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IN9004D - INTEGRATED MICROCHIP MICRO-CONTROLLER WITH MCS-51 SYSTEM OF COMMANDS, SUPERVISORS CIRCUIT AND EMBEDDED LCD DRIVER FOR APPLICATION IN ENERGY METERS

The microchip is essentially the high efficiency micro-controller, made under the high fidelity CMOS – technology.

The microchip contains the programs ROM with the capacity of 4,096 bytes, the embedded data RAM with the capacity of 128 bytes, 32 input/output lines, two 16-bit timers / counters, guard timer, interrupts system with five vectors and two priority levels, the serial port for expansion of input/output as the universal asynchronous transceiver, the embedded synchro generator and synchronization system, the embedded driver for the LC- display control (number of segments -124, duty rate - 1:4, frame frequency - 50-300 Hz, the LCD operational - voltage 3.6 V).

The micro-controller system of commands complies with the system of commands of the MCS-51 family. The microchip is initialized (reset) automatically when turning power on, when the guard timer is overflowed or effected by the RST signal (voltage active low level) if the external synchronization signal is applied or during the quartz connection.

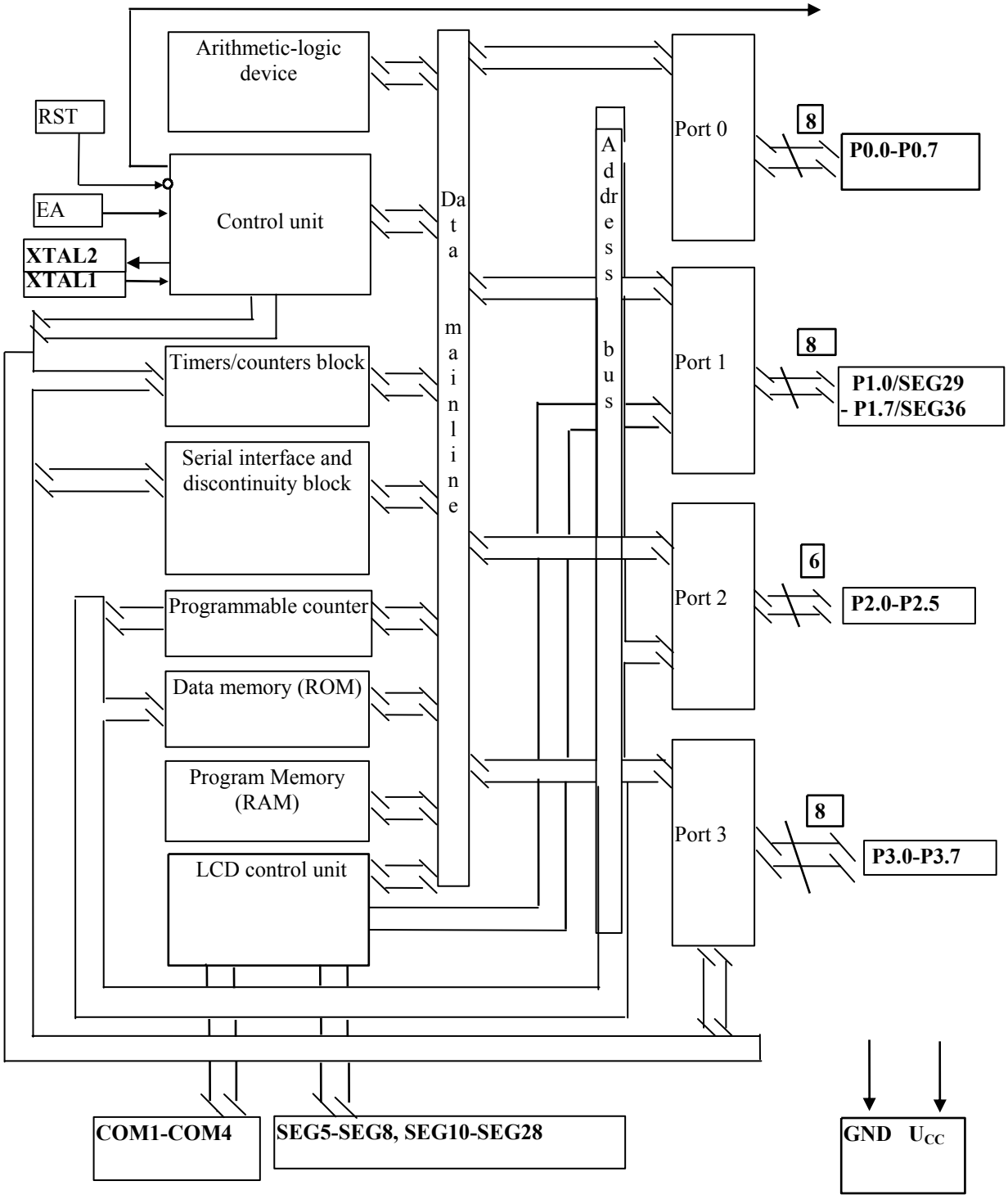
The LCD control micro-controller microchip with the MCS-51 system of commands can be successfully applied as the processor element in the electronic power counters.

The microchip has two programmable modes for the reduced power consumption, the idle mode and the micro-consumption mode. The idle run mode locks the central processor's operation, stores the condition of the internal ROM data, the timers, consecutive port, LCD control unit and the discontinuity system keep on functioning. The micro-consumption mode turns off the specifying generator, operation of all assemblies of the microchip stops and the ROM data contents is kept in storage.

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Structural diagram



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Leads Destination

Lead number	Description	Destination
1	SEG27	Digit output 27 of LCD segment control
2	SEG26	Digit output 26 of LCD segment control
3	SEG25	Digit output 25 of LCD segment control
4	SEG24	Digit output 24 of LCD segment control
5	SEG23	Digit output 23 of LCD segment control
6	SEG22	Digit output 22 of LCD segment control
7	SEG21	Digit output 21 of LCD segment control
8	SEG20	Digit output 20 of LCD segment control
9	SEG19	Digit output 19 of LCD segment control
10	SEG18	Digit output 18 of LCD segment control
11	SEG17	Digit output 17 of LCD segment control
12	SEG16	Digit output 16 of LCD segment control
13	SEG15	Digit output 15 of LCD segment control
14	SEG14	Digit output 14 of LCD segment control
15	SEG13	Digit output 13 of LCD segment control
16	SEG12	Digit output 12 of LCD segment control
17	SEG11	Digit output 11 of LCD segment control
18	SEG10	Digit output 10 of LCD segment control
19	SEG8	Digit output 8 of LCD segment control
20	SEG7	Digit output 7 of LCD segment control
21	SEG6	Digit output 6 of LCD segment control
22	SEG5	Digit output 5 of LCD segment control
23	RXD	Receiver input of the consecutive port. Exchange rate 9600 bauds.
24	TXD	Output of the consecutive port transmitter. Exchange rate 9600 bauds.
25	PFAIL	Control input of the voltage level of the primary power supply source. With voltage reduction at the input below the threshold value (about 1.25V) it retains contents of the energy counters in the power self-subsistent memory and turns the circuit into the micro-consumption mode.
26	OPTO_SW	Switching input of the display modes. With the signal alteration from the high to low level it consequently switches the display modes.
27	PULSE_IN	Frequency signal input of the consumed power from the primary converter.
28	P3.5/T1	Low level at the input ensures programming of the external power self-subsistent memory through the consecutive interface.
29	ZONE1	Input1 of the tariffication zone control
30	ZONE2	Input2 of the tariffication zone control.
31	XTAL2	Outlet2 for connection of the quartz resonator 3.6864 MHz
32	XTAL1	Outlet1 for connection of the quartz resonator 3.6864 MHz
33	GND	Common outlet.
34	RST	Input/output Reset.
35	EA	Test input. It should be connected to the power supply source of 5V.
36	PULSE_OUT	Output of the pulses, proportionate to the input signal of the consumed power with the duration of 50 мс. It is intended for control of the optical pair light diode.
37	MC_LED	Output of the pulses, proportionate to the input signal of the

Lead number	Description	Destination
		consumed power. Pulse porosity 50%. It is intended for control of the display light diode.
38	M_COUNT1	Control output for the mechanical counter of the tariffication zone 1. Low level pulse duration 100 мс.
39	M_COUNT2	Control output for the mechanical counter of the tariffication zone 2. Low level pulse duration 100 мс.
40	M_COUNT3	Control output for the mechanical counter of the tariffication zone 3. Low level pulse duration 100 мс.
41	M_COUNT4	Control output for the mechanical counter of the tariffication zone 4. Low level pulse duration 100 мс.
42	CLC_OUT	Generator output 3.6864 MHz.
43	SDA	Data input/output for connection of the power self-subsistent memory) (for instance, 24C02).
44	SCL	Synchronization output for connection of the power self-subsistent memory.
45	DIV_B	Control input B of the preliminary splitter(divider).
46	DIV_A	Control input A of the preliminary splitter.
47	1h_3h	Control input of the operational mode (single phase/three phase) of the power counter.
48	U_L3	Analysis input of the phase 3 voltage availability.
49	U_L2	Analysis input of the phase 2 voltage availability.
50	U_L1	Analysis input of the phase 1 voltage availability.
51	SEG29	Digit output 29 of LCD segment control
52	SEG30	Digit output 30 of LCD segment control
53	SEG31	Digit output 31 of LCD segment control
54	SEG32	Digit output 32 of LCD segment control
55	SEG33	Digit output 33 of LCD segment control
56	SEG34	Digit output 34 of LCD segment control
57	SEG35	Digit output 35 of LCD segment control
58	SEG36	Digit output 36 of LCD segment control
59	Ucc	Voltage supply of 5V.
60	COM4	Digit output 4 of LCD line control
61	COM3	Digit output 3 of LCD line control
62	COM2	Digit output 2 of LCD line control
63	COM1	Digit output 1 of LCD line control
64	SEG28	Digit output 28 of LCD segment control

Abbreviations
- LCD – liquid crystal display

Display modes

When turning power on LCD is tested. Meanwhile, all LCD segments are lit. When the test is over, the display is switched into the power counter display mode of the appropriate tariffication zone (signal determined at inputs Z1, Z2). Display is switched with the change of status at input OPTO_SW. Display mode switching takes place consequently in the following order:

1. Display of the power counter of tariffication zone 1;
2. Display of the power counter of tariffication zone 2;
3. Display of the power counter of tariffication zone 3;
4. Display of the power counter of tariffication zone 4;
5. Display of the total power value counter of all tariffication zones;
6. Display of the current consumed power in watts.
7. Display of the power counter of tariffication zone 1;

8. Etc..

Power count management

Input power pulses for the signal alteration at output MC_OUT and pulse formation at output PULSE_OUT.

PULSE_IN	DIV_B	DIV_A	Preliminary splitter	Коэффициент деления at output PULSE_OUT (t_{high} = 50 ms)	Коэффициент деления at output MC_OUT (duty=50%)
Fmax = 1500Hz. Fmin = 1 Hz.	0	0	:5	1200	1200
	0	1	:10	2400	2400
	1	0	:20	4800	4800
	1	1	:1	240	240

Input power pulses per one kW/hour of the tariff electric power counters.

1Ph/3Ph	DIV_B	DIV_A	Preliminary splitter	SW4 = 01	SW4 = 10	SW4 = 11
1	0	0	:5	1800	18000	180000
	0	1	:10	3600	36000	360000
	1	0	:20	7200	72000	720000
	1	1	:1	360	3600	36000
0	0	0	:5	600	6000	60000
	0	1	:10	1200	12000	120000
	1	0	:20	2400	24000	240000
	1	1	:1	120	1200	12000

SW4 – two junior register bits CONFIG.

Frequency of the input power pulses for acquisition of the appropriate readings of the consumed power.

1Ph/ 3Ph	PULSE_IN, Hz	Power, W			
		DIV_B= 0 DIV_A=0	DIV_B= 0 DIV_A=1	DIV_B= 1 DIV_A=0	DIV_B= 1 DIV_A=1
1	20	40	20	10	200
	1200	2400	1200	600	12000
0	20	120	60	30	600
	1200	7200	3600	1800	36000

Serial interface

Exchange rate 9600 bauds. 1 start bit. 8 data bits. 1 stop bit.
Control amount is calculated in compliance with CCIT8.

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List and structure of exchange commands by the serial interface.

№	Command description	Byte number								
		1	2	3	4	5	6	7	8	9
1	Total power counter reading	0xA0								
2	Tariff counter reading 1	0xA1								
3	Tariff counter reading 2	0xA2								
4	Tariff counter reading 3	0xA3								
5	Tariff counter reading 4	0xA4								
6	Consumed power readings	0xA5								
7	Reading of registers ST1, ST2, CFG	0xA6								
8	ID number reading	0xA7								
9	Entry in the total power counter.	0xB0	D1	D2	D3	D4	D5	D6	D7	crc
10	Entry in tariff counter 1	0xB1	D1	D2	D3	D4	D5	D6	D7	crc
11	Entry in tariff counter 2	0xB2	D1	D2	D3	D4	D5	D6	D7	crc
12	Entry in tariff counter 3	0xB3	D1	D2	D3	D4	D5	D6	D7	crc
13	Entry in tariff counter 4	0xB4	D1	D2	D3	D4	D5	D6	D7	crc
14	Entry in the configuration register	0xB6	CFG	0x00	0x00	0x00	0x00	0x00	0x00	crc
15	Identification number entry	0xB7	ID0	ID1	ID2	ID3	0x00	0x00	0x00	crc
16	Entry of the display registers of the LCD additional segments	0xB8	D1	D2	D3	D4	D5	D6	D7	crc
17	Entry of the display registers of the LCD additional segments	0xB9	D8	seg1	seg2	seg3	seg4	seg5	seg6	crc
18	Microchip response for command 0xA0	0xC0	D1	D2	D3	D4	D5	D6	D7	crc
19	Microchip response for command 0xA1	0xC1	D1	D2	D3	D4	D5	D6	D7	crc
20	Microchip response for command 0xA2	0xC2	D1	D2	D3	D4	D5	D6	D7	crc
21	Microchip response for command 0xA3	0xC3	D1	D2	D3	D4	D5	D6	D7	crc
22	Microchip response for command 0xA4	0xC4	D1	D2	D3	D4	D5	D6	D7	crc
23	Microchip response for command 0xA5	0xC5	D1	D2	D3	D4	D5	D6	D7	crc
24	Microchip response for command 0xA6	0xC6	ST1	ST2	CFG	0x00	0x00	0x00	0x00	crc
25	Microchip response for command 0xA7	0xC7	ID0	ID1	ID2	ID3	0x00	0x00	0x00	crc
26	Request for reception of commands 0xB8, 0xB9	0xC8								
27	Switching for display of tariff counter 1	0xD0								
28	Switching for display of tariff counter 2	0xD1								
29	Switching for display of tariff counter 3	0xD2								
30	Switching for display of tariff counter 4	0xD3								

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When turning power on of the microchip, on completion of the internal test the microchip applies the message with the reading 0xC6 to the serial interface.

Description of the status register bytes ST1

ST1	Purpose of bits							
Bit 0	1	Memory test of programs - Ок						
	0	Memory test error of programs						
Bit 1	1	Test of the external power self-subsistent memory - Ок						
	0	Test error of the external power self-subsistent memory						
Bit 2	0	Tariff 1	0	Tariff 2	1	Tariff 3	1	Tariff 4
Bit3	0		1		0		0	
Bit 4 Bit 5 Bit 6								
Bit 7	Input logic status T1							

Status of register ST2

ST2	Purpose of bits
Bit 0	Input status DIV_A
Bit 1	Input status DIV_B
Bit 2	Input status Z1
Bit 3	Input status Z2
Bit 4	Input status 1Ph/3Ph
Bit 5	Input status U_L1
Bit 6	Input status U_L2
Bit 7	Input status U_L3

Compliance of bits by command 0xB9 to the LCD additional segments.

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	Bit 0
seg1	S7	S6	S5	S4	S1	S2	S3	S12
seg2	S8	S9	S10	S11	**P**	**I**	**ΔU**	**Δf**
seg3	**A**	h3	h2	h1	**max**	**V**	**var**	**W**
seg4	**PLN**	k3	k2	k1	**Hz**	**L1**	**L2**	**L3**
seg5	**data**	**:**	**clock**	**tgφ**	**kredit**	**time**	**date**	
seg6	**W4**	**W3**	**W2**	**W1**	**T4**	**T3**	**T2**	**T1**

Purpose of the CFG register digits

CFG (bits 7..2 – are not used)		
Bit 1	Bit 0	SW4
0	0	Power counter format 0000.000 kW
0	1	Power counter format 0000.000 kW
1	0	Power counter format 00000.00 kW
1	1	Power counter farmat 000000.0 kW

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Table of compliance for the microchip segment outlets to the LCD wiring

PIN	seg5	seg6	seg7	seg8	seg9	seg10	seg11	seg12	seg13	seg14
COM0	S4	S12	S11	∆f	h1	W	k1	8a	8f	L1
COM1	S5	S3	S10	∆U	h2	var	k2	8b	8g	L2
COM2	S6	S2	S9	I	h3	V	k3	8c	8e	L3
COM3	S7	S1	S8	P			PLN	max	8d	

PIN	seg15	seg16	seg17	seg18	seg19	seg20	seg21	seg22	seg23	seg24
COM0	7a	7f	6a	6f	Hz	5a	5f	tg0	4a	4f
COM1	7b	7g	6b	6g		5b	5g	clock	4b	4g
COM2	7c	7e	6c	6e		5c	5e	:	4c	4e
COM3	7h	7d	6h	6d		5h	5d	4h	data	4d

PIN	seg25	seg26	seg27	seg28	seg39	seg30	seg31	seg32	seg33	seg34	seg35
COM0	3a	3f	2a	time	2f	1a	1h	date	T1	1i	W1
COM1	3b	3g	2b		2g	1b	1g	1f	T2	1j	W2
COM2	3c	3e	2c	A	2e	1c	1n	1e	T3	1k	W3
COM3	3h	3d	2h		2d	credit	1m	1d	T4	1l	W4

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Electric parameters

Item, Parameter, Unit, Measuring condition	Symbol	Min	Max	T, °C
Low output voltage, V -outlet: P2.2/M_COUNT1, P2.3/M_COUNT2, P2.4/M_COUNT3, P2.5/M_COUNT4, P3.1/TXD, P0.6/SCL, P0.7/SDA; -output: ALE/CLC_OUT, RST U_{CC}= 5.0В±5% I_{OL}=1.6 mA	U_{OL}	-	0.5	25±10 -25±3 65±3
Low output voltage,V -outlet: P2.0/PULSE_OUT, P2.1/MC_LED U_{CC}= 5.0В±5% I_{OL1}=10 mA	U_{OL1}	-	0.5	
High output voltage,V -outlet: P2.0/PULSE_OUT, P2.1/MC_LED, P2.2/M_COUNT1, P2.3/M_COUNT2, P2.4/M_COUNT3, P2.5/M_COUNT4, P3.1/TXD, P0.6/SCL, P0.7/SDA; -output: ALE/CLC_OUT, RST U_{CC}= 5.0В±5% I_{OH}= -80 μA	U_{OH}	$0.9U_{CC}$	-	
Low input current, μA – outlet: P3.0/RXD, P3.4/PULSE_IN, P3.5/T1, P0.3/1h-3h, P0.4/DIV_A, P0.5/DIV_B U_{CC}= 5.0В±5% U_{IN} =0.45 V	I_{IL}	-50	-150	
- input: P3.3/OPTO_SW U_{CC}= 5.0В±5% U_{IN} =0.45 V	I_{IL1}	-15	-50	
- input: RST U_{CC}= 5.0В±5% U_{IN} =0 V	I_{IL2}	-	-500	
Hight input current, μA –input RST U_{CC}= 5.0В±5% U_{IN} = U_{CC}	I_{IH}	-	500	
Low input current leakage,μA - outlet P0.0/U_L1, P0.1/U_L2, P0.2/U_L3, P0.6/SCL, P0.7/SDA, P3.2/PFAIL, P3.6/ZONE1, P3.7/ZONE2 U_{CC}= 5.0В±5% U_{IN} = 0 V	I_{LIL}	-	-0,1	
Hight input current leakage,μA -outlet P0.0/U_L1, P0.1/U_L2, P0.2/U_L3, P0.6/SCL, P0.7/SDA, P3.2/PFAIL, P3.6/ZONE1, P3.7/ZONE2 U_{CC}= 5.0В±5% U_{IN} = U_{CC}	I_{LIH}	-	-0,1	
Supply current dynamic, mA U_{CC}= 5.0В±5% f_C = 3.58 Hz	I_{CC}	-	5	
Output voltage, V - outlet for driving LCD COM1-COM4, SEG5-SEG8, SEG10-SEG36	U_1	4.450	4.750	
	U_2	3.263	3.863	

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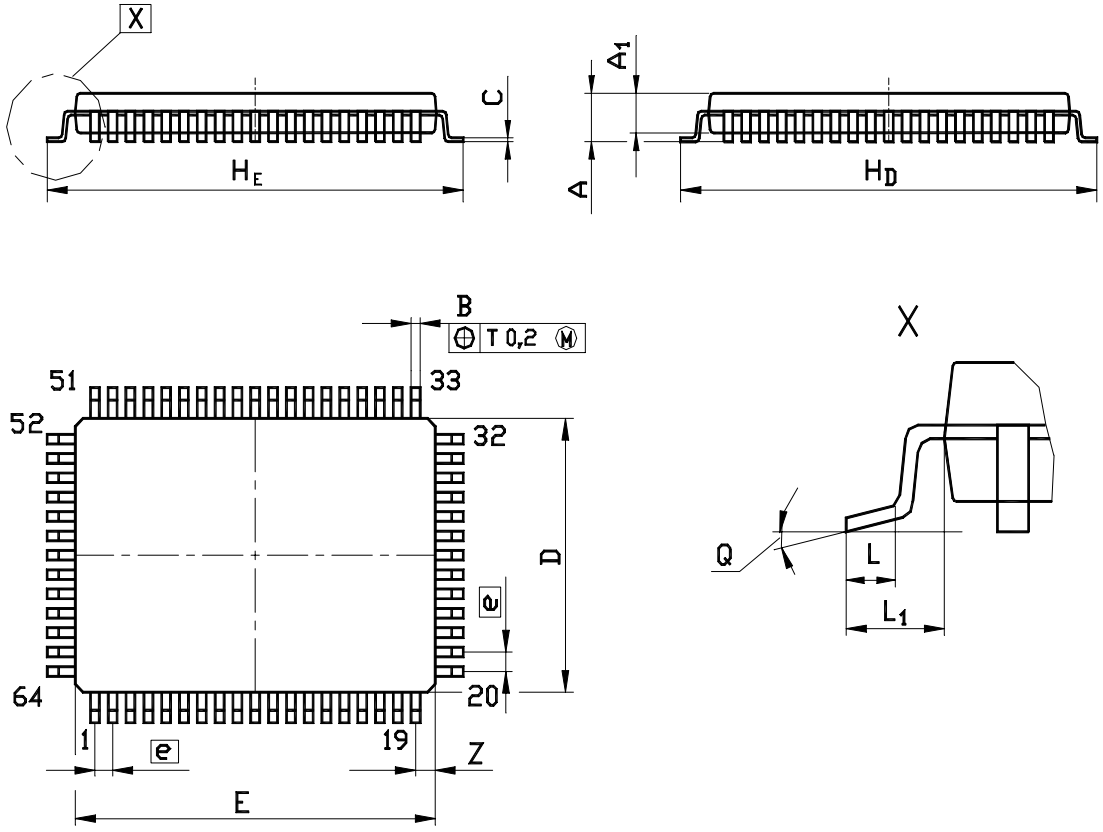
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Item, Parameter, Unit, Measuring condition	Symbol	Min	Max	T, °C
U_{CC}=4.75 В Io = 0 мкА	U_3	2.075	2.675	25±10 -25±3 65±3
	U_4	0.888	1.488	
Voltage off trigger Shmitt, V - outlet: P0.0/U_L1, P0.1/U_L2, P0.2/U_L3, P3.3/OPTO_SW, P3.6/ZONE1, P3.7/ZONE2 U_{CC}= 5.0В±5%	U_{T1-}	1.20	1.80	
Voltage on trigger Shmitt, V -outlet: P0.0/U_L1, P0.1/U_L2, P0.2/U_L3, P3.3/OPTO_SW, P3.6/ZONE1, P3.7/ZONE2 U_{CC}= 5.0В±5%	U_{T1+}	2.20	2.80	
Voltage off trigger Shmitt, V -outlet: P3.2/PFAIL U_{CC}= 5.0В±5%	U_{T2-}	1.15	1.35	
Voltage on triggerShmitt, V -outlet: P3.2/PFAIL U_{CC}= 5.0В±5%	U_{T2+}	1.47 1.45	1.75 1.80	25±10 -25±3 65±3
Supply voltage, (signal reset),V	U_{CCTP}	4.05 4.00	4.65 4.70	
RC-generator intrinsic frequency, Hz -outlet: COM1-COM4, SEG5-SEG8, SEG10-SEG36 U_{CC}=5.0В±5%	f_{RC}	50	100	25±10 -25±3 65±3
Delay time with supply voltage on , ms -outlat: RST U_{CC}=5.0В±5% (no load)	t_{ON}	150	300	

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Package dimensions



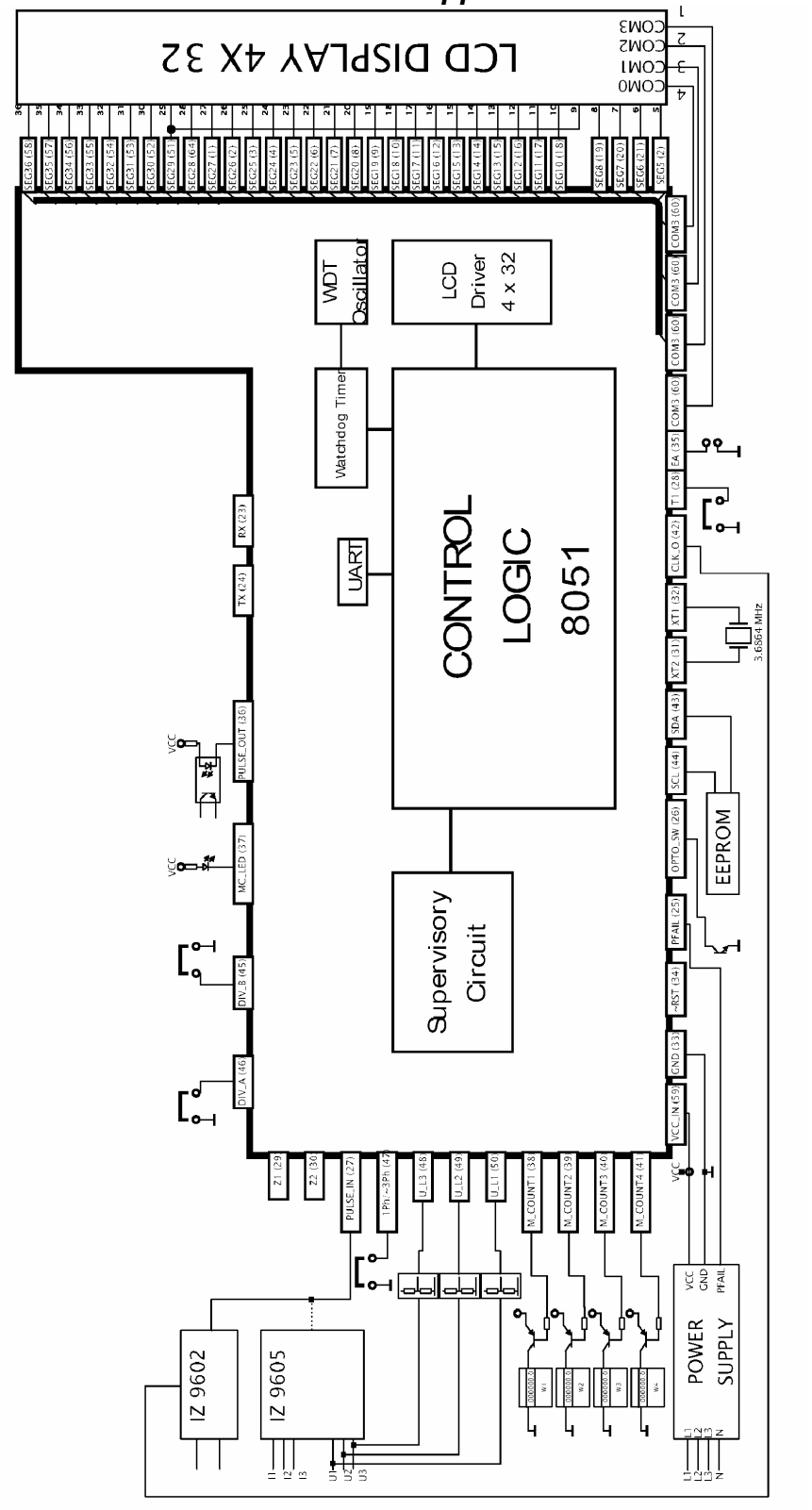
Package type: 4402.64-1 (QFP-64) **Q -** SUFFIX

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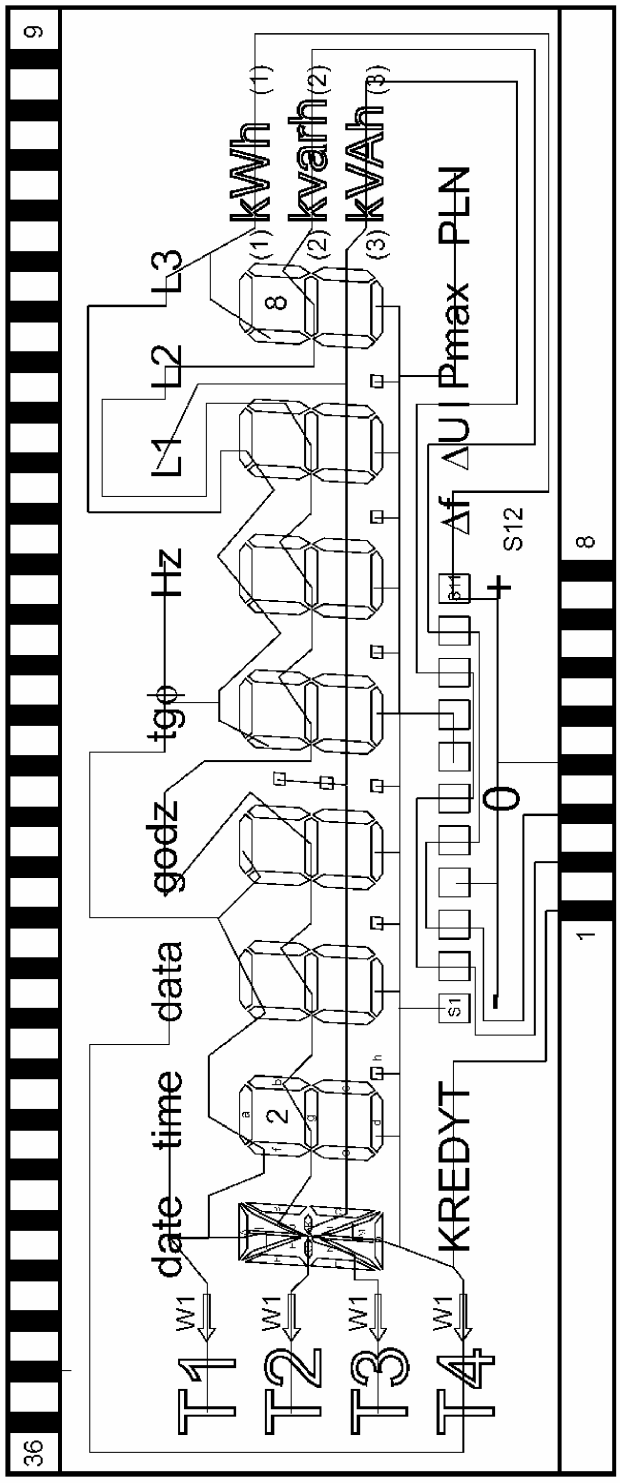
Application Circuit



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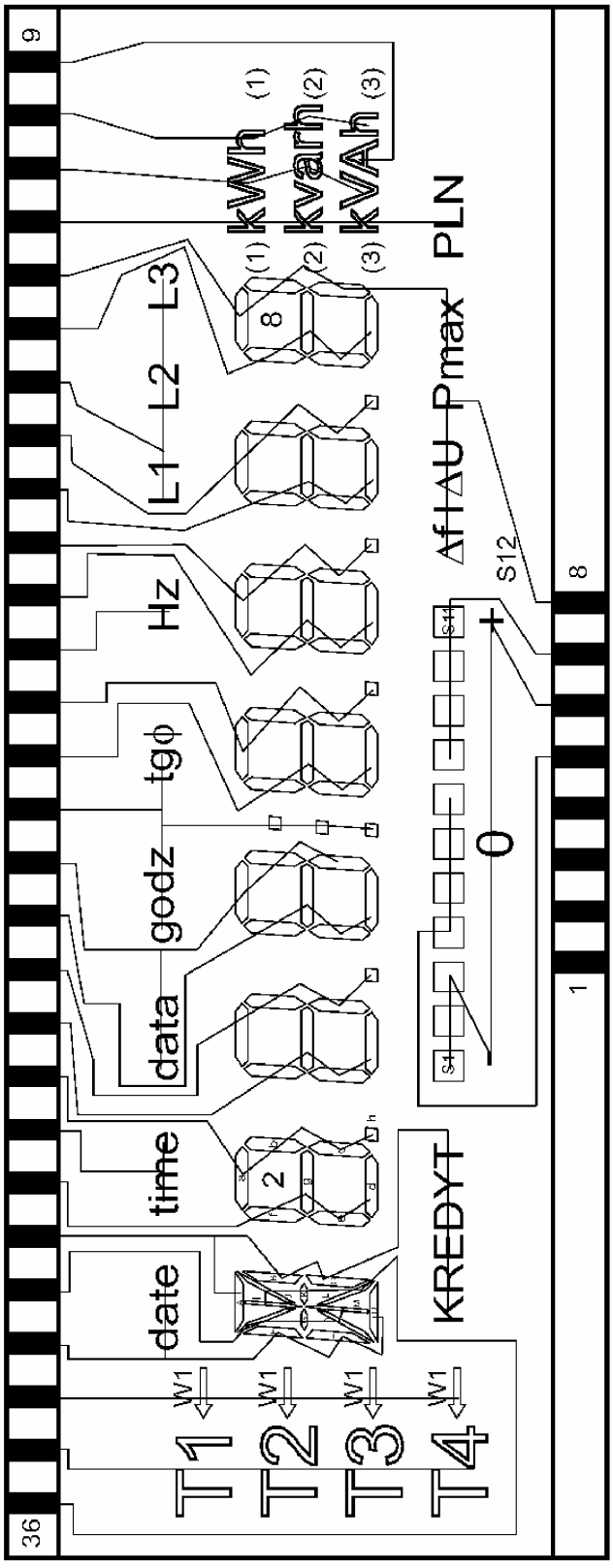
LCD Connection COM



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LCD Connection SEG



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