The Engineering Staff of
TEXAS INSTRUMENTS INCORPORATED
Components Group

F: Calc Prod

TMS 0100 NC MOS/LSI One-Chip Calculator Series

for Design Engineers

TEXAS INSTRUMENTS
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This document contains preliminary functional and operating specifications of the TMS 0100 NC series. Supplementary data may be available at a later date.

LIST OF ILLUSTRATIONS

The TMS 0100 has been designed to operate with very few external components. Because of the scanning technique used, the keyboard can be a simple switch matrix. Encoding and debouncing are internally performed by the TMS 0100. The circuit has been designed for use with popular segmented displays. The display outputs are fully decoded including interdigit blanking and leading-zero suppression. (Leading insignificant zeros will not be displayed.) Only simple level-shifting switches are needed to drive most types of numerical displays presently on the market.

II. TIMING

The basis for the timing is the external clock applied to the device. The nominal frequency of the clock is 250 kHz.

A state time is equivalent to 3 clock cycles (cc).

A digit time is equivalent to 13 state times or 39 clock cycles or nominally 156 microseconds. A digit time (D-time) corresponds to the amount of time during which each digit is displayed. Blanking in increments of one state time on the leading and trailing edges of each D output signal can be programmed.

Digits are displayed in scanning mode, so any digit is displayed for one D-time and displayed again one D-cycle later. A D-cycle is equivalent to 11 D-times – that is 1.72 milliseconds.

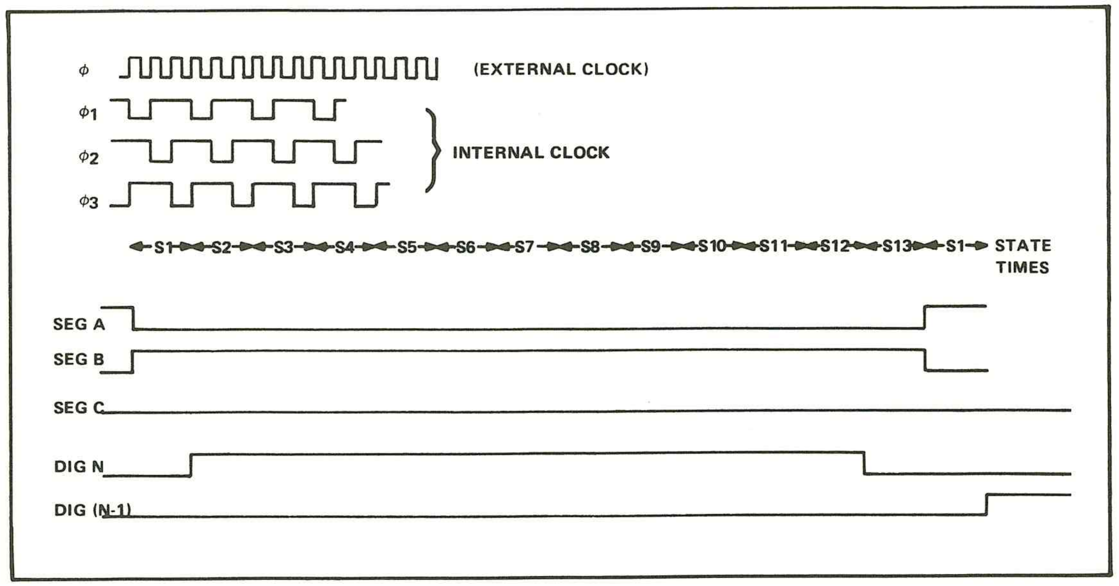

Figure 3. System Timing Diagram

III. DATA INPUT

A. INPUT FORMAT

In either floating-fixed or full-floating mode, entry is displayed as natural floating-point numbers. The data input is usually entered through the keyboard. Data input is always in floating format. It should be noted that in most standard versions of the TMS 0100, if more than one decimal point ⊡ is keyed with data entry, the last one is effective. In the TMS 0106 and TMS 0107 the first decimal point entered is effective.

B. KEYBOARD MATRIX

Data and mode information is entered through four input lines: KN, KO, KP, KQ. These "K" lines are scanned by use of 11 distinct digit timing signals, "D times," allowing up to 4 x 11 = 44 keys/switches. Keyboard encoding, key debounce, and functional characteristics are internally programmed. The keyboard need not be fully populated.

Data type information is usually conveyed through use of simple SPST momentary pushbutton keys at the junctures of the KN (numerical), KO (operational), and eleven D lines as illustrated in Figure 4.

Mode-type information such as fixed decimal point; constant or chain mode; and rounding up, off or down, is conveyed through two (or more)-position switches.

In most calculator applications, the key/switch assignments are as follows:

KN	numerical	data keys
KO	operational	
KP	decimal point	mode switches
KQ	constant	

The keyboard matrix for the TMS 0103 is shown in Figure 4.

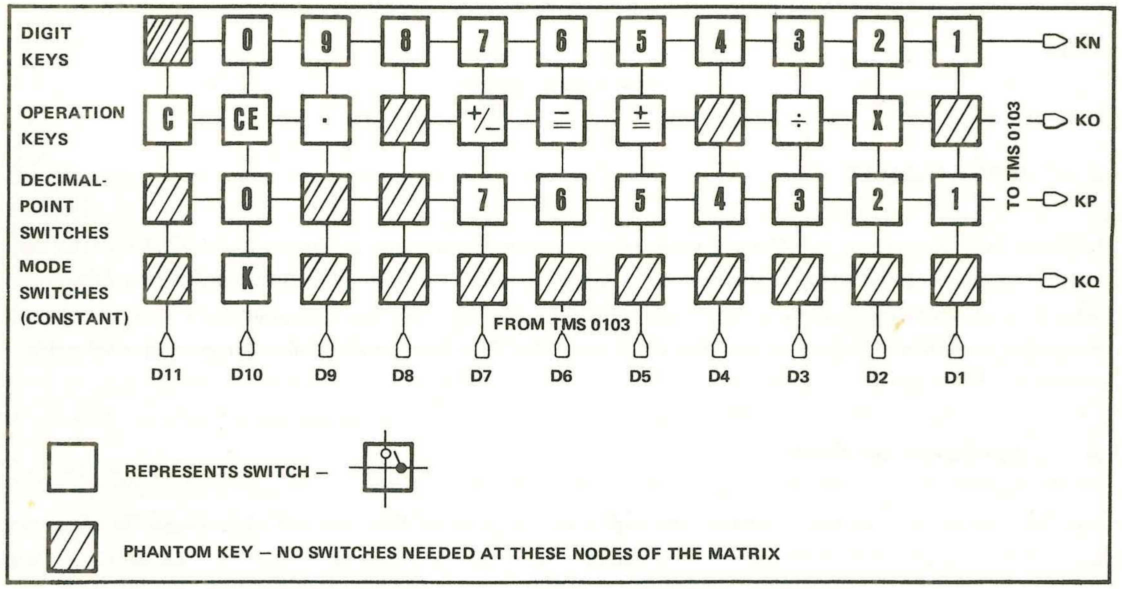

Figure 4. TMS 0103 NC Keyboard Matrix

C. BOUNCE PROTECTION

The switches that constitute the matrix can be of varied implementation (mechanical, reed relays, snap-action, etc.). The TMS 0100 input-sensing program provides protection against transient noise, double-entry, leading-edge bounce, and trailing-edge bounce. The IDLE routine simultaneously scans the [KO] and [KN] inputs until a nonquiescent input is detected. The input is sampled again four D cycles later to distinguish a valid key-push from transient noise. If the test is positive, then the program jumps to a routine to determine the specific key pressed. Otherwise it returns to IDLE. After the digit is entered or status is set, or the operation is performed, the calculator jumps to a LOCK routine. The LOCK routine performs a scan of the [KN] and [KO] inputs to determine if the entire keyboard is in its quiescent condition. After a successful (negative) test the program jumps back to the IDLE routine.

Total data-entry time (including debounce) is 10 D cycles.

NOTE: Other modes of entry may be performed in the TMS 0100. The data-entry mode described above has been optimized for calculator applications.

D. INPUT PULL-UP

Input pull-up resistors of 30 kΩ typical to V_{dd} are used on the K input lines. They have been incorporated on the chip to avoid the need for external resistors and to make the data input independent of the interface used for the display.

E. KEY ASSIGNMENTS

Any number of operational specifications can be programmed in the TMS 0100. For most calculator applications the following conventions have been used:

1) Number Keys (KN line)

There are ten numeric keys.

Operation of the [0], [1], [2], [3], [4], [5], [6], [7], [8], [9] keys left-shifts the display register one digit and enters the corresponding number into the least-significant digit.

Entry mode is always full floating.

2) Point Switch (KP line)

Floating or fixed mode of operation is selected by an 11-position switch

[F][9][8][7][6][5][4][3][2][1][0]

Positions [0] through [9] are used for fixed-point calculation results; the [F] position selects full-floating operation. Typically, the KP default for no switch connection is full-floating mode of operation.

3) Operation Keys (KO and KQ lines)

There is a total of 22 possible operation keys. These keys are sufficient to include the two main keyboard configurations presently used by calculator manufacturers.

Figure 8 shows a layout for the [±] [=] system of operation commonly encountered on business-type calculators.

Other implementations of the TMS 0100 permit operation in the [+][–][=] entry system.

[X] Stores multiplication command and performs a possible preceding operation

[÷] Stores a division command and performs a possible preceding operation

[+/–] Changes the sign of the display register

[±] Enters the last keyed-in number in the machine and performs a possible preceding operation

[−=] Enters the last keyed-in number in the machine as a negative number and performs a possible preceding operation

[+] Stores an add command and performs a possible preceding operation. If used after [X], [÷], [=], acts as positive-sign key

[−] Stores a subtract command and performs a possible preceding operation. If used after [X], [÷], [=], acts as negative sign key

[=] Causes any previously stored command to be executed. Clears data registers on next digit entry if not in constant mode

[·] Used to enter a decimal point during numerical entry. If not used, the decimal point is assumed to be after the last numerical entry. If the decimal point is keyed more than once during data entry, the specific circuit implementation determines which decimal point entry is effective. In the TMS 0106 and TMS 0107 the first entered is effective.

NOTE: The external role of the keys depends on the particular implementation of the TMS 0100 being used. Different conventions may be employed. The matrix and the role of operation keys is limited by the programming capacity of the TMS 0100. (Refer to data on specific devices.)

4) Special Mode Switches (KQ)

The constant switch [K] selects between chain operation and constant operation. Normal operation of the calculator, with the constant key [K] ↑, allows chained calculations without loss in intermediate results. Alternative operation with [K] ↓, allows constant operation.

Selected Rounding (if available) is selected using a two- or three-position switch. [5/4] [↑] or [↓] is available on some versions such as the TMS 0106 and TMS 0107.

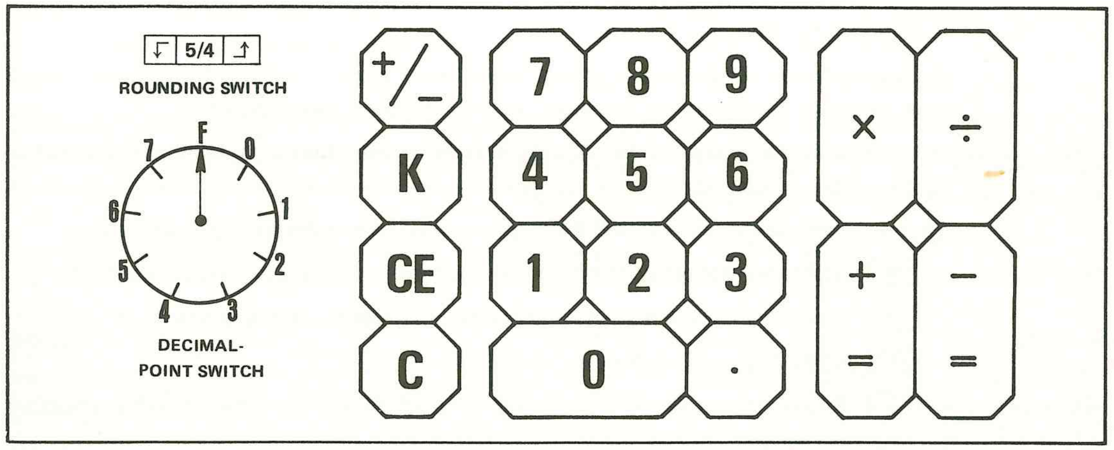

Figure 5. ± = Keyboard

IV. DATA OUTPUT

Data is extracted from the TMS 0100 in serial form with the most-significant digit first. The data consists of numerical information (contents of Register A entry or result) and status information (negative sign, error entry, overflow, etc.).

Two different groups of terminals are used to extract the data – digit-scan terminals and coded-segment terminals.

A. PHYSICAL IMPLEMENTATION

All output buffers are open-drain MOS buffers. No load resistor is provided on the chip. The load must be provided externally. Typical resistance of the buffer in the On state is 250 ohms.

B. DIGIT-SCAN TERMINALS

There are 11 digit-scan terminals, designated D_{11} through D_1. No more than one of the eleven D terminals will be on at any time.

The digit terminals have a dual function:

1) to scan the keyboard for input

2) to scan the display for output

D_{11} corresponds to the status information (sign, entry error, result overflow). D_{10} through D_1 correspond to the data stored in the display register. The most-significant digit is D_{10} in 10-digit versions of the chip, while D_8 is the most-significant digit in the 8-digit versions.

The polarity of the digit terminals is always positive.

A digit time corresponds to 13 state times. Blanking of the digit terminals is programmable on leading and trailing edges of the digit times in increments of one state time. Most calculator versions are blanked during state times 1 and 13. (See Figure 6).

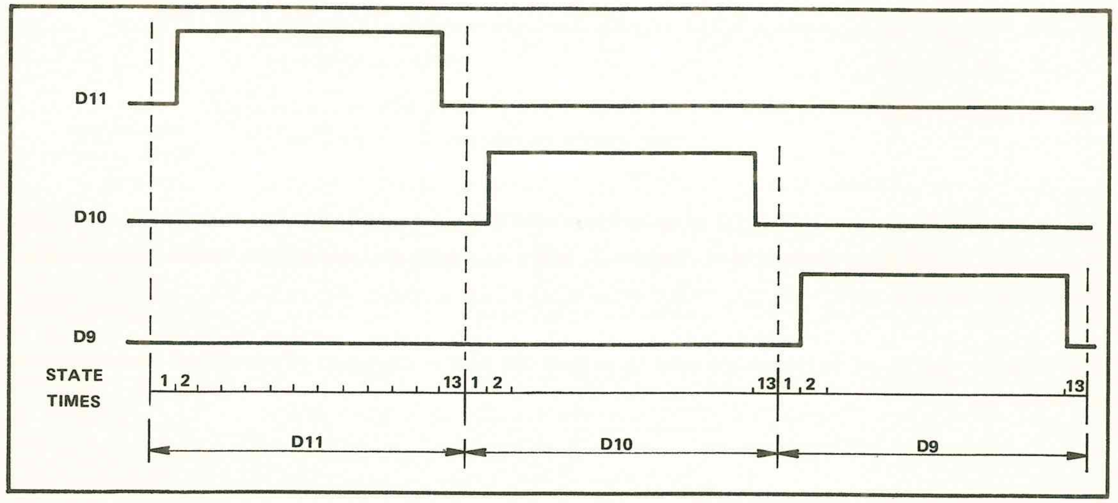

Figure 6. Typical 1, 13 Digit Blanking for Calculator Applications

C. CODED SEGMENT TERMINALS

Internal operation of the calculator circuit is in BCD or binary. Because the output decoder has 11 outputs (10 plus decimal point) and is programmable, any decimal code of up to 10 bits can be programmed on the TMS 0100 series. Most common are: BCD; seven, eight, and nine segments; and true decimal codes (e.g., nixie-type display). Versions of the TMS 0100 requiring more than 9 outputs (8 plus decimal point) are packaged in 40-pin dual-in-line packages. The segment outputs are labeled SA through SJ and SP (Figure 7). Most of the TMS 0100 series devices use a 7-segment code (or an augmented 7-segment [8] to include a segment for a "tail" on the digit "4").

The programmability of the TMS 0100 output decoder permits the use of any font (Figure 8).

The polarity of the segment output can be programmed. Some displays such as liquid crystals, are easier to interface with inverted polarity (true polarity means a buffer "on" for a lighted segment.) The blanking of the segments is also programmable within limits, and in increments of state time as described below (see Figure 9).

The segment blanking is either 0 or 1 state time on the leading and/or trailing edge. This facilitates the interface with certain displays (such as *Panaplex II**).

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* *Panaplex II* is a trademark of Burroughs Corporation.

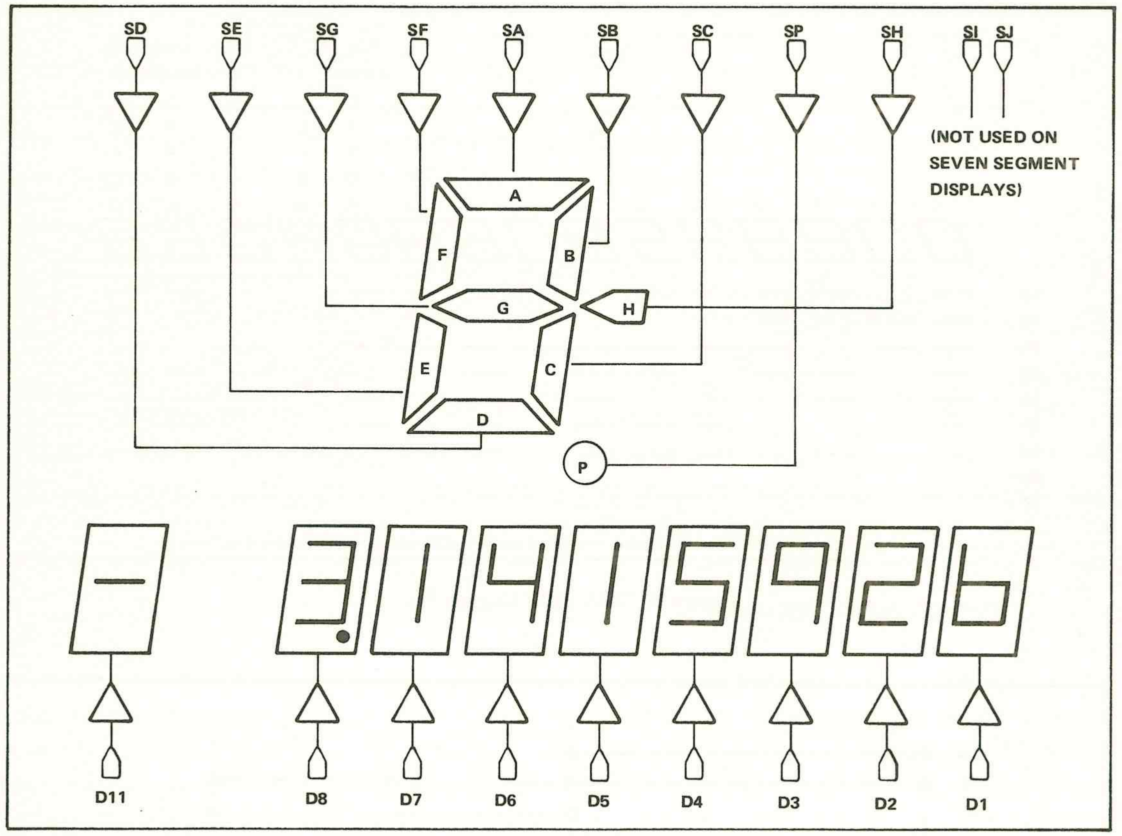
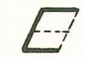


Figure 7. TMS 0103 Display Schematic

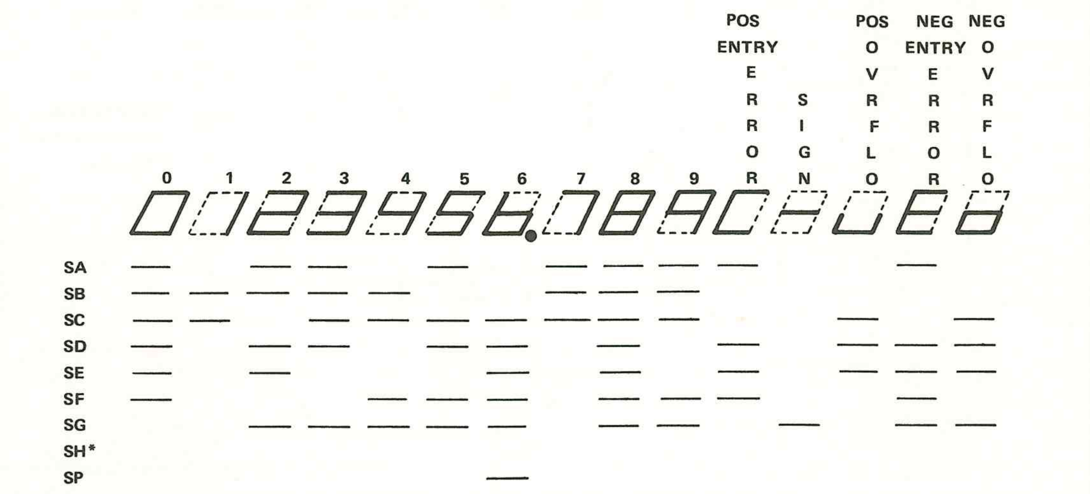
D. DATA ENTRY OVERFLOW

If the operator tries to enter too many digits, the entry overflow indication will appear (varies with specific device – see Section VI). For instance, in the TMS 0102 entry overflow will be indicated by the following:

 sign for positive entry

 sign for negative entry.

Additional digits will be ignored; the most-significant digits will be protected. This situation does not lock the machine.



*Some versions offer Segment H as the "tail" on the digit 4. However, use of the SH tail on such versions is optional.

Figure 8. TMS 0102 Display Font

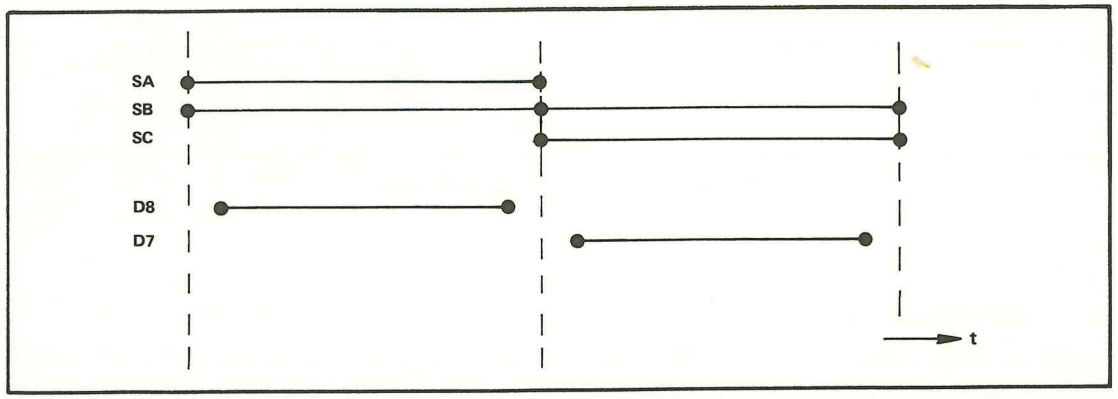


Figure 9. TMS 0103 Blanking — One-State-Time Leading- and Trailing-Edge Blanking on Digits; No Segment Blanking

E. RESULT OVERFLOW FLOATING POINT

In the event an intermediate or final-result overflow is encountered as a result of a mathematical operation, the proper answer is displayed multiplied by 1 x 10^{-8} (1 x 10^{-10} in 10-digit versions) with an overflow indication. Therefore, to determine the correct result, imagine the overflow indicator to say "x10^8 or

10^{10}"; that is, move the decimal point 8 or 10 places to the right. Further operations with the exception of Clear are not possible in this state.

The result overflow condition is detected by an indicator which varies with the specific TMS 0100 implementation used. For instance, in the TMS 0102 –

 sign for positive overflow

 sign for negative overflow.

F. UNDERFLOW

In fixed-point operation the decimal point will be shifted right if necessary to protect the most significant digits (MSDs) of the result of a mathematical operation. For intermediate or final results less than 10^8, the decimal point is protected and the digits underflow.

G. ROUNDING

In fixed-point operation, the number entered or resulting from an operation will be rounded if the number of digits after the decimal point exceeds the number of digits permitted by the decimal-point switch.

Depending on the particular TMS 0100 implementation, the result will be rounded off (5/4), up or down (on some versions the rounding may be selected by the position of a switch) with the following results:

Round-down (truncate)	digits underflow, no change of least significant digit (LSD)
Round-off (5/4)	the last digit that underflows will increase the LSD by one if its magnitude is ⩾ 5
Round-up	the last digit that underflows will increase the LSD by one if it is nonzero.

The following is a rounding example for decimal-point location 2:

ENTRY	ROUND-DOWN	ROUND-OFF	ROUND-UP
1.2706 + =	1.27	1.27	1.27
1.271 + =	1.27	1.27	1.28
1.2748 + =	1.27	1.27	1.28
1.275 + =	1.27	1.28	1.28
1.2799 + =	1.27	1.28	1.28

V. ELECTRICAL SPECIFICATIONS

A. ABSOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR TEMPERATURE RANGE (unless otherwise noted)

Supply voltage V_{DD} range (See Note 1) . . . . −20 V to 0.3 V
Supply voltage V_{GG} range (See Note 1) . . . . −20 V to 0.3 V
Clock input voltage range (See Note 1) . . . . −20 V to 0.3 V
Data input voltage range (See Note 1) . . . . −20 V to 0.3 V
Applied output voltage range (See Note 1) . . . . −20 V to 0.3 V
Operating free-air temperature range . . . . 0°C to +70°C
Storage temperature range . . . . −55°C to +150°C

NOTE 1: These voltage values are with respect to V_{SS} (substrate).

B. RECOMMENDED OPERATING CONDITIONS

CHARACTERISTICS	CONDITIONS	MIN	NOM	MAX	UNIT
Operating Voltages (See Note 2)					
Drain supply V_{DD} (See Note 3)		0	0	0	V
Substrate supply V_{SS}		6.6	7.2	8.1	V
Gate supply V_{GG}		−8.1	−7.2	−6.6	V
Clock Levels					
Clock high level $V_{\phi H}$		V_{SS} −1.5	V_{SS} −0.5	V_{SS}	V
Clock low level $V_{\phi L}$		V_{GG} −1	V_{GG}	V_{GG} +1	V
Clock Timing (See Figure 10)					
Frequency		100	250	400	kHz
Period T_1		2.5	4	10	μs
Half-period T_2		1.25	2	5	μs
Half-period T_3		1.25	2	5	μs
Clock T_r and T_f	f clock = 100 kHz	30		1000	ns
Clock T_r and T_f	f clock = 250 kHz	30		650	ns
Clock T_r and T_f	f clock = 400 kHz	30		300	ns
Key Contact Time (See Notes 4, 5)		6000			cc†
Key Bounce (See Note 4)				1500	cc†
Input level K lines					
Low		V_{GG}	V_{DD}	V_{SS} −6	V
High		V_{SS} −1.5	V_{SS} −0.5	V_{SS}	V

NOTES: 2. Effective zero suppression depends on a transient free rise of V_{SS} and V_{GG} during power-up. With certain supply systems it may be necessary to capacitively damp the supplies to ensure zero suppression.
3. V_{DD} is voltage reference.
4. Nominal timing. Key depression = 24 msec minimum.
5. Includes key bounce. Key bounce = 6 msec maximum.

† cc = clock cycle

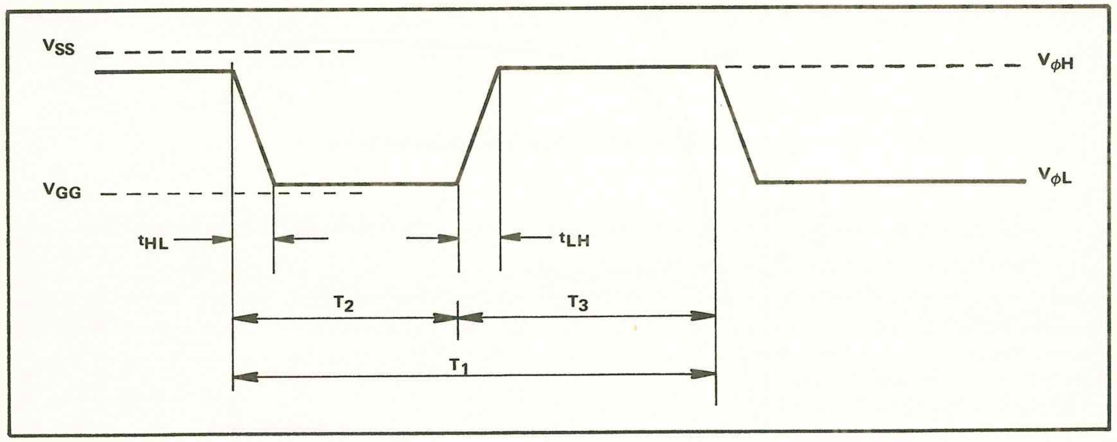


Figure 10. Clock Timing Diagram

C. ELECTRICAL CHARACTERISTICS AT NOMINAL CONDITIONS OVER 0°C TO 70°C TEMPERATURE RANGE

PARAMETER	MIN	TYP†	MAX	UNIT
Input current on K lines (K input low) (All other pins GND)		0.1	10	μA
Input pull-up resistance		30		KΩ
Output leakage (off state with V_{OUT} = V_{SS} −10 V) (See Note 1)		0.1	100	μA
Output resistance R_O (on state with V_{OUT} = V_{SS} −0.5 V) (See Figure 11)		250	500	Ω
Output saturation current I_{SAT} (See Paragraph D)		15		mA
Clock leakage (Low Level)		0.1	100	μA
K line input capacitance (V_K = V_{SS}, f = 100 kHz)		2.5	5	pF
Output capacitance (f = 100 kHz)		2.0	5	pF
Clock capacitance (f = 100 kHz)		10	20	pF
Avg supply current I_{GG} (See Note 1)		10	15	mA
Avg supply current I_{DD} (See Note 1)		17	25	mA
Power dissipation (See Notes 1 and 2)		265	400	mW

D. COMPUTATION TIMES

OPERATION	MIN	TYP†	MAX	UNIT
Add		10000	15000	cc
Subtract		10000	15000	cc
Multiply		20000	30000	cc
Divide		25000	35000	cc

† All typical values are at T_A = 25°C.

NOTES: 1. At 25°C. Output leakage cannot be measured with a curve tracer because capacitive coupling will turn on the output.
2. Power saving techniques, including pulsing of power supplies and reduction of clocking cycle may reduce power to 100 mW. These techniques involve special screening of the device.

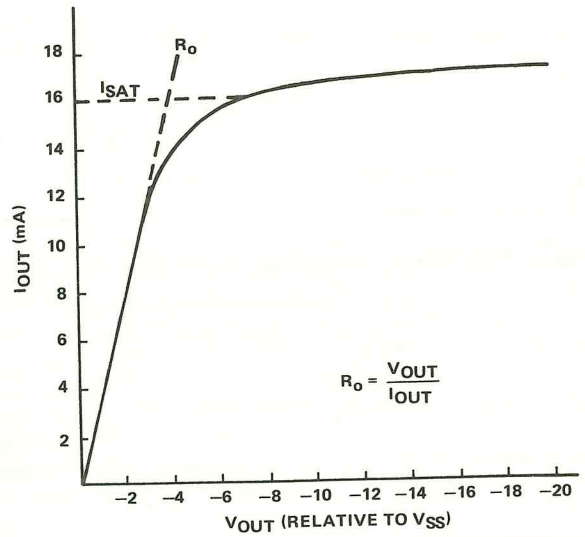
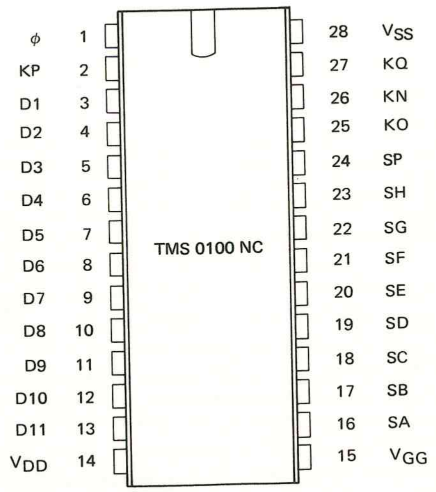


Figure 11. Typical Output Buffer Characteristics

E. MECHANICAL DATA

The TMS 0100 NC is mounted in a 28-pin plastic dual-in-line package. The package is designed for insertion in mounting-hole rows on 0.600-inch centers. Pin assignments are the same for all standard versions of the TMS 0100 series.

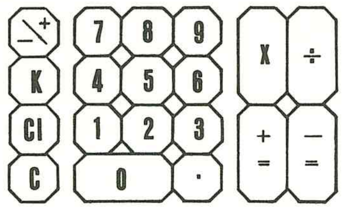


VI. STANDARD CALCULATOR PRODUCTS

A. KEYBOARD CONFIGURATION

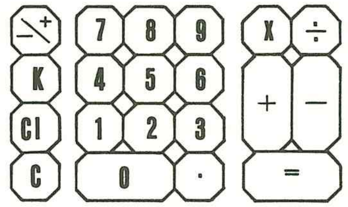
Standard product versions of the TMS 0100 are manufactured by TI with both the ± ∓ arithmetic keyboard configuration and the +, —, = algebraic configuration.

±, ∓, (ADDING MACHINE)



TMS 0102

+, —, =, (PEN AND PAPER)



TMS 0100

±, ∓	+, —, =
TMS 0102 (ex- TMS 1802)	TMS 0101
TMS 0103	TMS 0110
TMS 0105	TMS 0118 (10 digits)
TMS 0106 (10 digits)	
TMS 0107 (10 digits)	
TMS 0109	
TMS 0123* (10 digits)	
TMS 0126*	
TMS 0127* (10 digits)	
TMS 0128*	

*Additional functions are included on these products, as defined in this section.

B. GENERAL CHARACTERISTICS

Characteristics of the various standard versions are summarized below.

SPECIFICATION SUMMARY

	0101	0102	0103	0105	0106	0107	0109	0110	0118
KEYBOARD	+ – =	± =	± =	± =	± =	± =	± =	+ – =	+ – =
CONSTANT FACTORY (M/D)	1/2	1/2	1/2	1/2	1/2	1/2	1/2	2/2	2/2
DIGITS	8	8	8	8	10	10	8	8	10
ROUNDING	DOWN	OFF	OFF	OFF	3-POS	3-POS	OFF	DOWN	3-POS
SEGMENT POLARITY	+	+	+	+	+	+	+	+	+
SEGMENT BLANKING*	NONE	NONE	NONE	NONE	1, 13	1, 13	1, 13	NONE	1, 13
DIGIT BLANKING	1, 13	1, 13	1, 13	1, 13	1, 13	1, 13	1, 13	1, 13	1, 13
(6, 7, 9) FONT	679	679	679	679	679	679	679	679	679
(+ ENTRY ERROR) FONT	NONE	C	E	C	C	E	E	NONE	C
(– ENTRY ERROR) FONT	NONE	E	E	E	E	E	E	NONE	E
(+ OVERFLOW) FONT	C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	C	[illegible]
(– OVERFLOW) FONT	E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	E	[illegible]
SH†					4				4
PREFERRED TYPE	YES		YES		YES				YES

	0123	0126	0127	0128
KEYBOARD	± =	± =	± =	± =
CONSTANT FACTORY (M/D)	1/2	1/2	1/2	1/2
DIGITS	10	8	10	8
SELECTED FIXED DECIMAL	FULL FLOATING ONLY	FULL FLOATING ONLY	D0-D9, F	D0-D9, F
ROUNDING	NONE	NONE	OFF	OFF
SPECIAL FUNCTIONS	$\sqrt{\ }$, x^2	$\sqrt{\ }$, x^2	A/D, %/mil, 00	A/D, %/mil, 00
SEGMENT BLANKING*	1, 13	NONE	1, 13	1, 13
DIGIT BLANKING	1, 13	1, 13	1, 13	1, 13
FONT: (6, 7, 9)	679	679	679	679
SH†	4	4	4	4
ENTRY OVERFLOW +	C	C	C	C
ENTRY OVERFLOW –	E	E	E	E
OVERFLOW +	[illegible]	[illegible]	[illegible]	[illegible]
OVERFLOW –	[illegible]	[illegible]	[illegible]	[illegible]

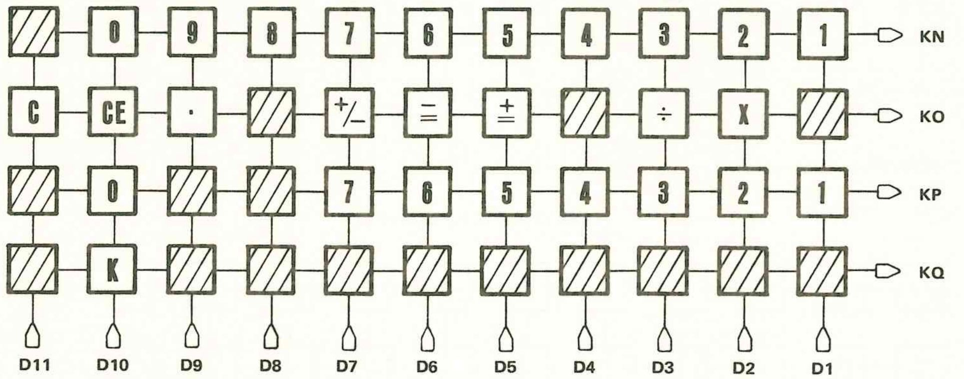
* Refers to state time.

† Additional segment may be used for a tail on the digit 4.

C. KEYBOARD CHARACTERISTICS

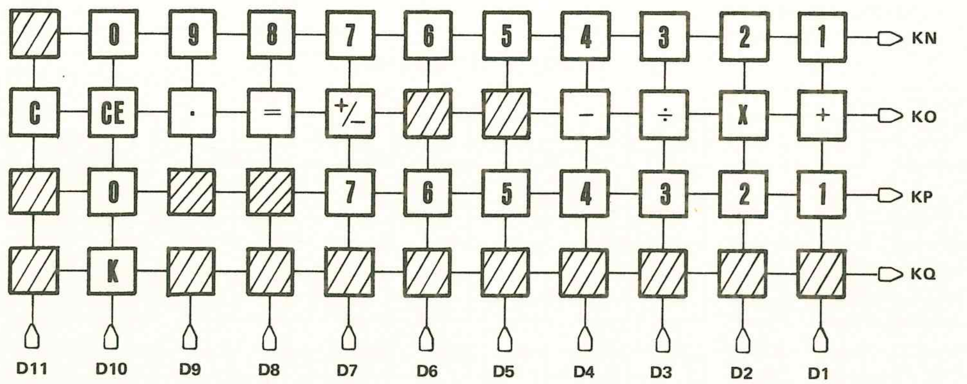
Keyboard and computing characteristics vary with the specific versions, while pin assignments and electrical characteristics remain constant. Keyboard characteristics are defined as follows:

TMS 0102, 0103, 0105, 0109 KEYBOARD



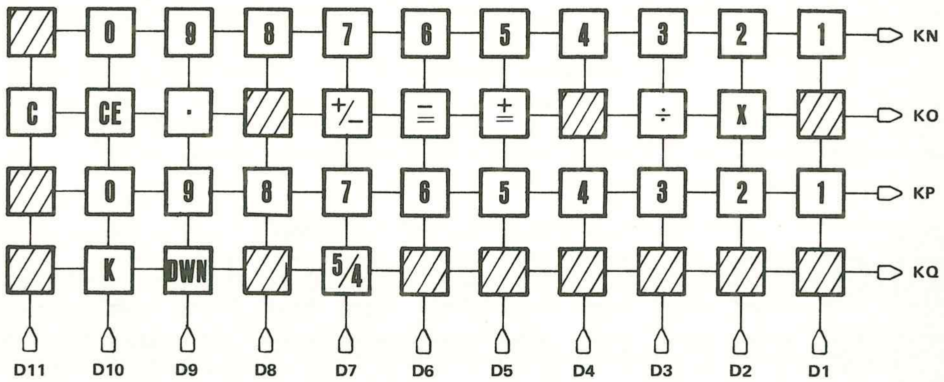
FLOATING – DEFAULT KP

TMS 0101, 0110 KEYBOARD



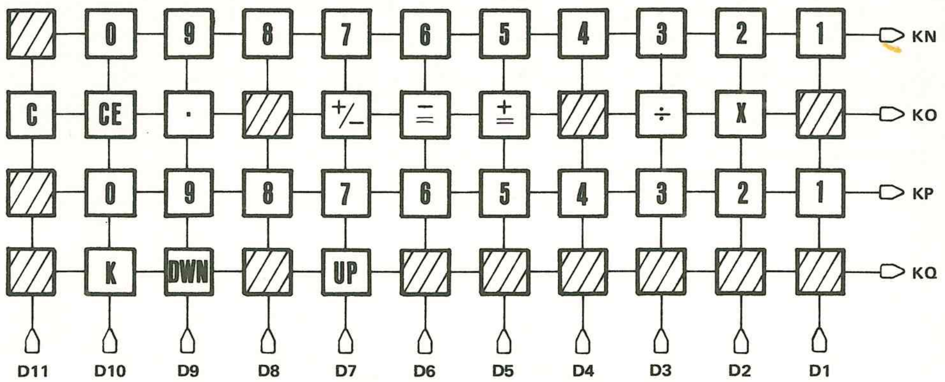
FLOATING – DEFAULT KP

TMS 0106 KEYBOARD



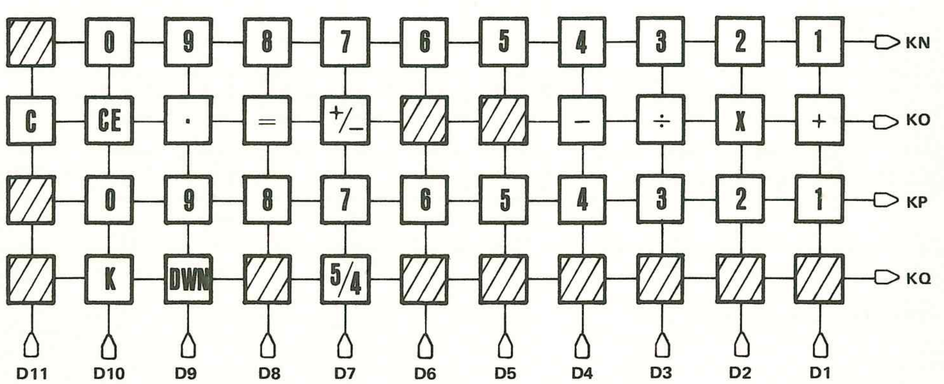
FLOATING – DEFAULT KP
ROUND-UP – DEFAULT KQ

TMS 0107 KEYBOARD



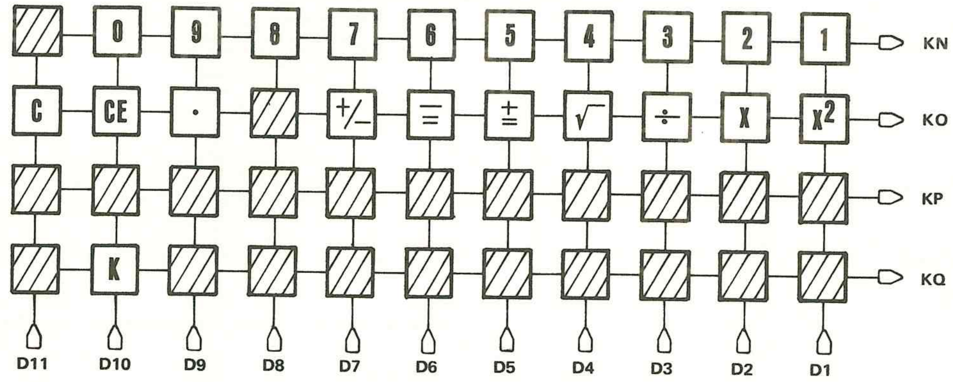
FLOATING – DEFAULT KP
ROUND-OFF – DEFAULT KQ

TMS 0118 KEYBOARD

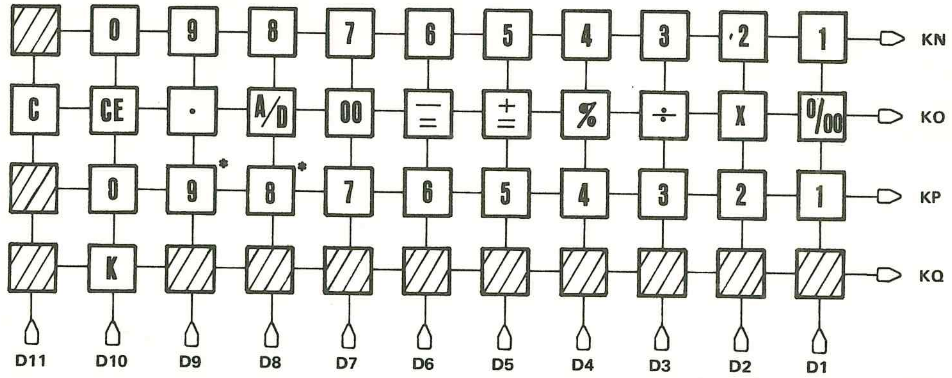


FLOATING – DEFAULT KP
ROUND-UP – DEFAULT KQ

TMS 0123, 0126 KEYBOARD



TMS 0127, 0128 KEYBOARD



FLOATING – DEFAULT KP
* 0127 ONLY

D. CALCULATION EXAMPLES

Computing characteristics for the standard versions are demonstrated in the following calculation examples.

TMS 0102, 0103, 0105, 0109, 0106, 0107

PROBLEM	KEY	DISPLAY
—a —b + c	[C]	0
	a	a
	[−=]	—a
	b	b
	[−=]	—a —b
	c	c
	[+=]	—a —b + c
(—a) x b =	[C]	0
	a	a
	[−=]	—a
	[×]	—a
	b	b
	[+=]	—(ab)
a ÷ (—b) =	[C]	0
	a	a
	[÷]	a
	b	b
	[−=]	—(a/b)
a × (—b) ÷ (—c) =	[C]	0
	a	a
	[×]	a
	b	b
	[−=]	—(ab)
	[÷]	—(ab)
	c	c
	[−=]	(ab/c)
$\frac{(a + b — c) \times d}{e}$ —f =	[C]	0
	a	a
	[+=]	a
	b	b
	[+=]	(a + b)
	c	c
	[−=]	(a + b —c)
	[×]	(a + b —c)
	d	d
	[÷]	(a + b —c)d
	e	e
	[+=]	(a + b —c)d/e
	f	f
	[−=]	(a + b —c) d/e —f

PROBLEM	KEY	DISPLAY
a x b =	[C]	0
a x c =	[K] ↓	0
a x d =	a	a
	[×]	a
	b	b
	[+=]	(ab)
	c	c
	[+=]	(ac)
	d	d
	[+=]	(ad)
a ÷ b =	c	0
c ÷ b =	[K] ↓	0
d ÷ b =	a	a
	[÷]	a
	b	b
	[+=]	(a/b)
	c	c
	[+=]	(c/b)
	d	d
	[+=]	(d/b)
a^4 x b =	[C]	0
	[K] ↓	0
	a	a
	[×]	a
	b	b
	[+=]	(ab)
	[+=]	(a^2b)
	[+=]	(a^3b)
	[+=]	(a^4b)
a ÷ b^3	[C]	0
	[K] ↓	0
	a	a
	[÷]	a
	b	b
	[+=]	(a/b)
	[+=]	(a/b^2)
	[+=]	(a/b^3)
a^4 =	[C]	0
	[K] ↓	0
	a	a
	[×]	a
	[+=]	a^2
	[+=]	a^3
	[+=]	a^4

NOTE: This basic algorithm is also used for the multifunction TMS 0123, 0126, 0127 and 0128.

TMS 0101

PROBLEM	KEY	DISPLAY
—a —b + c	[C]	0
	[−]	0
	a	—a
	[−]	—a
	b	—b
	[+]	—a —b
	c	c
	[=]	—a —b + c
(—a) x b =	[C]	0
	[−]	0
	a	—a
	[×]	—a
	b	b
	[=]	—(ab)
a ÷ (—b)	[C]	0
	a	a
	[÷]	a
	[−]	a
	b	—b
	[=]	—(a/b)
a x (—b) ÷ (—c) =	[C]	0
	a	a
	[×]	a
	[−]	a
	b	—b
	[÷]	—(ab)
	[−]	—(ab)
	c	—c
	[=]	(ab/c)
$\frac{(a + b — c) \times d}{e}$ —f =	[C]	0
	a	a
	[+]	a
	b	b
	[−]	(a + b)
	c	c
	[×]	(a + b —c)
	d	d
	[÷]	(a + b —c)d
	e	e
	[−]	(a + b —c)d/e
	f	f
	[=]	(a + b —c) d/e —f

PROBLEM	KEY	DISPLAY
a x b =	[C]	0
a x c =	[K] ↓	0
a x d =	a	b
	[×]	b
	b	a
	[=]	(ab)
	c	c
	[=]	(ac)
	d	d
	[=]	(ad)
a ÷ b =	c	0
c ÷ b =	[K] ↓	0
d ÷ b =	a	a
	[÷]	a
	b	b
	[=]	(a/b)
	c	c
	[=]	(c/b)
	d	d
	[=]	(d/b)
a^4 x b =	[C]	0
	[K] ↓	0
	a	a
	[×]	a
	b	b
	[=]	(ab)
	[=]	(a^2b)
	[=]	(a^3b)
	[=]	(a^4b)
a ÷ b^3	[C]	0
	[K] ↓	0
	a	a
	[÷]	a
	b	b
	[=]	(a/b)
	[=]	(a/b^2)
	[=]	(a/b^3)
a^4 =	[C]	0
	[K] ↓	0
	a	a
	[×]	a
	[=]	a^2
	[=]	a^3
	[=]	a^4

TMS 0110, 0118

PROBLEM	KEY	DISPLAY
—a —b + c	[C]	0
	[—]	0
	a	—a
	[—]	—a
	b	—b
	[+]	—a —b
	c	c
	[=]	—a —b + c
(—a) x b =	[C]	0
	[—]	0
	a	—a
	[X]	—a
	b	b
	[=]	—(ab)
a ÷ (—b) =	[C]	0
	a	a
	[÷]	a
	[—]	a
	b	—b
	[=]	—(a/b)
a x (—b) ÷ (—c) =	[C]	0
	a	a
	[X]	a
	[—]	a
	b	—b
	[÷]	—(ab)
	[—]	—(ab)
	c	—c
	[=]	(ab/c)
$\frac{(a + b - c) \times d}{e} - f =$	[C]	0
	a	a
	[+]	a
	b	b
	[—]	(a + b)
	c	c
	[X]	(a + b —c)
	d	d
	[÷]	(a + b —c)d
	e	e
	[—]	(a + b —c)d/e
	f	f
	[=]	(a + b —c) d/e —f

PROBLEM	KEY	DISPLAY
a x b =	[C]	0
a x c =	[K] ↓	0
a x d =	b	b
	[X]	b
	a	a
	[=]	(ab)
	c	c
	[=]	(ac)
	d	d
	[=]	(ad)
a ÷ b =	c	0
c ÷ b =	[K] ↓	0
d ÷ b =	a	a
	[÷]	a
	b	b
	[=]	(a/b)
	c	c
	[=]	(a/b)
	d	d
	[=]	(d/b)
$a^4 \times b =$	[C]	0
	[K] ↓	0
	b	b
	[X]	b
	a	a
	[=]	(ab)
	[=]	(a^2b)
	[=]	(a^3b)
	[=]	(a^4b)
$a \div b^3$	[C]	0
	[K] ↓	0
	a	a
	[÷]	a
	b	b
	[=]	(a/b)
	[=]	(a/b^2)
	[=]	(a/b^3)
$a^4 =$	[C]	0
	[K] ↓	0
	a	a
	[X]	a
	[=]	a^2
	[=]	a^3
	[=]	a^4

NOTE: A computer printout containing 1500 calculation examples defines the complete operating specification of the device and can be obtained from TI upon request. The examples above do not constitute an operating specification.

TMS 0123, TMS 0126

The TMS 0124 and 0126 are full-floating devices, deriving from the basic TMS 0106 algorithm. The added features are square and square root as defined below:

[√‾] – square root of display register; any previous multiply or divide command is executed first.

[x2] – square of display register; any previous multiply or divide command is executed first.

The square root of negative numbers is flagged as an error.

	KEY	DISPLAY
K ↑ or ↓	[C]	0.
	A	A
	[+=]	A
	B	B
	[√‾]	√B
	[x2]	B
	[C]	0.
	A	A
	[X]	A
	B	B
	[√‾]	√AB
	[C]	0.
	A	A
	[÷]	A
	B	B
	[√‾]	√A/B
	[C]	0.
	9	9.
	[+/—]	—9.
	[√‾]	□3.

NOTE: √X where X < 0 is flagged by □ (error symbol).

	KEY	DISPLAY
K ↑ or ↓	[C]	0.
	A	A
	[+=]	A
	B	B
	[x2]	BB
	[√‾]	B
	[C]	0.
	A	A
	[X]	A
	B	B
	[x2]	$(AB)^2$
	[C]	0.
	A	A
	[÷]	A
	B	B
	[x2]	$(A/B)^2$
	[C]	0.
	9	9.
	[+/—]	—9.
	[x2]	81.

TMS 0127, TMS 0128

The TMS 0127 and 0128 derive from the TMS 0106 algorithm. Added features are defined as follows:

- [A/D] – divide display register by 100, then execute any previous multiply or divide command
- [%] – divide display by 100 – does not terminate number entry
- [$^0/_{00}$] – divide display by 1000 – does not terminate number entry
- [00] – enters 00.

The add-on, discount is compatible with chain and constant mode of operation.

	KEY	DISPLAY	COMMENTS
K ↑ or ↓	[C]	0.	
	A	A	
	[X]	A	
	B	B	
	[A/D]	AB/100	B % of A (or A % of B)
	[+=]	A + AB/100	Add-on
K ↑ or ↓	[C]	0.	
	A	A	
	[+=]	A	
	B	B	
	[+=]	A + B	
	C	C	
	[+=]	A + B + C	Subtotal
	[X]	A + B + C	
	D	D	Tax rate
	[A/D]	(A + B + C) D/100	D % of Subtotal
	[+=]	(A + B + C) (1 + D/100)	Final total
K ↑ or ↓	[C]	0.	
	A	A	
	[X]	A	
	B	B	
	[A/D]	AB/100	B % of A
	[X]	AB/100	
	C	C	
	[A/D]	C/100 (AB/100)	C % of B % of A

	KEY	DISPLAY	COMMENTS
K ↑ or ↓	[C]	0.	
	A	A	
	[X]	A	
	B	B	
	[A/D]	AB/100	B % of A (or A % of B)
	[–=]	A – AB/100	Discount
K ↑ or ↓	[C]	0.	
	A	A	
	[÷]	A	
	B	B	
	[A/B]	100 A/B	Ratio A to B in %
	[+=]	A + 100 A/B	
K ↑ or ↓	[C]	0.	
	A	A	
	[A/D]	A/100	A/D as percent key
	[+=]	A/100	
	B	B	
	[+=]	B + A/100	
	[A/D]	$\frac{B + A/100}{100}$	

TMS 0127, TMS 0128 (Continued)

	KEY	DISPLAY
K ↓	[C]	0.
	A	A
	[X]	A
	B	B
	[A/D]	AB/100
	C	C
	[A/D]	AC/100
	D	D
	[A/D]	AD/100
	[+=]	A + AD/100
	E	E
	[A/D]	AE/100
	[+=]	A + AE/100

	KEY	DISPLAY
K ↑ or ↓	[C]	0.
	A	A
	[%]	A/100
	[+=]	A/100
	B	B
	[/mil]	B/1000
	[+=]	A/100 + B/1000
K ↑ or ↓	[C]	0.
	A	A
	[X]	A
	B	B
	[+=]	AB
	[%]	AB/100
K ↑ or ↓	[C]	0.
	5	5.
	[00]	500.
	[%]	5.00

E. OTHER VERSIONS

TI expects to add further standard calculator devices to the TMS 0100 series. For updating, contact your local TI representative.

If no standard device fulfills the needs of the user, TI will consider custom programmation for large-volume requirements.

VII. INTERFACE CHARACTERISTICS

Any number of display types can be used with TMS 0100 series devices. All popular segmented displays (LEDs, gas discharge, Fluorescent, etc.) are easily interfaced with the TMS 0100 circuits. For special applications the user may choose versions of the TMS 0100 with as few as four segment terminals (BCD code) or as many as ten segment terminals (Nixie tubes).

Other documents available from TI describe practical interface circuits for most available displays. TI offers integrated-circuit display drivers and TIL360 LED displays, specifically designed for use with the TMS 0100. The SN75491 segment drivers and SN75492 digit drivers have been designed to insure the level shifting between TIL360 displays and the TMS 0100 (Figure 12). Specifications are available from TI.

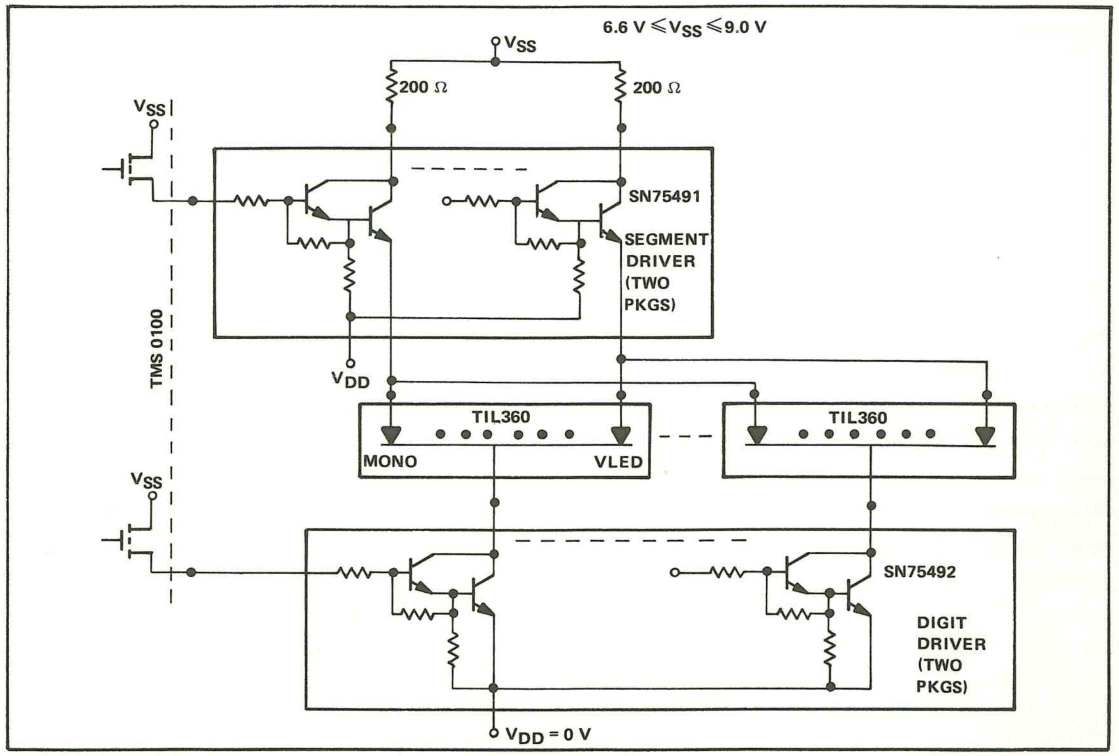


Figure 12. Monolithic 7-Segment Displays

Interface with the TTL/DTL logic family is achieved through pull-up and pull-down resistors as shown in Figure 13.

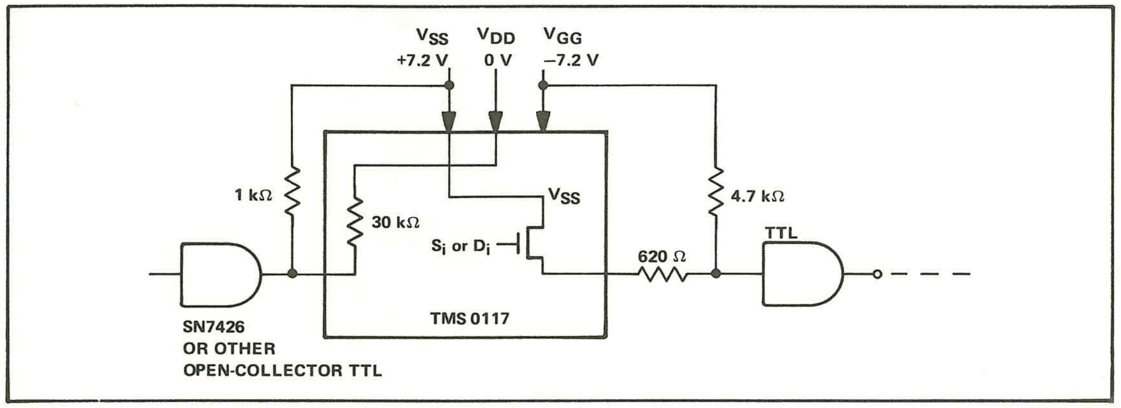


Figure 13. TTL/DTL Interface with TMS 0100 (0117)

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