



1522

Digital Wattmeter

Instruction Manual

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DIGITAL WATTMETER

Instruction Manual



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SAFETY

INSULATION CLASS I, POLLUTION DEGREE 2:IEC 1010-1

This instrument has been built & tested as per IEC publications prepared by Technical Committee No.66 (Ref. No. CEI/IEC 1010-1:1990) : Safety requirements for electrical equipment for measurement, control & laboratory use. This instructions manual provides information and warning data which must be taken into consideration by the user for safety of operator and instrument.

SAFETY PRECAUTIONS TO BE TAKEN BEFORE
SETTING THE INSTRUMENT INTO SERVICE :

Warning : Any interruption of the safety lead inside or outside the unit or disconnection of the protection ground terminal may render the instrument dangerous. An intentional disconnection is prohibited.

When the instrument is to be supplied via an auto-transformer, in order to reduce the supply voltage available, make sure the common terminal is connected to the neutral point (grounded) of the supply circuit. The jack should only be into a plug fitted with a grounding piece. The safety connection should never be interrupted by the use of an extension cord without a protection (ground) lead. The power supply cord must be connected to the mains network (with good value), before connecting the control of the measuring circuits.

SYMBOLS (as marked on equipment or in this manual) :



DANGER High Voltage.



Protective ground (earth) terminal.



ATTENTION : Refer to manual.
This symbol involves a mandatory reference to the operating manual.
The User is required to refer and follow the relevant instructions.

PCB Components DPM-0295 PCB REV- 01 contd..

| Ref Designator | Value |
|---------------------------|---------------------|
| <u>PRESETS</u> | |
| PR1 | 2K5,HOR,CERMET(REF) |
| <u>CAPACITORS</u> | |
| C1 | 220PF,50V,CD |
| C2 | 2.2uF,35V,EL,RAD |
| C3 | 0.1uF,50V,MP |
| C4 | 0.47uF,50V,MP |
| C5 | 0.01uF,50V,CD |
| C6 | 0.1uF,50V,CD |
| C7 | 0.1uF,50V,MP |
| C8 | 470uF,35V,EL,RAD |
| C9 | 10uF,35V,EL,RAD |
| C10 | 0.1uF,50V,MP |
| <u>DIODES</u> | |
| CR1 | 1N4148 |
| CR2 | 1N4148 |
| CR3 | Shorting Link |
| CR4 | Not Used |
| CR5 | Not Used |
| CR6 | Shorting Link |
| <u>IC's</u> | |
| IC1 | TL431 |
| IC2 | Not Used |
| IC3 | 7107CPL |
| <u>TRANSISTORS</u> | |
| Q1 | MPSA12 |

PCB Components **DPM-0295 PCB REV- 01** contd..

| Ref Designator | Value |
|-----------------------|--------------|
|-----------------------|--------------|

FND's

| | |
|---------------------|------------|
| DS1 Anode(GREEN) | 0.5"Common |
| DS2 Anode(GREEN) | 0.5"Common |
| DS3 Anode(GREEN) | 0.5"Common |
| DS4 Anode(GREEN) | 0.5"Common |

CONNECTORS

| | |
|------|------------------|
| CON1 | 5PIN,2.54MM MALE |
| CON2 | 3PIN,2.54MM MALE |

PCB Components **DPM-0295 PCB REV- 01**

| Ref Designator | Value |
|-----------------------|--------------|
|-----------------------|--------------|

RESISTORS

| | |
|-----|------------------|
| R1 | 2.7K,1/4W,5%,MFR |
| R2 | 2.4K,1/4W,5%,MFR |
| R3 | 27K,1/4W,5%,MFR |
| R4* | 8K2,1/4W,5%,MFR |
| R5 | 100E,1/4W,5%,MFR |
| R6 | 39K,1/4W,5%,MFR |
| R7 | 100E,1/4W,5%,MFR |
| R8 | 12K,1/4W,5%,MFR |
| R9 | 20K,1/4W,5%,MFR |
| R10 | 470K,1/4W,5%,MFR |
| R11 | Not Used |
| R12 | 1M,1/4W,5%,MFR |
| R13 | Not Used |
| R14 | Not Used |

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**SECTION - 1
GENERAL INFORMATION**

DESCRIPTION :

Vector model 1522 Digital Wattmeter is an accurate low cost instrument designed for use in Engineering, Quality control and Production Test departments to determine the power consumption of equipments operating directly from a standard 110 - 150V AC, 60Hz line. Instrument features large L.E.D. display.

In addition to power measurement, the wattmeter measures AC (true RMS) voltage and AC (true RMS) current.

The Digital Wattmeter is easy to operate. Each measurement function, voltage (V), current (I) or power (W) is selected by a simple pushbutton switch on the front panel.

The Digital Wattmeter can be connected to two different loads. The total load current can be upto 20A maximum.

| PCB Components | WD767-SW-0995 REV-01 contd... |
|---------------------------|-------------------------------|
| Ref Designator | Value |
| <u>CAPACITORS</u> | |
| C1 | 0.1uF,50V,CD |
| C2 | 10uF,16V,EL,RAD |
| C3* | 0.1uF,50V,CD |
| <u>TRANSISTORS</u> | |
| Q1 | NOT USED |
| Q2 | BC557 |
| Q3 | BC557 |
| Q4 | BC557 |
| <u>IC's</u> | |
| IC1 | 4013 |
| IC2 | 4071 |
| IC3 | 4071 |
| IC4 | 4013 |
| <u>LED'S</u> | |
| LED1 | Not Used |
| LED2 | 5mm,RED |
| LED3 | 5mm,RED |
| LED4 | 5mm,RED |
| <u>SWITCHES</u> | |
| SW1 | Not Used |
| SW2 | D6 KEY |
| SW3 | D6 KEY |
| SW4 | D6 KEY |
| <u>CONNECTORS</u> | |
| CON1 | 2.54mm,5PIN MALE |
| CON1 | 2.54mm,5PIN MALE |

**SECTION - 2
SPECIFICATIONS**

| Ref Designator | Value |
|----------------|----------|
| ICs | |
| IC6 | 4066 |
| IC8 | NOT USED |
| IC9,10,11 | TLO-81CP |
| IC12 | AD736 |
| IC13 | NOT USED |
| IC14 | AD736 |
| IC15 | AD633 |
| IC16 | TLO-81CP |
| IC17 | TLO-81CP |
| IC18 | TLO-81CP |
| IC19 | 7812 |
| IC20 | 7912 |
| IC21,22 | 7805 |

PCB Components WD767-SW-0995 PCB REV-01

| Ref Designator | Value |
|------------------|---------------------|
| RESISTORS | |
| R1,2 | 100K, 1/4W, 5%, MFR |
| R3 | Not Used |
| R4 | 1K5, 1/4W, 5%, MFR |
| R5 | 1K5, 1/4W, 5%, MFR |
| R6 | 1K5, 1/4W, 5%, MFR |
| R7 | 1K5, 1/4W, 5%, MFR |
| R8 | 1K5, 1/4W, 5%, MFR |
| R9 | 100K, 1/4W, 5%, MFR |
| R10 | 100K, 1/4W, 5%, MFR |

| | | |
|---------------------------|----------------|------------------------|
| LINE INPUT VOLTAGE | : | 110 - 150V AC, 60Hz |
| MAXIMUM AC CURRENT | | |
| | rms : | 20Amps. |
| | peak : | 35Amps peak. |
| MAXIMUM POWER | : | 1999W. |
| POWER FACTOR | : | 0.5 to unity. |
| CREST FACTOR | Volts : | 2.5:1 @ 120V AC. |
| | Amps : | 1.8:1 @ 20 Amps. |
| ACCURACY | Volts : | ±0.8% ±1digit. |
| | Amps : | ±1.0% ±2digit. |
| | Watts : | ±1.25% ±2digits. |
| RESOLUTION | Volts : | 0.1 Volt. |
| | Amps : | 0.01 Amp. |
| | Watts : | 1.0 Watt. |
| FREQUENCY RESPONSE | : | 40Hz To 5KHz. |
| NUMBER OF DIGITS | : | 3.5digits |
| DISPLAY | : | Green L.E.D. 0.56"high |
| SIZE (H X W X D) | : | 155mm X 170mm X 215mm |
| WEIGHT | : | 2.5Kg. (Approx). |

SECTION - 3 INSTALLATION

OPERATION :

Before operating the instrument, read the manual thoroughly and make sure that you understand and observe all safety instructions. The maximum continuous output current on the outlets(Front/Rear) should not exceed the maximum current indicated on the front panel.

The "ON" Switch provided on the front panel can be used to connect or disconnect the power to the load. Initially, keep the Power 'ON' switch on the front panel in the 'OFF' position.

Connect the instrument to the power line. Connect the load to the outlet on the front panel and turn on the switch on the front panel to the 'ON' position.

Voltage measurement :

As soon as the Digital Wattmeter is connected to the power line, the voltage measurement function is automatically selected and the voltage across the outlet is indicated on the display.

Current measurement :

To measure load current, press the 'A' switch. The load current is indicated in Amps.

Wattage measurement :

To measure the load power (Watts), press the 'W' switch. The load power is indicated in Watts.

| Ref Designator | Value |
|--------------------------|--------------------|
| <u>CAPACITORS</u> | |
| C10 | 47uF,35V,EL,RAD |
| C11 | 1uF,35V,EL,RAD |
| C12 | 0.1uF,50V,CD |
| C13 | 10uF,35V,EL,RAD |
| C14,15 | 220uF,35V,EL,RAD |
| C16 | 0.1uF,50V,CD |
| C17 | 10uF,16V,EL,RAD |
| C18 | 0.1uF,50V,CD, |
| C19 | 220uF,16,EL,RAD |
| C20 | 1000uF,16V*,EL,RAD |
| C21 | 0.1uF,50V,CD |
| C22 | 10uF,35V,EL,RAD |
| C23 | 220uF,35V,EL,RAD |
| <u>CONNECTORS</u> | |
| CON1 | 7PIN,2.54MM MALE |
| CON2,3 | 6PIN,2.54MM,MALE |
| <u>DIODES</u> | |
| CR1 | Not Used |
| CR2 | 1N4007 |
| CR3 | 1N4007 |
| CR4 | 1N4007 |
| CR5 | 1N4007 |
| CR6 | 1N4007 |
| CR7 | 1N4007 |
| <u>CONNECTORS</u> | |
| CR8 | 1N4007 |
| CR9 | 1N4007 |

| Ref Designator | Value |
|--------------------------|-------------------------------|
| <u>RESISTORS</u> | |
| R36 | 200K(390K),1/4W,0.1%,MFR |
| R37 | 10M(20M),1/4W,0.1%,MFR |
| R38 | 10M(20M),1/4W,0.1%,MFR |
| R39 | 200K(390K),1/4W,0.1%,MFR |
| R40 | 100K,1/4W,5%,MFR |
| R41 | 100K,1/4W,5%,MFR |
| R42 | 11K,1/4W,5%,MFR(SEL-W) |
| <u>PRESETS</u> | |
| PR5 | 1K,VER, M/T BOURNS (3296-W) |
| PR6 | 10K, VER, M/T BOURNS (3296-W) |
| PR7 | 10K, VER, M/T BOURNS (3296-W) |
| PR9 | 2K,VER, M/T BOURNS (3296-W) |
| PR10 | 2K,VER, M/T BOURNS (3296-W) |
| PR11 | 10K, VER, M/T BOURNS (3296-W) |
| PR12 | 10K, VER, M/T BOURNS (3296-W) |
| PR13 | 10K, VER, M/T BOURNS (3296-W) |
| PR14 | 10K, VER, M/T BOURNS (3296-W) |
| PR15 | 2K, VER, M/T BOURNS (3296-W) |
| <u>CAPACITORS</u> | |
| C1 | NOT USED |
| C2 | NOT USED |
| C3 | NOT USED |
| C4 | NOT USED |
| C5 | 10uF,35V,EL,RAD |
| C6 | 10uF,35V,EL,RAD |
| C7 | 47uF,50V,EL,RAD |
| C8 | 10uF,35V,EL,RAD |
| C9 | 10uF,35V,EL,RAD |

SECTION - 4 CIRCUIT DESCRIPTION

The Model 1522 Digital Wattmeter measures true rms values of voltage across the load, the load current and the power consumed by the load (real power in Watts).

Main PCB (ref: WD 76XX-01)

The line voltage is sensed at the "VIN H" and "VIN L" terminals. It is attenuated by a factor of approx.50 and connected to the inputs of IC16 (TL071). The circuit associated with IC16 converts the "floating" signal to a "single-ended" signal. The waveform on test point TPV1 is a scaled version of the line input voltage. This signal is connected to IC14 (AD736), which is a RMS - DC converter. The output at pin 6 of IC14 is a DC voltage proportional to the input line voltage. Attenuator network R31, PR10 (VCAL), and R33 is used to attenuate this DC voltage by a factor of approximately 2. The DC voltage on TPV2 should be exactly 1/100th the RMS value of the input line voltage.

The load current is sensed by a "shunt" resistor, R16, in the neutral return path. The voltage across R16 is connected to the inputs of IC9 (TL071). The circuit associated with IC9 converts the "floating" signal to a "single-ended" signal. The waveform on test point TPI1 is a scaled version of the load current. This signal is connected to IC12 (AD736), which is a RMS - DC converter. The output at pin 6 of IC12 is a DC voltage proportional to the input load current. The resistor network R30, PR9 (ICAL), and R28 is used to amplify this DC voltage by a factor of approximately 4.0. The DC voltage on TPI2 should be adjusted to 200mV for a load current of 10 A. IC15 (AD633) is an analog multiplier. Signals from TPV1 (corresponding to the line voltage) and TPI1 (corresponding to the load current) are connected to input pins 4 and 2 resp. of IC15. The output on pin 7 corresponds to waveform of the instantaneous power consumed by the load.

The instantaneous power consumed by the load. :

$$w(t) = v(t) * i(t)$$

where, w(t), v(t) and i(t) are instantaneous values of power, voltage and current respectively.

The instantaneous power waveform is filtered by R32, C11 and buffered by IC17 (TL071). IC18 (TL071) is configured as a non-inverting amplifier.

The gain is decided by the ratio of R34 and R42. Preset PR15 (WCAL) is used to set this gain to 2. The DC voltage at test point TPW2 should be adjusted to 200mV for a load power of 1000 W.

SECTION - 6 PART LIST & SCHEMATICS

| PCB Components | 767E/01 PCB REV-01 |
|-------------------------|-------------------------------|
| Ref Designator | Value |
| <u>RESISTORS</u> | |
| R11 | NOT USED |
| R12 | 1K,1/4W,5%,MFR |
| R13 | NOT USED |
| R14 | 1K,1/4W,5%,MFR |
| R15 | 1K,1/4W,5%,MFR |
| R16 | 0.025E/25W,KYOSH |
| R17 | 20K,1/4W,0.1%,MFR |
| R18 | NOT USED |
| R19 | NOT USED |
| R20 | NOT USED |
| R21 | 20K,1/4W,0.1%,MFR |
| R22 | 20E,1/4W,5%,MFR |
| R23 | 20K,1/4W,0.1%,MFR |
| R24 | 100K,1/4W,5%,MFR |
| R25 | NOT USED |
| R26 | 20K,1/4W,0.1%,MF |
| R27 | 100K,1/4W,5%,MFR |
| R28 | 10K(12K),1/4W,5%,MFR(SEL-A) |
| R29 | 100K,1/4W,5%,MF |
| R30 | 33K(91K),1/4W, 5%,MFR(SEL-A) |
| R31 | 10K(200K),1/4W,5%,MFR(SEL-V) |
| R32 | 1M,1/4W,1%,MFR |
| R33 | 10K,1/4W,5%,MFR(SEL-V) |
| R34 | 150K(180K),1/4W,5%,MFR(SEL-W) |
| R35 | 100K,1/4W,5%,MFR |

COMMON MODE REJECTION (CURRENT MEASUREMENT) :

Monitor the waveform on TPI1 on an oscilloscope and adjust preset PR5 (I-CMRR) so that the trace is flat. This can also be verified on an AC millivoltmeter. The reading will be minimum at the correct setting. With the Digital Wattmeter switched off, reconnect the VIN H and VIN L inputs on the Main pcb. Switch on the Digital Wattmeter.

VOLTAGE CALIBRATION :

Measure the line voltage with a multimeter (AC voltage measurement). Adjust preset PR10 (VCAL) so that the Digital Wattmeter shows the correct line voltage.

CURRENT CALIBRATION :

Connect a suitable resistive load across the output terminals and an AC current meter in series with it. Select the current function "A". Adjust preset PR9 (ICAL) so that the Digital Wattmeter shows the correct load current.

POWER (W) CALIBRATION :

Connect a suitable resistive load across the output terminals. Measure the voltage and current as given above. Select the power function "W". Adjust preset PR15 (WCAL) so that the Digital Wattmeter shows the correct power as given by the following equation :

$$W = V * I$$

(Since the load is resistive, power factor is 1)

SECTION - 5 CALIBRATION

DIGITAL PANEL METER (DPM) :

The reference voltage of the DPM is set to 1.00V. The Main pcb(767/01) has two test points marked DPM and GND. With reference to this test point (GND), measure the voltage on pin 36 of the IC1(7107) on DPM pcb (DPM-0295). Set this voltage to 1.00V by adjusting the preset PR1 on the DPM pcb.

MAIN PCB :

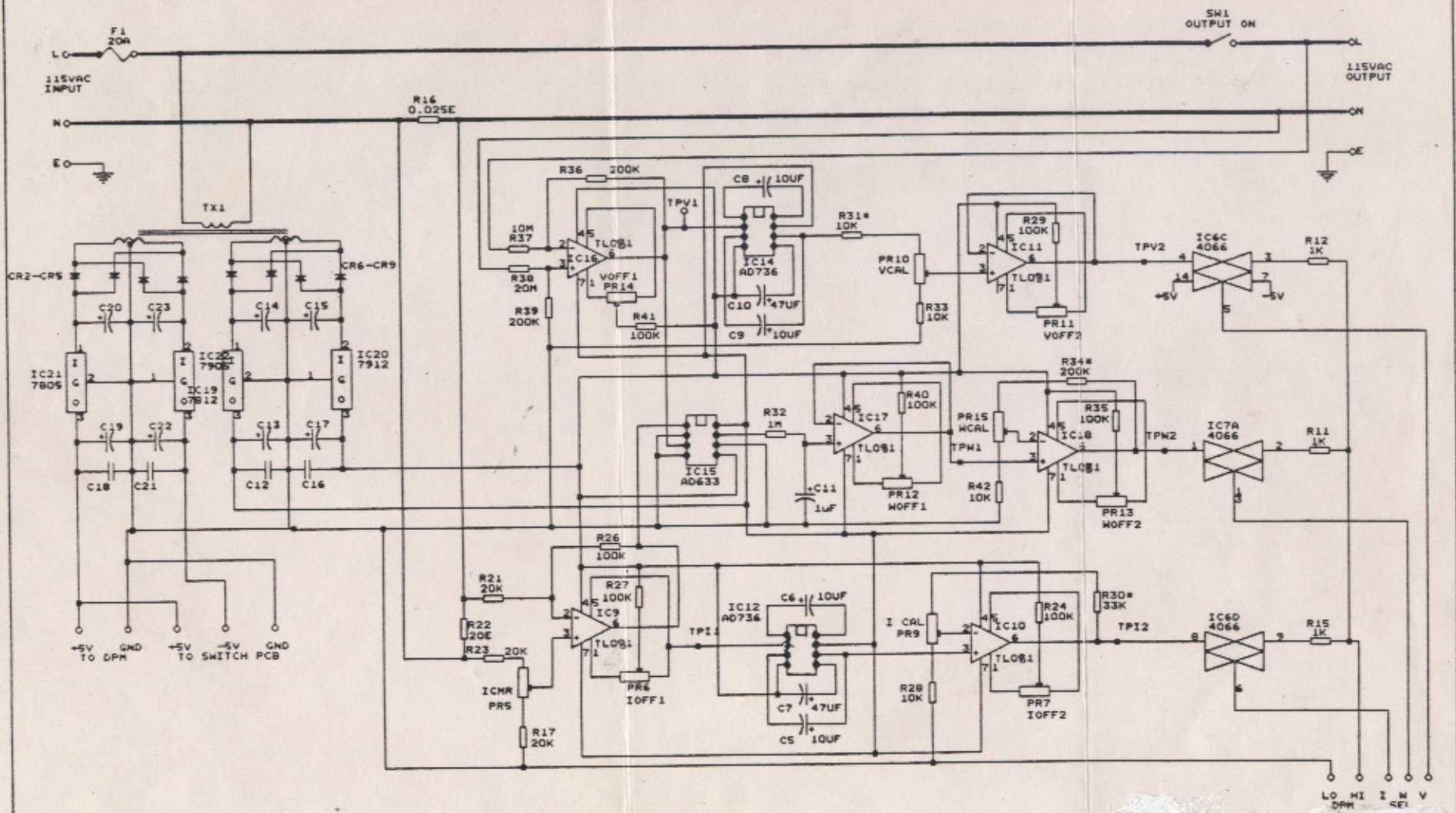
The Main pcb has two test points marked DPM and GND. All calibration should be done with reference to the test point marked GND.

With the Digital Wattmeter switched off, disconnect the VIN H and VIN L inputs of the Main pcb. (Take care to maintain the correct connection sequence during reconnection later). Switch on the Digital Wattmeter.

DC OFFSET ADJUSTMENTS :

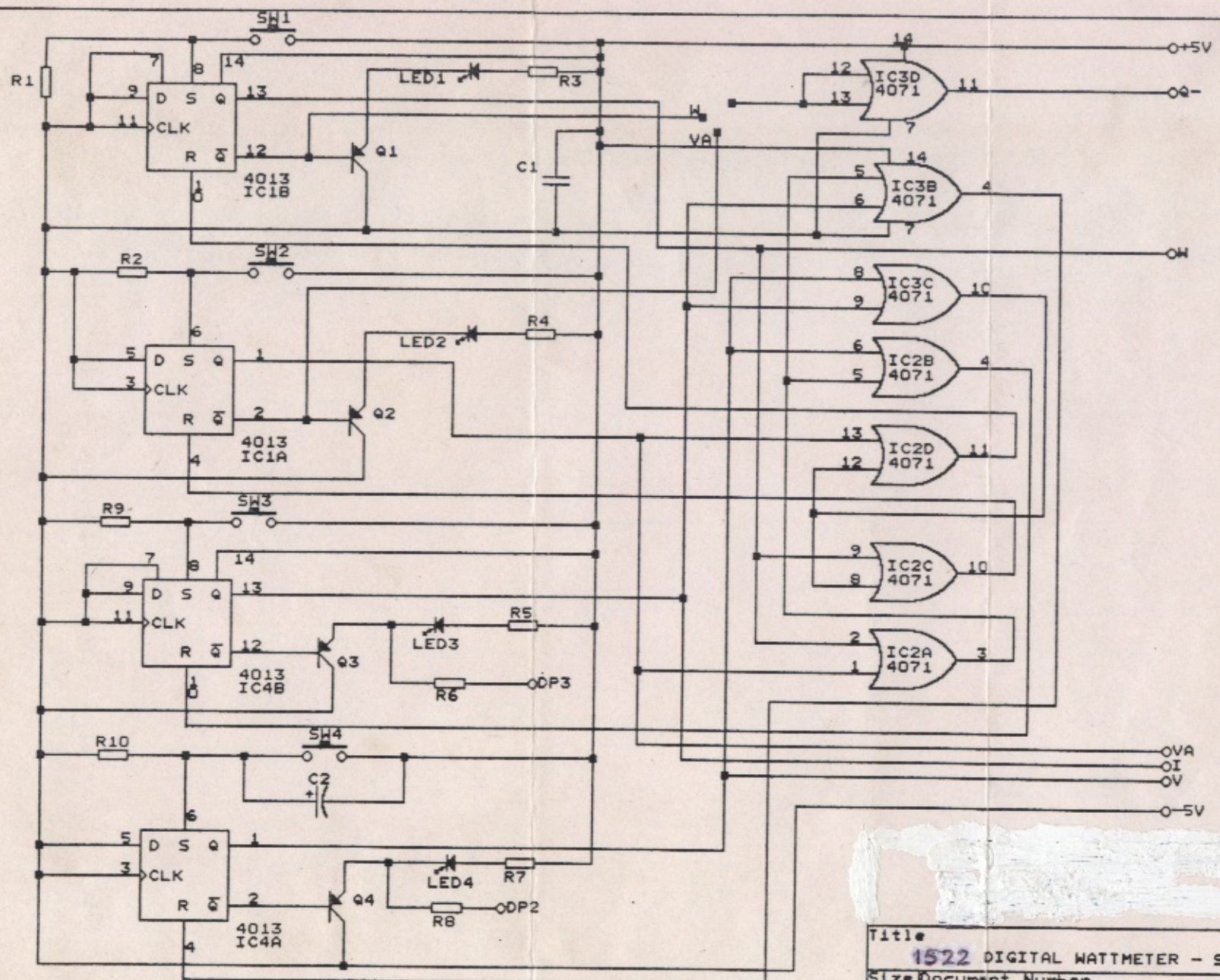
Adjust the presets as shown in the table and ensure that the DC voltage at the corresponding test point is within $0 \text{ V} \pm 1 \text{ mV}$.

| Adjust preset | Test Point |
|---------------|------------|
| PR14 (VOFF1) | TPV1 |
| PR11 (VOFF2) | TPV2 |
| PR6 (IOFF1) | TPI1 |
| PR7 (IOFF2) | TPI2 |
| PR12 (WOFF1) | TPW1 |
| PR13 (WOFF2) | TPW2 |

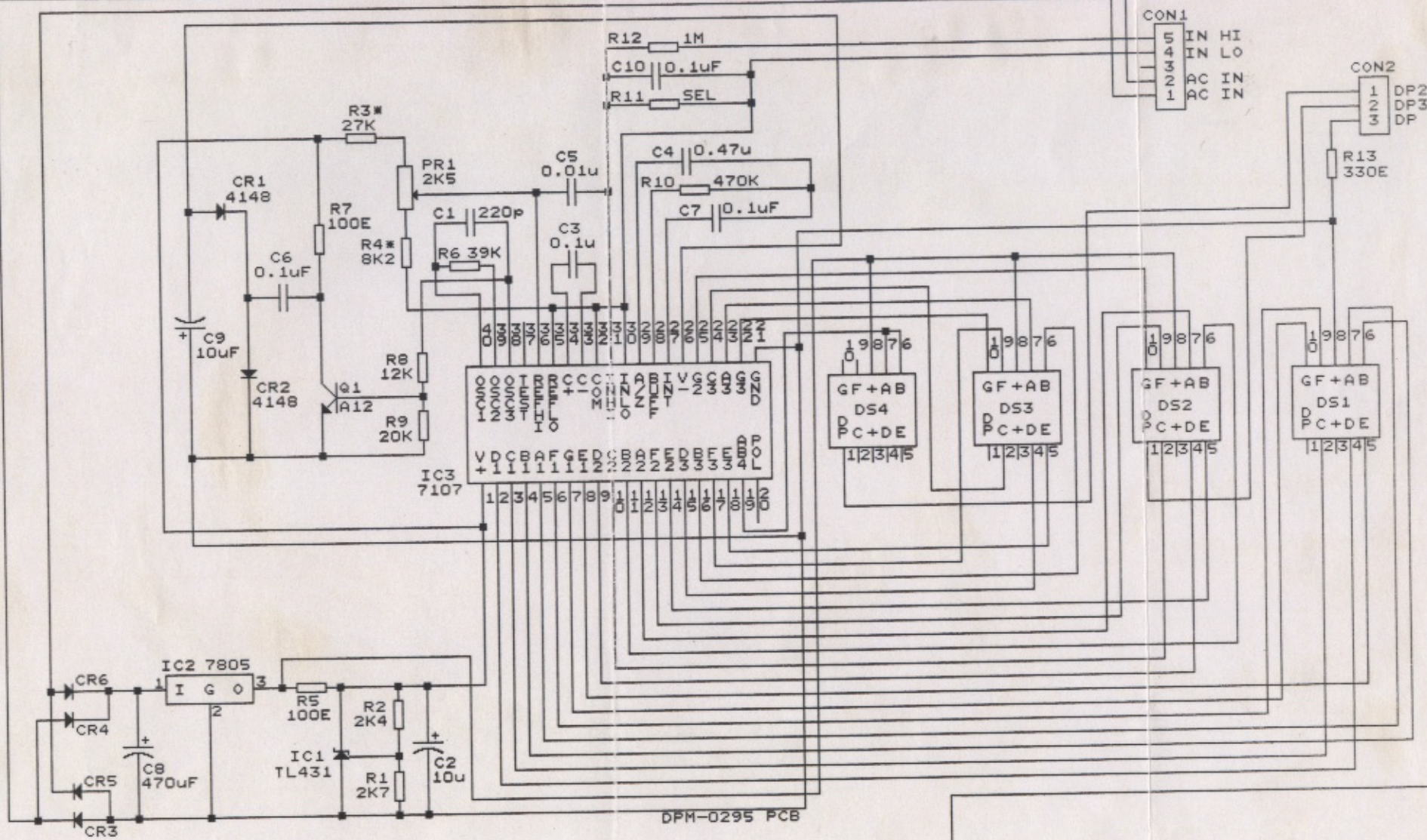


1522 DIGITAL WATTMETER - MAIN BOARD

| | | |
|-------|-----------------|--------|
| Size | Document Number | REV |
| A3 | C-00283 | 0 |
| Date: | | 1 of 1 |



| | | |
|-------------------------------------|-----------------|--------|
| Title | | |
| 1522 DIGITAL WATTMETER - SWITCH PCB | | |
| Size | Document Number | REV |
| A4 | C-00284 | 0 |
| Date: | | 1 of 1 |



| | | | |
|-------|------------------|-------|---------------------------|
| Title | | | 3.5 DIGIT DISPLAY CIRCUIT |
| Size | Document Number | REV | |
| A4 | C-00228 | 0 | |
| Date: | December 7, 1998 | Sheet | 1 of 1 |