

Note: Some non-essential portion of the document was intentionally omitted or abbreviated.

Revision 1.0

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1. Introduction

DTM0660 has a built-in 14 bit noise free sigma delta ADC and can achieve 6600 counts in all measurement ranges. It provides fast output, with rate up to 12.5 kHz. With its builtin DSP, It can measure true RMS up to 1kHz without any additional components.

It has built-in calibration routine with external EEPROM and can achieve high precision calibration and support many user configurations.

2. Main Features

- Maximum display count: 4000/6000 (9999 for frequency and capacitance)
- Conversion rate: 3/second
- Ranging: manual/automatic
- Polarity indication: automatic
- Supply voltage: 2.4V ~ 3.6V
- Current Consumption: ≤ 1 mA ($\leq 2\mu$ A in sleep mode)
- AC Rectification: built-in true RMS processor, no external components needed. 1 kHz bandwidth, error $< 0.5\%$. Fast reacting.
- Multifunction switching network, support fast autoranging.
- Configuration and calibration stored in external EEPROM
- Built-in 100ppm/C low drift 1.2V reference
- Function Keys: SELECT, RANGE, REL, HZ/DUTY, HOLD (BACKLIGHT), MAX/MIN, BACKLIGHT
- Support 4x15 LCD with symbols/units and backlights.
- Built in temperature detector. It can be used for thermocouple's cold junction compensation without the need for external components.
- Can set 2. Main FeaturesOL value for current and voltage measurements as well as alarm threshold.
- Min/Max data recording
- Auto power off: 15 min or 30 min (configurable)
- Low voltage detection: external or internal. Internal two-point voltage detection when using 3V supply,

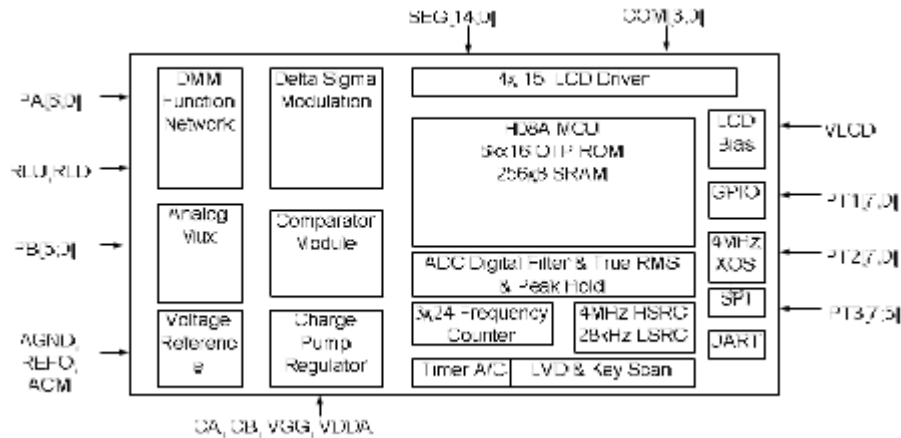
- external single-point voltage detection when using 4.5V ~ 9V supply.
- Beeper frequency: 1.95 kHz
- Packaging: bare die or LQFP64

3. Measurement Types

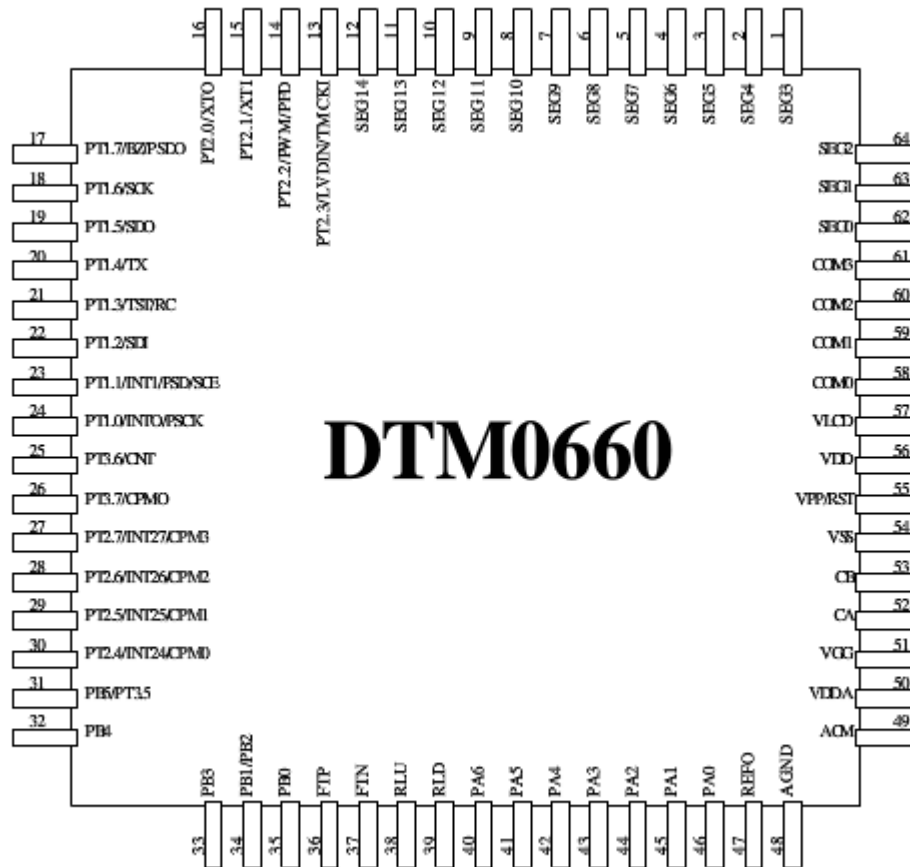
- DC Voltage: 60.00mV/600.0mV, (600.0mV)/6.000V/60.00V/600.0V/1010V
- AC Voltage: 60.00mV/600.0mV, (600.0mV)/6.000V/60.00V/600.0V/750V
- DC Current: 600.0uA/6000uA, 60.00mA/600.0mA, 6.000A/60.0A
- AC Current: 600.0uA/6000uA, 60.00mA/600.0mA, 6.000A/60.0A
- Resistance: 600.0Ω/6.000kΩ/60.00kΩ/600.0kΩ/6.000MΩ/60.00MΩ
- Capacitance: 9.999nF/99.99nF/999.9nF/9.999uF/99.99uF/999.9uF/9.999mF/99.99mF
- Frequency: 9.999Hz/99.99Hz/999.9Hz/9.999kHz/99.99kHz/999.9kHz/9.999MHz
- Duty cycle: 1% ~ 99%
- Diode: 0.000V ~ 3.000V. OL when above 3.0V
- Continuity: Beep when < 60Ω, OL when > 600Ω
- Clamp current meter: user can set range, decimal. Single or dual automatic ranges.
- Temperature: C/F
- Transistor: 0 ~ 2000 (hFE)
- Non-contact Voltage detection (NCV)

4. Applications

5. Block Diagram



6. Pinout



7. Pin Descriptions

Pin	Symbol	Port	Description
1~12	SEG3~SEG14	O	Segment 3 ~ 14
13	PT2.3 TMCK1, LVDIN	I/O I	Data input/output. RC clock input, LVD external input
14	P2.2 PWM, PFD	I/O I	Data input/output PWM output, frequency output
15	PT2.1, XTI	I/O, I	Data input/output, external oscillator in
16	PT2.0, XTO	IO, O	Data input/output, external oscillator out
17	PT1.7, PSDO, BZ	I/O, O	Data input/output, beeper output, OTP read/write port (PSDO)
18	PT1.6, SCK	I/O	Data input/output, SPI communication port (SCK)
19	PT1.5, SDO	I/O, O	Data input/output, SPI communication port (SDO)

20	PT1.4, TX	I/O, O	Data input/output, EUART port (TX)
21	PT1.3, RC, TST	I	Data input, EUART port (RC), mode test
22	PT1.2, SDI	I/O, I	Data input/output, SPI communication port (SDI)
23	PT1.1 SCE, PSDI, INIT	I/O I	Data input/output SPI communication port (SCE), OTP read/write port (PSDI), interrupt source (INITI)
24	PT1.0 PSCK, INTO	I/O I	Data input/output OTP read/write port (PSCK), interrupt source (INTO)
25	PT3.6, CNT	I/O, I	Data input/output, frequency counter input
26	PT3.7, CMPO	I/O, O	Data input/output, comparator output
27	PT2.7 CMP3, INT27	I/O I	Data input/output comparator input, interrupt E27IF
28	PT2.6 CMP2, INT26	I/O I	Data input/output comparator input, interrupt E26IF
29	PT2.5 CMP1, INT25	I/O I	Data input/output comparator input, interrupt E25IF
30	PT2.4 CMP0, INT24	I/O I	Data input/output comparator input, interrupt E24IF
31	PT3.5, PB5	I/O, I	Data input/output A/D input
32	PB4	I	A/D input
33	PB3	I	A/D input
34	PB1/PB2	I	A/D input
35	PB0	I	A/D input
36	FTP	I/O	Front-end filter capacitor
37	FTN	I/O	Front-end filter capacitor
38	RLU	I/O	A/D switch network port
39	RLD	I/O	A/D switch network port
40-46	PA6-PA0	I/O	A/D switch network port
47	REFO	I/O	1.2V reference output
48	AGND	I/O	Analog ground (COM)
49	ACM	I/O	Reference voltage
50	VDDA	I/O	Voltage after doubling regulated
51	VGG	O	Voltage pump
52	CA	I/O	Voltage pump capacitor
53	CB	I/O	Voltage pump capacitor
54	VSS	P	IC ground
55	RST, VPP	I, P	IC reset, EEPROM read/write voltage
56	VDD	P	IC supply voltage
57	VLCD	I/O	LCD power

58~61	COM0~COM3	O	Common cathod 0~3
62~64	SEG0~SEG2	O	Segment 0~2

8. Technical Specifications (VDD=3V, Ta=25°C)

Maximum ratings

Parameter	Symbol	Maximum value
Power supply voltage	VDD(VDDA) – VSS(VSSA)	-0.2V~4V
Voltage applied to any pin		-0.3V ~VDD+0.3V
Pin protection diode withstand current		+2mA
Storage temperature	Tstg	-50C~150C
Soldering temperature	Temp	300 C
Soldering time	Time	10 Second
Power dissipation		500 mW

Re commanded working condition

Symbol	Parameter	Measurement Condition	Min	Typical	Max	Unit
VDD	Power supply	Peripherals and CPU	2.2		3.6	V
		Analog peripherals	2.4		3.6	
VSS	Power supply		0		0	
XT	Clock Crystal	VDD=2.2V ENXT[0]=1	XTSP[0]=0 XTHSP[0]=0	32.768 kHz		Hz
	Ceramic Osc		XTSP[0]=1 XTHSP[0]=0	400k	8M	
	Crystal Osc		XTSP[0]=01 XTHSP[0]=0	1M	8M	

Internal RC Oscillator

Symbol	Parameter	Condition	Min	Typical	Max	Unit
HAO	High speed oscillator	ENHAO[0]=1		4		MHz
LPO	Low power oscillator	VDD LPO		32		kHz

Power draw

Symbol	Parameter	Test Condition	Min	Typical	Max	Unit
IAM1	Active mode 1	OSC_CY=8MHz, OSC_HAO=off CPU_CK=8MHz		1.34	2	mA

IAM2	Active mode 2	OSC_CY=off, OSC_HAO=4MHz CPU_CK=4MHz		0.36	0.55	mA
IAM3	Active mode 3	OSC_CY=off, OSC_HAO=4MHz CPU_CK=2MHz		0.2	0.3	mA
ILP1	Low Power 1	OSC_CY=32768Hz, OSC_HAO=off CPU_CK=16384Hz		7	12	uA
ILP2	Low Power 2	OSC_CY=off, OSC_HAO=off CPU_CK=LPO, Idle state		1.65	3	uA
ILP3	Low Power 3	OSC_CY=off, OSC_HAO=off CPU_CK=off, Sleep mode		0.65	1.3	uA

Port 1~ Port 3

Symbol	Parameter	Condition	Min	Typical	Max	Unit
Input Voltage, Schmitt Trigger, Leak current, duration						
VIH	Input HIGH				2.2	V
VIL	Input LOW		0.9			
VHYS	Input hysteresis (VIH-VIL)			0.8		
ILKG	Leakage current				0.1	uA
RPU	Pull-up resistor			180		kΩ
Output Voltage, Current						
VOH	Output HI	IOH=10mA	Vdd-0.3			V
VOL	Output LOW	IOL=10mA			Vss+0.3	

Reset (power loss, external reset, low voltage detection)

Symbol	Parameter	Condition	Min	Typical	Max	Unit
BOR	Pulse width for internal reset, td-LVR		2			us
	VDD reset transition voltage (L->H) VLVR		1.6	1.85	2.1	V
	Hysteresis VHYS-VLVR			70		mV
RST	Pulse width for reset (/VPP), td-RST		2			us
	Input voltage for reset		0.9			V
	Hysteresis, VHYS-RST			0.8		V
LVD	Current ILVD			10	15	uA
	Reference Voltage			1.2		V
	Reference Temp Co	TA=-45C~85C		100		ppm/C
	First LVD detection voltage			2.4		V
	Second LVD detection voltage			2.2		V

BOR=Brownout Reset

LVR=Low Voltage Reset of BOR

LVD=Low Voltage Detect
RST=Reset (External Reset Pin)

Parameters in DMM application

Parameter	Condition	Min	Typical	Max	Unit
0 input reading	VIN=0, Calibrated at 500mV	-1	0	+1	digit
0 input tempco	VIN=0, Calibrated at 500mV, TA=0~70C	-0.003	0	+0.003	digit/C
Linearity	Calibrated at 500mV	-1	0	+1	digit
Input leakage current	VIN=0V		1	10	pA
Comparator Bandwidth (CMPH & CMPL)	VIN=600mVp-p (sine) VIN=400mVp-p (sin)		6 2		MHz MHz
Comparator Current	CMPH & CMPL		40		uA
Switch network resistance	PS0~PS1		20		Ω
	DS0~DS1		40		
	DS2~DS6, PS2~PS6		80		
	SS0~SS6, FS0~FS6		400		
ADI Operating Current	No input to reference buffer		90		uA
Low pass filter current			50		uA
True RMS converter Current			210		uA
Current in Sleep mode			1		uA

9. Key definition

10. Miscellaneous

- Upon power up, all segments are lit for 2 seconds and then enter normal measuring mode. If there is an EEPROM error, ErrE is displayed.
- Auto power off. If there is no activity for 15 minutes (can be configured) meter enters sleep mode. If Select function key is pressed while in sleep mode, the meter resumes to normal function. If Select is pressed while turning on meter, auto power off is disabled. Auto power off is re-enabled if the meter is power cycled.
- Beeper. The beeper will beep once (~0.25 sec) whenever a valid key is pressed or the range is changed. In current and voltage mode, the beeper will beep when the current or voltage exceeds the preset maximum value (e.g. AC>600V, DC>1000V, Current>10A) as warning. The beeper will beep 5 times 1 minute prior to power down. Before power down, there will be a long beep. If auto power off is disabled, every 15 minutes (or at the preset power off interval), the beeper will beep 5 times.
- Low voltage detection: when using 3V as power supply the battery symbol will display if voltage drops below 2.4V but the meter can still function normally. If the voltage drops below 2.2V, only the battery

symbol will display upon power on.

- When the supply voltage is 4.5V~9V, the design condition is such that when the supply voltage drops to 75% of the original value and the value at PT2.3/LVD should measure 1.2V. In practice, two resistances can be connected in series between the positive and negative terminal of the battery, connect the divider to PT2.3/LVD, adjust the divider so that the if PT2.3 is lower than 1.2V display the battery symbol. Meter remains functional when the battery symbol is displayed.
- PT1.2 outputs high when active and low when in sleep mode. It can be used to control peripherals.

11. EEPROM Settings

EEPROM initialization data

addr	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	FF	FF	FF	FF	FF	FF	FF	FF	FF	52	00	FA	00	00	BE	03
10	10	17	38	18	44	02	6E	4B	64	3C	3C	3C	0A	FF	40	FF
20	99	99	00	80	64	00	96	00	00	80	00	80	00	80	00	80
30	4E	02	09	4E	D2	09	77	FD	0A	9A	19	0A	00	00	0A	00
40	00	01	00	01	00	07	98	00	64	00	64	00	64	00	00	00
50	00	80	00	80	00	80	00	80	00	80	00	80	00	80	00	80
60	00	80	00	83	01	00	6D	2A	00	00	00	00	00	00	00	00
70	00	80	00	80	00	80	E0	7C	18	01	00	00	00	00	00	00
80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
C0	0D	00	02	10	0D	00	03	20	20	00	03	20	20	00	03	10
D0	41	00	03	08	41	00	03	05	41	00	03	05	0D	00	02	20
E0	00	80	00	80	00	80	00	80	00	80	00	80	00	80	00	80
F0	00	80	FF	FF	FF	FF	FF	FF	5A	C7	CC	0F	0F	82	00	00

EEPROM Setting Description (do not change data that is reserved or unmentioned)

Address	Default	Description
F9H	Bit 7: 1	Reserved
	Bit 6: 1	Reserved
	Bit 54: 00	VDD, 00=3.6V, 01=3.2V, 10=2.8V, 11=2.4V
	Bit 32: 01	VLCD, 00=3.3V, 01=3.0V, 10=2.8V, 11=2.5V
	Bit 1: 1	PT1.2 state upon power on: 1: PT1.2=1, 0: PT1.2=0 (note, when PT1.2 used to synchronize with NCV state, it can only be set to 1)

	Bit 0: 1	1 NCV (PT1.2 is synchronized with the beeper. 1 = beep, 0 = no beep)
FAH	Bit 7: 1	1: MV ranges are 60.00mV/600.0mV; 0: MV range is 600.0mV
	Bit 6: 1	Reserved
	Bit 43: 01	00: when backlight is on PT2.2=0; when off PT2.2=1 01: when backlight is on PT2.2=1; when off PT2.2=0 10: when backlight is on PT2.2=PWM, PT2.3=0; when off PT2.2=1, PT2.3=1 11: when backlight is on PT2.2=PWM, PT2.3=1; when off PT2.2=1, PT2.3=0 (when backlight is in on/off mode, PT2.3 is used for low voltage detection. When backlight is in PWM mode, PT2.3 is used as the backlight switch)
	Bit 2: 1	1: HOLD key can turn on backlight via long press; 0: Function unavailable
	Bit 1: 0	1: REL key can turn on RS232 via long press; 0: Function unavailable
	Bit 0: 0	1: clamp meter, 0: multimeter
	FBH	0FH
FCH	0FH	Backlight on duration (1-255 seconds). Default: 15 seconds. 0: backlight stays on.
FDH	82H	Bit 7: 1 Frequency range switchable. Pt3.6 & RLD : 0 Frequency range fixed Pt3.6 Bit 6: 1 UART format bit3~bit0 → com0~com3 : 0 UART format bit3~bit0 → com3~com0 Bit 5: 1 UART uses 14 bytes format (seg0~seg13) : 0 UART uses 15 bytes format (seg0~seg14) Bit 4: 1 PT1.2 used for NCV LED only : 0 PT1.2 used for NCV LED and power LED Bit 3~Bit 0: Low voltage power off delay (seconds), default 2s, max 15s
10H, 11H	1770H	Default full range 6000d (10H stores low byte 70H, 11H stores high byte 17H) same low byte/high byte arrangement below
12H, 13H	1838H	Range switch upper limit 6200d (for full range of 4000d the upper limit is 4200d)
14H, 15H	0244H	Range switch lower limit 580d (for full range of 4000d the lower limit is 380d)
16H	6EH	DC Voltage OL value : 1100V (unit *10V)
17H	4BH	AC Voltage OL value: 750V (unit *10V)
18H	64H	DC Voltage warning voltage 1000V (unit *10V)
19H	3CH	AC Voltage warning voltage 600V (unit *10V)
1AH	3CH	uA range warning current 6000uA (unit *100uA)
1BH	3CH	mA range warning current 600mA (unit *100mA)
1CH	0AH	A range warning current 10A (unit A)
1EH	40H	NCV display symbol default is the G segment (bit0~6 corresponds to ABCDEFG segment)
20H, 21H	9999H	Amplifier parameter
22H, 23H	8000H	500mV calibration adjustment ratio
24H, 25H	0064H	NCV base number (10.0 mV)
26H, 27H	0096H	NCV resolution (15.0 mV)

28H, 29H	8000H	AC 6V range compensation ratio (frequency)
2AH, 2BH	8000H	500uA calibration adjustment ratio
2CH, 2DH	8000H	50mA calibration adjustment ratio
2EH, 2FH	8000H	5A calibration adjustment ratio
60H, 61H	8000H	50K resistor calibration adjustment ratio
62H, 63H	8000H	50M resistor calibration adjustment ratio
70H, 71H	8000H	500nF capacitor calibration adjustment ratio
74H, 75H	8000H	50uF capacitor calibration adjustment ratio
76H, 77H	8000H	50mF capacitor calibration adjustment ratio
0BH, 0CH	00FAH	Environment temperature (25 C)
0DH~0FH	03BE00H	Environment temperature default ADC value
50H, 51H	8000H	6A range calibration adjustment ratio
52H, 53H	8000H	60A range calibration adjustment ratio
54H, 55H	8000H	600A range calibration adjustment ratio
56H, 57H	8000H	6000A range calibration adjustment ratio
40H, 41H	0100H	AC60mV range noise to be subtracted (input signal is internally amplified)
42H, 43H	0100H	AC600mV range noise to be subtracted (input signal is not amplified)
44H, 45H	0700H	AC600mV range noise to be subtracted (10M/1.111M resistor divider, amplified)
46H, 47H	0098H	AC6V range noise to be subtracted (10M/1.111M resistor divider)
48H, 49H	0064H	AC60V range noise to be subtracted (10M/101K resistor divider)
4AH, 4BH	0064H	AC600V range noise to be subtracted (10M/10K resistor divider)
4CH, 4DH	0064H	AC1000V range noise to be subtracted (10M/1K resistor divider)
78H, 79H	0118H	Capacitor 9nF range base line to be subtracted (e.g. when no capacitor is connected, unit 0.001 nF)
80H~BFH		Measurement functionality setting (shaded area)
E8H, E9H	8000H	DC 600mV range calibration adjustment ratio
EAH, EBH	8000H	DC 6V range calibration adjustment ratio
ECH, EDH	8000H	DC 60V range calibration adjustment ratio
EEH, EFH	8000H	DC 600V range calibration ratio
F0H, F1H	8000H	DC 1000V range calibration ratio

12. Calibration procedure

Key assignment in Calibration mode:

SELECT: skip/function select

HOLD: subtract (-)

Other keys: add (+)