TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

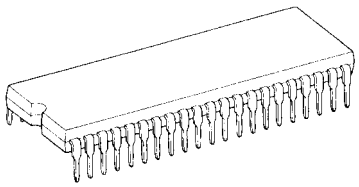
TC83220-0020

TC83220-0020 Single-Chip CMOS LSI for FL (fluorescent) Calculator

The TOSHIBA printing/display calculator circuit TC83220-0020 is 10- or 12-digit calculator on single-chip CMOS LSI.

TC83220-0020 can drive the printing machine (M2158II/ M2156II; EPSON) with magnet driver circuit, and can drive the fluorescent display tube with DC-DC converter.

It contains a 4 K-word ROM, a 256 × 4-bit RAM.



SDIP42-P-600-1.78

Weight: 4.12 g (typ.)

Features

Operational Features

- Print: 11 or 13 digits of data.
  (including decimal point. 2 digits of operational symbol.)
  3 digits of commas.
- Display: 10 or 12 digits of data. (including punctuation in each digit.)
  1 digit of floating minus sign, memory load, error symbol.
  3 digits of commas.
- Decimal output: Decimal set lock key controls output format.
  Fixed decimal setting (“0”, “1”, “2”, “3”, “4”, “6”), full floating decimal, and ADD mode.
- Key input buffer: 8 stages
- Function: 4 basic arithmetic functions (+, −, ×, ÷).
  Repeat addition and subtraction.
  Automatic constants in multiplication, division, percent calculation, calculations.
  Automatic percent add-on and percent discount calculation.
  Memory calculation.
  Automatic accumulating calculation.
  Gross margin profit calculation.
  Delta percent calculation.
  Tax calculation.
  Grand total calculation.
  Two-key rollover.
- Item counter: 0~999 count up or −999~0~999 count up/down by depressing of [+], [−] key.
- Punctuation: Commas for thousands on display
- Kinds of touch key: [0]~[9], [·], [00], [000], [C], [CE], [C/CE], [+/−], [#/P], [Feed], [+], [−], [◇], [*], [×], [÷], [=], [%], [MU/D], [M+], [M−], [M], [M*], [Δ%], [M◇*], [→], [GT], [+TAX], [−TAX]

- Kinds of lock key: "NP" printing mode selectable switch.
  "Σ" summation mode selectable switch.
  "5/4" "CUT" "UP" rounding switch.
  Fixed point mode selectable switch.
  "0", "1", "2", "3", "4", "6", "F", "A".
  "IC+" "IC±" item counter mode selectable switch.
  "GT" grand total memory selectable switch.
  "SET", "CAL" tax memory selectable switch.
- Duty of display: Duty = 1/17.77
- Leading zero suppression
- Trailing zero suppression
- Tax calculation: [+TAX] key is calculation for included tax.
  [−TAX] key is calculation for excluded tax.
  [SET] selects set mode for tax rate.
  [CAL] selects normal calculation mode.
  Changing lock key from [SET] to [CAL] stores number of display to tax memory.
  Changing lock key from [CAL] to [SET] recalls tax rate to display from tax memory.
  Depression of [+TAX] following data key at CAL mode performs the calculating included tax.
  Depression of [−TAX] following data key at CAL mode performs the calculating excluded tax.

Electrical Features

- P-MOS output buffer with pull down resistor for direct driving of fluorescent display tube.
- Oscillator/clock generator internal to chip.
- Key board encoding internal to chip.
- Dual in line package.

Protection

(1) In the overflow condition, all key except "C", "C/CE", "CE", "Feed", "→" key are inoperative.
(2) Key bouncing protection (at 4 MHz clock)
Key read in: 15 ms
Key off: 40 ms

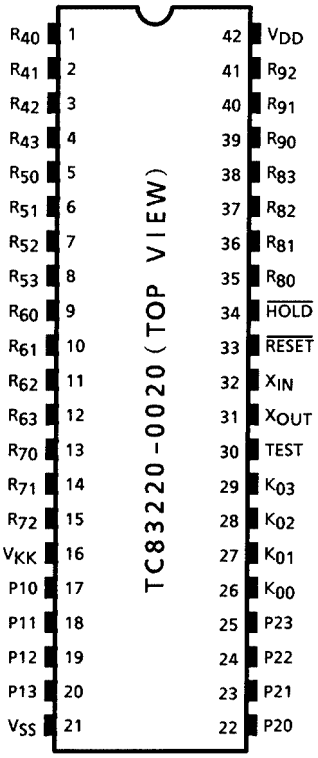
Function Select

(1) "10/12" selectable with auto power off mode
ON……. 10-digits calculated
OFF…… 12-digits calculated

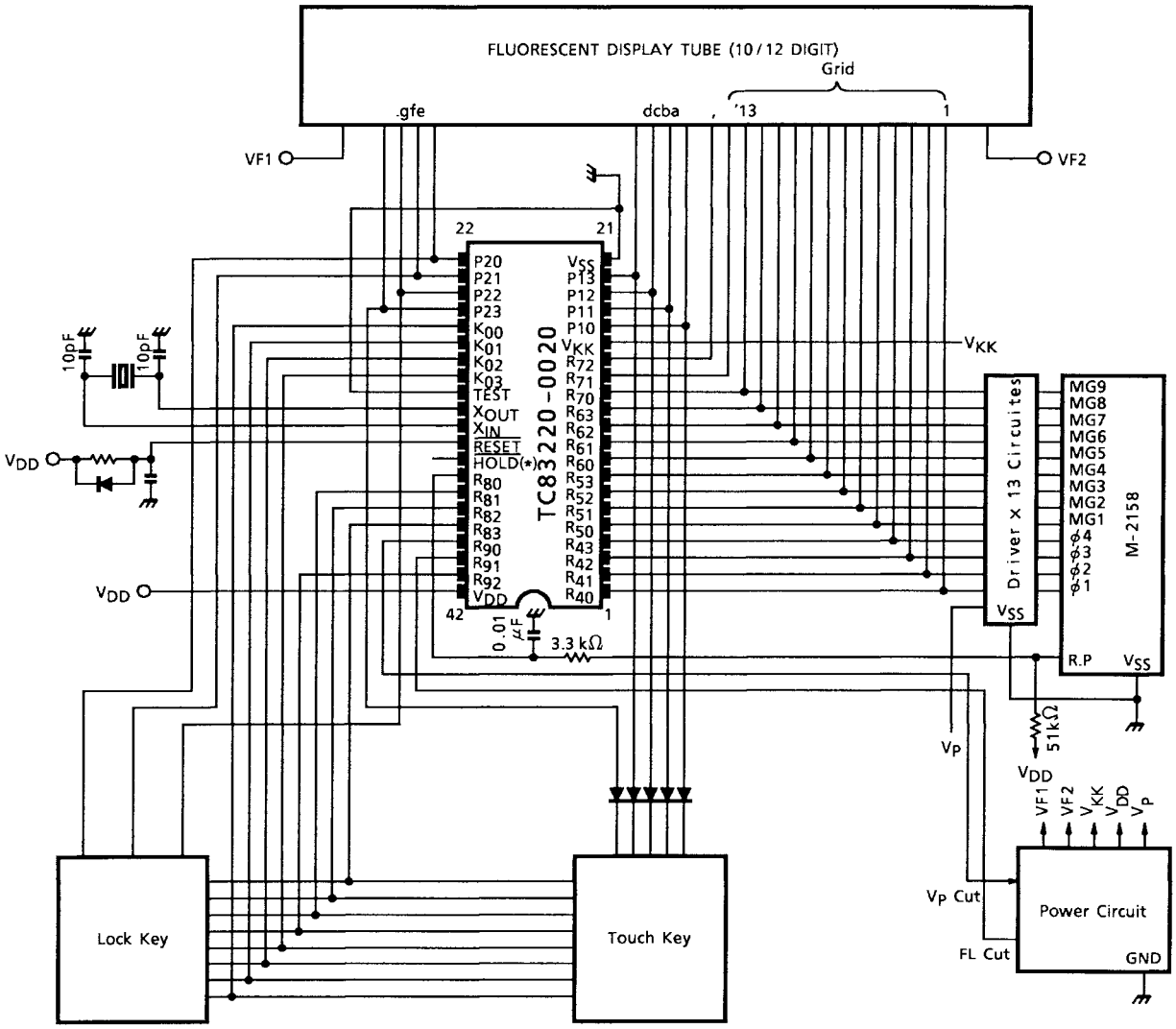
Speed of Calculation (at 4 MHz clock)

(1)	Addition	1 + 1 +	31.2 ms
(2)	Multiplication	× 999999999999 =	26.8 ms
(3)	Division	999999999999 ÷ 1 =	100.6 ms
(4)	Memory calculation	999999999999 ÷ 1 M +	108.8 ms
(5)	Percentage calculation	1 × 999999999999%	35.2 ms

Pin Assignment (top view)

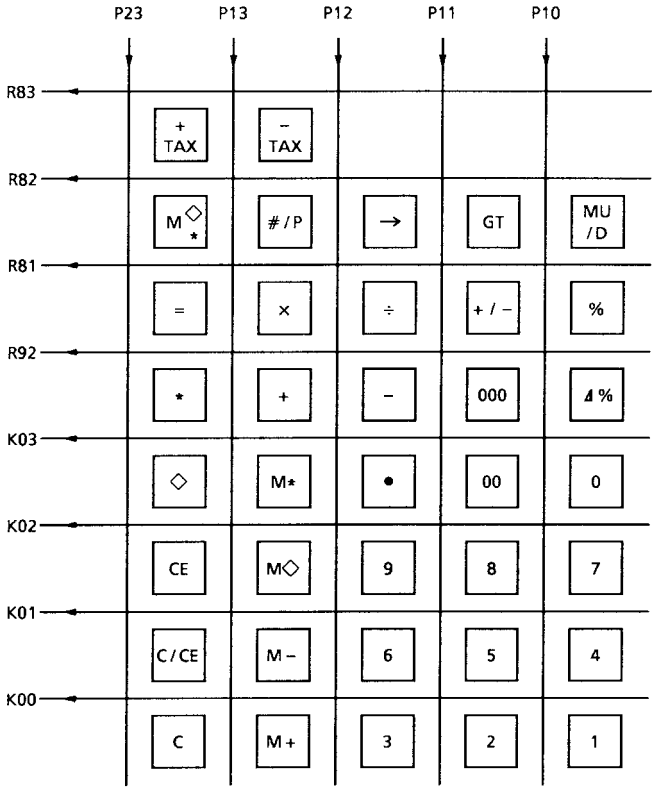


System Diagram

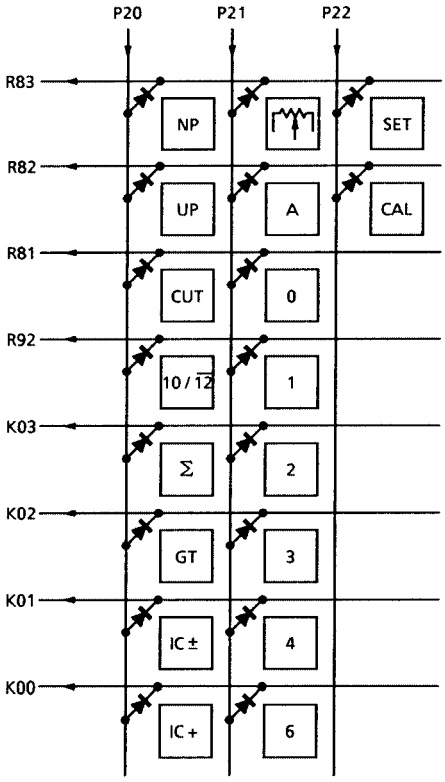


*: Connection to $\overline{\text{HOLD}}$ pin is shown in the following page.

Key Connection

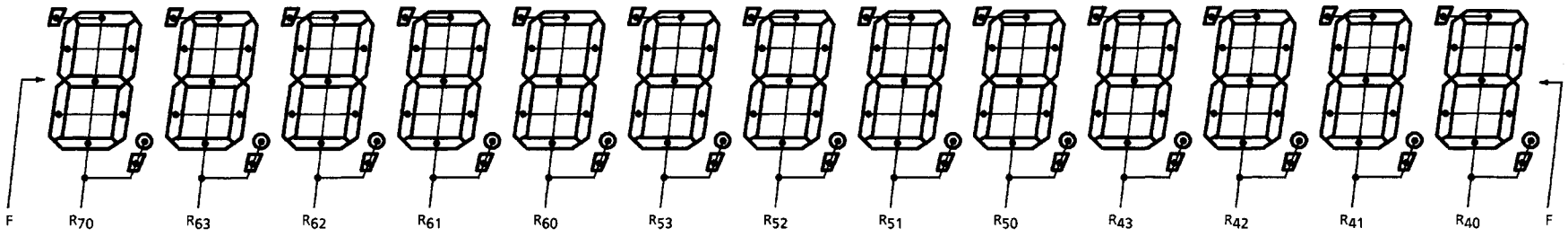


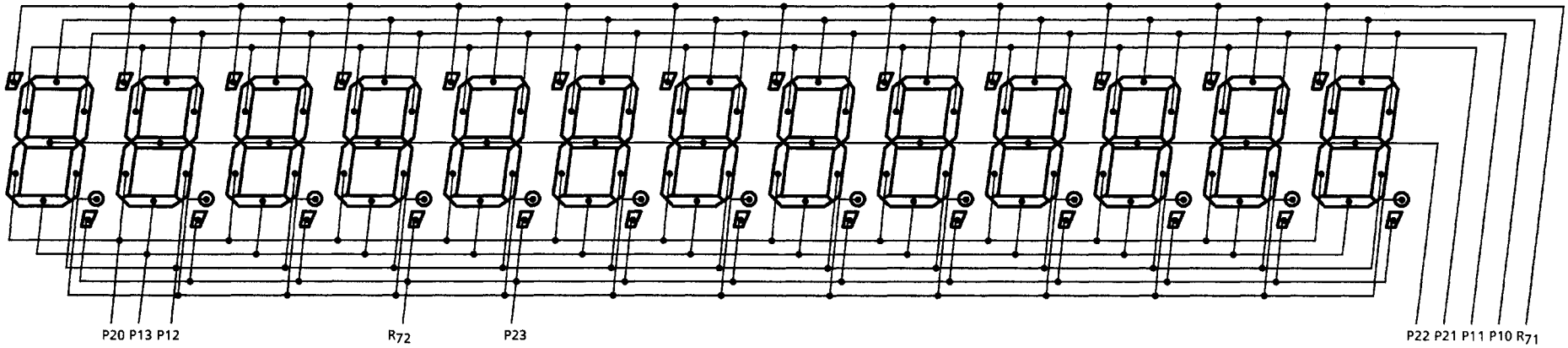
Touch Key



Lock Key

Connection of FL





Note 1: R_{70} digit (P20) of “E” data.

Note 2: R_{70} digit (P22) of “–” data.

Note 3: R_{70} digit (P23) of “M” data.

Note 4: R_{70} digit (P21) of “GT” data.

Operation Example

Key		Print		Display
TAB 4/5 IC 10/12 Σ GT MOD	Touch			
F 4/5 OFF 10 OFF OFF CAL	POWER ON			
		<PF>		
		C		
		<PF>		0.
	1+	1. +		1.
	2-	2. -		-1.
	◊	-1. ◊		-1.
	*	-1. *		
		<PF>		-1.
IC+	1+	1. +		1.
	2-	2. -		-1.
	◊	002		
		-1. ◊		-1.
	*	002		
		-1. *		
		<PF>		-1.
OFF	3×	3. ×		3.
	4÷	4. ÷		12.
	=	4. =		
		3. *		
		<PF>		3.
	5×	5. ×		5.
	6%	6. %		
		0.3 *		
		<PF>		0.3
	+	5.3 + %		
		<PF>		5.3
	2÷	2. ÷		2.
	3%	3. %		
		66.66666666 *		
		<PF>		66.66666666
	2 MU/D	2. M		2.
	3=	3. %		
		0.06185567 Δ *		
		2.06185567 *		
		<PF>		2.06185567
	2Δ%	2. Δ		2.
	3=	3. =		
		1. Δ *		
		50. Δ %		50.
		<PF>		

Note 5: <PF> ..... Paper feed

Key		Print		Display
TAB 4/5 IC 10/12 Σ GT MOD	Touch			
F 4/5 OFF 10 Σ OFF CAL	3×	3. ×		3.
	4÷	4. ÷		12.
	=	4. =		
		3. +		
		<PF>		3.
	5×	5. ×		5.
	6%	6. %		
		0.3 +		
		<PF>		0.3
	+	5.3 + %		
		<PF>		5.3
	2÷	2. ÷		2.
	3%	3. %		
		66.66666666 +		
		<PF>		66.66666666
	2 MU/D	2. M		2.
	3=	3. %		
		0.06185567 Δ *		
		2.06185567 +		
		<PF>		2.06185567
	2Δ%	2. Δ		2.
	3=	3. =		
		1. Δ *		
		50. +		
		<PF>		50.
	*	122.0285223 *		
		<PF>		122.0285223
	GT	0. G ◊		0.
GT	2+	2. +		2.
	3+	3. +		5.
	*	5. G +		
		<PF>		5.
	3-	3. -		-3.
	4-	4. -		-7.
	5-	5. -		-12.
	*	-12. G +		
		<PF>		-12.
	GT	-7. G ◊		-7.
	GT	-7. G *		
		<PF>		-7.
OFF	M+	-7. M +		M -7.
	C	0. C		M 0.

Note 5: <PF> ..... Paper feed

Key		Print		Display
TAB 4/5 IC 10/12 Σ GT MOD	Touch			
	M◊	<PF>		M -7.
	M*	-7. M ◊		
		-7. M *		
F 4/5 OFF 10 Σ OFF CAL		<PF>		-7.
	#/P	-7. ◊		-7.
	2 #/P	#2		2.
	#/P	2. ◊		2.
	0÷	0. ÷		0.
	=	0. =		
		.....		
		0. *		
		<PF>		E 0.
	C	0. C		
		<PF>		0.
F CUT OFF 12 OFF OFF CAL	POWER ON	<PF>		
		C		
		<PF>		
	SET	0. %		
		<PF>		0.
	3			3.
	CAL	3. %		
		<PF>		0.
	C	0. C		
		<PF>		0.
	SET	3. %		
		<PF>		3.
	CAL			0.
	1560			1,560.
	+TAX	1,560.		
		46.8 Δ		
		1,606.8 *		
		<PF>		1,606.8
	+TAX	1,606.8 ◊		
		48.204 Δ		
		1,655.004 *		
		<PF>		1,655.004
	1560			1,560.
	×	1,560. ×		1,560.
	78900			78,900.
	+TAX	78,900. =		
		123,084,000. ◊		
		3,692,520. Δ		
		126,776,520. *		

Note 5: <PF> ..... Paper feed

Key		Print			Display
TAB 4/5 IC 10/12 Σ GT MOD	Touch				
		<PF>			126,776,520.
	=				126,776,520.
	5				5.
	×	5.	×		5.
	+TAX				5.
	=	5.	=		
		25.	*		
		<PF>			25.
F CUT OFF 12 OFF OFF CAL	+TAX	25.	◊		
		0.75	Δ		
		25.75	*		
		<PF>			25.75
	=				25.75
	C	0.	C		
		<PF>			0.
2	1560				1,560.
	+	1,560.00	+		1,560.00
	1100				1,100.
	+	1,100.00	+		2,660.00
	+TAX	2,660.00	◊		
		79.80	Δ		
		2,739.80	*		
		<PF>			2,739.80
F	+TAX	2,739.80	◊		
		82.194	Δ		
		2,821.994	*		
		<PF>			2,821.994
	980000000000				980,000,000,000.
	+TAX	980,000,000,000.			
		29,400,000,000.	Δ		
		.....			
		1.00940000000	*		
		<PF>			E 1.00940000000
	C	0.	C		
		<PF>			0.
	1560				1560.
	+/-				-1,560.
	+TAX	-1,560.			
		-46.8	Δ		
		-1,606.8	*		
		<PF>			-1,606.8
	1560				1,560.
	-TAX	1,560.			

Note 5: <PF> ..... Paper feed

Key		Print		Display
TAB 4/5 IC 10/12 Σ GT MOD	Touch			
F CUT OFF 12 OFF OFF CAL		-45,43689321 Δ		
		1,514.56310679 *		
		<PF>		1,514.56310679
	-TAX	1,514.56310679 ◊		
		-44.11348855 Δ		
		1,470.44961824 *		
		<PF>		1,470.44961824
SET		3. %		
		<PF>		3.
	C			0.
CAL		0. %		
		<PF>		0.
SET		0. %		
		<PF>		0.
	1234			1,234.
CAL		1,234. %		
		<PF>		0.
	980000000000			980,000,000,000.
	+TAX	980,000,000,000.		
		.....		
		0. *		
		<PF>		E 0.
	C	0. C		
		<PF>		0.

Note 5: <PF> ..... Paper feed

Maximum Ratings (V_{SS} = 0 V)

Characteristics	Symbol	Rating	Unit
Supply voltage 1	V_{DD}	−0.5~7	V
Supply voltage 2	V_{KK}	−40~+0.5	V
Input voltage	V_{IN}	−35~V_{DD} + 0.5	V
Output voltage	V_{OUT}	−35~V_{DD} + 0.5	V
Output current	I_{OUT}	−10	mA
Power dissipation (T_{opr} = 70°C)	P_D	600	mW
Soldering temperature, time	T_{sld}	260 (10 s)	°C
Storage temperature	T_{stg}	−55~125	°C
Operating temperature	T_{opr}	0~40	°C

Recommended Operating Conditions (V_{SS} = 0 V)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Max	Unit
Operating temperature	T_{opr}	—	—	0	40	°C
Supply voltage	V_{DD}	—	—	4.5	6	V
Supply voltage (FL)	V_{KK}	—	—	−30	−15	V
Supply voltage (hold)	V_{DDH}	—	—	2	6	V
Input high voltage (except schmitt circuit input)	V_{IH1}	—	$V_{DD} \geqq 4.5$ V	$V_{DD} \times 0.7$	V_{DD}	V
Input high voltage (schmitt circuit input)	V_{IH2}	—		$V_{DD} \times 0.75$	V_{DD}	V
Input high voltage	V_{IH3}	—	$V_{DD} < 4.5$ V	$V_{DD} \times 0.9$	V_{DD}	V
Input low voltage (except schmitt circuit input)	V_{IL1}	—	$V_{DD} \geqq 4.5$ V	V_{KK}	$V_{DD} \times 0.3$	V
Input low voltage (schmitt circuit input)	V_{IL2}	—		V_{KK}	$V_{DD} \times 0.25$	V
Input low voltage	V_{IL3}	—	$V_{DD} < 4.5$ V	V_{KK}	$V_{DD} \times 0.1$	V
Output voltage (source open drain)	V_{OUT}	—	—	V_{DD} − 35	V_{DD}	V
Clock high pulse width (Note 6)	T_{WCH}	—	$V_{IN} = V_{IH}$	80	—	ns
Clock low pulse width (Note 6)	T_{WCL}	—	$V_{IN} = V_{IL}$	80	—	ns

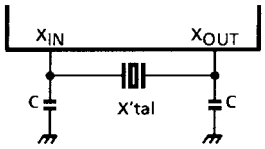
Note 6: In case of the external clock operation.

Electrical Characteristics

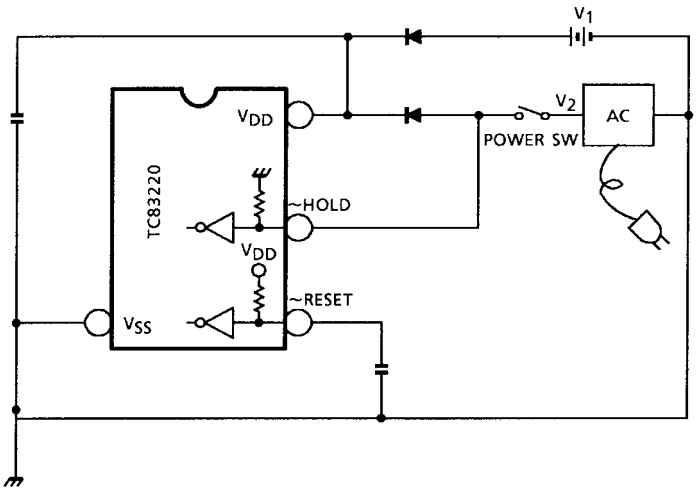
DC Characteristics (V_{SS} = 0 V, V_{DD} ± 10%, T_{opr} = 0~40°C)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Hysteresis voltage (schmitt circuit input)	V_{HS}	—	—	—	0.7	—	V
Input current ($\overline{RESET}$, $\overline{HOLD}$, $\overline{TEST}$)	I_{IN}	—	V_{DD} = 5.5 V, V_{IN} = 5.5/0 V	—	—	±50	μA
Output leak current (source open drain)	I_{LO}	—	V_{DD} = 5.5 V, V_{OUT} = −32 V	—	—	−10	μA
Output high voltage (P1~P2, R_4~R_9)	V_{OH}	—	V_{DD} = 4.5 V, I_{OH} = −6 mA	2.4	—	—	V
Input pull down resistor (K_0, R_7~R_9)	R_{IN}	—	V_{DD} = 5.5 V, V_{KK} = −30 V	—	100	—	kΩ
Pull down resistor (source open drain)	R_{KK}	—		50	80	200	kΩ
Operating supply current	I_{DD} 0	—	V_{DD} (V_{DDH}) 5.5 V, f_c = 4 MHz, V_{IN} = 5.3/0.2 V	—	3	6	mA
Supply current (after clear)	I_{KK} 1	—	V_{KK} = −30 V, f_c = 4 MHz	—	0.6	0.9	mA
Supply current (shown full digits)	I_{KK} 2	—		—	3.5	6	mA
Holding supply current	I_{DD} H	—	V_{DD} = 5.5 V	—	0.5	10	μA

Oscillation Characteristics (T_{opr} = 0~40°C, V_{DD} = 4.5~6.0 V)

Circuit	Test Condition	Min	Typ.	Max	Unit
	C = 10 pF X'tal (or ceramic) = 4 MHz	—	4	—	MHz

The Proposal of Outer Circuit for Tax Rate Holding with Back-Up Battery



Note 7: V_1 = 3 V: Battery supply

V_2 = 5 V: AC supply

(~HOLD pin is pulled down in the LSI, but normally pulled up to V_{DD}.
~RESET pin is pulled up to V_{DD}.)

(1) Setting POWER SW to ON, V_2 is supplied to V_{DD} pin, and also to HOLD pin.
Then calculator operates normally.

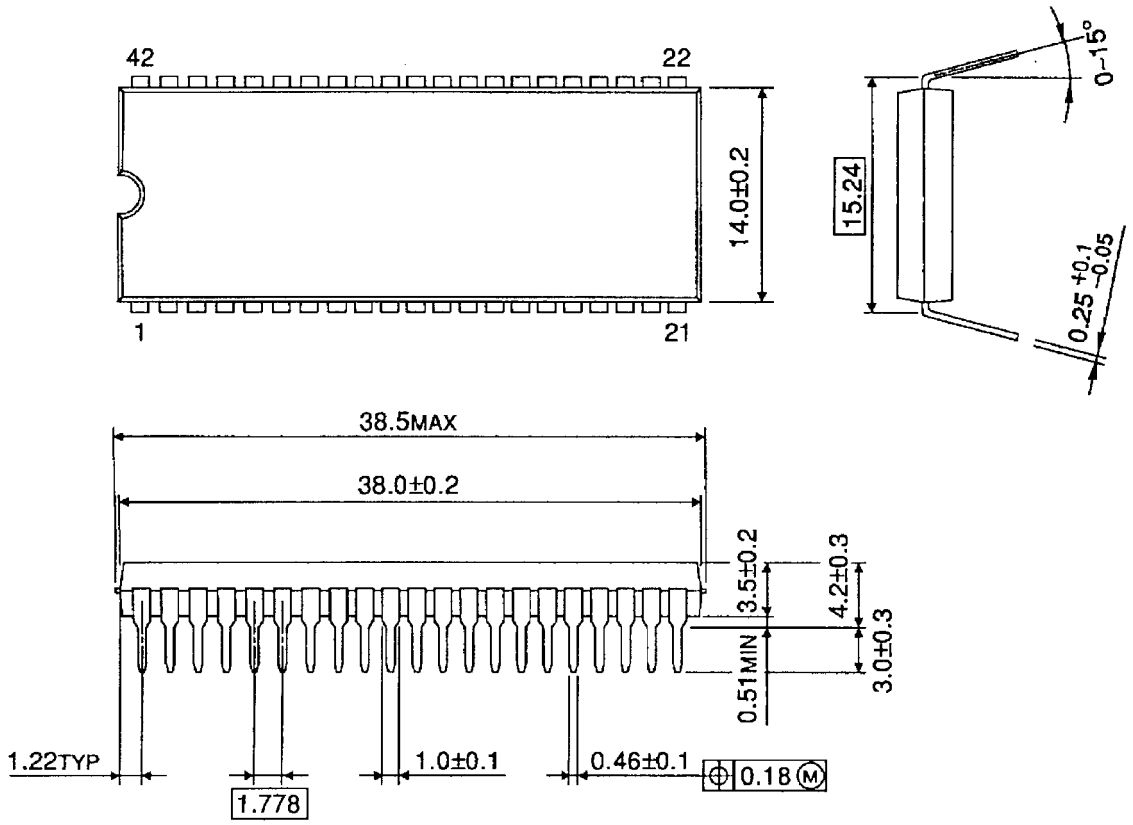
(2) Setting POWER SW from ON to OFF, V_1 is supplied to V_{DD} pin and V_{SS} is supplied to HOLD pin.
Under this connection, TAX RATE is held.

(3) Setting POWER SW to ON, V_2 is supplied to V_{DD} pin, and also to HOLD pin.
Then calculator operates normally with TAX RATE to be held.

Note 8: V_1 (battery) should be supplied to the circuit after V_2 (AC) supply, because of prevention from exhaustion of battery and abnormal operation.

Package Dimensions

SDIP42-P-600-1.78 Unit : mm



Weight: 4.12 g (typ.)

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000707EBA

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