



เอกสารอ้างอิง

ภาษาไทย

กองบรรณาธิการ, "LAN การเชื่อมต่อเพื่อเพิ่มประสิทธิภาพ", คอมพิวเตอร์รีวิว, หน้า 42-49, ฉบับที่ 38, พฤษภาคม, 2530.

ยีน กัวร์วอร์ด, เทคโนโลยี ฮาร์ดแวร์ IBM PC, บ.ซีเอ็ดยูเคชั่น จำกัด, 2533.

_____ . "โวลต์แลนเน็ตเวิร์ค(LAN)", การสื่อสารข้อมูลและการบริการข่าวสาร, สมาคมอิเล็กทรอนิกส์แห่งประเทศไทย, 2528.

ไพศาล สงวนหม่ม และ ยีน กัวร์วอร์ด, การสื่อสารข้อมูลและคอมพิวเตอร์เน็ตเวิร์ค, บ.ซีเอ็ดยูเคชั่น จำกัด, 2528.

ภาษาต่างประเทศ

ANSI/IEEE std 802.2, Logical Link Control, The Institute of Electrical and Electronics Engineers, Inc., 1984.

ANSI/IEEE std 802.5, Token Ring Access Method and Physical Layer Specifications, The Institute of Electrical and Electronics Engineers, Inc., 1984.

Beam, Walter R., System Engineering Architecture and Design, McGraw-Hill Book Co., Singapore, 1990

Black, Uyles, Computer Networks Protocols, Standards and Interfaces, Prentice-Hall, Inc, Engwood Cliffs, N.J., 1987.

Burdge, Joni and Bird, Tim, "Cracking the Netware Shell", NetWare Technical Journal, Novell Inc., 1989.

- Comier, Denney, "LAN ICs let you build networks for PCs", EDN, p.136-144, December 11, 1986.
- Dawkins, William, "Network Schemes and Hardware, Part1", NetWare Technical Journal, p.27-35, Novell Inc., 1989.
- Glass, Brett, "Understanding NetBios", BYTE, p.301-306, January , 1989.
- Greenfield, David , " Multivendor token ring networks come of age", Data Communication, p.37-43, November 21, 1989.
- Halsall, Fred, Data Communications, Computer Networks and OSI, Addison-Wesley Publishing company, 1989.
- IBM, Token-Ring Network PC Adapter Technical Reference, IBM Corporation 1986.
- Jordan ,Larry and Churchill, Bruce, Communications and Networking for the IBM PC and Compatibles, Simon & Schuster, Inc., 1990.
- Lefkon, Dick, "A LAN Primer", BYTE, p.147-154, July, 1987.
- Marsden, Brian, Communication Network Protocols, Chartwell-Bratt (Publishing and Trianing)Ltd., 1985.
- Martin, James, Local Area Networks Architectures and Implementations, Prentice-Hall International, Inc., 1989.
- Miller, Mark A., LAN Protocol Handbook, M&T Publishing, Inc., 1990.
- Nance, Barry, Network Programming in C, QUE corpration, 1990.
- Protopapas, D.A., Microcomputer Hardware Design, Prentice-Hall International, Inc., 1988.
- Roetzheim, H., William, A C Programmer's Guide to the IBM Token Ring, Prentice-Hall , 1991.

Stallings, William ,Data and Computer Communications, Macmillan
Publishing Company, a division of Macmillan, Inc., 1985.

Texas Instruments, TMS380 Adapter chipset User's Guide, Texas
Instruments Incorporated, 1986.

Texas Instruments, TMS380 Adapter chipset User's Guide Supplement,
Texas Instruments Incorporated, 1987.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ก.

รายละเอียดไอซีทีที่ใช้ในการศึกษาการออกแบบวงจร

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

TMS38010 COMMUNICATIONS PROCESSOR

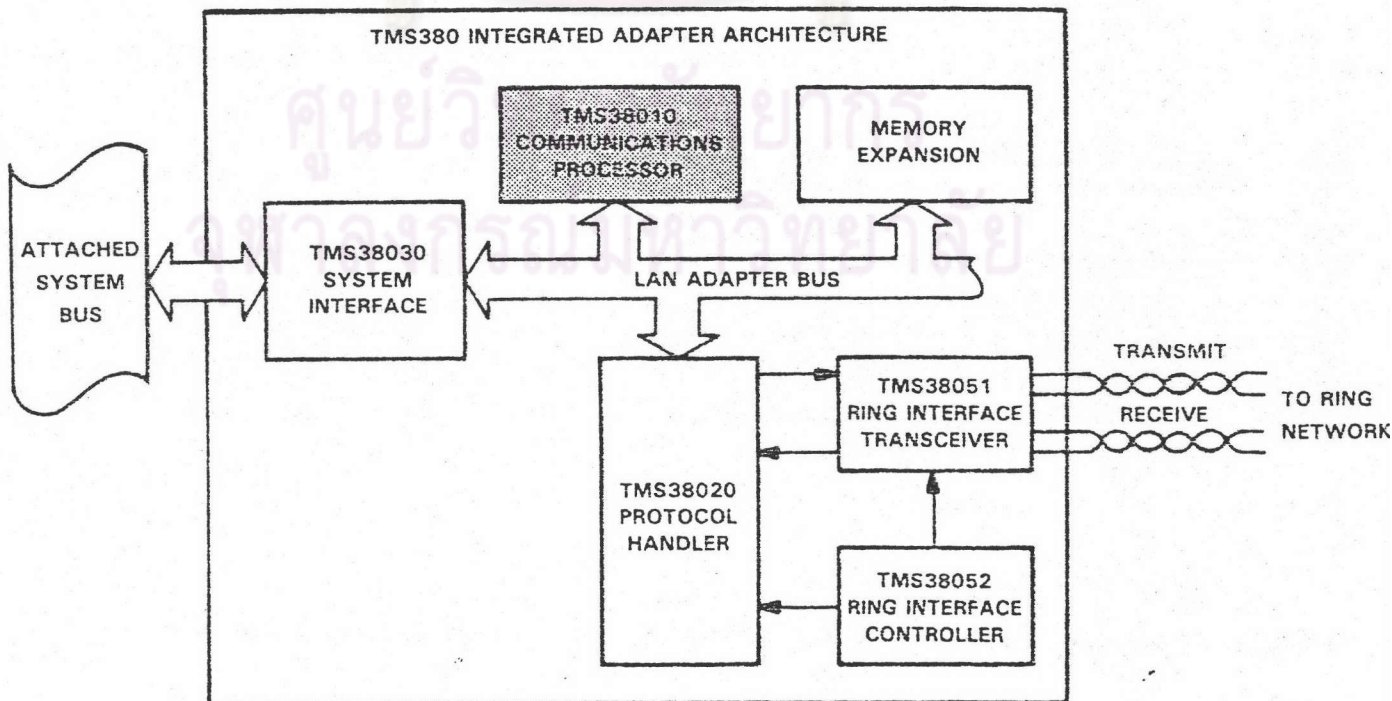
SEPTEMBER 1985 — REVISED MAY 1986

- High-Performance 16-Bit CPU for Processing Communications Protocols
 - 333-ns Machine and Bus Cycle Time
 - Single Cycle Pipelined Bus Arbitration
 - 9 Interrupt Priority Levels
 - 8-Bit General Purpose Timer
- On-Chip 2.75K-Byte RAM for Buffering Network Data
 - 1408 x 18-Bit Organization
 - Byte Parity Protection
 - 6 Megabyte per Second Data Transfer Rate
- Expandable Program and Data Memory Space up to 256K Bytes
- Built-in Real Time Error Detection
- Test Pins for Hi-Z, Module-in-Place Testing
- Single 5-V Supply
- 24-MHz Crystal Oscillator or Crystal Input (Internal Oscillator Option)
- Low-Power Scaled-NMOS Technology

JD PACKAGE
(TOP VIEW)

VCC1	1	48	TEST0
LBSYNC	2	47	TEST1
TEST	3	46	LAD15
TEST2	4	45	LAD14
LBGR1	5	44	LAD13
LBGR2	6	43	LAD12
LBRDY	7	42	LAD11
LR/W	8	41	LAD10
LBCLK2	9	40	LAD9
LBCLK1	10	39	LAD8
MXTALOUT	11	38	LPL
VSS1	12	37	VSS3
VSS2	13	36	LPH
MXTALIN	14	35	LAD7
MXTAL2	15	34	LAD6
VCC2	16	33	LAD5
LI/D	17	32	LAD4
LEN	18	31	LAD3
LAL	19	30	LAD2
LBRQ2	20	29	LAD1
LBRQ1	21	28	LAD0
LRESET	22	27	LIRQ2
LNMI	23	26	LIRQ1
CLKDIV	24	25	LIRQ0

token ring LAN application diagram



TMS38010 COMMUNICATIONS PROCESSOR

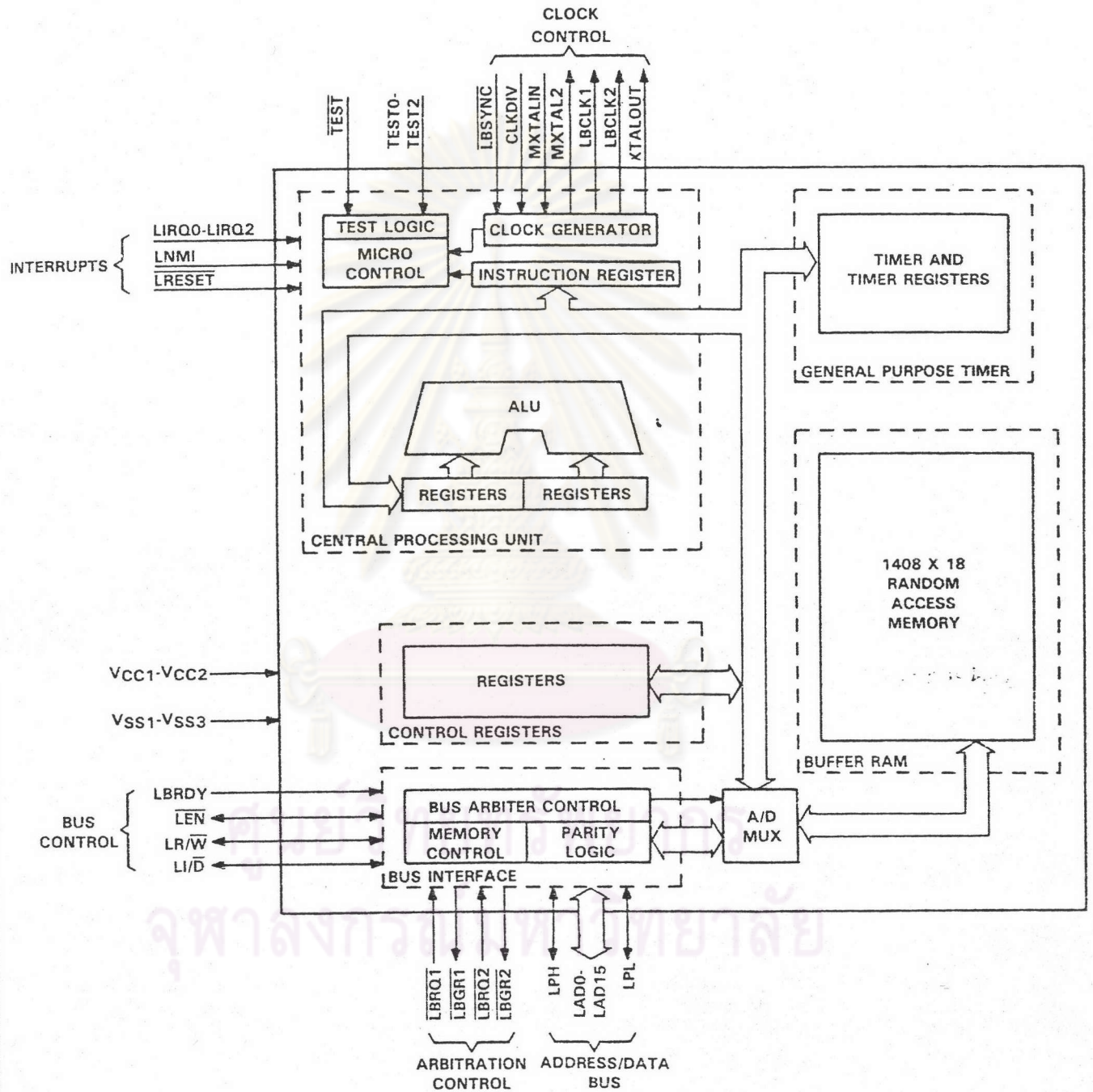
pin descriptions

NAME	I/O	DESCRIPTION
$\overline{\text{LRESET}}$	I	TMS38010 Reset
$\overline{\text{LBCLK1}}, \overline{\text{LBCLK2}}$	O	Bus Clocks
$\overline{\text{LBSYNC}}$	I	Bus Synchronization. This pin is reserved and should be left unconnected.
$\overline{\text{LAL}}$	I/O	Address Latch Enable
$\overline{\text{LEN}}$	I/O	Data Enable
$\overline{\text{LBRDY}}$	I	Bus Ready. Used to force wait states on bus read/write cycles.
$\overline{\text{LIRQ0}}, \overline{\text{LIRQ1}}, \overline{\text{LIRQ2}}$	I	Interrupt Request Level Request
$\overline{\text{LNMI}}$	I	Non-Maskable Interrupt (NMI) Request
$\overline{\text{LBRQ1}}, \overline{\text{LBRQ2}}$	I	Bus Request 1 and 2. Used by bus masters to request control of the bus.
$\overline{\text{LBGR1}}, \overline{\text{LBGR2}}$	O	Bus Grant 1 and 2
$\overline{\text{LAD0}} - \overline{\text{LAD15}}$	I/O	Address/Data bus. $\overline{\text{LAD0}}$ is the most-significant bit and $\overline{\text{LAD15}}$ is the least-significant bit. $\overline{\text{LAD15}}$ serves as a "Page Select" during the address phase of memory cycles.
$\overline{\text{LPH}}, \overline{\text{LPL}}$	I/O	Parity High Byte and Low Byte. Parity for data carried over $\overline{\text{LAD0}} - \overline{\text{LAD15}}$.
$\overline{\text{LI/D}}$	O	Instruction Fetch/Data Transfer Status Code
$\overline{\text{LR/W}}$	I/O	Read/Write signal
$\overline{\text{CLKDIV}}$	I	This pin is reserved and should be tied to V_{CC} .
$\overline{\text{MXTALIN}}$	I	Input to internal oscillator from crystal or external clock
$\overline{\text{MXTAL2}}$	O	Connection to internal oscillator from crystal
$\overline{\text{MXTALOUT}}$	O	Crystal Frequency Output. This frequency is $\text{MXTALIN}/3$.
$\overline{\text{TEST}}, \overline{\text{TEST0}} - \overline{\text{TEST2}}$	I	TMS38010 Test Pins. These pins should be left unconnected.
V_{CC}	I	5-V supply pins
V_{SS}	I	Ground pins

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

TMS38010
COMMUNICATIONS PROCESSOR

functional block diagram



TMS38020 PROTOCOL HANDLER

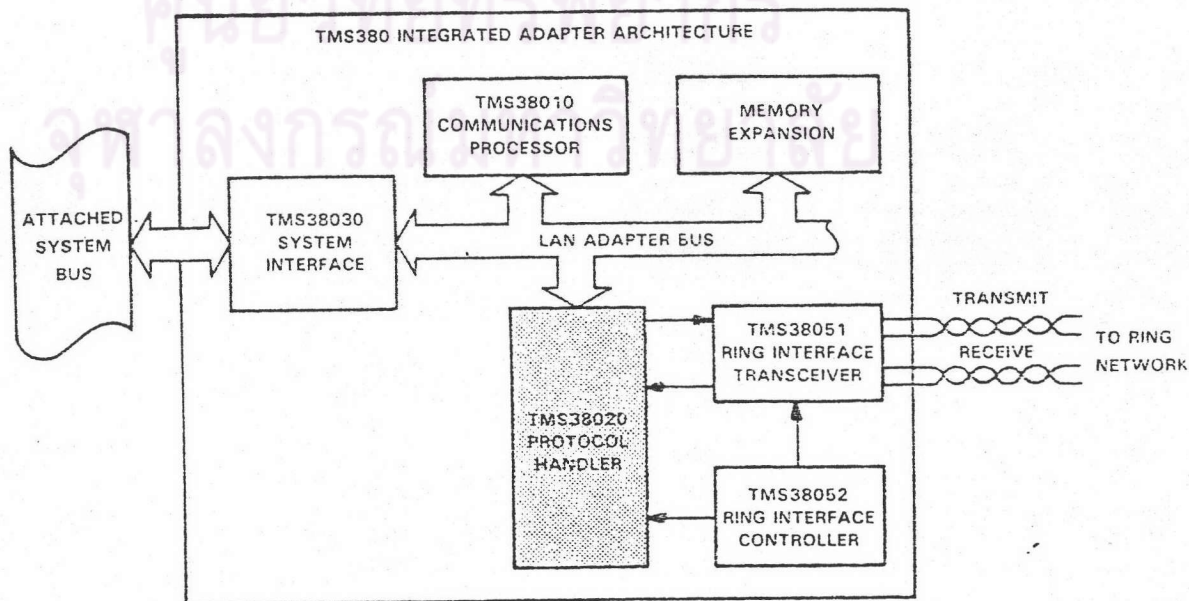
SEPTEMBER 1985 - REVISED MAY 1986

- Compatible with IEEE Std 802.5-1985*
Token Ring Access Method and Physical Layer Specifications
 - Differential Manchester Code Conversion on 4M-Bit per Second Serial Data Stream
 - Address Recognition (Functional, Group and Specific)
 - Manchester Code Violation Detection
 - Starting and Ending Delimiter Generation and Detection
 - CRC Generation and Checking
 - High-Speed Frame Repeat Path Minimizes Ring Latency (2-Bit Times)
 - Token Transmit and Priority Control
 - Monitor Functions
- Separate Pairs of DMA Channels for Receive and Transmit
- Automatic Frame Buffer Management
- On-Chip 16K-Byte ROM for Adapter Software
 - 8K x 18-Bit ROM with Byte Parity Protection
 - Single Word Prefetch
- Test Pin for Hi-Z, Module-in-Place Testing
- 48-Pin, 600-Mil, Ceramic Dual-in-Line Packaging
- Low-Power Scaled-NMOS Technology

JD PACKAGE
(TOP VIEW)

VSS3	1	48	FRAQ
RCLK	2	47	DRVR
VCC3	3	46	WRAP
REDY	4	45	RCVR
PXTALIN	5	44	NSRT
LBROP	6	43	WFLT
LBGRP	7	42	VBB
LBRDY	8	41	PHTEST
PHCS	9	40	NC
VSS1	10	39	PIRQ
LAD15	11	38	VCC2
LAD14	12	37	VSS2
LAD13	13	36	LR/W
LAD12	14	35	LBCLK1
LAD11	15	34	LBCLK2
LAD10	16	33	LI/D
LAD9	17	32	LEN
LAD8	18	31	LAL
LPL	19	30	PHRESET
VCC1	20	29	LAD0
LPH	21	28	LAD1
LAD7	22	27	LAD2
LAD6	23	26	LAD3
LAD5	24	25	LAD4

token ring LAN application diagram



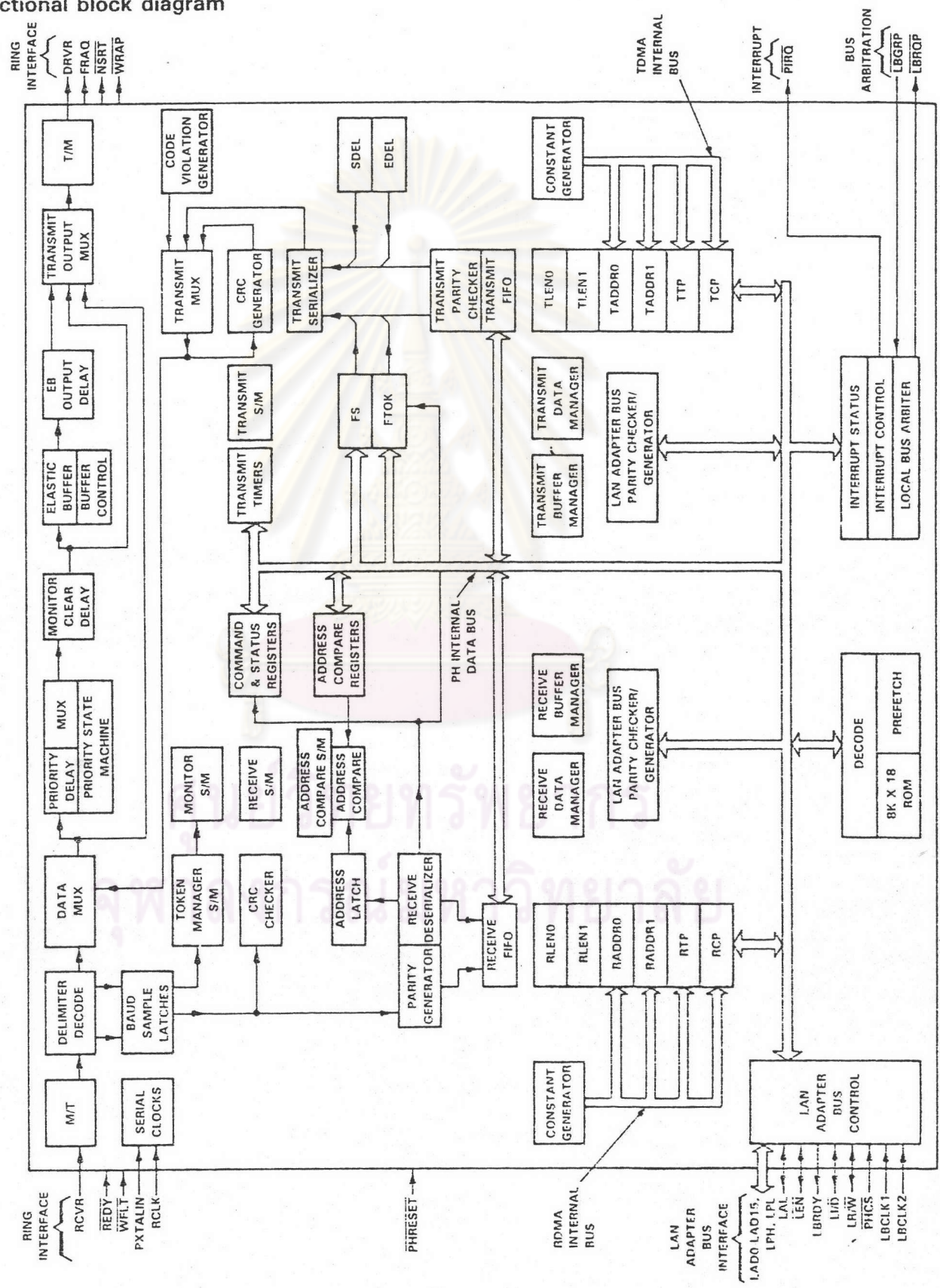
TMS38020 PROTOCOL HANDLER

pin descriptions

NAME	I/O	DESCRIPTION
LAN ADAPTER BUS INTERFACE PINS		
LBCLK1, LBCLK2	I	Bus Clocks
<u>LAL</u>	I/O	Address Latch Enable
<u>LEN</u>	I/O	Data Enable
<u>LBRDY</u>	I/O	Bus Ready
<u>PIRQ</u>	O	PH Interrupt Request
<u>LBRQP</u>	O	Bus Request
<u>LBGRP</u>	I	Bus Grant
LAD0 - LAD15	I/O	Address/Data bus. LAD0 is the most-significant bit, LAD15 is the least-significant bit.
LPH,LPL	I/O	Parity High/Parity Low
<u>LI/D</u>	I/O	Instruction/Data Bus Status Code
<u>LR/W</u>	I/O	Read/Not Write
<u>PHRESET</u>	I	Reset
<u>PHCS</u>	I	Chip Select
RING INTERFACE PINS		
<u>DRVR</u>	O	Transmitter Data
<u>FRAQ</u>	O	Frequency Acquisition Select
<u>NSRT</u>	O	Insert Control
<u>RCLK</u>	I	Recovered Data Clock
<u>RCVR</u>	I	Received Data
<u>REDY</u>	I	Ring Interface Ready
<u>WFLT</u>	I	Wire Fault Detect
<u>WRAP</u>	O	Wrap Select
<u>PXTALIN</u>	I	Ring Frequency Reference Clock
MISCELLANEOUS PINS		
<u>PHTEST</u>	I	Module-in-Place Test Mode Select. This pin should be left unconnected.
VCC		5-V supply pins.
VSS		Ground pins.
VBB		Substrate bias. This pin is reserved and should be left unconnected.
NC		Reserved. This pin should be left unconnected.

จุฬาลงกรณ์มหาวิทยาลัย

functional block diagram

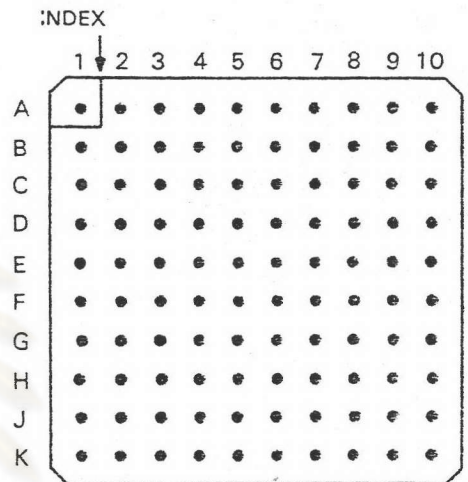


TMS38030 SYSTEM INTERFACE

SEPTEMBER 1985 - REVISED MAY 1986

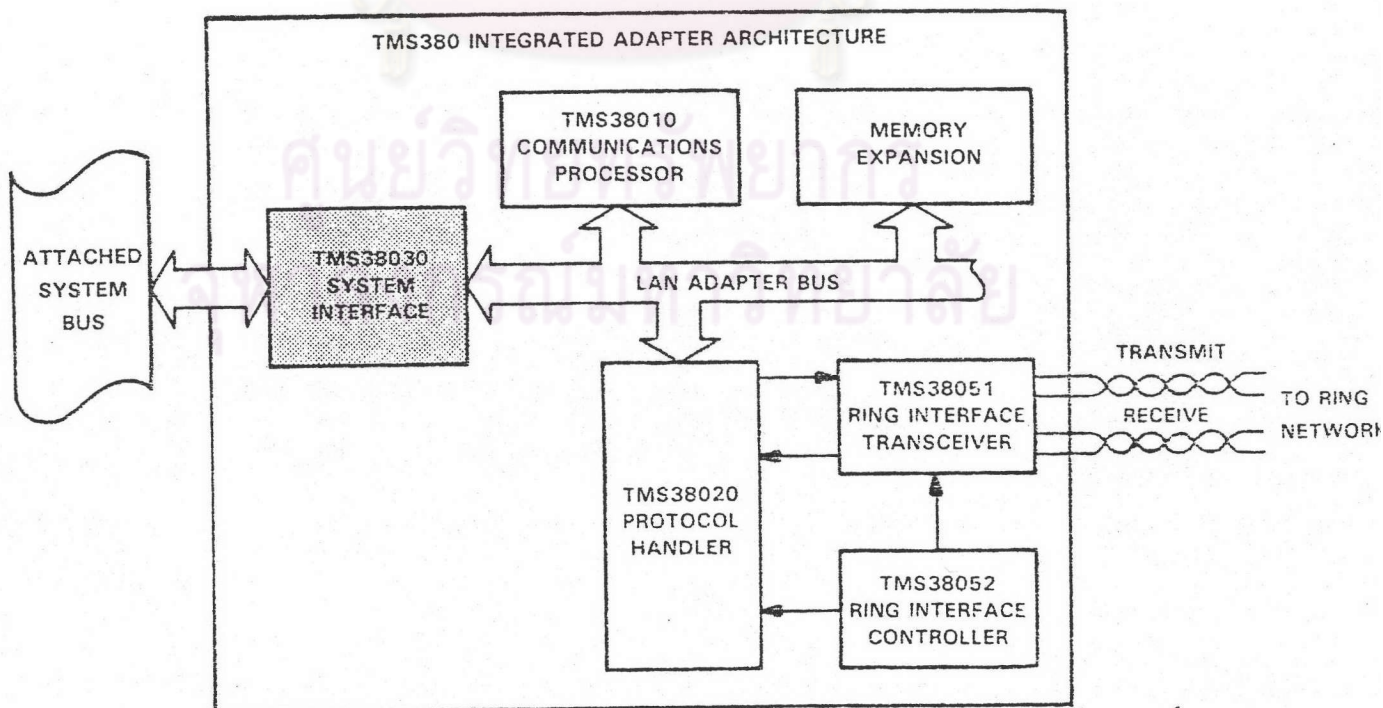
- Connects Two High-Speed Asynchronous Buses
 - Up to 5M Bytes/Second DMA on Host System Bus
 - 6M Bytes/Second DMA on LAN Adapter Bus
- Provides Dual-Port DMA and Direct I/O Transfer Between Buses
- Selectable Host System Bus Options
 - 808X- or 680XX-Type Bus and Memory Organization
 - 8- or 16-Bit Data Bus for 808X-Type Buses
 - Optional Parity Checking
- Provides Direct Control of Latches and Drivers on Host System Bus Interface
- Test Pin for Hi-Z, Module-In-Place Testing
- Single 5-V Supply
- 100-Pin Ceramic Grid Array Package
- Low-Power Scaled-NMOS Technology

GB PACKAGE†
(TOP VIEW)



†See pin description table (Page 2) for location and description of all pins.

token ring LAN application diagram



TMS38030

SYSTEM INTERFACE

pin descriptions

NAME	PIN	I/O	DESCRIPTION
SYSTEM BUS ADDRESS/DATA PINS			
SADH0	H7	I/O	System address/Data bus — High Byte. SADH0 is the most-significant bit and SADH7 is the least-significant bit.
SADH1	K10	I/O	
SADH2	J8	I/O	
SADH3	J7	I/O	
SADH4	K6	I/O	
SADH5	J6	I/O	
SADH6	K9	I/O	
SADH7	K8	I/O	
SADL0	J5	I/O	System Address/Data bus — Low Byte. SADL0 is the most-significant bit and SADL7 is the least-significant bit.
SADL1	H5	I/O	
SADL2	G5	I/O	
SADL3	K4	I/O	
SADL4	F5	I/O	
SADL5	J4	I/O	
SADL6	H4	I/O	
SADL7	K3	I/O	
SPH	K7	I/O	System Parity High Byte
SPL	K5	I/O	System Parity Low Byte
SYSTEM BUS CONTROL PINS			
$\overline{SI/M}$	H8	I	808X/680XX Mode Select
$\overline{S8/16}$	H9	I	8/16-Bit Data Bus Select
\overline{SRESET}	H10	I	System Reset
\overline{SCS}	J2	I	Chip Select
SRS0	K2	I	Register Select 0 (MSB)
SRS1	H3	I	Register Select 1
SRS2	G4	I	Register Select 2 (LSB)
$\overline{SBHE}/SRNW$	K1	I/O	Byte High Enable (808X mode)/Read Not Write (680XX mode)
$\overline{SWR}/SLDS$	H1	I/O	Write Strobe (808X mode)/Lower Data Strobe (680XX mode)
$\overline{SRD}/SUDS$	G1	I/O	Read Strobe (808X mode)/Upper Data Strobe (680XX mode)
$\overline{SRAS}/\overline{SAS}$	G3	I/O	Register Address Strobe (808X mode)/Memory Address Strobe (680XX mode)
$\overline{SRDY}/\overline{SDTACK}$	J1	I/O	Bus Ready (808X mode)/Data Transfer Acknowledge (680XX mode)
SALE	D3	O	Address Latch Enable
SXAL	D2	O	Extended Address Latch Enable
SBCLK	E2	I	System Bus Clock
SYSTEM BUS DRIVER/RECEIVER CONTROL PINS			
SDDIR	C2	O	Data Direction
\overline{SDBEN}	C1	O	Data Bus Enable
SOWN	E5	O	System Bus Owned

pin descriptions (continued)

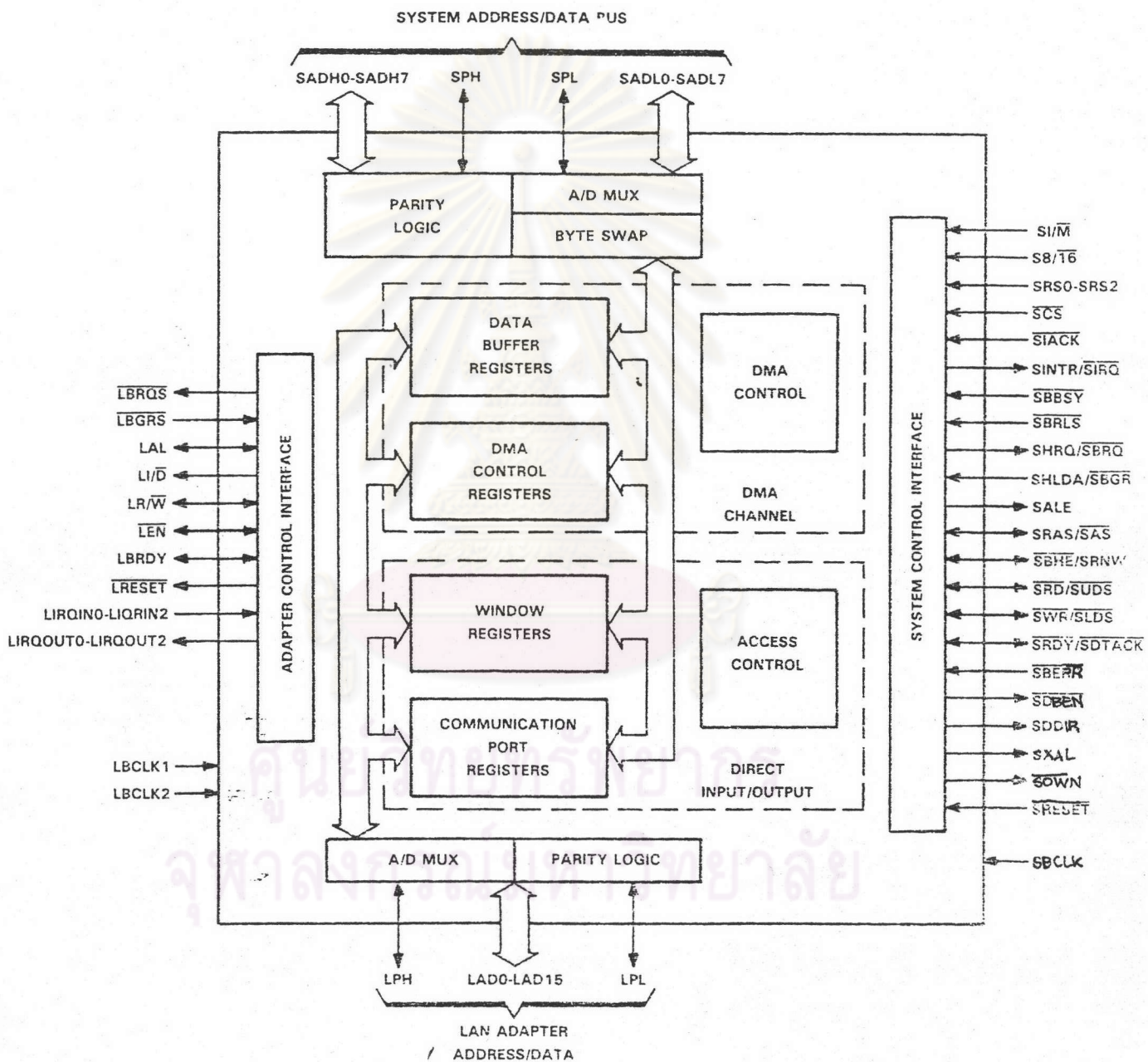
NAME	PIN	I/O	DESCRIPTION
SYSTEM BUS ARBITRATION/DMA CONTROL PINS			
SHRQ/ $\overline{\text{SBRQ}}$	H2	O	Hold Request (808X mode)/Bus Request (680XX mode)
SHLDA/ $\overline{\text{SBGR}}$	F1	I	Hold Acknowledge (808X mode)/Bus Grant (680XX mode)
$\overline{\text{SBSY}}$	G2	I	Bus Busy
$\overline{\text{SRLS}}$	B2	I	Bus Release
$\overline{\text{SBERR}}$	F2	I	Bus Error
SYSTEM BUS INTERRUPT CONTROL PINS			
SINTR/ $\overline{\text{SIRQ}}$	D4	O	Interrupt Request (808X mode)/Interrupt Request (680XX mode)
$\overline{\text{SIACK}}$	D1	I	Interrupt Acknowledge
LAN ADAPTER BUS ADDRESS/DATA PINS			
LAD0	B8	I/O	LAN Adapter Bus Address/Data Bus. LAD0 is the most-significant bit and LAD15 is the least-significant bit.
LAD1	A8	I/O	
LAD2	C7	I/O	
LAD3	B7	I/O	
LAD4	A7	I/O	
LAD5	D6	I/O	
LAD6	C6	I/O	
LAD7	B6	I/O	
LAD8	A3	I/O	
LAD9	A2	I/O	
LAD10	B5	I/O	
LAD11	A5	I/O	
LAD12	B4	I/O	
LAD13	B3	I/O	
LAD14	A1	I/O	
LAD15	C4	I/O	
LPH	A6	I/O	LAN Adapter Bus Parity High Byte
LPL	A4	I/O	LAN Adapter Bus Parity Low Byte
LAN ADAPTER BUS CONTROL PINS			
LBCLK1	B10	I	LAN Adapter Bus Clock 1
LBCLK2	C10	I	LAN Adapter Bus Clock 2
LAL	D9	I/O	LAN Adapter Bus Address Latch Enable
$\overline{\text{LI/D}}$	D8	I	LAN Adapter Bus Instruction/Data Bus Status Code
$\overline{\text{LEN}}$	C9	I/O	LAN Adapter Bus Data Enable
$\overline{\text{LR/W}}$	E7	I/O	LAN Adapter Bus Read/Not Write
LBRDY	A9	I	LAN Adapter Bus Ready

**TMS38030
SYSTEM INTERFACE**
pin descriptions (concluded)

NAME	PIN	I/O	DESCRIPTION
LAN ADAPTER BUS INTERRUPT PINS			
LIRQIN0	G10	I	LAN Adapter Bus Interrupt Request 0 Input
LIRQIN1	F7	I	LAN Adapter Bus Interrupt Request 1 Input
LIRQIN2	F8	I	LAN Adapter Bus Interrupt Request 2 Input
LIRQOUT0	F6	O	LAN Adapter Bus Interrupt Request Output 0
LIRQOUT1	F10	O	LAN Adapter Bus Interrupt Request Output 1
LIRQOUT2	F9	O	LAN Adapter Bus Interrupt Request Output 2
<u>LRESET</u>	G9	O	LAN Adapter Bus Reset
LAN ADAPTER BUS ARBITRATION PINS			
<u>LBROS</u>	A10	O	LAN Adapter Bus Request
<u>LBGRS</u>	C8	I	LAN Adapter Bus Grant
MISCELLANEOUS PINS			
<u>CHPTST</u>	J10	I	This pin is reserved and should be left unconnected.
<u>TEST</u>	G8	I	Module-in-Place Test Mode Select
VBB	D10		This pin is reserved and should be left unconnected.
NC	E6		This pin is reserved and should be left unconnected.
POWER PINS			
VCC	J3		5-V power supply (All pins must be connected.)
VCC	J9		
VCC	E9		Ground pins (All pins must be connected.)
VCC	D7		
VCC	D5		
VCC	E3		
VSS	C3		
VSS	E4		
VSS	E1		
VSS	F3		
VSS	F4		
VSS	H6		
VSS	G6		
VSS	G7		
VSS	E8		
VSS	E10		
VSS	B9		
VSS	C5		
VSS	B1		

TMS38030
SYSTEM INTERFACE

functional block diagram†



†For signal names separated by a slash (/), the first signal name given is for the 808X mode and the second signal name is for the 80XX mode.

TMS38051, TMS38052 RING INTERFACE CIRCUITS

SEPTEMBER 1985 - REVISED MAY 1986

- Token Ring Electrical Connection
- Compatible with Electrical Interface of IEEE Std 802.5-1985 Token Ring Access Method and Physical Layer Specifications
- Phase-Lock Loop for Clock Generation from Data Signal
- 4 Megabit per Second Differential Manchester-Encoded Data Rate
- Independent Transmit and Receive Channels
- Phantom Drive for Physical Insertion into Ring
- Cable Wire-Fault Indication
- Receive Data-Loss Detection
- Receiver Frequency Equalization and Low-Level Hysteresis Circuit
- Loop Back (Wrap Mode) for Self-Test Diagnostics
- Two Chip Set
 - TMS38051 Ring Interface Transceiver (22 Pin)
 - TMS38052 Ring Interface Controller (20 Pin)
- Single 5-V Supply
- Low-Power Schottky Technology

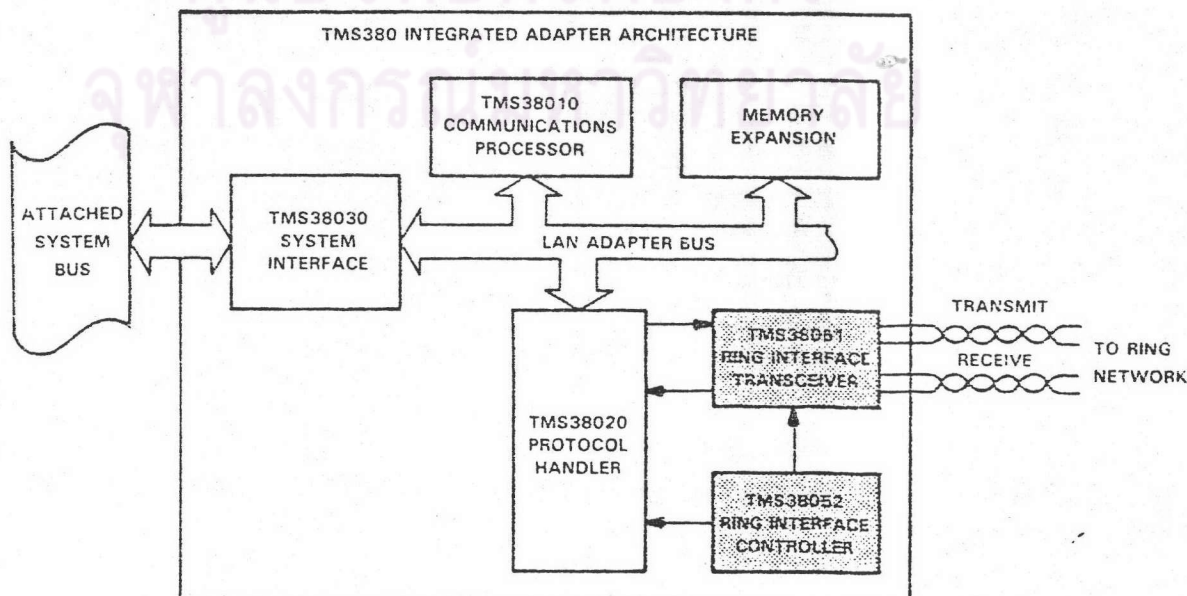
TMS38051 . . . N PACKAGE
(TOP VIEW)

DRVR	1	22	XTAL
DROUTA	2	21	FRAQ
DROUTB	3	20	NRGCAP
GNDDRV	4	19	ENERGO
GND	5	18	CHGPMP
VCC	6	17	GND
WRAP	7	16	VCCA
DCLKIN	8	15	RCVINA
ENABLE	9	14	RCVINB
RCVR	10	13	EQUALA
RCVHYS	11	12	EQUALB

TMS38052 . . . N PACKAGE
(TOP VIEW)

GNDREG	1	20	NSRT
VCOGAN	2	19	PHOUTA
FILTER	3	18	PHOUTB
VCOCPA	4	17	WFLT
VCOCPB	5	16	VCC
GND	6	15	GND
VCCA	7	14	ENABLE
DCLKOUT	8	13	REDY
RCLK	9	12	LOCKIN
ENERGI	10	11	LOCKRF

token ring LAN application diagram



TMS38051, TMS38052 RING INTERFACE CIRCUITS

pin descriptions

TMS38051

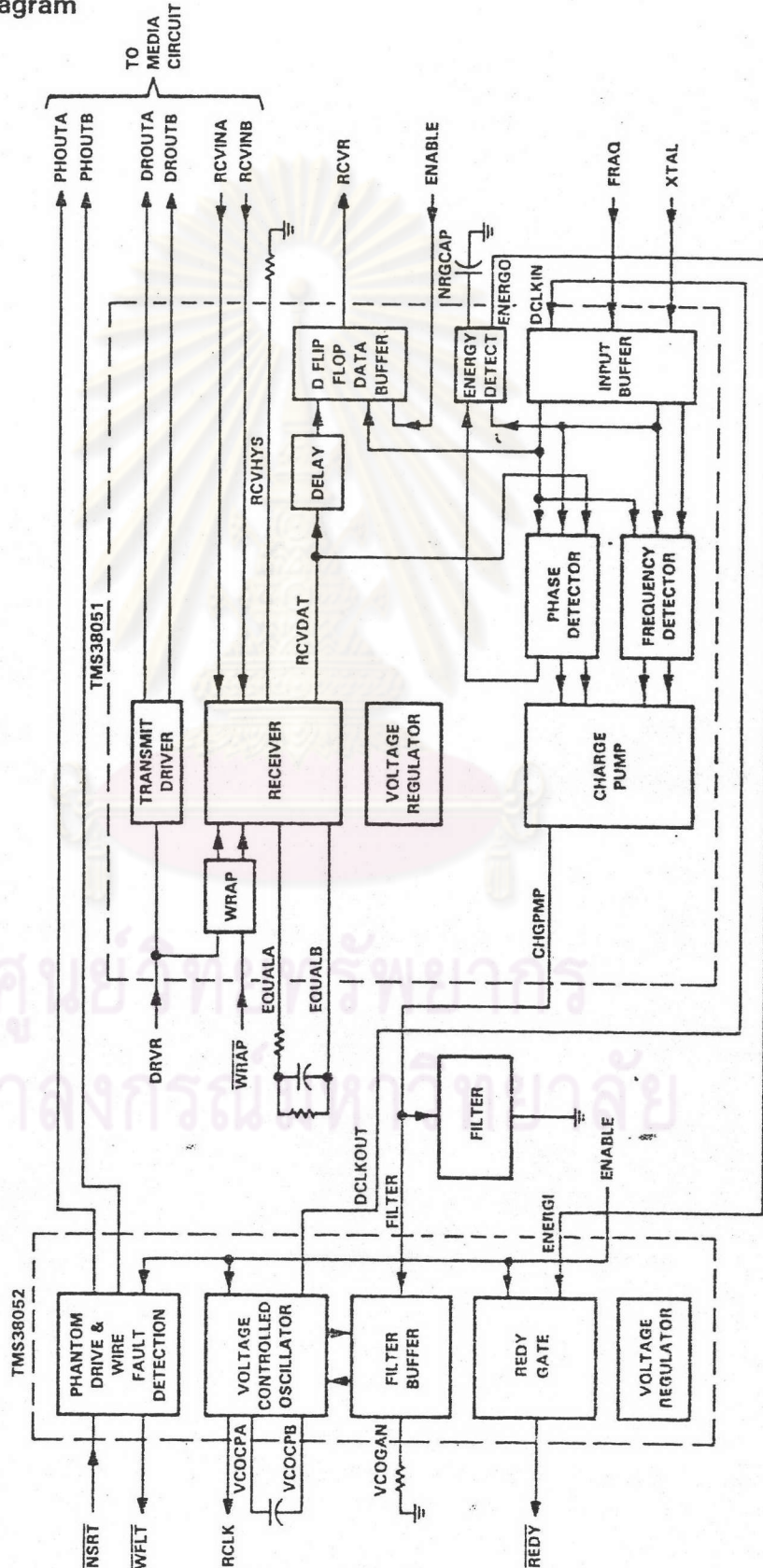
NAME	I/O	DESCRIPTION
RCVINA	I	Receiver Input A
RCVINB	I	Receiver Input B
EQUALA	I	Equalization/Gain Point A
EQUALB	I	Equalization/Gain Point B
RCVHYS	I	Receiver Hysteresis Resistor
RCVR	O	Receive Data
DRVR	I	Driver Data Input
DROUTA	O	Driver Output A
DROUTB	O	Driver Output B
CHGPMP	O	Charge-Pump Output
DCLKIN	I	Data-Latch Clock
NRGCAP	I	Energy-Detect Capacitor
ENERGO	O	Energy-Detect Output Signal to TMS38052
WRAP	I	Internal Wrap-Mode Control
ENABLE	I	Output-Enable Control
FRAQ	I	Frequency Acquisition Control
XTAL	I	Crystal-Oscillator Input
VCC		General 5-V Power
VCCA		Analog 5-V Power
GND		General Ground
GNDDRV		Ground for Driver Output
GND A		Analog Ground

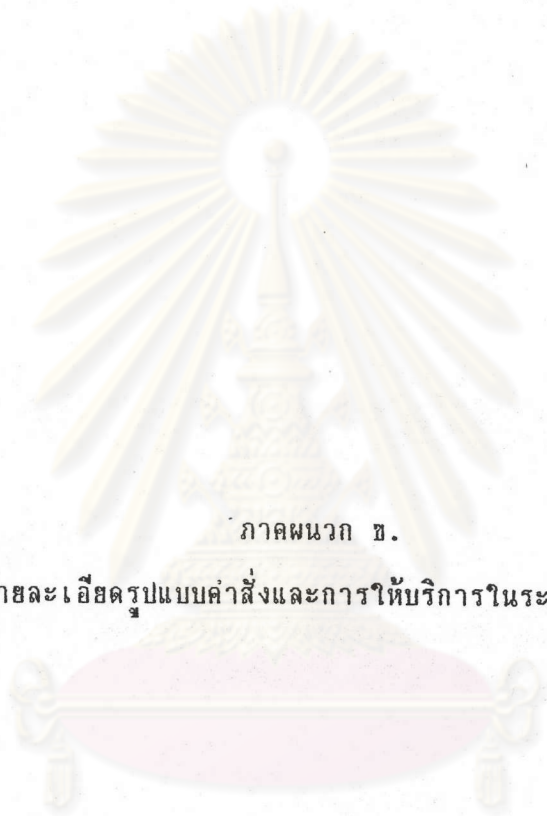
TMS38052

NAME	I/O	DESCRIPTION
NSRT	I	Phantom-Driver Control
PHOUTA	O	Phantom-Driver Output A
PHOUTB	O	Phantom-Driver Output B
WFLT	O	Wire-Fault Indicator
FILTER	I	Filter-Buffer Input
VCOGAN	I	VCO-Gain Resistor
VCOCPA	I	VCO Timing Capacitor Pin A
VCOCPB	I	VCO Timing Capacitor Pin B
RCLK	O	Recovered Clock
DCLKOUT	O	Data-Latch Clock
LOCKIN	I	Reserved, must be tied to ground.
LOCKRF	I	Reserved, must be tied to ground.
ENERGI	I	Energy-Detect Input Signal
RDY	O	Ready Signal
ENABLE	I	Output-Enable Control
VCC		General 5-V Power
VCCA		Analog 5-V Power
GND		General Ground
GNDREG		Ground for Voltage Regulator
GND A		Analog Ground

TMS38051, TMS38052 RING INTERFACE CIRCUIT

functional block diagram





ภาคผนวก ข.

รายละเอียดรูปแบบคำสั่งและการให้บริการในระดับ LLC

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Command	Inputs	Outputs	Summary
BUFFER_FREE (0x27)	station_id (*) first_buffer (*)	buffer_left	Returns one or more buffers to the SAP's buffer pool.
BUFFER_GET (0x26)	station_id (*) buffer_get	buffer_left first_buffer	Gets one or more buffers from the SAP's buffer pool.
DLC_CLOSE_SAP (0x16)	station_id (*)		Closes a SAP.
DLC_CLOSE_STATION (0x1A)	station_id (*)		Closes a link access station.
DLC_CONNECT_STATION (0x1B)	station_id (*) routing_addr		Places both local and remote stations in data transfer state.
DLC_FLOW_CONTROL (0x1D)	station_id (*) flow_control (*)		Sets a SAP or link access station busy status.
DLC_MODIFY (0x1C)	station_id (*) timer_t1 timer_t2 timer_ti maxout maxin maxout_incr max_retry_cnt access_priority group_count group_list		Modify working parameters for an open SAP or link access station.
DLC_OPEN_SAP (0x15)	timer_t1 timer_t2 timer_ti maxout maxin maxout_incr max_retry_cnt max_members max_i_field sap_value (*) options_priority group_count group_list dlc_status_exit dlc_buf_size dlc_pool_len dlc_pool_addr (*)	station_id	Activate a SAP and reserve SAP link access stations. A buffer pool is also assigned for the SAP.

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

DLC_OPEN_STATION (0x19)	sap_station_id (*) timer_t1 timer_t2 timer_ti maxout maxin maxout_incr max_retry_cnt rsap_value (*) max_i_field access_priority destination (*)	link_station_id	Allocates local resources for a link access station in preparation for establishing a connection.
DLC_RESET (0x14)	station_id (*)		Reset a SAP and all associated link access stations. If a station_id of 0x0000 is used, all SAPs and link access stations are reset.
DLC_SET_THRESHOLD D (0x33)	station_id (*) buffer_threshold (*) alert_semaphore (*)		This command applies to OS/2 only and is not available for DOS.
DLC_STATISTICS (0x1E)	sap_station_id (*) log_buf_length (*) log_buf_addr (*) options	log_act_length	Read (and optionally reset) a DLC log.
DLC_CLOSE_ADAPTE R (0x04)	lock_code (if opened with a lock code)		Close an adapter and terminate network communication.
DIR_CLOSE_DIRECT (0x34)			This command applies to OS/2 only and is not available for DOS.
DIR_DEFINE_MIF_EN VIRONMENT (0x2B)	ncb_input (*) ncb_open (*) ncb_close (*)	ncb_enable	This command allows a NetBIOS emulator to operate with the adapter support software.
DIR_INITIALIZE (0x20)	sram_address adptr_chk_exit netw_status_exit pc_error_exit	bring_ups sram_address	This command initializes the adapter, resets all adapter tables and buffers, and performs bring-up tests.
DIR_INTERRUPT (0x00)			This command forces an adapter interrupt but performs no action (a NOP).
DIR_MODIFY_OPEN_ PARMS (0x01)	dir_buf_size dir_pool_blocks dir_pool_address adpt_chk_exit netw_status_exit pc_error_exit open_options		This command allows you to modify many default values set when an adapter was opened.

DIR_OPEN_ADAPTER (0x03)	adapter_parms (*) direct_parms (*) dic_parms (*) ncb_parms (NOTE: The contents of the four structures are de- scribed fully in Section 4.3.2)	Various - see section 4.3.2	This command opens the adapter and reinitializes all buffers and tables. Parame- ter structures set defaults for use within the adapter.
DIR_RESTORE_OPEN _PARAMETERS (0x02)			This command is used to restore adapter parameters set when the adapter was opened after they have been modified with DIR_MODIFY_OPEN_PA RMS.
DIR_SET_EXCEPTION _FLAGS (0x2D)			This command applies to OS/2 only.
DIR_SET_FUNCTION AL_ADDRESS (0x07)	bits_to_change (*)		This command allows you to temporarily modify the adapter's internal address used for receiving frames from the token ring net- work.
DIR_SET_GROUP_AD DRESS (0x06)	bits_to_change (*)		This command allows you to temporarily modify the adapter's internal group address.
DIR_SET_USER_APPE NDAGE (0x2D)	adpt_chk_exit netw_status_exit pc_error_exit		This command allows you to set (or modify) the adapt- ers interrupt service func- tions you wish called on certain conditions.
DIR_STATUS (0x21)		encoded_addr node_address group_address functional_addr max_sap open_sap max_station open_station avail_station adapter_config microcode_level adapter_parms_addr adapter_mac_addr tick_cntr_addr last_ntwk_status	This command returns sta- tus information about the adapter.

PDT_TRACE_ON (0x24)	table_length (*)	current_off start_tick_0 stop_tick_0 start_tick_1 stop_tick_1	This command logs all interrupts for adapter traffic.
PDT_TRACE_OFF (0x25)			This command stops logging of all interrupts for adapter traffic.
PURGE_RESOURCES (0x36)			This command applies to OS/2 only.
READ (0x31)			This command applies to OS/2 only.
READ_CANCEL (0x32)			This command applies to OS/2 only.
RECEIVE (0x28)	station_id (*) user_length (*) received_data options	first_buffer	This command is used to receive all DLC data, whether connection oriented or datagram.
RECEIVE_CANCEL (0x29)	station_id (*)		This command cancels an outstanding receive command.
RECEIVE_MODIFY (0x2A)	station_id (*) user_length received_data subroutine (*)	first_buffer	This command receives specially formatted data and places it into both the SAP buffer pool and a user buffer.
TRANSMIT_I_FRAME (0x0B)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits a frame of data over a connection.
TRANSMIT_TEST_CMD (0x11)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits a test command frame with the poll bit set.

ศูนย์ทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

DIR_TIMER_CANCEL (0x23)	ccb_pointer (*)		This command cancels a timer set with DIR_TIMER_SET.
DIR_TIMER_CANCEL_GROUP (0x2C)	post (*)		This command cancels all timers whose post address (from the CCB) is equal to post.
DIR_TIMER_SET (0x22)	time (*)		This command starts a programmable timer set to interrupt your application at time * 5 seconds. Upon expiration, the post routine (from the CCB block) will be executed.
TRANSMIT_UI_FRAME (0x0D)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits a datagram.
TRANSMIT_XID_CMD (0x0E)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits an XID (transmit ID) command with the poll bit set to on.
TRANSMIT_XID_RESP_FINAL (0x0F)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits an XID response with the final bit on.
TRANSMIT_XID_RESP_ONSE_NOT_FINAL (0x10)	station_id (*) rsap (*) xmit_queue_one xmit_queue_two buffer_len_one buffer_len_two buffer_one buffer_two	transmit_fs	This command transmits an XID response with the final bit off.

Code	Name	Description	Action
0x00	SUCCESS	Operation completed normally.	None.
0x01	INVALID_COMMAND	The command code passed in the CCB was invalid.	Use a valid code.
0x02	DUPLICATE_COMMAND	Only one command of this type can be outstanding at a time, but you tried to execute a second one.	Wait for the earlier command to complete.
0x03	ADAPTER_OPEN	This command requires that the adapter be closed, but the adapter is already open.	Close the adapter.
0x04	ADAPTER_CLOSED	This command requires that the adapter be open, but the adapter is closed.	Open the adapter.
0x05	MISSING_PARAM	A required parameter was not provided.	Check your input parameters to be sure that no required parameters are coded to zero.
0x06	INVALID_OPTIONS	An invalid option was provided, or a combination of options is invalid.	Check your option lists and try again.
0x07	UNRECOVERABLE_FAILURE	The adapter has been closed because of an unrecoverable error condition.	Determine the cause of the error, correct the error if necessary, then initialize and open the adapter.
0x08	UNAUTHORIZED_PRIORITY	The requested access priority is not authorized for this adapter.	Use a lower priority. 0 is always valid.
0x09	NOT_INITIALIZED	The adapter must be initialized for this command to work, and it has not been initialized.	Initialize the adapter.
0x0A	USER_CANCEL	The command was successfully cancelled per user request.	None.
0x0B	CLOSE_CANCEL	The adapter was closed while this command was in progress.	Determine why the adapter was closed.
0x0C	NOT_OPEN_SUCCESS	The command completed, although the adapter is not opened.	None.
0x10	NETBIOS_FAILURE	NetBIOS was accessed but it is not loaded, or one or more NetBIOS parameters used during the adapter open command was invalid.	If you will be using NetBIOS, close the adapter, correct the problems, then reopen the adapter.
0x11	TIMER_ERROR	A timer value for timer_set or timer_cancel is not in the range of 0-13107, or you tried to cancel a timer which was never set.	Correct and try again.

0x12	WORK_AREA_OVERFLOW	The available work area has overflowed. The work area includes the adapter's internal memory and the application provided work space.	Reduce the values for max_station and/or max_sap. You can also increase the memory made available to the adapter to match the value returned in the work_len_act field.
0x13	INVALID_LOG_ID	The requested log_id is not defined.	Correct and retry.
0x14	INVALID_RAM	The shared RAM segment or size is invalid.	Adjust the value. Values must often be even multiples of 16.
0x15	LOG_OVERFLOW	The buffer allocated for the log was too small, resulting in the loss of some statistics. The information that overflowed is permanently lost if the command indicated reset.	Be sure to use a buffer size which is large enough.
0x16	BUFFER_TOO_LARGE	The requested buffer size cannot be satisfied using the SAP buffer pool.	Increase the SAP buffer pool size or decrease the requested buffer size.
0x17	NETBIOS_OPERATIONAL	Attempt to change a NetBIOS parameter which is currently being used by NetBIOS.	Close, then reopen the adapter.
0x18	INVALID_BUFFER_LENGTH	The specified SAP buffer size is invalid.	The size must be at least 80 bytes and a multiple of 16.
0x19	NO_BUFFERS	Inadequate buffers remain to satisfy the request.	Retry with fewer buffers or wait for more buffers to become available.
0x1A	USER_LENGTH_TOO_LARGE	The user requested area is too large for the available buffer sizes.	Reduce the user length field value.
0x1B	PARAMETER_INVALID	The CCB parameter field pointer is invalid. This can be caused by the pointer pointing into the PC system interrupt vector area or being too near the end of the segment which will cause wrap-around for some of the fields.	Correct and retry.
0x1C	INVALID_POINTER	A pointer within a parameter table is invalid.	Correct and retry.
0x1D	INVALID_CCB_ADAPTER	The ccb_adapter value is outside of the prescribed range.	Correct and retry.
0x20	LOST_DATA_NO_BUFFERS	There were no available buffers in the SAP's buffer pool when a frame was received, resulting in lost data. This error only occurs for connectionless transmissions.	Free some buffers (buffer_free), then retry.

0x21	LOST_DATA_BUFFER_OVERFLOW	There was inadequate space in the SAP's buffer pool to hold a received frame. Part of the frame will be lost. This message only occurs for connectionless transmissions.	Free some buffers, then retry.
0x22	TRANSMIT_ERROR	The frame was not successfully transmitted.	Check the FS byte in the OCB to determine the cause of failure.
0x23	FRAME_ERROR	A frame error was detected during transmission. This may indicate that corrupted data was received by the destination.	Application specific.
0x24	UNAUTHORIZED_MAC	An attempt was made to send a MAC frame which this adapter was not authorized to do. Possible causes include an invalid source class, an attempt to send a MAC frame or a SAP, or an attempt to send a MAC frame on the PC Network (not token ring).	Adjust the source class value and try again.
0x25	MAX_XMIT_CMDS	128 transmit commands are already cued for this station.	Wait for some commands to complete.
0x27	LINK_NOT_AVAILABLE	An error was detected over a connection, causing the connection to be closed.	Try to re-open the connection using dlc_connect_station.
0x28	INVALID_FRAME_LENGTH	The frame length is too short to contain header information or too long for the transmit buffer. If you are using a connection, this error also causes the connection to enter a disconnected state.	Modify the frame length. For connection, re-open the connection.
0x30	INADEQUATE_RCV_BUFFERS	There were an inadequate number of receive buffers allocated when the adapter was opened.	Free up RAM using open adapter parameters.
0x32	NODE_ADDRESS	The defined node address is invalid.	The node address contains an unallowed bit or number.
0x33	INVALID_REC_BUFFER_LENGTH	The receive buffer length is over the allowed maximum, less than the allowed minimum, or not a multiple of 8.	Adjust and retry.

0x34	INVALID_XMIT_BUF_LEN	The transmit buffer length is over the allowed maximum, less than the allowed minimum, or not a multiple of 8.	Adjust and retry.
0x40	INVALID_STATION_ID	The station_id either does not exist or is not valid for this particular command.	Be sure that you are using the SAP or link access station station_id as assigned by the adapter.
0x41	PROTOCOL_ERROR	Attempt to connect a link station while the link is disconnected or closed (you must first open it), or to transmit over a connection which is not connected.	Correct your application code.
0x42	PARAMETER_TOO_LARGE	One or more parameters exceed the maximum allowed.	Correct and retry.
0x43	INVALID_SAP	The SAP value is either invalid or already in use.	Invalid SAPs are the null, global, and group sap. Correct and retry.
0x44	INVALID_ROUTE	The routing field is too short, larger than 18 bytes, or an odd number of bytes long.	Correct and retry.
0x45	INVALID_GROUP_REQUEST	An attempt was made to join a nonexistent group.	Correct and retry.
0x46	INADEQUATE_LINK_STATIONS	When opening a SAP, this error indicates that the adapter has inadequate link stations remaining to satisfy the request. When opening a station, this error indicates that all assigned link stations for this SAP are already in use.	Correct and retry.
0x48	LINK_STATION_OPEN	An attempt was made to close a SAP which has one or more link stations open.	Close the link stations prior to closing the SAP.
0x49	GROUP_SAP_FULL	The group SAP is currently full.	Application specific.
0x4A	SEQUENCE_ERROR	The station is closing or establishing a connection while you are attempting to execute a command.	Wait for the command to complete before trying your command.
0x4B	STATION_CLOSE_NO_ACK	The station closed without remote acknowledgment.	Application specific.
0x4C	OUTSTANDING_COMMANDS	Attempt to close a link station while outstanding commands are queued.	Wait until commands complete or issue a reset.
0x4D	NO_CONNECTION	The link station could not establish a connection.	Verify rsap values, routing information, the remote adapter address, and physical connectivity, then try again.
0x4F	INVALID_ADDRESS	The remote address is not valid because the high bit is set to 1 which indicates a group address, but a group address is not allowed for this command.	Correct the remote address.

ตารางแสดงคำสั่ง LLC(DLC) ของ IBM เทียบกับของ TMS380

IBM TOKREUI COMMAND	TMS380 COMMAND	COMMENTS
DIR.CLOSE.ADAPTER	CLOSE	
DIR.CONFIG.BRIDGE.PARMS	CONFIG.BRIDGE.PARMS	
DIR.INITIALIZE	INITIALIZATION PROCEDURE	EXECUTED THRU DIO
DIR.INTERRUPT	DIR.INTERRUPT	
DIR.MODIFY.OPEN.PARAMETERS	MODIFY.OPEN.PARAMETERS	
DIR.OPEN.ADAPTER	OPEN	
DIR.READ.LOG	READ.ERROR.LOG	
DIR.RESTORE.OPEN.PARAMETERS	RESTORE.OPEN.PARAMETERS	
DIR.SET.BRIDGE.PARAMETERS		DEPENDENT ON SPECIFIC BRIDGE IMPLEMENTATION
DIR.SET.FUNCTIONAL.ADDRESS	SET.FUNCTIONAL.ADDRESS	
DIR.SET.GROUP.ADDRESS	SET.GROUP.ADDRESS	
DIR.STATUS	READ.ADAPTER	CAN BE USED TO GET STATUS INFORMATION
DLC.CLOSE.SAP	CLOSE.SAP	
DLC.CLOSE.STATION	CLOSE.STATION	
DLC.CONNECT.STATION	DLC.CONNECT.STATION	
DLC.FLOW.CONTROL	DLC.FLOW.CONTROL	
DLC.MODIFY	MODIFY.LLC.PARMS	
DLC.OPEN.SAP	OPEN.SAP	
DLC.OPEN.STATION	OPEN.STATION	
DLC.REALLOCATE	LLC.REALLOCATE	
DLC.RESET	LLC.RESET	
DLC.STATISTICS	STATION.STATS	
RECEIVE	RECEIVE	
RECEIVE.CANCEL		USE RECEIVE.CANCEL INTERRUPT
RECEIVE.MODIFY	RECEIVE	USE RECEIVE.VALID INTERRUPT
TRANSMIT.DIR.FRAME	TRANSMIT	FRAME TYPE = 000
TRANSMIT.I.FRAME	TRANSMIT	FRAME TYPE = 110
TRANSMIT.UI.FRAME	TRANSMIT	FRAME TYPE = 001
TRANSMIT.TEST.CMD	TRANSMIT	FRAME TYPE = 101
TRANSMIT.XID.CMD	TRANSMIT	FRAME TYPE = 010
TRANSMIT.XID.RESP.FINAL	TRANSMIT	FRAME TYPE = 011
TRANSMIT.XID.RESP.NOT.FINAL	TRANSMIT	FRAME TYPE = 100
BUFFER.FREE	- EXECUTED ENTIRELY BY PC SOFTWARE	
BUFFER.GET	- EXECUTED ENTIRELY BY PC SOFTWARE	
DIR.TIMER.SET	- EXECUTED ENTIRELY BY PC SOFTWARE	
DIR.TIMER.CANCEL	- EXECUTED ENTIRELY BY PC SOFTWARE	
DIR.TIMER.CANCEL.GROUP	- EXECUTED ENTIRELY BY PC SOFTWARE	
DIR.SET.USER.APPENDAGE	- EXECUTED ENTIRELY BY PC SOFTWARE	
DIR.DEFINE.MIF.ENVIRONMENT	- EXECUTED ENTIRELY BY PC SOFTWARE	
PDT.TRACE.ON	- EXECUTED ENTIRELY BY PC SOFTWARE	
PDT.TRACE.OFF	- EXECUTED ENTIRELY BY PC SOFTWARE	



ประวัติผู้เขียน

ข้าพเจ้า นาย ภาสกร ไหลสกุล เกิดเมื่อวันที่ 2 ตุลาคม พ.ศ.2505 ณ.จังหวัด
อุทัยธานี จบการศึกษาระดับปริญญาตรีจาก ภาควิชาวิศวกรรมไฟฟ้า คณะวิศวกรรมศาสตร์ มหา
วิทยาลัยสงขลานครินทร์เมื่อปีการศึกษา 2527 และเข้าทำงานในตำแหน่ง system engineer
บริษัท ไทยสงวนพาณิชย์วิศวกรรมจำกัด เป็นเวลาประมาณ 1 ปี แล้วได้เข้าทำการศึกษาต่อใน
หลักสูตรวิทยาศาสตรมหาบัณฑิต ที่จุฬาลงกรณ์มหาวิทยาลัย เมื่อ พ.ศ.2529 และภายหลังจาก
การเสร็จสิ้นการศึกษาภาคทฤษฎี ได้เข้าทำงานในบริษัท KS.Brotherbox(Thailand) จำกัด
ในตำแหน่ง system programmer เป็นเวลา 1 ปี ภายหลังจากนั้นได้ทำงานอยู่บริษัท
มาบุญครองเอ็นเตอร์ไพรส์ จำกัด และ บริษัท ไทยเซลล์ จำกัด อยู่ช่วงระยะเวลาหนึ่ง แล้วลา
ออกมาทำวิทยานิพนธ์ฉบับนี้

ศูนย์วิทยุโทรคมนาคม
จุฬาลงกรณ์มหาวิทยาลัย