up with electrons in proportion to the amount of light that enters it.
5. The CCD takes this optical and converts it into an electronic signal.
6. The electronic signal is then processed to either produce an image or provide information.





HOW THE CCD SENSES FAX IMAGE



KEY ASPECTS OF THE ITU FAX STANDARD

Scanning Track:

1. The message area should be scanned in the same direction in the transmitter and receiver.
2. Viewing the message area in a vertical plane, the picture elements should be processed as if the scanning direction were from left to right.
3. Subsequent scans are adjacent and below the previous scan.

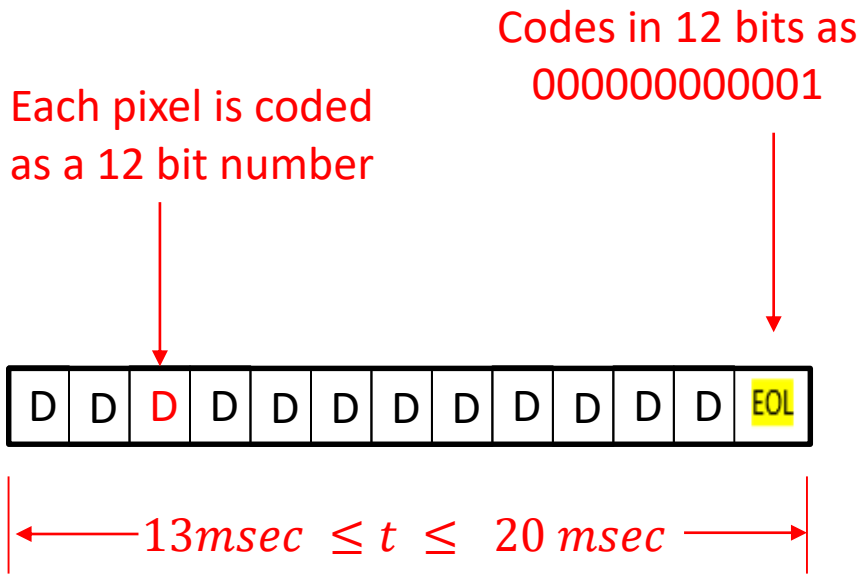
TRANSMISSION TIME PER TOTAL CODED SCAN LINE

1. The total coded scan line is defined as the sum of data bits plus any required fill bits plus the end of line (EOL) bits.

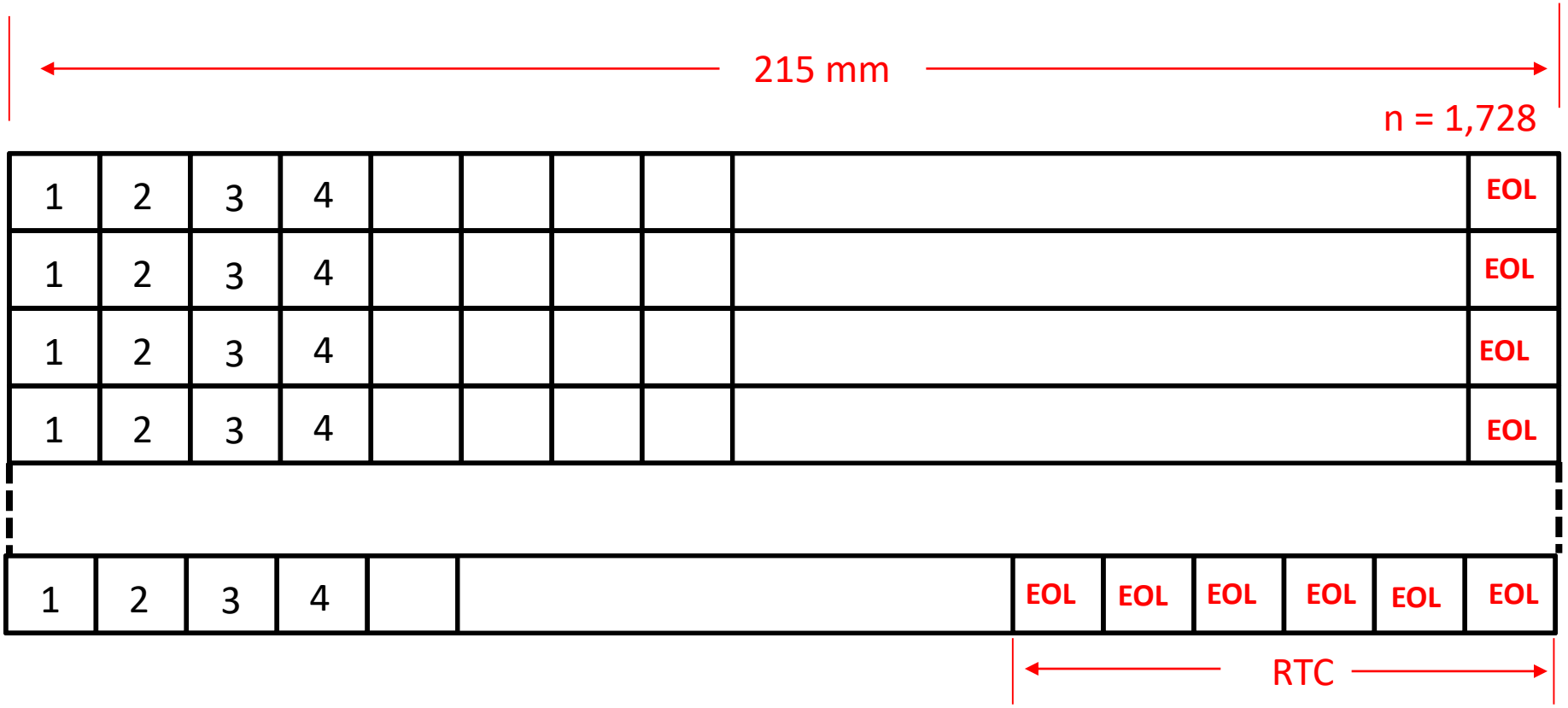
2. The minimum transmission times of the total coded scan line should be 13 milliseconds

3. The maximum transmission time of any total coded scan line should be 20 miliseconds.

4. Optional error correction is utilized to transmit the total coded scan line.

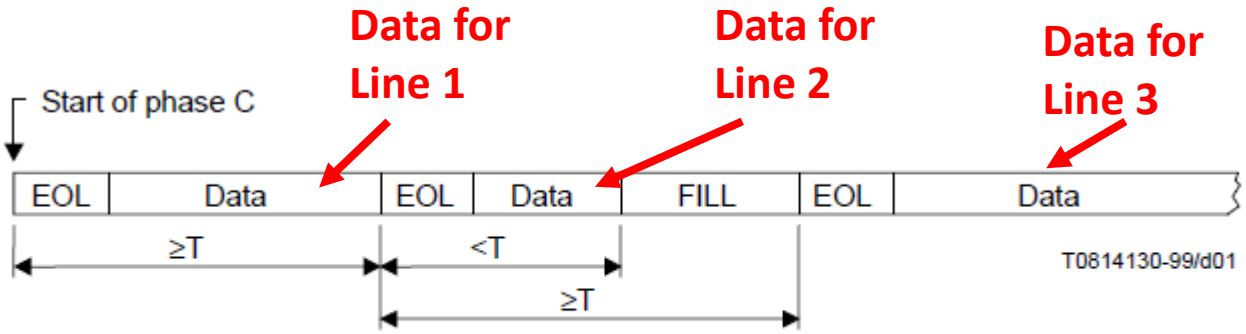


FACSIMILE DATA LINE

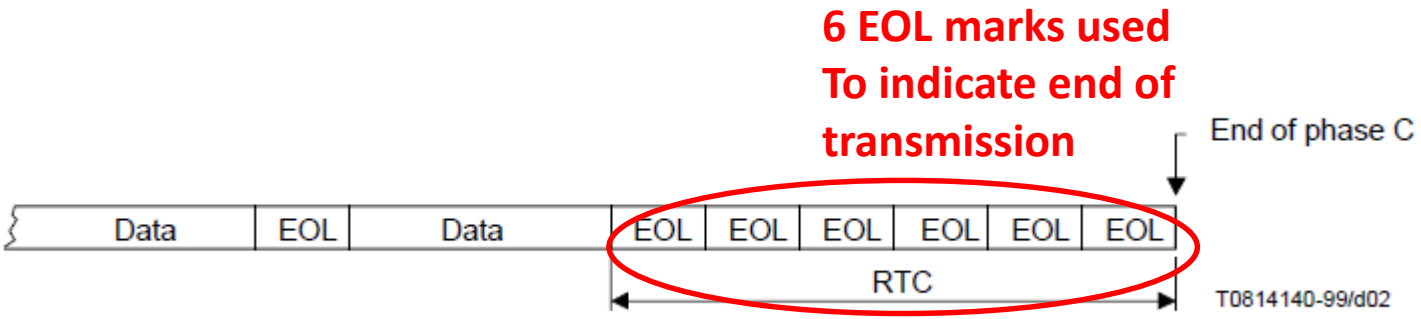


Return To Control (RTC): The end of a document transmission is indicated by sending six consecutive EOLs. i.e 000000000001, ..., 000000000001 (total of 6 times)

FORMATS FOR A LINE OF DATA



T Minimum transmission time of a total coded scan



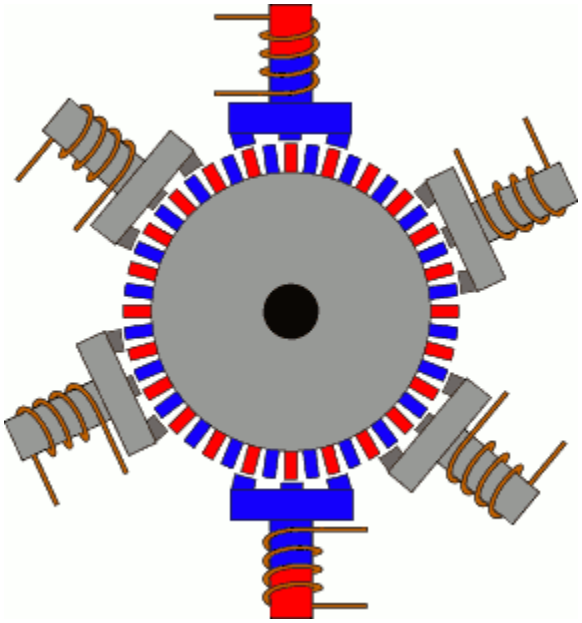
RTC- Return To Control used to mark end of transmission

HIGHER RESOLUTION SCANNERS

1. A scanner scans **one horizontal row of pixels** at a time, moving that scan line down the page with a carriage motor.
2. The dpi number is the **optical resolution** of the CCD sensor cells.
3. A 1200 dpi scanner takes 1200 samples per inch (creates 1200 pixels per inch) **horizontally** from the width being scanned.

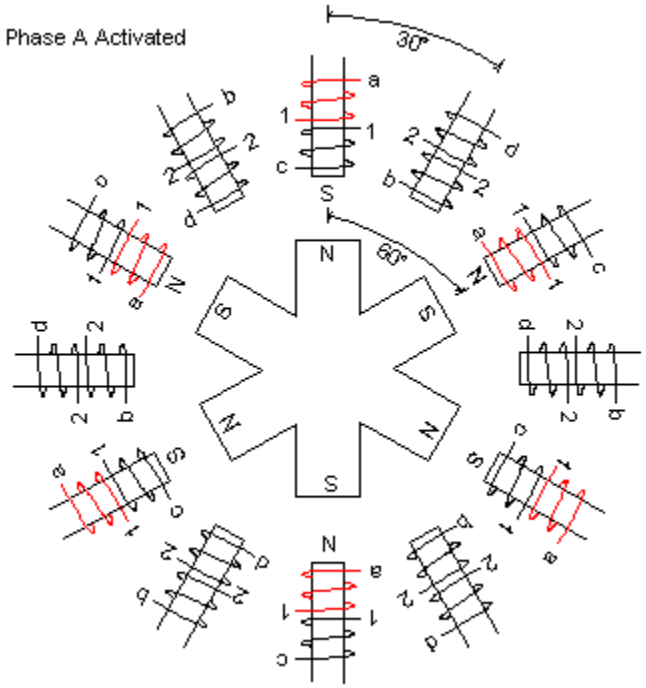
HIGHER RESOLUTION SCANNERS

1. **Higher Resolution (dpi)** is possible through proper control of the carriage **stepping motor**.



2. **Example:** A 1200x2400 dpi scanner is geared so that each pulse of the carriage motor moves in $^{1}/_{2400}$ inch steps **vertically**.
3. At 300 dpi, the carriage moves eight motor steps at a time vertically, then stops and re-samples the scan line to $\frac{1}{4}$ size horizontally, to create the image.

STEPPING MOTOR CONTROL



Stepping motor control is fundamental to the proper operation of scanners and printers.