TACHMASTER II

Designed by MikeDorffler

ASSEMBLY AND OPERATION MANUAL

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26K25 Tachmaster II, Kit

I. INTRODUCTION

Accurate measurement of model aircraft engine performance is extremely important in engine life and upkeep, prop selection, and optimizing for a particular aircraft design. Sport and competition fliers alike need nothing less than an excellent tachometer to accomplish this. The Ace Tachmaster II was created to provide the required accuracy, ease of use, non-confusing meter scale, and a cost that is less than half of the so-called "super" tachs.

In addition to our primary goal of creating a tachometer which provides fine performance at a reasonable cost, we at all times wanted to keep the construction reasonably simple so that it would provide the first time kit builder a great margin of success. We feel that all these objectives have been accomplished.

II. OPERATION

Refer to the following Construction, Final Wiring, Checkout, Calibration and Final Assembly sections to assemble your unit and then return to this section to properly operate your Tachmaster II. All that's necessary to get it operational is to remove the back and install a 9V Transistor battery (Alkaline type is recommended.) The battery slips into the bracket provided in the bottom of the case. Re-install the back.

While you're inside a room with fluorescent lights on, push the "ON" button and note the meter needle deflection; it should be higher with the range switch in the 0-5000 range, lower in the 0-10,000, and even lower in the 0-25,000 range.

Operation in the field is straight forward and will provide you with an accurate RPM measurement on any engine with a two bladed prop. Please observe the following suggestions:

First of all, try to keep the tach fairly level when taking readings as this is how the meter was calibrated and gravity can influence any meter. You will probably find that you achieve better and more consistant RPM readings when the detector in the top of the case is aimed about half-way to 2/3rds out on the prop from the engine spinner or crankshaft. Try to keep the sun over one shoulder when taking readings. On cloudy or overcast days you may have to hunt just a bit for the best position when taking readings and this is normal. Readings should be taken at about 4-6 inches from the propeller but lighting conditions can change this too, so use whatever works best for you.

The circuitry of the Tachmaster II uses so little current, a fresh 9V battery will last all flying season, and then some. However, it will tell you when it is time to replace the battery by giving erratic or totally ridiculous readings.

The Tachmaster II is a fine unit and should be treated as such. Carry it to and from the flying site somewhere in your field box where it will not be battered around and abused by other goodies in that part of the box. The meter face will scratch fairly easily. A fabric bag could be made to protect it from abuse.

III. PARTS LIST

	Resistors:		(5% unless specified)
[ ]	4 R4-103	10K	Brn, Blk, Or, Gld
[ ]	2 R4-103B	10K 1%	Brn, Blk, Blk, Rd, Brn
[ ]	1 R4-124B	121K 1%	Brn, Rd, Brn, Or, Brn
[ ]	1 R4-153B	15K 1%	Brn, Grn, Blk, Rd, Brn
[ ]	1 R4-155	1.5 Meg	Brn, Grn, Grn, Gld
[ ]	1 R4-333	33K	Or, Or, Or, Gld
[ ]	2 R4-471	470 Ohm	Yel, Vio, Brn, Gld
[ ]	3 R4-472	4.7K	Yel, Vio, Rd, Gld
[ ]	5 R4-473	47K	Yel, Vio, Or, Gld
[ ]	2 R4-492B	4.99K 1%	Yel, Wht, Wht, Brn, Brn
[ ]	1 RV078	5K	Vertical Trim Pot
	Capacitors:		
[ ]	1 CD102	.001 mf	Disc (.001P)
[ ]	1 CD221	220 pf	Disc (221K)
[ ]	2 CE475PI	4.7 mf	Electrolytic, P.I.
[ ]	1 CT475A	4.7 mf	Dipped Tantalum
[ ]	1 CY103	.01 mf	Mylar 5%
[ ]	2 CY 104	.1 mf	Mylar (104K)
	Semiconductors:		
[ ]	2 SS121	1N4446	Diode
[ ]	4 SS029	2N4400	Transistor
[ ]	1 SS041	LM340	Voltage Regulator
[ ]	1 SS087A	LM324A+	IC
[ ]	1 SS151	GEL14G2	Photo Transistor
	Hardware:		
[ ]	2 HW040	2-56 X 3/16"	Flat Head Screw
[ ]	2 HW001	2-56	Nut
[ ]	1 HW010H	7mm	Nut
[ ]	1 HW020D	7mm	Washer
[ ]	2 HW111	#2 X 3/16"	Self Tap
[ ]	2 HW080	4-40 X 1/8"	Screw
[ ]	2 HW192	L-Bracket	
[ ]	3 HW171	#6	Solder Lug
	Miscellaneous:		
[ ]	1 PC153A	Tachmaster II PC Board	
[ ]	1 MT010A	Tachmaster II Meter	
[ ]	1 SW018	DP3T Slide Switch	

( ) Referring to Figure 1, install and solder the 6" Black wire into the PC board.

( ) Repeat for the 6" Red wire, ( ) the 4" Brown wire, ( ) the 3" Orange wire, ( ) the 6" Green wire, ( ) the 6" Yellow wire, ( ) the 6" Blue wire, ( ) and the 6" White wire.

( ) Clean the bottom of the board with alcohol and an old toothbrush. Carefully inspect for missed joints, solder bridges, and cold solder joints. Check again for misplaced components . . .now is the time to correct all errors. Note that Q1, the Photo-transistor, has not been installed yet. It will be installed later.

( ) Pass the wires through the hole in the PC board.

( ) Temporarily mount the two "L" brackets to the PC board with the two 4-40 X 1/8" screws. The screw heads are on the component side of the board and they screw into the threaded portion of the "L" bracket on the other side of the board. . .position the bend on the edge with the rest of the bracket going away from the board. Refer to Figure 2 for help. Snug up the screws.

( ) Set the board on edge and check that both brackets are close to 90 degrees in relation to the board. If not, remove one or both of the brackets and correct with a pair of pliers. If this step is not done, it is possible to tear one of the circuit lands when the board is installed due to warpage. Now check that both brackets and the edge of the board are even and re-tighten the screws.

( ) Refer to Figure 2 for the following steps.

( ) The SW1 slide switch and SW2 push switch are installed at one time. Begin by removing the nut off the SW2 push switch and leaving the lockwasher on the switch. Insert the switch into the switch bracket as shown in Figure 2. Place the 7mm flat washer on the SW2 push switch then insert the SW1 slide switch into the bracket. Insert the push switch and slide switch through their holes in the faceplate and secure this assembly using the SW2 switch nut. After tightening the SW2 switch nut securely, position the switch bracket so the bat of the switch will not rub on the case when the SW1 slide switch is moved. Install the PLA381 slide switch topper over the switch bat.

( ) Remove the two screws from the meter terminals and install a No. 6 solder lug as shown in Figure 2. Before retightening the meter terminal screws, look at the meter faceplate to make sure the solder lugs are pointing toward the bottom of the meter. Then tighten the meter terminal screws.

( ) Install the meter into the front of the case and secure by installing the washer, lockwasher and nut provided: do this on the lower right-hand mounting bolt only. Look at the front of the case and make sure that the meter has not been installed upside down.

( ) Install the No. 6 solder lug over the lower left-hand mounting bolt; and then secure with the washer, lockwasher, and nut provided. Do not install the washer, lockwasher, and nut on the top mounting bolts at this time.

( ) Install the battery bracket in the bottom of the case using 2-56 X 3/16" Flat Head screws and nuts. Tighten securely.

( ) Install the rubber grommet in the small round opening in the top of the case. Wetting the grommet will aid insertion.

( ) Install but DO NOT SOLDER Q1 (Photo-transistor) in the PC board. Make sure the small tab on the body is oriented as shown in Fig. 1, the Overlay drawing. DO NOT SOLDER YET.

( ) Mount the PC board in the case by slipping the angle brackets down over the meter posts. Secure the board in the case by threading the remaining nuts and lockwashers onto the posts. Do not install the flat washers because they are too large to fit on the "L" brackets. Use a small needle-nosed pliers to tighten all four meter mounting nuts.

( ) Now wet the end of Q1, the Photo-transistor, and carefully insert it into the grommet in the top of the case. Push it in until there is just enough lead left protrudng through the PC board to solder (about 1/16").

( ) Carefully solder the three Photo-transistor leads to the PC board while everything is installed in the case.

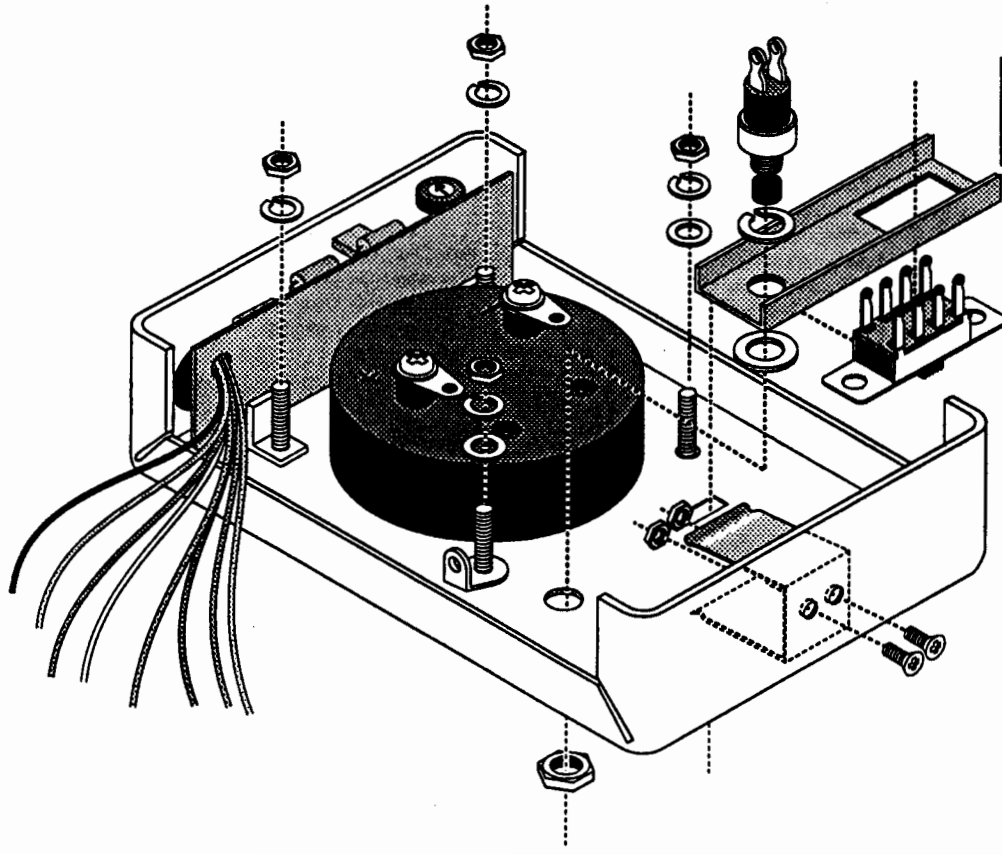
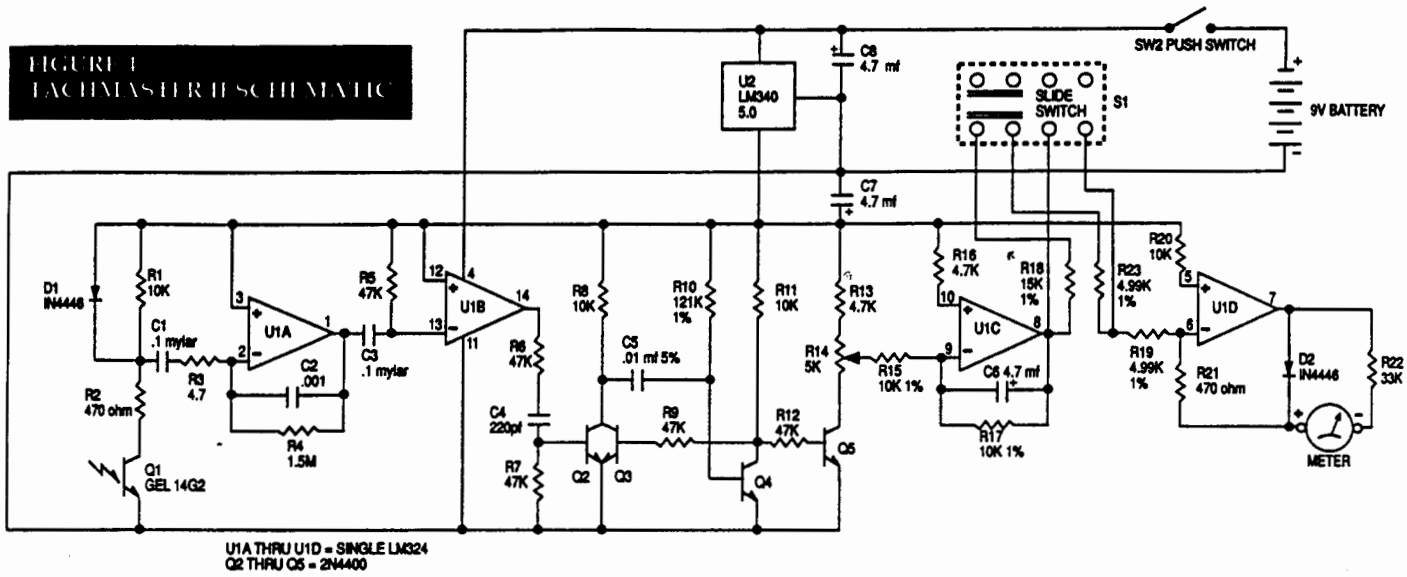


FIGURE 2
MECHANICAL
ASSEMBLY

FIGURE 1
TACHMASTER II SCHEMATIC



IX. CIRCUIT DESCRIPTION

The Tachmaster II falls into the category of optical tachometers. What this means is that the RPM of the engine is measured by detecting the light fluctuations caused by sunlight being reflected off of the revolving propeller. To do this electronically, we first start by devising a scheme to detect these reflections and this is done by using a device called a Photo-transistor. For those of you who are not electronically inclined, let's take a moment to briefly explain the prinicipal of how any transistor works, and how it applies in our application of detecting these light reflections. Any transistor operates in a fashion comparable to that of an ordinary light dimmer in your home. When you turn the knob of the dimmer, you change the intensity of the light in the room. In a transistor you change the ability of its emitter-collector junction to conduct current by changing the amount of current injected into its base. We control the transistor at its base, as we control the light dimmer with a knob. These are the three terms (base, emitter, and collector) associated with the typical three leads protuding from the transistors body. The ratio of how much current the emitter-collector junction carries versus the injected base current is called Gain. If we defined the Gain of a particular transistor to be 100, then if we inject 1 ma of current into the base, then the current flowing in the emitter-collector junction would be 100 ma, under proper conditions. The ability of a Photo-transistor to conduct current is altered so that instead of injecting electrical current into the base, we use light directed straight onto the "chip" which is the heart of the transistor. You can see this chip by looking into the top of the Photo-transistor. Therefore, by changing the intensity of the light falling on the chip we can change its ability to conduct current. This provides an excellent scheme of detecting the reflected light off of our propellers. While our human sight system only detects a transparent disc as the propeller revolves, the Photo-transistor reacts with a change in emitter-collector current each time a propeller blade passes in front of it, due to the change in light intensity. This current change is very small and must be amplified in order to reach a usable amount which can be used by the rest of the circuitry to decide whether the prop blade is in front of the Photo-transistor or not. This is accomplished by one of the four operational amplifiers in the LM324. The small light fluctuations detected are amplified about 250 times by this amp. The output is fed directly to the second amplifier connected as a comparator. This amp compares a voltage present on one input to the voltage on the other. One of the inputs is tied to the 5.0 volt reference/supply line. Therefore, if the other input should rise above or fall below this voltage the output of the amplifier will change accordingly. In this manner, we can make a very decisive decision whether or not the propeller blade is in front of the Photo-transistor or not. Also in the scheme, we have decided that for every two passes of the prop blade we will count them as only one, so that the rest of the circuitry is not fooled into doubling the actual RPM. This second decision making amp then fires a mono-stable multivibrator which produces one output pulse of about 800 micro-seconds for every revolution of the prop. This circuitry is composed of Q2, 3, and 4, and the associated components of resistors and capacitors. The third operational amplifier is connected to produce an output voltage which is an average of the number of pulses it receives from the mono-stable multivibrator. This voltage when flowing through the two 1% resistors (range select) appears as a definite current flowing into the fourth op amp. This amp drives the meter with current proportional to the current flowing through the precision resistors. The end result is a meter reading that is deadly accurate in respect to the actual RPM.

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