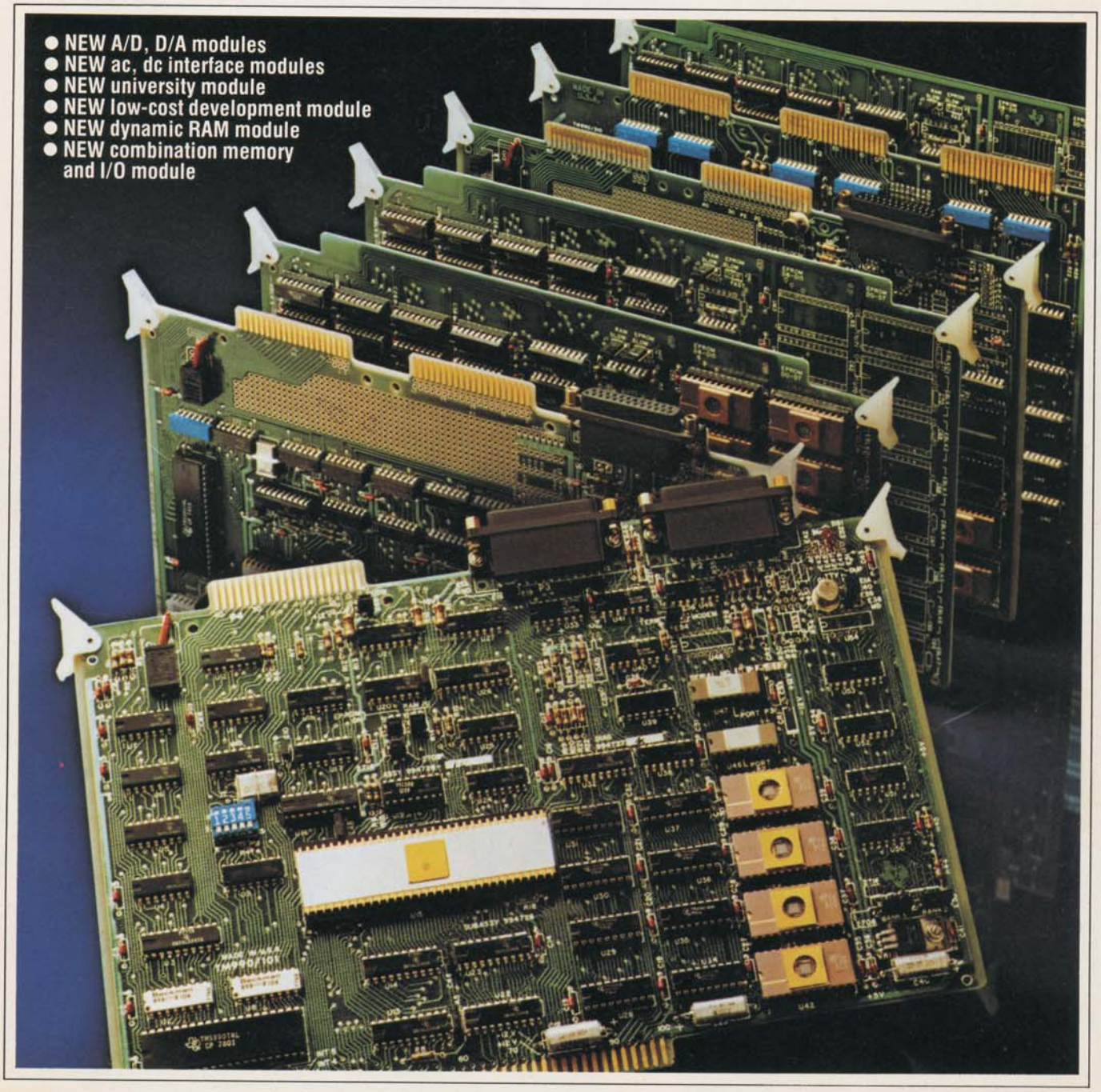
Bulletin CL-377C

NEW ADDITIONS

TM 990 Series 16-bit Microcomputer Modules from Texas Instruments



Fifty Years of Innovation

TM 990 Series:
The first choice in micro Maximum savings. Mini

Take the shortcut. TI's TM 990 Series microcomputer modules. The wide, proven choice available here and now to meet your system design needs. These modules are simple to apply. Economical. The easy route to the power and performance of TI's 16-bit 9900 First Family.

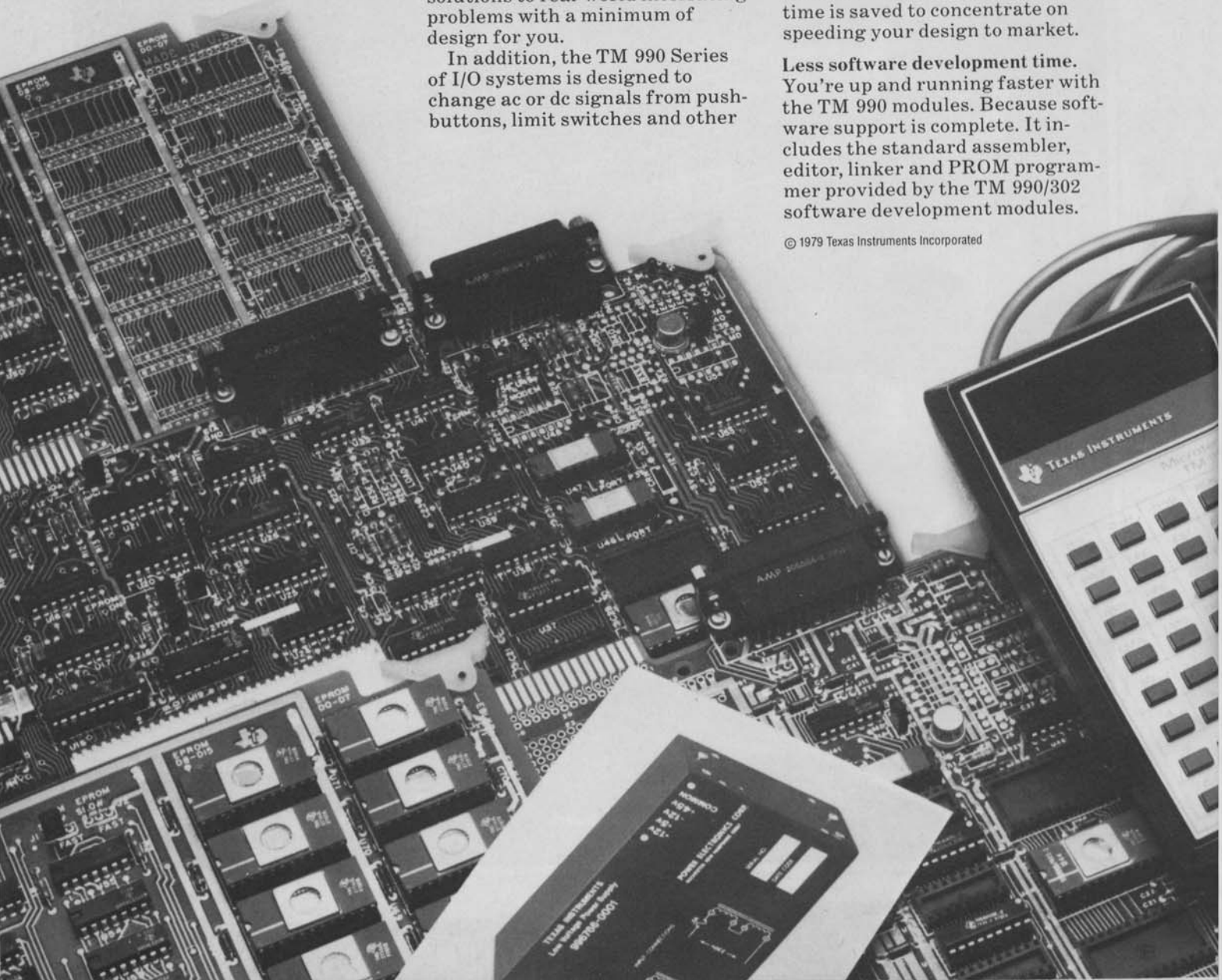
Less design time. CPU modules incorporate microprocessor, memory, and I/O on a single board. They come preassembled. Pretested. Ready to use. With the result that you are spared much time-consuming planning. For example, all system interconnects are determined for you.

Further, the TM 990 bus is widely recognized and compatible. Modules are available throughout the industry to expand system features. This capability provides solutions to real-world interfacing problems with a minimum of design for you.

In addition, the TM 990 Series of I/O systems is designed to change ac or dc signals from pushbuttons, limit switches and other pilot devices into low, TM 990-compatible logic levels. Systems are available to convert TM 990 logic levels into high ac or dc output signals to drive such loads as motor starters, contactors, positioning valves, and pilot lights.

Just order TM 990 modules and you've got hardware quickly in hand... hardware you know will work reliably from the outset because TI makes the components and assembles the modules. Your time is saved to concentrate on speeding your design to market.

Less software development time. You're up and running faster with the TM 990 modules. Because software support is complete. It includes the standard assembler, editor, linker and PROM programmer provided by the TM 990/302 software development modules.



computers.
mum risk.

Additional support tools include TIBUG* interactive debug monitor; POWER BASIC* high level language; the DX 10 multiuser software development system; and TI's Advanced Microprocessor Prototyping Lab (AMPL*).

Less programming time. As members of TI's pace-setting 9900 First Family, these microcomputer modules are based on the family's advanced memory-to-memory architecture. This innovative approach requires fewer instructions to perform a given function. This, in conjunction with a common instruction set, substantially reduces programming time and effort.

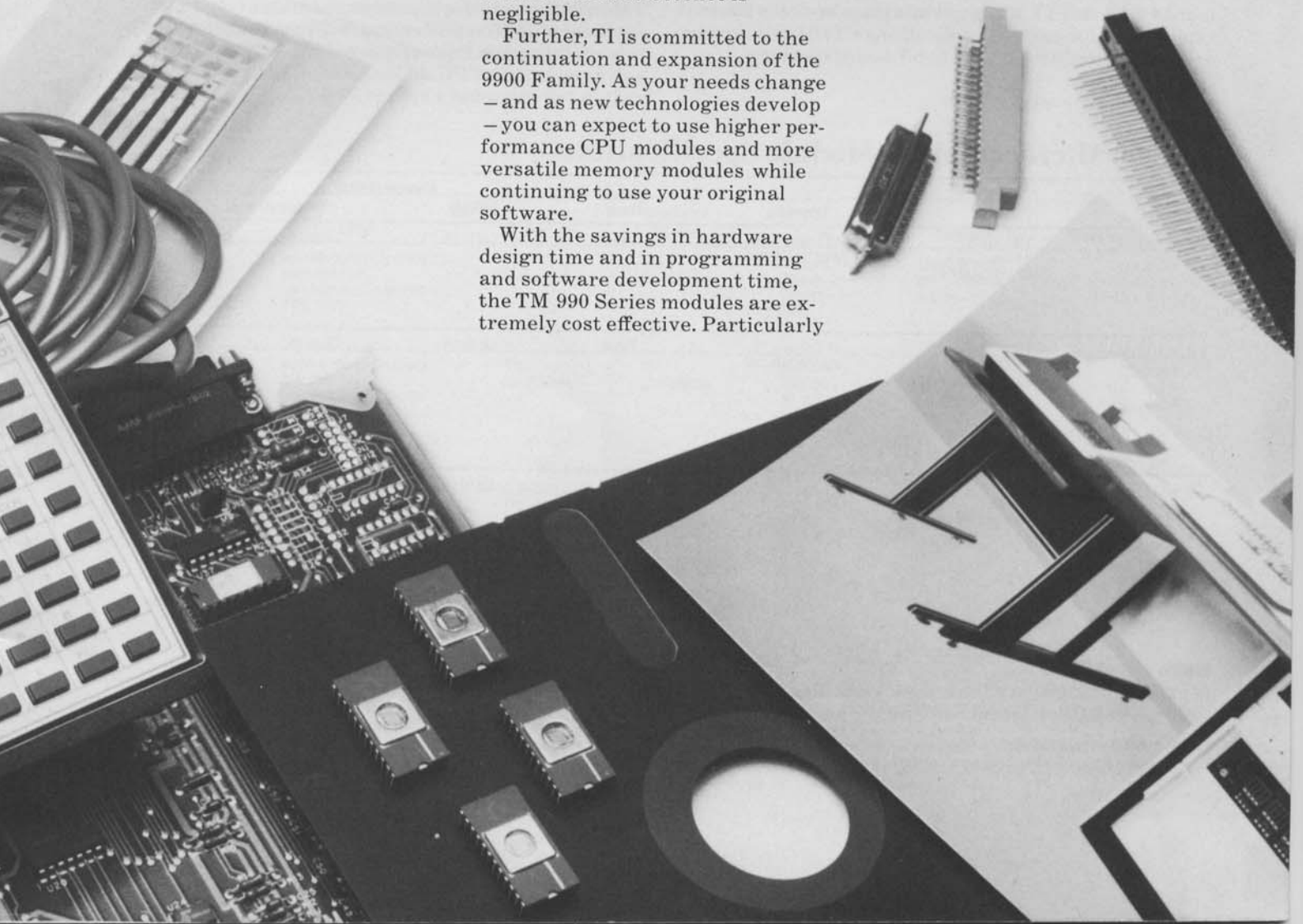
Greater software protection. The 9900 Family has been carefully structured to provide a mutual compatibility that preserves your software investment and avoids software "migration" expense. Which means you don't have to spend today worrying whether your software will apply as you upgrade components or change applications tomorrow. Your risk of software obsolescence is negligible.

Further, TI is committed to the continuation and expansion of the 9900 Family. As your needs change – and as new technologies develop – you can expect to use higher performance CPU modules and more versatile memory modules while continuing to use your original software.

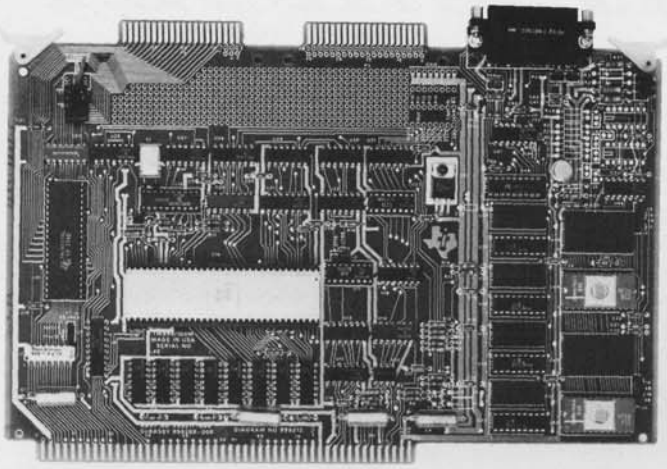
With the savings in hardware design time and in programming and software development time, the TM 990 Series modules are extremely cost effective. Particularly when you consider that CPU module prices begin at about the cost of an 8-bit system.

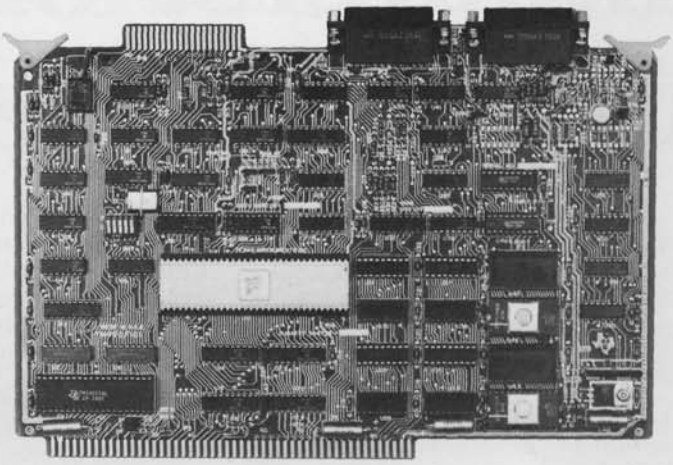
The TM 990 Series modules are available from your nearest authorized TI distributor. Many of these distributors now operate TI Microprocessor System Centers to help you in your applications. Microprocessor specialists are also on hand in TI field sales offices, and TI maintains extensive learning facilities in Austin, Texas, for in-depth training on sophisticated development systems.

*Trademark of Texas Instruments Incorporated



Microcomputer Modules





TM 990/100M

• TMS 9900 16-bit CPU • Up to 1K bytes of RAM • Up to 8K bytes of EPROM • TMS 9901 programmable system interface • TMS 9902 asynchronous communications controller; TMS 9903 synchronous communications controller optional plug-in replacement • EIA or TTY terminal interface option • Prototyping area for custom applications • TIBUG operating monitor • DMA* to off-board memory

*Requires external control circuitry

TM 990/101M

• TMS 9900 16-bit CPU • Up to 4K bytes of RAM • Up to 8K bytes of EPROM • DMA* to off-board and on-board memory • TMS 9901 programmable system interface • Two serial I/O ports using TMS 9902 asynchronous communications controllers (one TMS 9903 synchronous communications controller optional plug-in replacement) • Three programmable interval timers • Edge triggered interrupt, with software reset • CPU addressable LED and DIP switch for customer applications

TM 990 Microcomputer Module Specifications

Module	CPU	Interrupts	Interval Timer	Memory (Bytes) EPROM	RAM	OFF Board
TM 990/100M	TMS 9900 3 MHz 69 Instructions	16 Levels—15 may be external	Two	Up to 8K	Up to 1K	Up to 64K
TM 990/101M	TMS 9900 3 MHz 69 Instructions	16 Levels—15 may be external	Three	Up to 8K	Up to 4K	Up to 64K
TM 990/180M	TMS 9980 2.5 MHz 69 Instructions	6 Levels—4 may be external	Two	Up to 4K	Up to 1K	Up to 16K

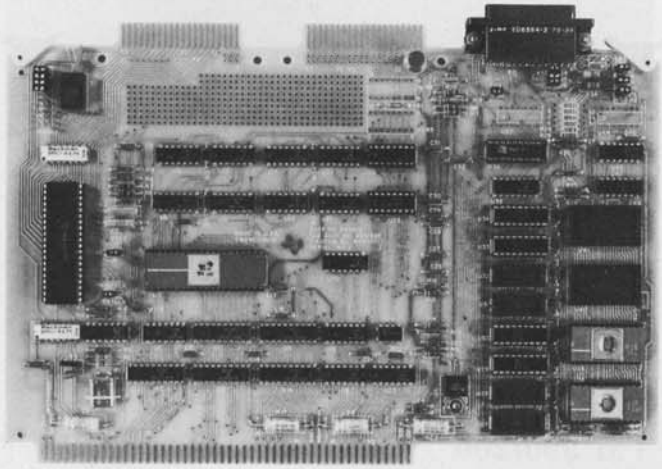
Ordering Information

TM 990/100M-1 — TMS 9900 microcomputer module with TIBUG monitor in two 8K ROM/EPROMs and EIA or TTY serial I/O jumper option.

TM 990/100M-2 — TMS 9900 microcomputer module with unprogrammed TMS 2708 EPROMs and EIA or differential line driver jumper option.

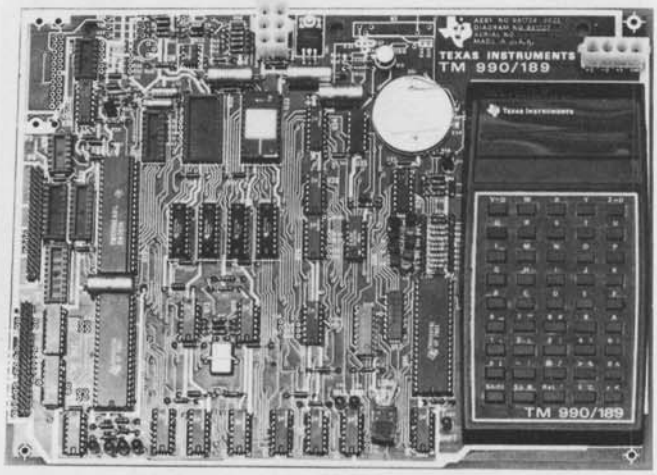
TM 990/100M-3 — TMS 9900 microcomputer module with fully expanded memory (four TMS 2716 EPROMs and eight TMS 4042-2 RAMs) and EIA or differential line driver jumper option.

TM 990/101M-1 — TMS 9900 microcomputer module with TIBUG monitor in two 8K ROM/EPROMs and TTY, EIA, and microterminal on the local serial port. The remote serial port supports synchronous/asynchronous communications.



TM 990/180M

• Stand-alone evaluation module • TMS 9980 16-bit CPU • Up to 1K bytes of RAM • Up to 4K bytes of EPROM • TMS 9901 programmable system interface • TMS 9902 asynchronous communications controller; TMS 9903 synchronous communications controller optional plug-in replacement • EIA or TTY terminal interface option • Prototyping area for custom applications



TM 990/189

• Stand-alone educational module for teaching microcomputer fundamentals, machine and assembly language programming, and microcomputer interfacing • Alpha-numeric keyboard and display • Complete tutorial text included • See page 12 for more information

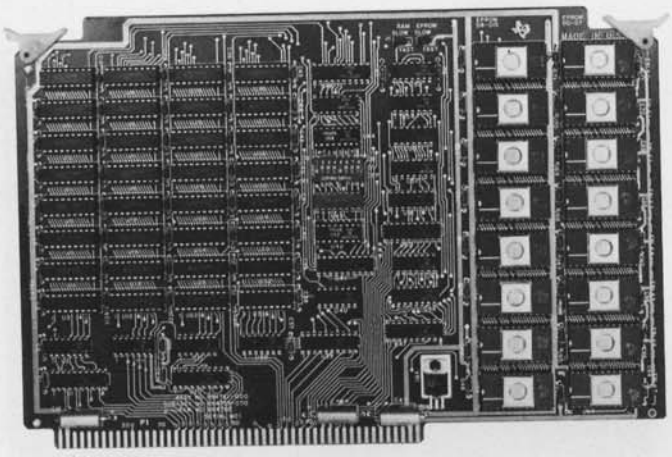
Input/Output			Interfaces			
Parallel	Serial	Bus	Parallel	Serial	Software	Power Requirements (±3%)
16 Bits expandable to 4K	Asynchronous Controller TMS 9902 or Synchronous Controller TMS 9903	TTL Compatible	TTL Compatible	RS232C or 20 mA Current loop	TIBUG Monitor self-contained in EPROM	5 V, 1.3 A 12 V, 0.2 A −12 V, 0.1 A
16 Bits expandable to 4K	Asynchronous Controller TMS 9902 or Synchronous Controller TMS 9903	TTL Compatible	TTL Compatible	Port A — RS232C or 20 mA Current loop Port B — RS232C or Modem	TIBUG Monitor self-contained in EPROM	5 V, 1.6 A 12 V, 0.2 A −12 V, 0.2 A
16 Bits expandable to 2K	Asynchronous Controller TMS 9902	TTL Compatible	TTL Compatible	RS232C or 20 mA Current loop or Multidrop	TIBUG Monitor self-contained in EPROM	5 V, 1.3 A 12 V, 0.2 A −12 V, 0.1 A

TM 990/101M-2 — TMS 9900 microcomputer module with unprogrammed TMS 2708 EPROMs and multidrop. EIA, and microterminal option on the local series port The remote serial port supports synchronous/asynchronous communications.

TM 990/101M-3 — TMS 9900 microcomputer module with fully expanded memory (four TMS 2716 EPROMs and eight TMS 5045-45 RAMs) and TTY, EIA, and microterminal on the local serial port. The remote port supports synchronous/asynchronous communications.

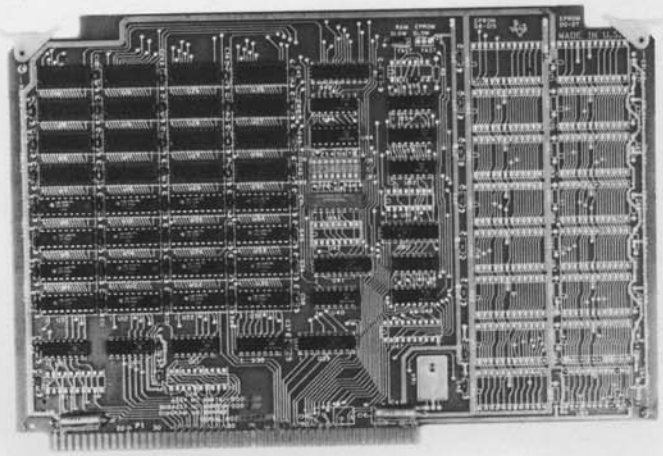
TM 990/180M-1 — TMS 9980 CPU module with TIBUG monitor in two 8K ROM/EPROMs and EIA or TTY serial I/O jumper option.

Memory Expansion Modules



TM 990/201

• 8K bytes of TMS 2716 EPROM expandable to 32K bytes • 4K bytes TMS 4045 static RAM expandable to 16K bytes • Jumper selectable access time • TTL-compatible interface



TM 990/206

• 8K bytes of TMS 4045 static RAM expandable to 16K bytes • Jumper selectable access time • TTL-compatible interface

Memory Module Specifications

	TM 990/201			TM 990/206	
Memory Configuration	TMS 4045-45, 1K x 4 static RAM TMS 2716, 2K x 8 EPROM			TMS 4045-45, 1K x 4 static RAM	
Typical Power Requirements for Various Model Numbers (±3%)	**-41**	**-42**	**-43**	**-41**	**-42**
5 V	1.0 A	1.4 A	2.15 A	1.3 A	2.15 A
12 V	0.16 A	0.225 A	0.475 A	Not required	Not required
−12 V	0.05 A	0.125 A	0.225 A	Not required	Not required
Cycle Time					
Memory Device Access Time	450 ns	450 ns	450 ns	450 ns	450 ns
Memory Cycle Time at 3 MHz	1.0 μs	1.0 μs	1.0 μs	1.0 μs	1.0 μs
Bus Interface					
Data and Address	Three-state TTL compatible			Three-state TTL compatible	
Control	TTL compatible			TTL compatible	
Temperature Range	0-70° C			0-70° C	

Ordering Information

TM 990/201-41 – 8K bytes EPROM, 4K bytes SRAM, half socketed

TM 990/201-42 – 16K bytes EPROM, 8K bytes SRAM, fully socketed

TM 990/201-43 – 32K bytes EPROM, 16K bytes SRAM, fully socketed

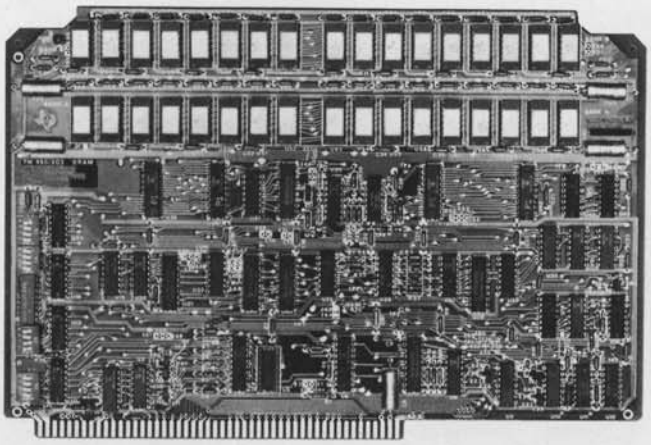
TM 990/203-21 – 16K bytes DRAM

TM 990/203-22 – 32K bytes, expandable 64 bytes, DRAM

TM 990/203-23 – 64K bytes DRAM

TM 990/206-41 – 8K bytes SRAM, sockets for 16K bytes

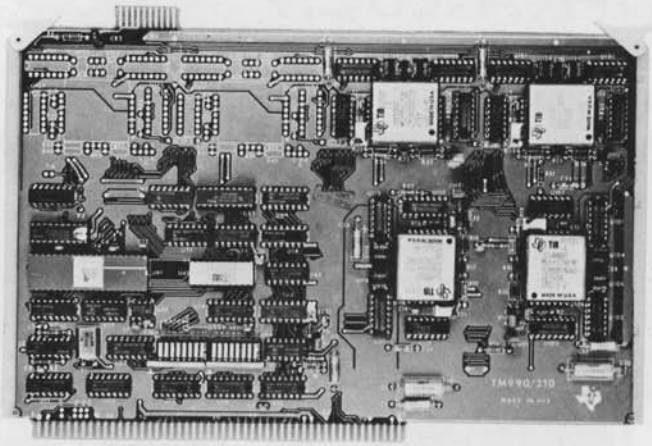
TM 990/206-42 – 16K bytes SRAM, fully socketed



TM 990/203

• Up to 64K bytes of dynamic RAM • Jumper selectable access times • Parity option provides parity indicator light and interrupt signal • Cycle steal or transparent refresh modes

TM 990/203		
TMS 4027, 4K x 1 dynamic RAM TMS 4116, 16K x 1 dynamic RAM		
4027 -21	4116 -22	4116 -23
2.0 A 0.2 A 0.01 A	1.95 A 0.125 A 0.01 A	2.1 A 0.225 A 0.01 A
250 ns 0.667 μs	250 ns 0.667 μs	250 ns 0.667 μs
Three-state TTL compatible TTL compatible		
0-70° C		

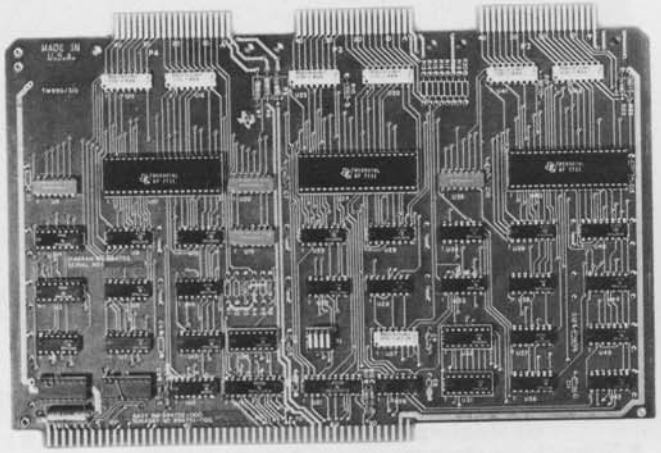


TM990/210 Bubble Memory Module

• Non-volatile memory storage • Up to 64K bytes of data storage • Memory-mapped data transfers (single or multiphase) • 0-50°C temperature range • Write/protect feature on two bubbles

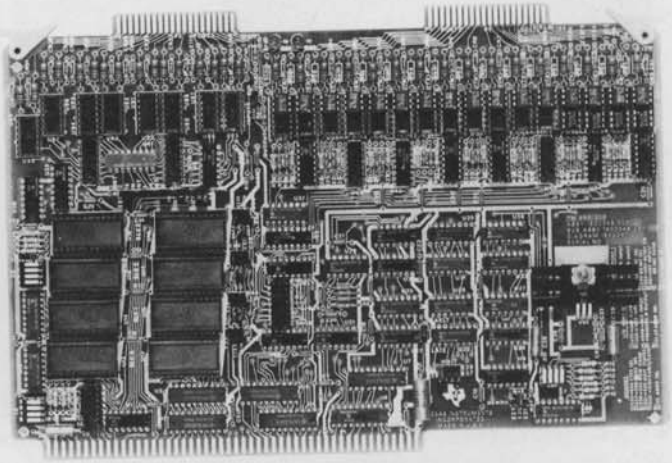
TM990/210			
Memory Configuration TIB0203S 1 × 92K Magnetic Bubble Memory			
Typical Power Requirements for Various Model Numbers (±3%)	-1	-2	-3
5V	0.87A	1A	1.1A
12V	0.035A	0.35A	0.35A
-12V (idle)	0.095A	0.19A	0.29A
-12V (active)	0.245A	0.33A	0.42A
Cycle Time	Access time: 860 μs minimum to 7.3 ms maximum Average time: 4 ms Continuous data transfer rate: 44K bits/sec		
Temperature range	0-50°C		

I/O Expansion Modules



TM 990/310

• 48 I/O bits programmable either as inputs or outputs • Up to 27 I/O lines may be programmed as prioritized, unlatched interrupts • Three real time clocks • Three positive and three negative edge-triggered and latched, prioritized interrupt inputs



TM 990/305

• Combination memory and I/O module • Memory capacity up to 32K bytes using TMS 2516 or TMS 2532 EPROMs • Memory map configuration is jumper selectable • 32 optically isolated I/O lines, 16 dedicated input lines and 16 user configurable I/O lines • Designed to accommodate new pin-compatible SRAMs now in development

Expansion Module Specifications

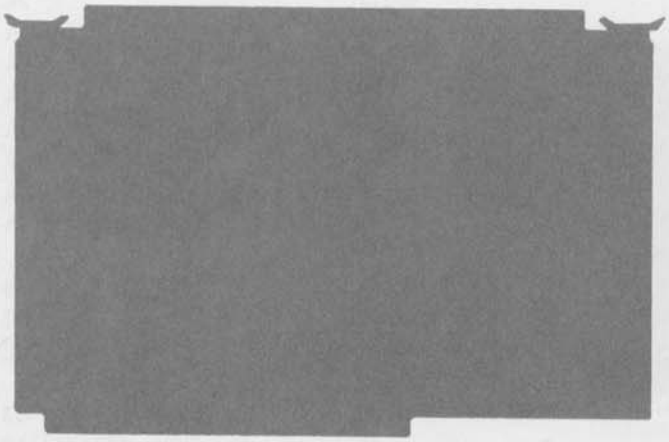
TM 990/310	
Input/Output	48 bits programmed as inputs, outputs, or up to 27 unlatched interrupts
Interrupts	33 maximum [six are (+) or (−) edge-detect latches]; output of priority encoders may be jumpered to three levels of the 15 external TM 990 interrupt levels.
Interval Timers	Three 14-bit timers
Resolution	21.3 μs
Maximum interval (for 3 MHz CPU clock)	349 μs
Input Levels	
High-level input voltage	2.0 V minimum
Low-level input voltage	0.8 V maximum
Maximum input voltage range	−0.3 V to V_{cc}
Input current	−1.01 mA maximum at 0.4 V
Edge-Detect Interrupts	
Positive-going threshold voltage	1.9 V maximum
Negative-going threshold voltage	0.5 V minimum
Hysteresis	0.4 V minimum, 0.8 V typical
Maximum input voltage range	−0.3 V to +7.0 V
High-level input current	−1.22 mA maximum at 2.7 V
Low-level input current	−2.72 mA maximum at 0.4 V
Outputs	
High-level output voltage	2.4 V minimum at −300 μA 2.0 V minimum at −460 μA
Low-level output voltage	0.56 V maximum at 2.3 mA
Power Requirements	5 V ±3%, 800 mA (typical)

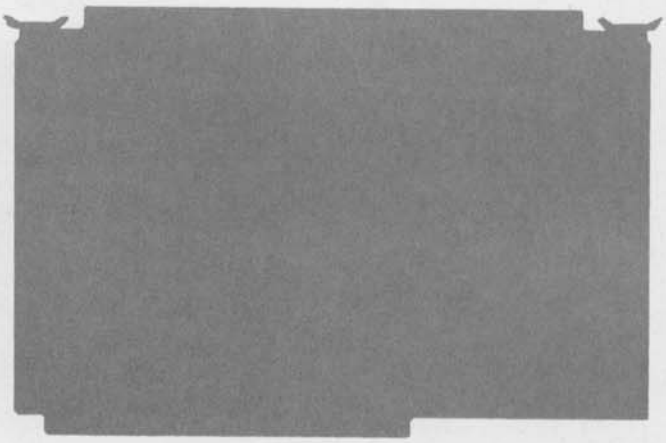
TM 990/305		
Input/output	16* optically-isolated parallel input lines 16* optically-isolated parallel I/O lines user configurable	
Memory	Up to 32K bytes capability 8 memory sockets to accommodate TMS 2516 2K x 8 EPROMs TMS 2532 4K x 8 EPROMs 24-pin 2K by 8 static RAMs	
Parallel Inputs	Input Voltage	Input Current
With standard series resistor	3.8 – 8.5 V	12 – 34 mA
With user-supplied series resistor	3.3 – 30.0 V	12 – 34 mA
Parallel Outputs	Collector-Emitter Saturation Voltage	Collector-Emitter Breakdown Voltage
TTL option	0.4 V at I_C = 2 mA	30 V
Current option	1.0 V at I_C = 30 mA	30 V
Input to Output Isolation	500 V	
TM 990/5MT Interface Capability	+8 V supply for interface is generated on the TM 990/305 module and a TM 990/509 interface cable is available for direct interconnection to the 5MT series, supporting up to 16 I/O modules	
Power requirements†	V_{cc} = 5 V, I_{cc} (typical) = 750 mA	

*20 optical isolators supplied with module.
†+12 V at 600 mA also required if TM 990/5MT Interface is fully populated.

Communications Modules

NEW





TM990/308 Industrial Communications Board

• Provides a serial, synchronous communication link between two or more stystems • Point-to-point or multi-point operation • Up to 32 stations • Baud rates up to 9600 bits/sec • Compatible with other Texas Instruments systems (eg 990/4 minicomputer) • Up to 10,000 feet cable using 22 gauge wire • Optically isolated two wire connection (twisted pair) • Intelligent module using TMS 9900 to control data transmission reception and buffering • Separate RS232C interface for modem use •Full error checking using hardware • Cyclic redundancy checking • Over 900 bytes of available buffer space • Self-test capability

Typical Power Requirements	
5V	2.0A
12V	0.5A
-12V	0.1A

On-Board Processor System Includes:
TMS9980A processor
1K bytes RAM expandable to 2K bytes
2K bytes EPROM

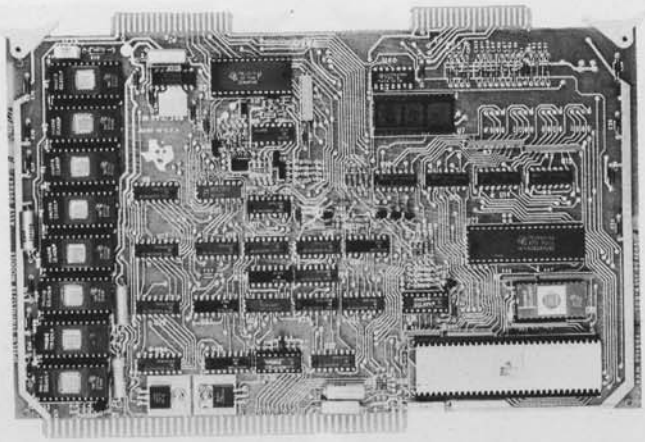
TM990/307 Communications Expander Module

• Synchronous (using TMS9902) or asynchronous (using TMS9903) • Four RS232 E/A ports • Bell® automatic calling unit interface • Individual channels (individually addressable) • DIP switches and LEDS provided for port identification • Loopback feature allows self-test • Software programmable baud rates • Four real time clocks/interval timers

Typical Power Requirements	
5V	1A
12V	0.2A
-12V	0.2A

Inputs/Outputs	
3 off	EIA RS232C standard
1 off	EIA RS232C/RS422
1 off	Autodialer interface

Speech Module



TM990/306 Speech Module

• Compatible with the TM990 microcomputer module CRU bus • Designed to fit the TM990/510 chassis • Inputs/outputs are TTL-compatible • Contains an interval timer accessible through the CRU bus • Self contained word vocabulary • On-board amplifier drives 8-ohm speaker to 2.5 watts • Pre-amplifier outputs for user supplied amplifier system • CRU interrupt or polled-status operation • Data set in TMS2716 EPROMs • External system interface allows stand-alone operation

Operation

There are two different ways the TM990/306 module could be utilized:

- Status-polled operation
- Interrupt-driven operation

Polled Status Operation, TM990 Host Processor

In this mode of operation the CPU issues the address of a word to be spoken, sets the talk command and waits for the word to be spoken. When the talk flag goes inactive CPU decides whether to say another word. All communication is through the CRU bus to the TMS9901 on board.

Interrupt-Driven Operation, TM990 Host Processor

Since generating speech is a very slow operation compared to computer cycles, computer time could be tied up in a polled-status mode where the CPU would spend all its time checking to see if the speech has stopped. The system may be free to do other things while it is talking if the interrupt mode is selected. A jumper-selectable interrupt is issued when the speech processor stops talking. When the host CPU sees the interrupt, it decides whether to say another word or delay or stop speaking entirely.

Vocabulary

In addition to the numbers from 0 to 12 and alphabet from A to Z, there are 140 words in the base vocabulary. The user is encouraged to be ingenious in his use of the speech set. For instance, it is suggested that certain letters sound like words: "R" = are, "N" = in, "B" = be, "C" = see. From these letters, words can be constructed such as "N" + crease = increase and "D" + crease = decrease.

Specifications

Vocabulary:	179 words base speech set (140 words plus 13 numbers plus 26 letters)
Interface:	CRU or external control via 40-pin edge connector
Power Requirements	+12V @ 195 mA −12V @ 185 mA +5V @ 4.15 mA
Temperature Range	Operating: 0°C to 70°C Storage: 40°C to 100°C

Demonstration Software

Demonstration software for TM990/306 is provided in two TMS 2716 EPROMs and is sold as a separate product, the TMS990/426. The purpose of this software is to allow the user to demonstrate operation of the TM990/306 speech modules producing speech immediately upon powering the associated modules. The software prompts the user and instructs him to enter appropriate commands for generation of sample phrases and sentences. The program listing is also provided to instruct the user on necessary software generation.

The following items are required to implement the sample program:

- TM990/426 Demonstration Software
- TMS990/306 Speech Module
- TM990/10X CPU Module
- TM990/518 or TM990/518A DC Power Supply
- Any TM990-Series Card Cage
- Suitable Terminal and cable that interfaces to CPU Module
- Speaker 8 ohms, 2.5W
- 40-pin connector (TM990/524 or equivalent)

TM990/306 Vocabulary

A
ABORT
ADJUST
ALERT
ALL
AMPS
AND
AUTOMATIC

B
BACK
BUTTON

C
CALIBRATE
CALL
CANCEL
CARPENTER
CHECK
CLOCKCLOSE
CONTROL
CRANE
CREASE
CYCLE

D
DANGER
DAYS
DEGREES
DEVICE
DIRECTION
DISPLAY
DOOR
DOWN

E
ELECTRICIAN
ELEVEN
ENTER
EQUAL
EXIT
EIGHT
EAST

F
FAIL
FARAD
FAST
FEET
FIRE
FLOW
FOREMAN
FREQUENCY
FROM
FOUR
FIVE

G
GAGE
GATE
GET
GO
GREEN

H
HENRY
HERTZ
HIGH
HOLD
HOURS
HUNDRED

I
INCH
INITIALIZE
INSPECTOR
INTRUDER
IS

J
JOG

K

L
LEFT
LIGHT
LINE
LOW

M
MACHINE
MAKER
MANUAL
MEASURE
MEGA
METER
MICRO
MILI
MILL
MINUS
MINUTES
MOTOR
MOVE

N
NUMBER
NINE
NORTH

O
OF
OFF
OHMS
ON
ONE
OPEN
OPERATOR
OUT
OVER

P
PASS
PASSED
PERCENT
PICO
PLUS
POINT
POSITION
POUND
POWER
PRESS
PRESSURE
PRIORITY
PROBE
PROCESSING
PULL
PUSH
PUT

Q

R
RANGE
READY
RED
REPAIR
REPEAT
REPLACE
RIGHT

S
SAFE
SECONDS
SET
SEVEN
SHUT
SIX
SLOW
SMOKE
SOUTH
SPEED
START
STOP
SWITCH

T
TEMPERATURE
TEN
TEST
THE
THOUSAND
THREE
TIME
TIMER
TOOL
TURN
TWELVE
TWO

U
UNDER
UNIT
UP

V
VALVE
VOLTS

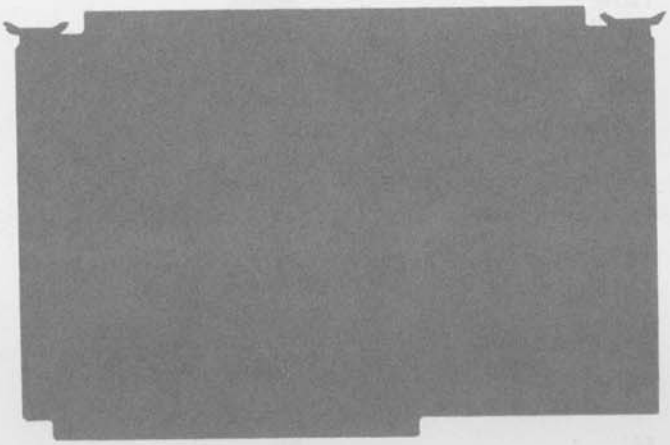
W
WAIT
WARD
WATTS
WELDER
WEST

X

Y
YELLOW

Z
ZERO

Floppy Disk Control Module



TM990/303 Floppy Disk Controller

The TM990/303 floppy disk controller module provides a controlling interface between a microcomputer such as the TM990/101M and the following disk drives:

- Shuggart model SA 400 (mini)
- Shuggart model SA 800 (standard)
- Control data model CDC 9404B (standard)

The TM990/303 can be used with either the TM990/100M or TM990/101M board. DMA can be accomplished directly with the TM990/101M board or with any expansion memory board.

- Formats supported: (soft sectored)
  - IBM single density format
  - IBM double density format
  - TI single density FD800 (currently used on the FS 990/4 and AMPL systems)
  - TI digital systems group (DSG) double density format.

• Disk sizes: Standard or mini • Disk sides: Single only • Number of disk drives (daisy chained); Four maximum standard size and three maximum for mini size • Recording methods: - Single density frequency modulation (FM) -Double density modified frequency modulation (MFM) • Data structure:- IBM 3740 compatible - TI FS 990 compatible • System interface:- CRU (controller initialization) - DMA transfer (data and commands) • Three LED's indicate controller status • Bootstrap load features can be used to initialize system from diskette • Controller firmware provided on two TMS 2716's (2K words); controller firmware EPROM space expandable to 4K words by using two TMS 2532's • DMA data transfer • 20-bit host memory addressing • Read after write • Disk command chaining

Software

• Seventeen commands including controller self test, read and write to/from diskette, read to and write from controller/RAM, bootstrap load from diskette software, format diskette, execute program in controller memory, read status of specified drive • Command completion interrupt to host (interrupt level jumper selectable); completion status reported to host • Controller initialization through interrupt via CRU

Specifications

Interface: CRU or DMA
Power Requirements: +12V @ 200 mA
-12V @ 200 mA
+5V @ 3.0 A

Disk Drive DC Power:

	+5 Vdc		-5 Vdc		+12 Vdc		+24 Vdc		
	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX	UNIT
SA400	0.5	0.7	–	–	0.9	1.8	–	–	A
SA800	0.8	1.0	0.05	0.07	–	–	1.3	1.7	A
CDC9404B	0.7	–	–	–	–	–	1.3	–	A

Temperature Range:
Operating: 0°C to 70°C
Storage: -40°C to 100°C

Optional Accessories

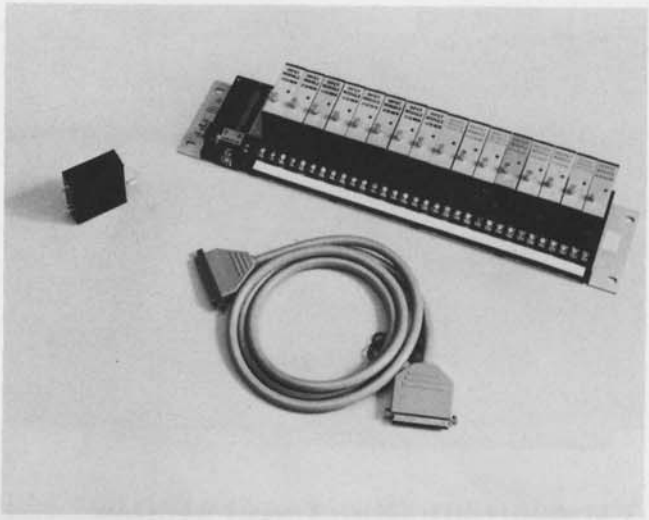
TM 990/425 Demo Software

TM 990/527 Dual Standard Floppy Cable

TM 990/535 Mini Floppy Interface Cable

Industrial AC and DC I/O Modules

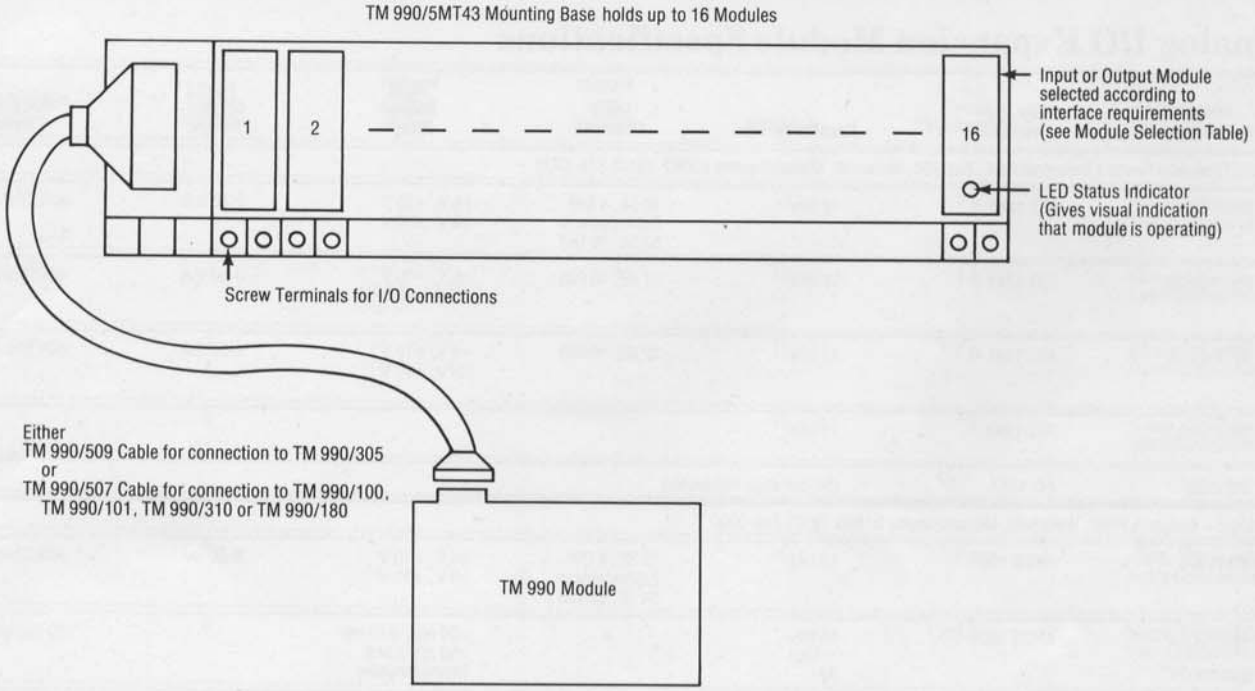
The TM 990/5MT series of input and output modules enable you to interface your microcomputer modules directly with ac or dc signals and loads. The new 5MT series – pre-engineered, preassembled and off-the-shelf – spare you the time and expense of designing the interface yourself. These modules provide optical coupling, plug-in mounting to the mounting base, and LED status indicators. The 5MT series provides one I/O point per module.



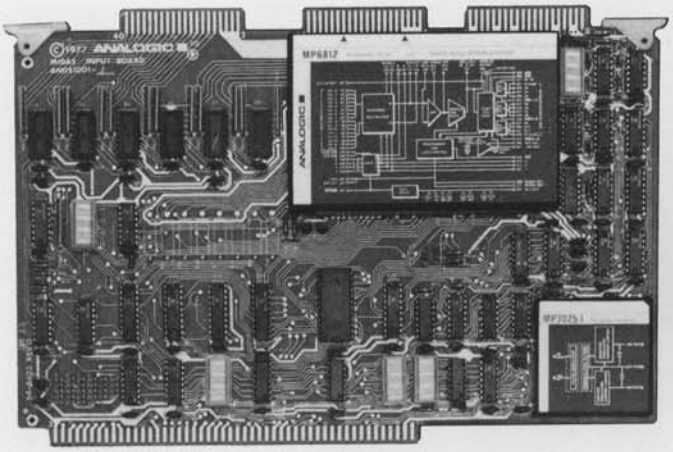
Module Selection Table

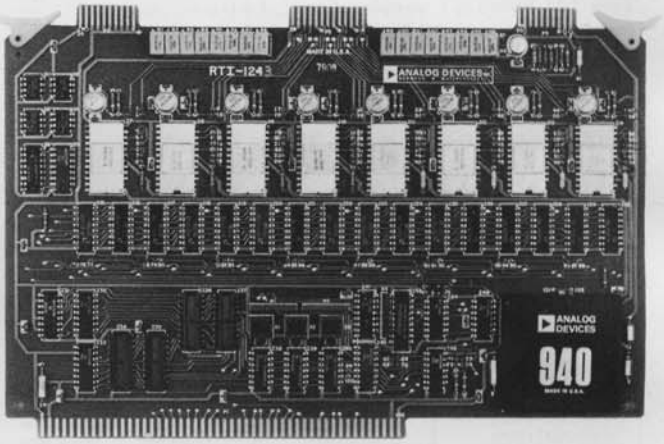
Part Number	Type of Device	Rating	
		Voltage	Current
TM990/5MT1A05L	AC Input	90-132 VAC	35 mA Max
TM990/5MT1E05L	AC Input	17-28 VAC	18 mA Max
TM990/5MT240AL	AC Output	90-132 VAC	3 A Max
TM990/5MT240EL	AC Output	17-28 VAC	3 A Max
TM990/5MT3DO3L	DC Input	3-28 VDC	30 mA Max
TM990/5MT430CL	DC Output	10-28 VDC	1 A

System Configuration



A/D and D/A Interface Modules





TM 990/1001 High Level Analog Input System

• Up to 64 SE/32 DI input channels • Switch programmable input configuration • On-board dc/dc converter • Provision for eight 0-50 mA current inputs • ±025% FS accuracy at a full throughput rate of 30 kHz

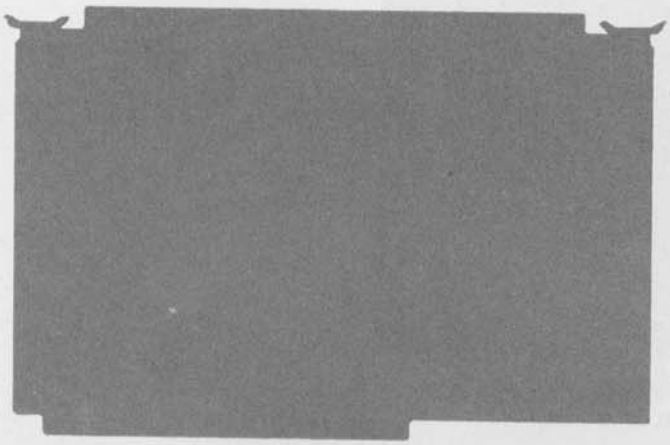
TM 990/1243 High Level Analog Output System

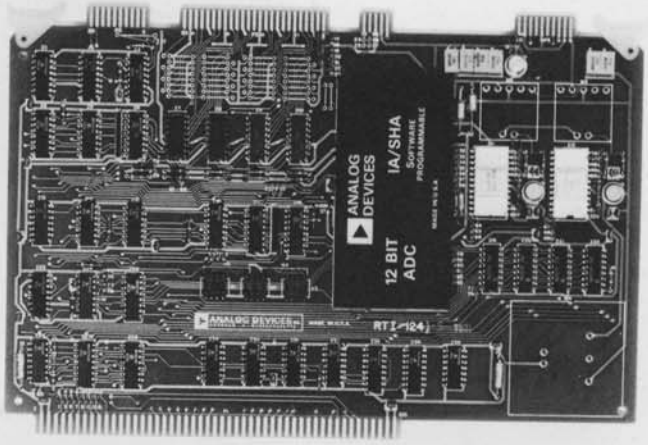
• 8 channels of analog output • 8 high current logic driver outputs • 8 12-bit DACs with input codes and output ranges independently selectable • On-board 10 V precision reference

Analog I/O Expansion Module Specifications

Product	Mfgr. Part Number	Resolution	Input Channels	Input Voltage Range	Input Current Range	Throughput Rates
Analog Devices—Route 1 Industrial Park, Box 280, Norwood, Massachusetts 02062 (617) 329-4700						
TM 990/1240R	RTI-1240-R	12 bits	16 SE, 8 Diff Expandable to 32 SE, 16 Diff	+5 V, +10 V ±5 V, ±10 V	0-50 mA	40K Chan/sec
TM 990/1241S	RTI-1241-S	12 bits	32 SE, 16 Diff	+5 V, +10 V ±5 V, ±10 V	0-50 mA	40K Chan/sec
TM 990/1241R	RTI-1241-R	12 bits	32 SE, 16 Diff	+5 V, +10 V ±5 V, ±10 V	0-50 mA	40K Chan/sec
TM 990/1243	RTI-1243	12 bits				
TM 990/528	AC-1557	(50-pin edge connector)				
Analogic—Audubon Road, Wakefield, Massachusetts 01880 (617) 246-0300						
TM 990/1001	ANDS 1001	12 bits	16 SE, 8 Diff Expandable to 64 SE, 32 Diff	+5 V, +10 V ±5 V, ±10 V	0-50 mA	30K Chan/sec
TM 990/1002J* TM 990/1002K*	ANDS 1001-1	15 bits + Sign Bit	4	±20 mV, ±40 mV ±80 mV J or K Thermocouples		10 Samples/sec
TM 990/2001	ANDS 2001-4	12 bits	0			
TM 990/3001	ANDS 3001-22	12 bits	32 SE, 16 Diff	+5 V, +10 V ±5 V, ±10 V	0-50 mA	30K Chan/sec

Note: Listed modules are available from authorized TI distributors. Modules with other user options are available direct from either Analog Devices or Analogic.
*Coming soon





TM 990/1002 Low Level Input System

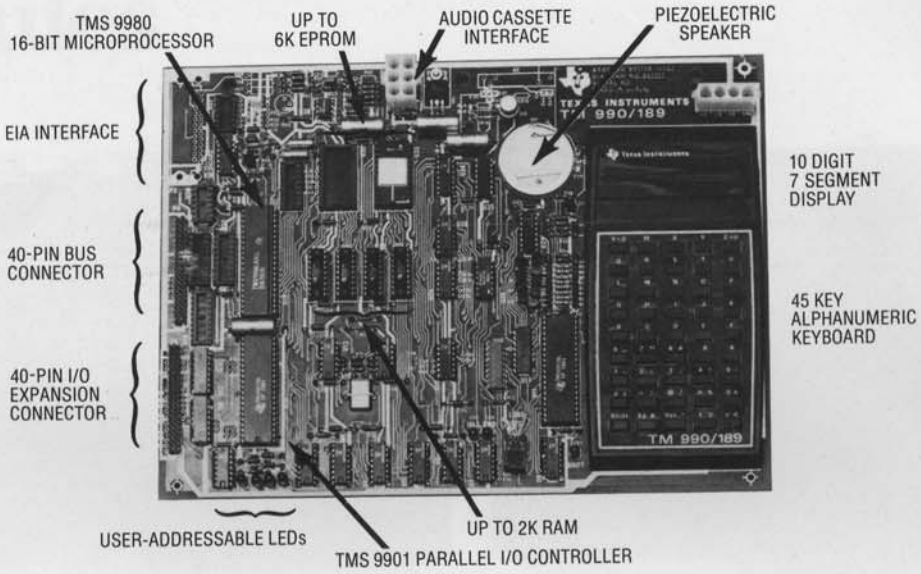
• Premium grade 16-bit A/D converter • Excellent accuracy, linearity and stability • Thermocouple cold junction compensation and linearization • Environmental immunity

TM 990/1241 Combination Analog I/O Interface

• Up to 32 SE/16 DI input channels and 2 channels of 12-bit analog output • On-board 10 V precision reference

Programmable Gain	Output Channels	Voltage Output Range	Current Loop Outputs	Interrupts	+5 V Power Requirements	Output Codes
1-1000	0			15	1.4 A	Binary, Offset Binary Two's Complement
1,2,4,8	2	+5 V, +10 V ±2.5 V, ±5 V ±10 V	4-20 mA	15	1.4 A	Binary, Offset Binary Two's Complement
1-1000	2	+5 V, +10 V ±2.5 V, ±5 V ±10 V	4-20 mA	15	1.4 A	Binary, Offset Binary Two's Complement
	8			15	1.4 A	Binary, Offset Binary Two's Complement
	0			15	700 mA	Binary, Offset Binary Two's Complement
	0				1500 mA	Binary, Offset Binary Two's complement
	4	+5 V, +10 V ±5 V, ±10 V	4-20 mA		500 mA	Binary, Offset Binary Two's Complement
	2	+5 V, +10 V ±5 V, ±10 V	4-20 mA	15	1400 mA	Binary, Offset Binary Two's Complement

University Module



The TM 990/189M University Module is a stand-alone educational tool. Easy to use, it gives engineers, students and hobbyists an extremely effective means for acquiring hands-on understanding of microprocessors.

Features of the University Module include the 9980 16-bit microprocessor • 1K bytes of RAM expandable to 2K on board • 4K bytes of PROM expandable to 6K on board • Audio cassette interface • 16-bit programmable I/O port and interrupt monitor • 45 key alphanumeric keyboard allows user to program in assembly language • Ten-digit seven-segment display with 64 character buffer • Visual and acoustic indicators • Resident monitor • Symbolic assembler

In addition to on-board memory expansion, two other system expansion options are available. You may add either RS232C or 20 mA current loop terminals. Secondly, the bus can be fully expanded by use of the 40-pin bus interface.

A complete 500-page tutorial text accompanies each module. This comprehensive book can be used for self-paced learning or as a text for a university course. Chapter titles include overview of computers, microprocessors and minicomputers • ALU • Program development, assembly language • Memory systems • I/O concepts • I/O designs • Modular programming • Software engineering • Product development

A user's guide also accompanies each University Module. The 200-page guide covers the installation and operation of the monitor, symbolic assembler, and instruction set, as well as assembler directives, options and modifications.

Optional TM 990/519 Power Supply for the University Module: 5 V at 2 A, +12 V at 250 mA, −12 V at 180 mA.

Ordering information

TM 990/189M—Assembled and tested module includes tutorial text and user's guide

TM 990/519—Power supply

Data Entry and Display Microterminal

TM 990/301

• Performs front panel functions of microcomputer systems • Allows programmer to display and change register and memory information • 4-digit hexadecimal display of address and data • Register, memory, or CRU display and entry keys • Operates under TIBUG monitor • Hexadecimal pushbutton keyboard • Execute, single instruct and convert keys • Integral cable connects directly to serial EIA port on CPU module

Firmware Support

TIBUG Monitor

TM 990/401 is a comprehensive, interactive debug monitor included in the basic price of the 990 CPU modules. (Optionally, you may order the board with blank EPROM.) TIBUG includes 13 user commands plus six user accessible utilities and operates with 110, 300, 1200 and 2400 baud terminals.

TIBUG Functions

- Inspect/change CPU, memory location, program counter, workspace pointer, status registers, workspace elements
- Execute user programs under breakpoint in single/multiple steps
- Dump/load memory to, from paper tape or cassettes
- Find word/byte
- Hexadecimal arithmetic

User Accessible Terminal Interface Utilities

- Read/write character
- Hexadecimal numeric input/output
- ASCII message output

Line-by-Line Assembler

TM 990/402 is a line-by-line assembler supplied preprogrammed into a ROM kit for immediate system use. By allowing you to enter instructions in mnemonic form and performing simple address resolution calculations up to a displacement range of +254/–256 bytes, the assembler is an extremely powerful tool for assembly language input of short programs or easy patching of long programs.

LBLA features

- Handles all 9900 standard mnemonics
- Accepts binary, octal, hexidecimal and decimal input
- Each line is assembled automatically after input
- Assembly address can be changed through a single command
- Allows comments to be entered after source statement

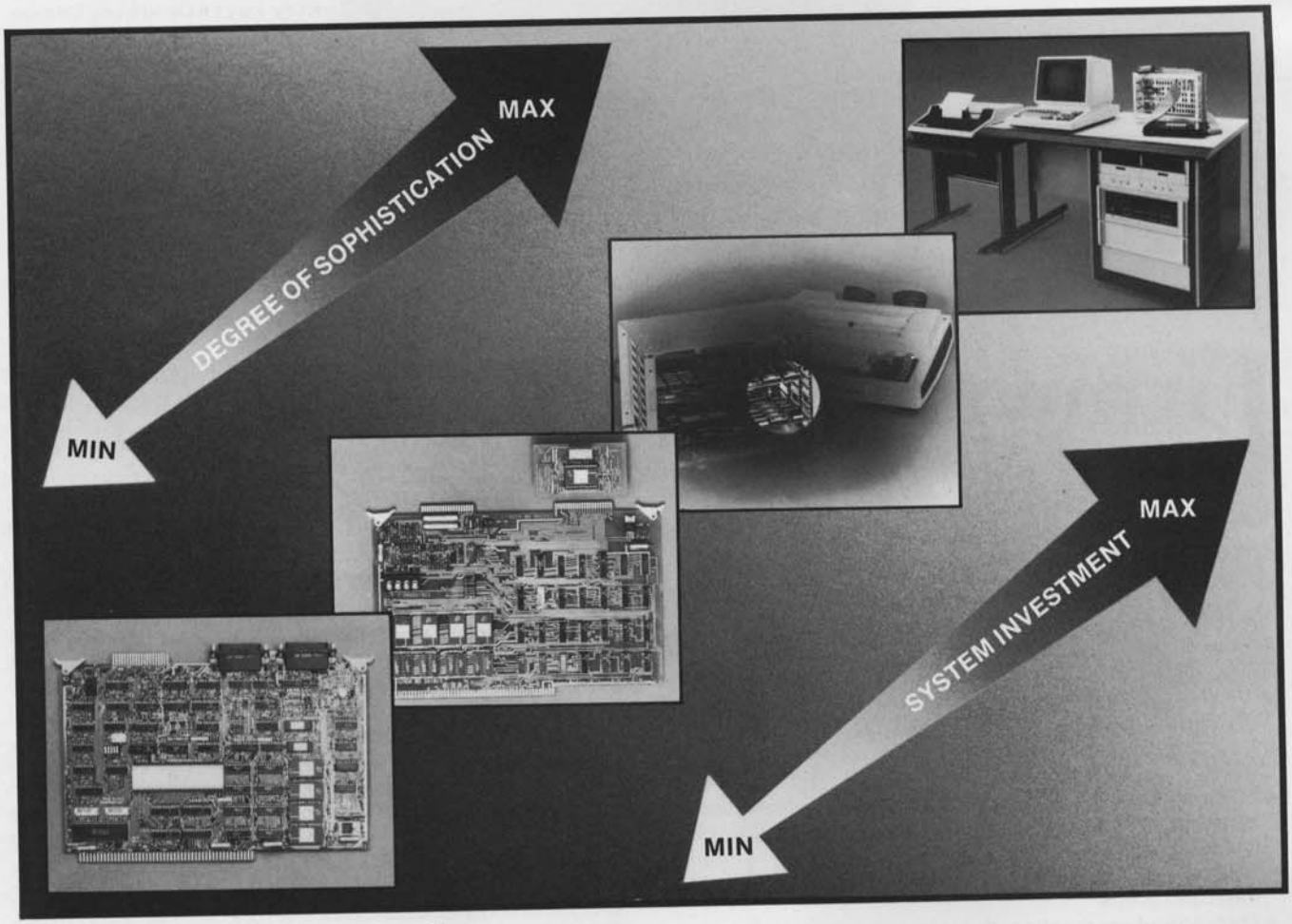
Software

POWER BASIC
High-level language

POWER BASIC, a versatile extension of the original high-level language, is specifically intended for the industrial real-time I/O environment. It is easy to learn, easy to use, easy to document. And it is one of the *fastest* BASICs on the market, providing bit manipulation capability as well as the ability to call assembly language subroutines directly.

POWER BASIC language interpreters are available with capabilities ranging from evaluation to EPROM programming.

POWER BASIC features include: 11-digit accuracy • 24 hour time-of-day clock • EPROM programming • Fast • Can call Assembly Language routines



Product	Evaluation POWER BASIC	Development POWER BASIC	Development POWER BASIC plus Enhancement Package	Configurable POWER BASIC
Media	ROM (8K bytes)	ROM (12K bytes)	ROM (16K bytes)	Floppy diskette (for FS 990 minicomputer)
Description	Designed for small applications and evaluation of POWER BASIC. This 8K byte version executes stand-alone on a TM 990/100M or TM 990/101M module. Also available as an option on the TM 990/101 microcomputer module*.	Targeted for the module-level designer, POWER BASIC is ideal for a wide range of applications. Development POWER BASIC provides additional capability for design, development and debug. This 12K POWER BASIC executes on TM 990/302 or TM 990/201 module in conjunction with a TM 990/100M or TM 990/101M module.	Designed for the user who requires EPROM programming and audio cassette storage directly from POWER BASIC. This 16K byte package provides full module-level capability to develop POWER BASIC programs and then "burn" them into EPROM.	Designed for the OEM who wants the least memory overhead in his target POWER BASIC application. Configurable POWER BASIC executes on the FS 990 minicomputer and provides all of the capability of ROM resident development POWER BASIC.
Part Number	TM 990/450 *TM 990/101-10	TM 990/451	TM 990/451 and TM 990/452	TMSW510F

Microprocessor Pascal

Texas Instruments Microprocessor Pascal is a complete high-level language development system specifically designed for microprocessor applications. It has been developed for execution across the range of TI products based on our 9900 family of 16-bit microprocessors - from a 9900 microprocessor chip to TM990 microcomputer modules to 990 minicomputers.

Pascal lets you solve your application without getting involved in the intricacies of machine architecture. The block structure results in fewer programming errors because the code is easier to write, read and modify. And it encourages "top down" design methodology that gives a high degree of programmer efficiency.

TI's Microprocessor Pascal system consists of six parts to provide the most Pascal capability ever:

- Source Editor - specifically designed to create/edit Pascal programs and check program syntax
- Compiler - compiles conventional Pascal programs as well as TI's Pascal concurrent extensions into interpretive code, which can then be executed directly, or converted into 9900 native machine code
- Host Debugger - over fifteen options for tracing variables and modifying data
- Configurator - enables the target system to retain only those parts of the run-time support necessary for program execution
- Native-Code Generator - converts Pascal interpretive code into 9900 native machine code
- Run-Time Support - both interpretive and native-code execution provide a speed/memory trade-off

The Microprocessor Pascal system provides total software capability - from design to debug - resulting in a dramatic decrease in software costs and application development time.

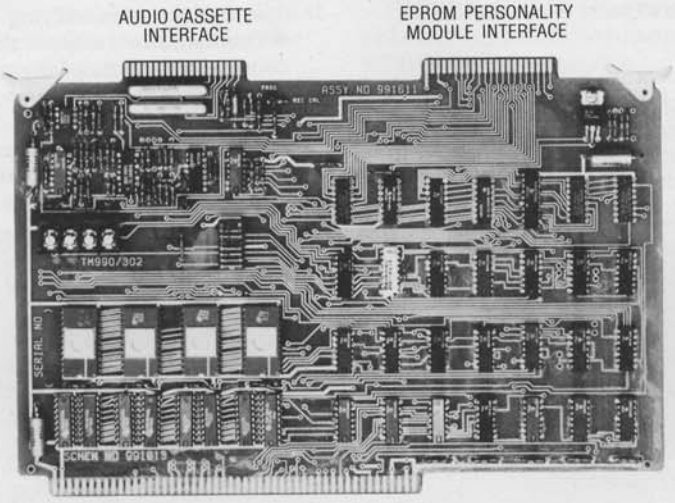
TM 990 transportable cross support

Texas Instruments provides cross support for its microprocessor components. The program is written in ANSI STANDARD X3.0 (1966) FORTRAN and consists of three parts: Assembler, Simulator and PROM utility. The user can design, execute and debug TM 990 assembly language programs on minicomputers such as PDP-11, VAX and 370. In addition, the cross-support package includes tape verification and system operation programs.

The sources, input and object output are fully compatible with TI's time-sharing services (GE TERMINET, NCSS AND TYMSHARE).

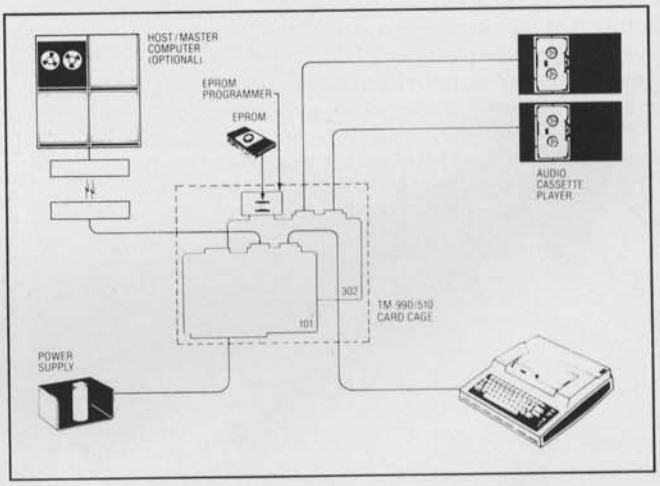
PART NUMBER: TMSW101T

Software Development Module

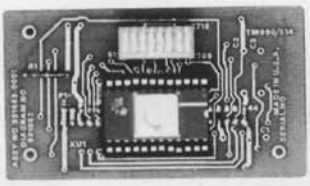


TM 990/302

• An assembled, tested, stand-alone software development system supporting program generation, editing, assembly, debugging and EPROM programming at an extremely attractive cost • For use with either TM 990/100M or TM 990/101M microcomputer modules • Provides dual or single audio cassette interface, both static RAM and ROM memory and hardware circuitry for programming EPROMs • Programming options – TMS 2708, TMS 2716, TMS 2508, TMS 2516, TMS 2532 • 4K x 16 EPROM or preprogrammed ROM • 2K x 16 RAM • Memory expandability for additional performance – TM 990/201, TM 990/206 or TM 990/203 • EIA communication with other computers • Bus compatible with other TM 990 family members • Optional POWER BASIC development software residing in ROM (12K bytes) • Power requirements are 5 V @ 0.8 A, 12 V @ 0.13 A, −12 V @ 0.6 A, 45 V @ 80 mA.



EPROM Programming Personality Module plugs directly into the TM 990/302 allowing for programming TMS 2708, TMS 2716, TMS 2508, TMS 2516 or TMS 2532.



Audio Cassette Interface Cable interfaces either single or dual audio cassettes directly to the TM 990/302. One cable is included with each TM 990/302 module. For extra cables, order catalog number TM 990/508.

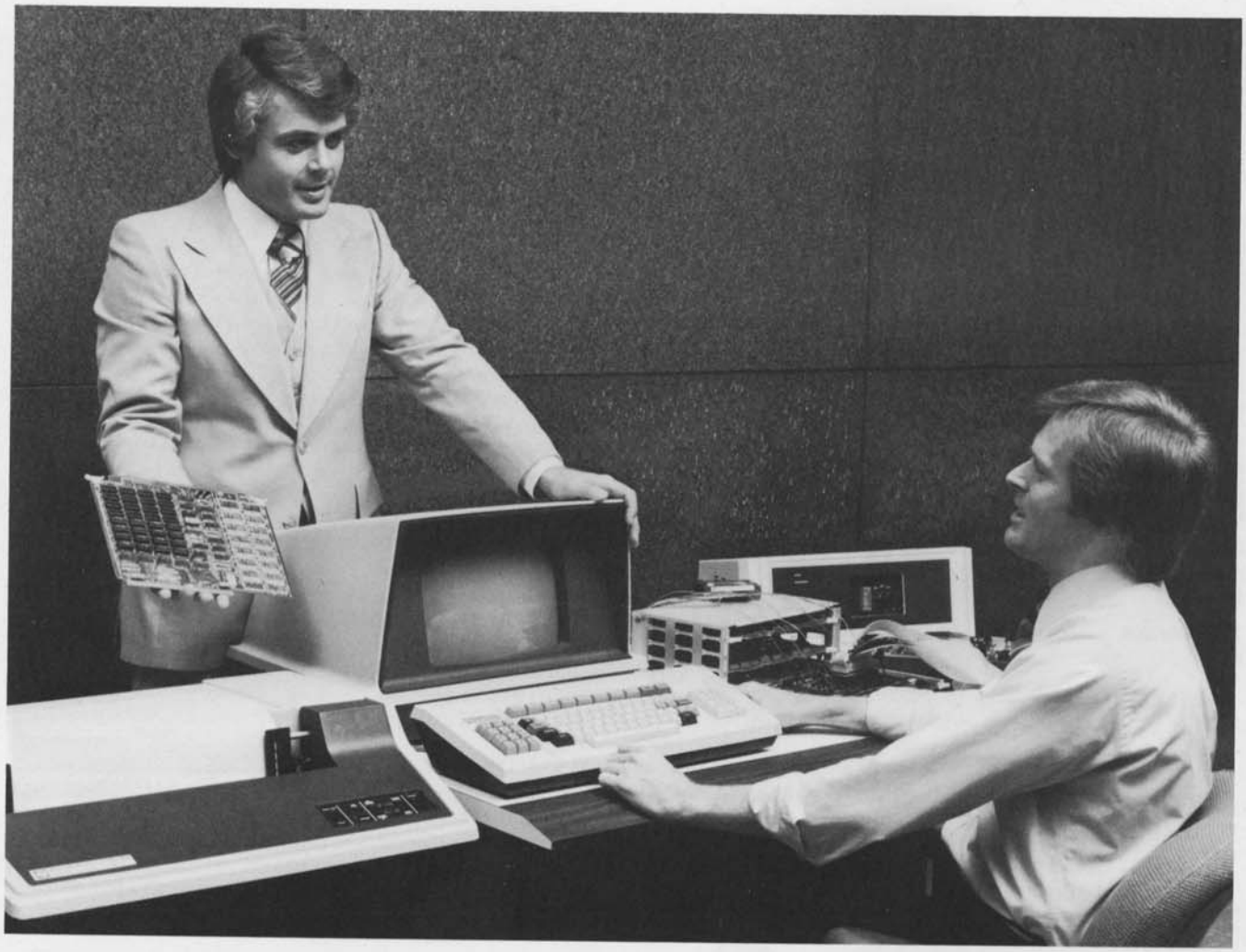
Ordering Information

TM 990/302 – Software Development Module

TM 990/514 – EPROM Personality Module – TMS 2708 and TMS 2716

TM 990/515 – EPROM Personality Module – TMS 2516 and TMS 2532

Advanced Microprocessor Prototyping Lab



AMPL uses TI's 990 computer and offers 10 MHz trace capability and universal emulation for the 9900 Family microprocessors. The AMPL system includes a video display terminal, disk system, and software license.

The lab is available as a floppy disk system or as a hard-disk system that accommodates multiple users. Programs can be edited, assembled, linked, loaded and executed much faster than conventional paper tape or cassette based systems.

In-Circuit Emulation Support permits development and debugging directly on a TM 990 module while monitoring and controlling the operation from AMPL.

Logic-State Trace features interactive on-line control and analysis to provide fast data reduction and programmable emulation control based on the results of this analysis.

AMPL Software, a high-level language, has designed-in features that simplify orientation for the new user yet provide extensive flexibility and support for the experienced user.

PROM Programming implements target system memory in PROM and EPROM.

AMPL's interactive process makes it easy to identify and implement needed design changes. Result: substantial savings in design time and cost.

Accessories

Connectors

TM 990/501 connector kit – contains a TM 990/523, TM 990/524, and TM 990/525.

Part No.	Industry No.	Description
TM 990/523	TI H321150 (wire wrap)	Bus connector: 100 pin, 3.20 mm (0.125 in.) cc
TM 990/524	TI H312120 Viking 3VH20/ 1JN5 (solder tail)	Parallel connector: 40 pin, 2.54 mm (0.100 in.) cc
TM 990/525 (includes connector hood)	Cinch DB-25P Amp DB-25P	Serial connector: 2J pin (male)
TM 990/528 kit	———	50-pin connector kit for interface to analog devices A/D or D/A board

Cables

TM 990/502 General purpose EIA cable

TM 990/503 EIA cable for 743 KSR or 745 terminals

TM 990/504 Standard current loop TTY cable

TM 990/505 EIA cable for 733 ASR

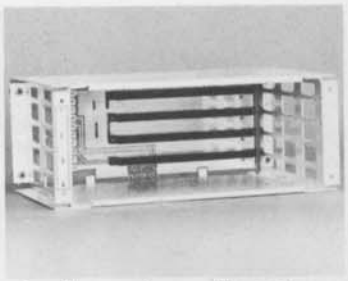
TM 990/506 Modem cable for use with TM 990/101M

TM 990/507 Cable to interface the 5MT Series of AC and DC Input and Output Modules Directly to CPU Modules

TM 990/508 Audio interface cable used with TM 990/302 Software Development Module.

TM 990/509 Cable to interface TM 990/5MT Series of AC and DC Input and Output Modules directly to a TM 990/305 Optically Isolated I/O and Memory Module.

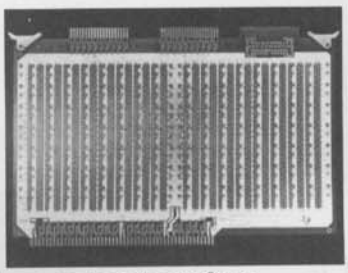
Card Cages



TM 990/510 4-slot card cage with 1-inch centers. Back panel contains address bus, data bus, interrupt and control lines to permit memory, I/O and DMA expansion of CPU modules. 10-terminal barrier strip on back panel permits connection of these signals as required: Reset; Restart; ±5 V; ±12 V; ±15 V; GND. 12.7 cm high x 31.75 cm wide x 20.32 cm deep (5 x 12.5 x 8 in). 2.5 cm (1 in) board separation.

TM 990/520 8-slot card cage same as TM 990/510 except 20.96 cm high x 31.75 cm wide x 20.32 cm deep (8.25 x 12.5 x 8 in). 1.91 cm (0.75 in) board separation.

Auxiliary Modules



TM 990/511 Extender board for operating TM 990 modules outside card cage; includes card guide at edges.

TM 990/512 Universal prototyping module allows custom interface to TM 990 bus. Has GND and 5 V planes, two power strips for ±12 V, plus two power strips for user-selectable voltage option.

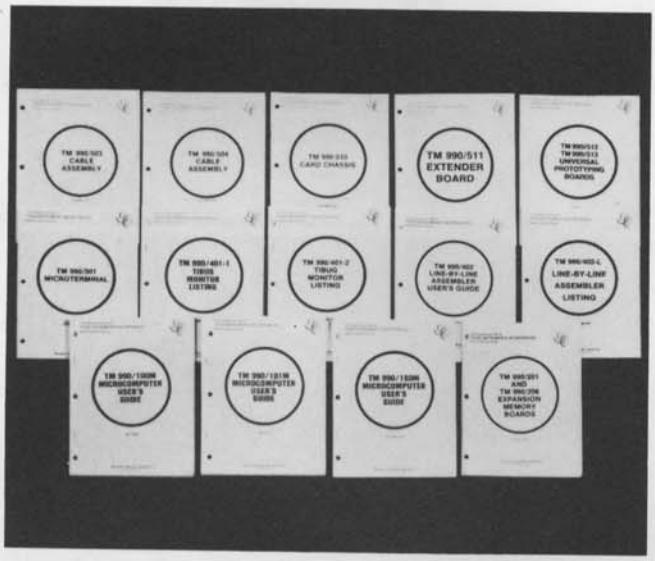
TM 990/513 Universal prototyping wire wrap module with pins installed to simplify custom interfacing.

Power Supply

TM 990/518A Low voltage power supply with cover, cable, fuse and switch, DC power outputs +12 V (0.6 A), −12 V (0.4 A), +5 V (4.0 A), and +45 V (0.1 A). Input voltage 115 or 230 VAC; over voltage on +5 V only; current limiting on +5 and ±12 V.

TM 990/518 low voltage power supply. Same except no cover, cable, fuse or switch. DC outputs of +12 V (0.9 A), −12 V (0.9 A), +5 V (6.0 A).

Quality Assurance and Full Documentation



Typical TM 990 documentation

TM 990 burn-in chambers

- All components used in TM 990 module construction are subjected to TI's strict quality assurance criteria

- All assembled modules go through a computer-controlled test station providing verification of product compliance with all specifications

- All modules are dynamically exercised in a severe environment chamber which cycles products through a 25-65°C temperature range; burn-in time varies from eight hours to four days

- Prior to shipping, all modules are system tested for strict compliance to system specifications and quality assurance criteria

Documentation

Each TM 990 Series microcomputer module is supported with all documentation necessary for using the module. A microcomputer module comes with a complete user's manual for that board, including schematics, and component manuals for all pertinent LSI integrated circuits. For most software products, user's manuals as well as source listings are included or are readily available.

Contact your local TI Field Sales Office or authorized TI Distributor for a copy of the TM 990 Microcomputer Handbook.

General TM 990 Series Specifications

Operating Temperature Range: 0° C to 70° C

Physical Characteristics

Width: 279 mm (11 in.)
Height: 190 mm (7.5 in.)
Board Thickness: 1.58 mm (0.062 in.)
Component Height: 9.9 mm (0.40 in.)

Texas Instruments Northern European Semiconductor Division

UNITED KINGDOM PLANTS AND SALES OFFICES

HEAD OFFICE

Texas Instruments Limited
Northern European
Semiconductor Division,
Manton Lane,
Bedford MK41 7PA.
Telephone (0234) 67466
Telex 82178

TI SUPPLY REGIONAL SALES OFFICES

Bedford
Texas Instruments Limited
Manton Lane,
Bedford MK41 7PA.
Telephone (0234) 67466
Telex 82178

Slough
Texas Instruments Limited,
186 High Street,
Slough, Berks. SL1 1LD.
Telephone (0753) 33411
Telex 848363

Manchester
Texas Instruments Limited,
St. James House,
Wellington Road North,
Stockport SK4 3EL.
Telephone (061) 442 0645
Telex 667478

Edinburgh
Texas Instruments Limited,
24 Rutland Street,
Edinburgh EH1 2AN.
Telephone (031) 229-5573/1481
Telex 72637

INDEPENDENT DISTRIBUTORS

ENGLAND

Bristol
BA Electronics Limited,
Millbrook Road,
Yate,
Bristol BS17 5NX,
Telephone (0454) 315824
Telex 449150

Bristol
ITT Electronic Services,
30 Denmark Street,
Bristol.
Telephone (0272) 290125
Telex 449260

Derby
Quarndon Electronics (Semiconductors) Limited,
Slack Lane,
Derby DE3 3ED.
Telephone (0332) 32651
Telex 37163

Harlow
ITT Electronic Services,
Edinburgh Way,
Harlow,
Essex.
Telephone (0279) 26777
Telex 817379

Leicester
ITT Electronic Services,
56 Welford Road,
Leicester.
Telephone (0533) 548292
Telex 341237

Manchester
ITT Electronic Services,
110 Corn Exchange,
Manchester M4 3BN.
Telephone (061) 832-2681 and
(061) 834-7827/8
Telex 669177

Portsmouth
Celdis-SDS,
57 Kingston Road,
Portsmouth PO2 7DP.
Telephone (0705) 65311
Telex 86114

Reading
Celdis-SDS,
Loverock Road,
Reading RG3 1ED
Telephone (0734) 585171
Telex 848370

Sevenoaks
Jermyn-Mogul Electronics Limited,
Vestry Industrial Estate,
Sevenoaks, Kent.
Telephone (0732) 50144
Telex 95142

Slough
Macro-Marketing Limited,
396 Bath Road,
Slough, Berks SL1 6JA.
Telephone (06286) 4422
Telex 847945

Sunbury-on-Thames
Cramer Components Limited,
Hawke House,
Green Street,
Sunbury-on-Thames,
Middlesex.
Telephone (01) 979-7799
Telex 923592

SCOTLAND

East Kilbride
Celdis-SDS,
111 Alexandra House,
East Kilbride G74 1LX.
Telephone (03552) 35888/9
Telex 779044

Johnstone
ITT Electronic Services,
62 High Street,
Johnstone,
Renfrewshire.
Telephone (0505) 24357
Telex 778622

IRELAND

Dublin
Hawthorne Electronics Limited,
7 Ontario Terrace,
Dublin.
Telephone (0001) 962022/962308

ITT Electronic Services,
142 Phibsborough Road,
Phibsborough, Dublin.
Telephone (0001) 307522
Telex 8288

Larne
Hawthorne Electronics Limited,
18 Cross Street,
Larne,
County Antrim.
Telephone (0574) 5321
Telex 747286

BELGIAN T.I. SALES OFFICE

Belgium
S.A. Texas Instruments Belgium N.V.,
Raketstraat, 100, Rue De La Fusee,
1130 Brussels.
Telephone (02) 720 80 00
Telex 61 161

BELGIAN T.I. DISTRIBUTOR

Inelco Belgium S.A.
Avenue Des Croix De Guerre, 94
1120 Brussels.
Telephone 02/216.01.60
Telex 25 441

SCANDINAVIAN T.I. PLANTS AND SALES OFFICES

Sweden
Texas Instruments International Trade Corpn.,
(Sverige Filialen),
Fack S100-54,
Stockholm.
Telephone 08-23 54 80
Telex 10377

Norway
Texas Insruments Norway AS,
KR August GT.13,
Oslo 1.
Telephone (02) 689485
Telex 19628

Denmark
Texas Instruments A/S,
Marielundvej 46E,
2730 Herlev.
Telephone (02) 91 74 00
Telex 35123

Finland
Texas Instruments Finland OY,
Elimaenkatu 14-16
PL53 00511
Helsinki 51
Telephone 40 83 00
Telex 12 1457

SCANDINAVIAN T.I. DISTRIBUTORS

Sweden
AB Gosta Backstrom,
Box 12009,
Alstromergatan 22,
S-102 21 Stockholm 12.
Telephone (08) 541080
Telex 10135

Sweden
Multikomponent,
Fack,
Ankdammsgatan 32,
171 20 Solna.
Telephone (08) 835150
Telex 10516

Multikomponent,
Box 29047
Lundgatan 12,
400 62 Goteborg.
Telephone (031) 801980

Multikomponent,
Hålsjögatan 4,
217 66 Malmö.
Telephone (040) 130020

Interelko AB,
Sandborgsvägen 55,
S-122-33 Enskede,
Sweden.
08/49 26 60
Telex 10689

Norway
Ingeniorfirma Morgenstierne & Co. AS,
PB 6688 Rodelokka,
Oslo 5,
Telephone (02) 356110
Telex 11719

Denmark
Peter Petersen & Co. A/S,
Tindbjergvej 16,
8600 Silkeborg.
Telephone (06) 83 62 11
Telex 63243

Mer-El A/S,
Ved Klaedebo 18,
2970 Hoersholm.
Telephone (02) 57 10 00
Telex 37360

Finland
Multikomponent
P.O. Box 53.
00520 Helsinki 52
Tel: (90) 739100
Telex 12 1450

Fifty Years of Innovation

TEXAS INSTRUMENTS
LIMITED

CL-377C 85587 MP408B