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A Maxcess International Company

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INSTRUCTION MANUAL MODEL U-TRAC CONTROL

850A40 - 1
7/87

I. INTRODUCTION

The MAGPOWR® U-TRAC Tension Readout and Control System is a closed loop, feedback system designed to measure and control the tension on any moving web. It may be used in unwind, rewind, or point-to-point tension control applications. The system consists of one or two MAGPOWR tension sensor(s), a MAGPOWR Model U-TRAC controller, and a drive capable of using one of the U-TRAC output signals. For best results, the drive should be configured so the **torque** is proportional to the U-TRAC output. One way to do this is to operate the drive in torque mode. Another is to use the U-TRAC to trim a drive which has a speed control loop which is holding shaft speed at approximately the correct speed for the present roll. Tension sensors can be located at any position where the wrap angle of the web does not change. The path of the web around the sensing roll need not be vertical, as the sensors read only the force component of the tension in the "up and down" plane as indicated by the arrow on the coupling.

In wide web applications a pair of Model TS or TSU sensors are used on any nondriven idler roll. The sensors are mounted on both sides of the machine and support the idler roll.

For single strand applications, the idler "roll" is the sensing sheave of the Model SSTS sensor.

II. INSTALLATION

All user connections are made on TB1 terminal block. TB1 can be unplugged from the PCB to ease wiring. Unplug by sliding TB1 towards the edge of the PCB.

Various options are available by moving or cutting jumpers on the 3D100 PCB. See Figure 1 for jumper locations. Normal positions are:

J4	Movable jumper 9-10.
J7	Movable jumper 1-2.
J11	Movable jumper 2-3.

J10 OUTPUT SELECTION

One of the four outputs is selected by moving jumpers on J10. Either polarity is available since the output is isolated from the input and control circuitry.

OUTPUT SELECTED	J10 MOVABLE JUMPER
0 to 10 VDC or 10 to 0 VDC	3-10, 6-7
1 to 5 VDC or 5 to 1 VDC	1-12, 6-7
4 to 20 mADC or 20 to 4 mADC	4-9, 5-8
−10 to +10 VDC	2-11, 6-7 Also cut J13 for −10VDC to +10VDC

J1, 2, 3, 6, 8, 9, 12, 13, 14, 15 are wire jumpers on the 3D100 PCB.

The following options can be used with no additional internal hardware:

Single strand	Cut J1.
Reverse acting	Move jumper on J11 to J11 (1-2)
Taper tension	Cut J6.
Automatic soft start	Add external contact from TB1-10 to TB1-11 (continuous contact, close with motor stop/open with motor start). When clutch is used on rewind this refers to the motor that drives the clutch.
External tension meter	Cut J14 and add external meter (1 mAdc) between TB1-6(+) and TB1-7(−).
Remote tension ON/OFF or rewind E-Stop	Cut J15 and add external contact between TB1-8 and TB1-9 (open for tension OFF or rewind E-STOP).
Slower start time	Cut J12.
Hold level varies with AUTOMATIC TENSION pot	Move Jumper on J4 to J4 (8-9).
Hold level varies with MANUAL TENSION pot	Move jumper on J7 to J7 (2-3).

1. Mount the enclosure in a protected area with a temperature range of 0-40 deg. C (32-104 deg. F).

   NOTE: All external electrical connections should be made through conduit or through sealing type cord connectors to prevent contamination of the low level circuits on the 3D100 PCB which could reduce system accuracy.

2. After installing tension sensor(s) per sensor instruction manual, connect leads to the appropriate terminals (14 thru 17) per Figure 1. For two sensor applications the sensors are wired in parallel (both GRN wires to 14, both RED wires to 15, etc.). For single strand applications cut jumper J1 on 3D100 PCB.

3. Power lines must be 115 VAC, 50/60 Hz, single phase. Connect line to terminals 1 and 2.

   IMPORTANT — NOTE: If one of the incoming leads is at ground potential, connect it to terminal 2. Ground the enclosure at the ground post connected to terminal 3. Do not remove ground wire connected to terminal 3. Route power leads as far as possible from sensor leads and from PCB. Inside enclosure twist power leads.

4. Connect load between TB1-4 and TB1-5.

5. A soft start feature is included in the U-TRAC that is required for proper tension control. Connect an external RUN/STOP contact between TB1-10 and TB1-11 (continuous contact, open for run/close for stop).

6. Mechanically zero the front panel TENSION pot.

7. Select the desired output by installing movable jumpers on J10 per the above table.

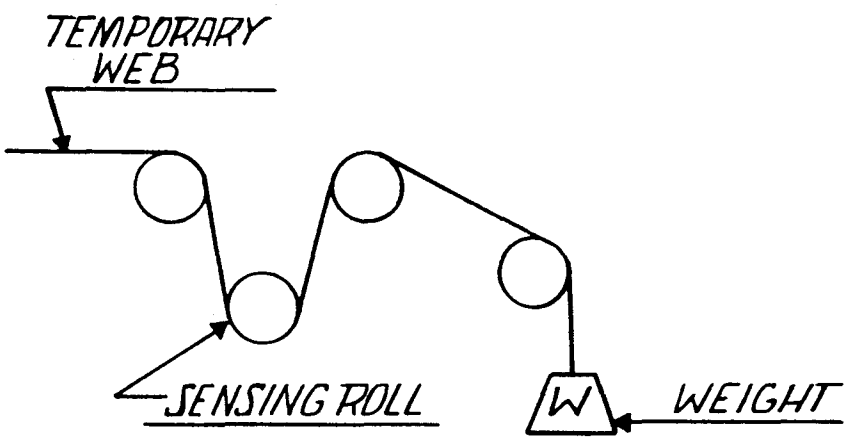
8. Proceed with calibration.

III. CALIBRATION (See figure 1 for PCB control locations).

Tension Readout calibration is accomplished by two adjustments ZERO and GAIN. The ZERO adjustment is used to cancel the weight of the sensing roll so that the meter reads "0" with ZERO tension. The ZERO adjustment is therefore made with the sensing roll unloaded (i.e., without web on the sensing roll).

The GAIN adjustment is made with a known load on the sensing roll. The known force may be applied using an accurate spring scale or (more accurately) a dead weight as shown below. In either case, the temporary web should be threaded as the web would normally be threaded in the machine to insure the same wrap angles.

In wide web applications, the known force should be applied near the center of the sensing roll using a narrow web (a rope is satisfactory).



Apply 115 VAC power.

NOTE: Unless otherwise noted, all adjustments are on the main 3D100 PCB. Some controls are 22-turn pots which may require many turns to make the adjustment. These pots have clutches and cannot be damaged by full CW or CCW rotation. Full CW or CCW rotation causes a faint clicking sound.

TENSION READOUT CALIBRATION

Unload sensing roll. Adjust 22 turn ZERO pot for zero meter reading.

Load the sensing roll. Adjust 22 turn GAIN pot for a meter reading equal to the applied load in percent of full scale.

OFFSET ADJUSTMENT

Normal acting mode. Adjusted at factory for 4 mADC on 4 to 20 mADC output.

Set TENSION ON/OFF switch to OFF.

Adjust OFFSET for the appropriate output between TB1-4 and −5 (0 VDC for 0 to 10 VDC and ±10 VDC, 1 VDC for 1-5 VDC, and 4 mADC for 4-20 mADC).

Go to STABILITY Adjustments.

Reverse acting mode (Do not use for −10V to +10V).

Move jumper on J11 to J11(1-2).

Set AUTOMATIC/MANUAL switch to MANUAL.

Set TENSION ON/OFF switch to ON.

Set the MANUAL TENSION pot full CW.

Adjust OFFSET for the appropriate output between TB1-4 and −5 (0 VDC for 0 to 10 VDC, 1 VDC for 1 to 5 VDC, 4 mADC for 4 to 20 mADC).

STABILITY ADJUSTMENTS

NOTE: OUTPUT LIMIT and START TIME pots can prevent proper adjustment by limiting maximum torque. If in doubt, set OUTPUT LIMIT full CW and START TIME full CCW.

NOTE: When asked to optimize a control in the following steps: Slowly rotate that control CCW until oscillations occur. Then rotate that control CW until the oscillations cease. If oscillations do not occur with full CCW rotation, then full CCW rotation is optimal.

NOTE: The response controls have been intentionally put into their most stable positions to insure that oscillations will not occur during the initial operation in AUTOMATIC mode. The tension errors will therefore correct very slowly when the AUTOMATIC mode is first used.

STABILITY ADJUSTMENTS WITHOUT TAPER TENSION

For initial set-up, set:
- START TIME pot full CCW.
- STOP LEVEL pot full CCW.
- OUTPUT LIMIT pot full CW.
- 22-turn STAB pot full CW.

Set COMP pot full CW.
Set TAPER pot full CCW.
Set ERROR LIMIT pot full CW.
Operated the machine at a slow speed using the MANUAL start procedure.

MANUAL START PROCEDURE

Start the machine in MANUAL mode using the MANUAL TENSION pot to obtain the desired web tension.

Set the AUTOMATIC TENSION pot to the setting that matches the TENSION reading (1/4 rotation for 1/4 meter deflection, etc.).

Set the AUTOMATIC/MANUAL switch to AUTOMATIC.

Tension is now set by the AUTOMATIC TENSION pot.

With the unwind/rewind near full roll, optimize the STAB control.

After optimizing the STAB control, optimize the COMP control with the unwind/rewind near core.

Optimize the ERROR LIMIT control (full CCW rotation is often optimal).

If oscillations occur after the initial set-up:
Rotate ERROR LIMIT CW until the oscillations cease.

If unsuccessful, rotate COMP CW until the oscillations cease and then optimize ERROR LIMIT.

If full CW rotation of the ERROR LIMIT and COMP pots does not eliminate the oscillations:
Rotate STAB CW until oscillations cease.
Then optimize COMP with the unwind/rewind near core.
Then optimize ERROR LIMIT.
Go to OUTPUT LIMIT ADJUSTMENT.

STABILITY ADJUSTMENTS WITH TAPER TENSION

For initial set-up, set:
START TIME pot full CCW.
STOP LEVEL pot full CCW.
OUTPUT LIMIT pot full CW.
22-turn STAB pot full CW.
Set COMP pot full CW.
Set TAPER pot full CCW.
Set ERROR LIMIT pot full CCW.
Operated the machine at a slow speed using the MANUAL start procedure.

MANUAL START PROCEDURE

Start the machine in MANUAL mode using the MANUAL TENSION pot to obtain the desired web tension.

Set the AUTOMATIC TENSION pot to the setting that matches the TENSION reading (1/4 rotation for 1/4 meter deflection, etc.).

Set the AUTOMATIC/MANUAL switch to AUTOMATIC.

Tension is now set by the AUTOMATIC TENSION pot.

With the unwind/rewind near full roll, optimize the STAB control.

After optimizing the STAB control, optimize the COMP control with the unwind/ rewind near core.

If oscillations occur after the initial set-up:
Set TAPER POT FULL CCW.
Rotate COMP CW until the oscillations cease.
If full CW rotation of the COMP pot does not eliminate the oscillations:
Rotate STAB CW until oscillations cease.
Then optimize COMP with the unwind/rewind near core.
Readjust TAPER as required.

OUTPUT LIMIT ADJUSTMENT (Do not use with −10 VDC to +10 VDC output)
(optional, normally full CW)
(Affects HOLD LEVEL, see below)

If in MANUAL mode, switch to AUTOMATIC mode.
Run the machine at maximum tension and with the unwind/rewind near full roll.
Rotate the OUTPUT LIMIT pot CCW until the tension just begins to decrease.

START/STOP ADJUSTMENTS

STOP TIME: (Factory set at approximately 10 seconds).
(Affects START TIME, see below).

Description: When the "stop" signal is received by the U-TRAC while in AUTOMATIC mode (TB1-10 is shorted to TB1-11 by an external stop contact), the U-TRAC goes into a STOP mode. The STOP TIME pot determines how long the U-TRAC stays in STOP mode before switching to HOLD mode.

Set STOP TIME to be slightly longer than the time taken for the machine to stop (CW rotation increase STOP TIME. Range is 0.5 to 60 seconds).

Measure STOP TIME as follows (web not needed):

Open TB1-10/TB1-11 (Open STOP contact).

Wait for a length of time equal to 10% of STOP TIME (If J12 is cut, the wait must equal the STOP TIME).

Short TB1-10 to TB1-11 (Close STOP contact).

STOP TIME equals the time taken for the HOLD MODE LED to come ON.

START TIME: (Readjust if STOP TIME setting is changed).
(Only needed if machine is started with slack in web).

Description: Adjusts the start ramp which limits how fast output can be applied following start (Normal range—adjustable up to 10% of STOP TIME. Adjustable up to 100% of STOP TIME by cutting J12).

Stop the machine and wait for the HOLD MODE LED to come ON.

Set HOLD LEVEL pot at the minimum running output level.

If initial set-up, turn START TIME pot full CCW.

Start the machine in AUTOMATIC mode.

Increase START TIME setting if a high tension transient occurs at start.

If full CW rotation of START TIME is not sufficient, cut J12 and begin adjustment again with START TIME full CCW.

HOLD LEVEL: (Readjust if OUTPUT LIMIT setting is changed).

Description: Following the delay set by the STOP TIME pot (see above), the U-TRAC enters HOLD mode in which output is set by the HOLD LEVEL pot.

Adjust with the machine stopped in AUTOMATIC mode.

Wait for the HOLD MODE LED to turn ON.

Normally set at the minimum running output level. If set too high, a high tension transient may occur at start.

Normally HOLD LEVEL is the only control which affects this output [jumpers on J4 (9-10) and on J7 (1-2)].

OPTIONAL CONFIGURATIONS FOR HOLD LEVEL:

Hold level varies with AUTOMATIC TENSION pot (Best for point-to-point systems).

Move jumper on J4 to J4 (8-9).
Operate the machine near core using MANUAL START procedure above.

Switch to AUTOMATIC mode.

Set tension near the highest tension to be used.

Set HOLD LEVEL full CW.

Stop the machine slowly so that tension stays constant during stop.

Rotate HOLD LEVEL slowly CCW until tension just begins to decrease.

Hold level varies with MANUAL TENSION pot.

Move jumper on J7 to J7 (2-3).

Set HOLD LEVEL full CCW.

U-TRAC now starts in MANUAL and switches immediately to AUTOMATIC.

STOP LEVEL (unwinds only):

Description: When the system first receives the "stop" signal, it increases the output to help stop the unwind roll. The amount of increase is adjusted by the STOP LEVEL pot. Adjustable up to 3:1 increase.

While running at maximum speed near full roll press the stop button.

If the unwind roll does not stop fast enough, increase the STOP LEVEL setting and repeat.

If oscillations occur during stopping but not otherwide, rotate STAB CW to eliminate the oscillation.

TAPER ADJUSTMENT
(optional, rewinds only)

Description: Taper is sometimes used on rewinds to make the tension decrease while the roll diameter increases. On the U-TRAC, taper can be measured only by comparing full roll tension with core tension. Large taper means that a large decrease in tension occurs.

Taper is increased by rotating the TAPER pot CW.

ERROR LIMITING cannot be used with taper. Set ERROR LIMIT full CCW.

If oscillations occur, stabilize by rotating STAB CW.

IV. ADJUSTMENT AND SWITCH DESCRIPTION

Front Panel:

POWER ON/OFF switch	Applies power to entire U-TRAC.
TENSION ON/OFF switch	Drives output to the OFFSET level independent of all other controls (Zero in normal acting mode. Full on in reverse acting).
AUTOMATIC/MANUAL switch	Switch between AUTOMATIC and MANUAL modes. Manual mode overrides all automatic controls.
AUTOMATIC TENSION CONTROL	Controls tension in AUTOMATIC mode. Full CCW to full CW rotation commands 0 to 100% tension. Inoperative in manual mode.
MANUAL TENSION CONTROL	Controls output in manual mode. Full CCW to full CW rotation commands zero to rated output. Inoperative in AUTOMATIC mode.

INTERNAL:

ZERO	Nulls the dead weight of the idler roll. The adjustment range is 50% of load cell rating. If two 500 lb. sensors are used, 250 lb. per sensor can be nulled. Since each sensor supports 1/2 the roll weight, a total dead weight of 500 lbs. can be nulled.
GAIN	Provides full scale calibration of the system. The range of gain adjustment is 8:1. The tension meter can be made to read full scale for loading of the sensors from one-eighth of their rating to full rating. Therefore, with two 500 lb. sensors, full scale meter deflection (10 volt output) may be obtained with a minimum individual sensor loading of 62.5 lbs. or a maximum individual sensor loading of 500 lbs. (total loading of 1000 lbs.). NOTE: This is not web tension. The web tension may be higher than this depending on the wrap angle.
OFFSET	Adjusts the output which occurs when TENSION ON/OFF is set to OFF.
ERROR LIMIT	Adjusts the maximum error that can be applied to the integrator. This limits the response to large transients without affecting the response to small transients. The adjustment range is 10% to 100% of maximum error.
COMP	Adjusts the proportional feedback which improves the response of the system.
STAB	Adjusts the integrator time constant. This is the basic stability control of the U-TRAC.

STOP TIME	When the "stop" signal is received by the U-TRAC while in AUTOMATIC mode (TB1-10 is shorted to TB1-11 by an external stop contact), the U-TRAC goes into a STOP mode. The STOP TIME pot determines how long the U-TRAC stays in STOP mode before switching to HOLD mode.
HOLD MODE LED	Lights when the U-TRAC enters HOLD mode following the STOP TIME.
START TIME	Normally only needed if slack is in the web during start. Adjusts the start ramp which limits how fast output can be applied following start (Normal range—adjustable up to 10% of STOP TIME. Adjustable up to 100% of STOP TIME by cutting J12).
HOLD LEVEL	Adjusts output during HOLD mode. Following the delay set by the STOP TIME pot (see above), the U-TRAC enters HOLD MODE. Normally HOLD LEVEL is the only control which affects this output [jumpers on J4 (9-10) and on J7 (1-2)]. OPTIONAL CONFIGURATIONS: **Hold level varies with AUTOMATIC TENSION pot** (Best for point-to-point systems). Move jumper on J4 to J4 (8-9). Leave jumper at J7 (1-2). **Hold level varies with MANUAL TENSION pot.** Move jumper on J7 to J7 (2-3). HOLD LEVEL must be full CCW. U-TRAC now starts in MANUAL and switches immediately to AUTOMATIC.
STOP LEVEL	For unwinds only, the output momentarily increases to compensate for roll inertia while maintaining closed-loop control. The output increase is adjustable up to a ratio of 3:1.
OUTPUT LIMIT	Limits the maximum output of the PCB. Adjustable from zero to 100% of span.
TAPER	Adjusts the amount that tension decreases with increasing roll diameter. With full CCW rotation, tension is constant (zero taper). Taper at full CW rotation depends upon the percent of span needed for full scale tension and upon build ratio. Up to 50% taper is available with large build *ratios. For TAPER to work properly torque must be zero* when the output is minimum (i.e. – 10VDC for – 10 VDC to + 10 VDC, 1 VDC for 1 VDC to 5 VDC, etc.).

V. THEORY OF OPERATION

The MAGPOWR U-TRAC Tension Readout and Control System consists of one or two MAGPOWR tension sensor(s), a MAGPOWR Model U-TRAC controller, and a drive capable of using one of the U-TRAC output signals.

Each tension sensor contains four foil-type strain gages in a full Wheatstone bridge configuration. These gages convert the load on the sensor to an electrical signal. Within the U-TRAC, the signals from the sensors are averaged and amplified. By averaging the load of both sensors, the true total tension is measured, no matter where the web is situated on the roll. Thus, wide or narrow webs may be run in the center of the roll, or to either side, and the U-TRAC will still read and control true total tension.

The total tension signal is compared to the set point of the front panel AUTOMATIC TENSION control, and the difference is applied to the exclusive Triple Mode compensation circuits. This compensation method allows for the use of the U-TRAC in a wider range of applications then would otherwise be possible. The output of the compensation circuits is applied to the power amp through an opto-isolator.

CLOSED LOOP START UP — The U-TRAC has circuits designed to eliminate the high tension transient inherent in starting the web in all closed loop, feedback tension control systems. When the process is stopped, errors between actual and desired tension **cannot** be corrected, but such errors invariable occur; i.e., the web relaxes slightly. The controller sees this error and attempts to correct it by commanding higher output. Since the tension cannot change without web movement, the controller and drive eventually end up in their full on state. When the web again begins to move, a very high tension transient occurs which can break the web. U-TRAC has two means available to avoid this transient — MANUAL mode and automatic HOLD mode.

MANUAL START — The most obvious way to avoid this transient is to start the process in MANUAL mode and then switch to AUTOMATIC. Many closed loop systems have a manual mode, but few have one that is useful for this purpose because the MANUAL mode drives the output circuits rather than the compensation circuits. Any difference between the manually controlled tension and the closed loop set point tension will drive the compensation circuits either full on or full off. When the system is switched to AUTOMATIC mode, a large tension transient (high or low) occurs until the compensation circuits settle to their proper output.

The U-TRAC MANUAL mode drives the compensation circuits directly. Differences between the manually controlled tension and the set point tension results in a smooth transition from one to the other just as if the set point had been readjusted. Note that the operator will have to readjust the MANUAL TENSION control for varying tensions and diameters. This can be avoided by using automatic HOLD mode.

HOLD MODE — Automatic HOLD mode is actuated when the user supplied "stop" contact is closed, shorting TB1-10 to TB1-11. On rewinds this contact should be closed when the rewind motor is commanded to stop. On unwinds it should be closed when the main drive is commanded to stop.

When the "stop" signal is received, the U-TRAC first goes into STOP mode and then automatically switches to HOLD mode. The length of time spent in STOP mode is adjusted by the STOP TIME pot which has an adjustment range of 0.5 seconds to 60 seconds. During STOP mode the U-TRAC is still in AUTOMATIC mode, and it is still controlling the output to keep the tension equal to the tension set by the AUTOMATIC TENSION control. The U-TRAC can be adjusted to increase the output to help stop unwind rolls. The amount of increase is proportional to the running output and is adjusted by the STOP LEVEL pot. Adjustment range is up to 3:1 increase.

When the U-TRAC enters HOLD mode, a HOLD MODE LED on the 3D100 PCB comes on; and the output is commanded to the hold level (adjusted by the HOLD LEVEL pot). When the web again starts moving, the output is being held at the hold level and the large tension transient does not occur.

In HOLD mode the output is normally controlled only by the HOLD LEVEL pot. The HOLD LEVEL pot is normally set at the minimum running output level. Two optional configurations are available with no additional internal hardware.

Hold level varies with the AUTOMATIC TENSION pot [Obtained by moving the jumper on J4 to J4 (8-9)]. This is particularly useful on point-to-point tension control systems. Since there is no changing roll radius to change the torque required, hold level will be approximately equal to running level even if the AUTOMATIC TENSION control is readjusted.

Hold level varies with MANUAL TENSION control [Obtained by moving the jumper on J7 to J7 (2-3)]. This could be useful if the hold level needs to be frequently readjusted. The U-TRAC is effectively in MANUAL mode at start and immediately switches to AUTOMATIC mode.

REMOTE TENSION OFF OR REWIND E-STOP — At times the hold level will be adjusted too high to turn the roll manually in order to change rolls, take up slack, etc. The output can be turned off using the front panel TENSION ON/OFF switch or a remote tension off switch can be located at the rewind/unwind roll. This remote switch should be connected between TB1-8 and TB1-9 (Cut J15 to use this option). Tension is turned off by opening the contact. If more than one remote switch is needed, the switches should be in series. All switches must be closed to command output and to maintain tension control.

Emergency stop is another instance in which it is desirable to turn off the output. During E-Stop the web tension must stop the rewind roll in the time it takes the web to stop. With large inertia rolls this could break the web. Turning the output off will not help stop the roll, but it will prevent the output from adding to the tension. The E-Stop contacts should be in series with remote tension off switches (if used) and should be closed during normal operation (Cut J15 to use this option).

VI. SPECIFICATIONS

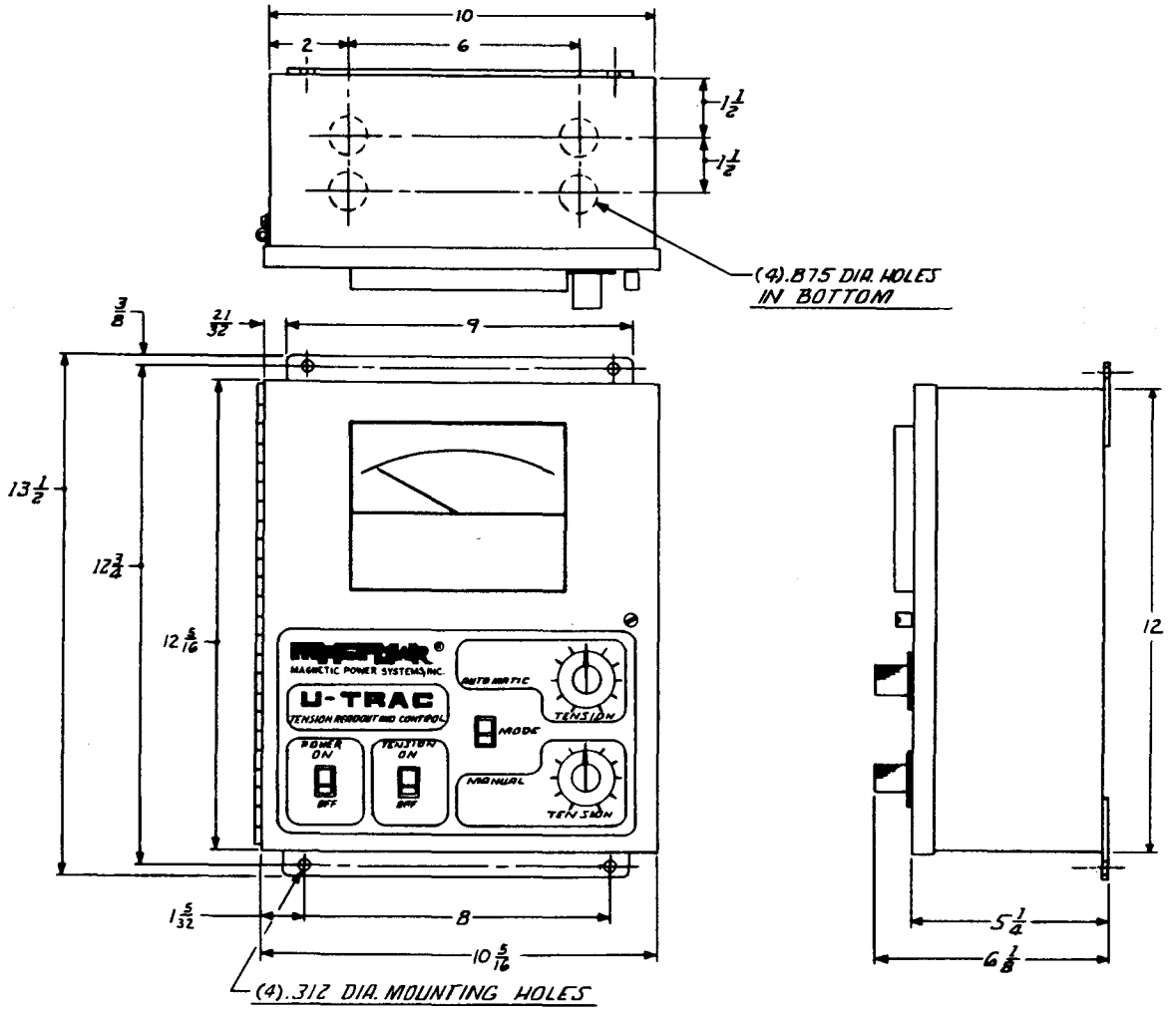
Overall System Accuracy	±2% of Full Scale maximum at minimum gain. ±5% of Full Scale maximum at maximum gain.
Sensors — TS, TSU & SSTS	
Gage Resistance	350 Ohms
Excitation Voltage	10 VDC nominal
Output Signal	21MV nominal per sensor
Operating Temperature	−30° to 95° degrees C
Temperature Effect on Zero	.02% of rating per C degree
Combined Non-Linearity and Hysteresis	.5% of Full Scale maximum
Repeatability	.2% of Full Scale maximum
Overload Stops	Internal, at 105 ot 150% of full load rating
Deflection at Full Load	Model TS & SSTS .10 in., 5, 15, and 50 lbs. .007 in., 150 lbs. .006 in., 500 lbs. Model TSU .012 in., all sizes .012

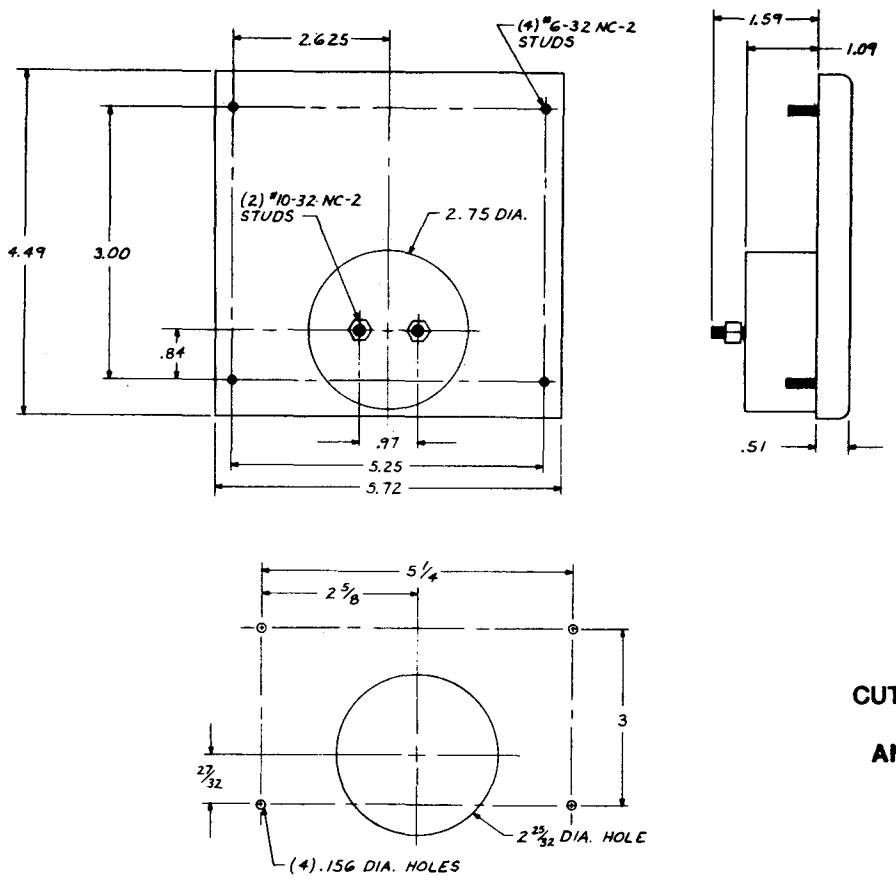
U-TRAC

Tension Meter	4″ by 6″ Pivot and Jewel Sealed Meter 0% to 100% standard	
Input Power	115 VAC 10%, 50/60 Hz, 150 VA	
Output	Corrective signal: (in either polarity, as output is isolated	0 to 10 VDC, 4 to 20 ma 10 to 0 VDC, 20 to 4 ma −10 to +10 VDC, 1 to 5 VDC 5 to 1 VDC
Tension Sensor Excitation	±5 VDC	
Temperature	0° to 40°C Operating −30° to +65°C Storage	
Weight	16 lbs.	
Zero Adjust	50% of sensor rating	
Gain Range	8 to 1	

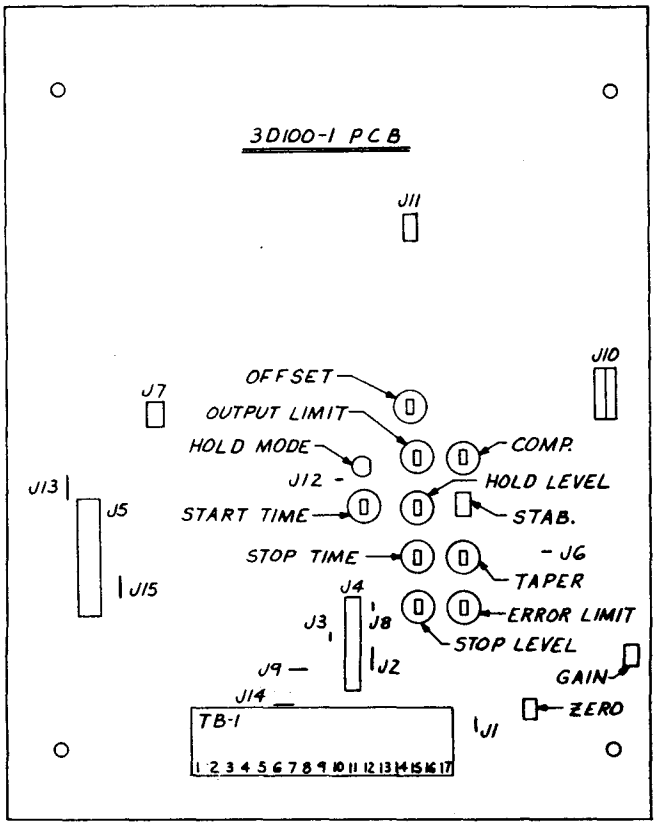
VII. U-TRAC REPLACEMENT PARTS LIST

DESCRIPTION	MPS PART NO.
Readout/Control PCB	3D100-1
Meter, Analog (0-100%)	9A22-1
Switch; POWER ON/OFF	8A36-1
Switch; TENSION ON/OFF, AUTO/MAN	8A37-1
Pot; Tension, Manual	21A2-12
Knob, Pot	5A114-1
Sensor Cable (15 ft.)	350B19-1
Sensor Cable (20 ft.)	350B19-2





CUTOUT REQUIRED FOR ANALOG METER


3D100-1 PCB
J11
J10
J7
OFFSET
OUTPUT LIMIT
HOLD MODE
COMP.
J12
HOLD LEVEL
J13
J5
START TIME
STAB.
STOP TIME
J6
TAPER
J15
J4
J3
J8
ERROR LIMIT
STOP LEVEL
J9
J2
GAIN
J14
ZERO
TB-1
J1
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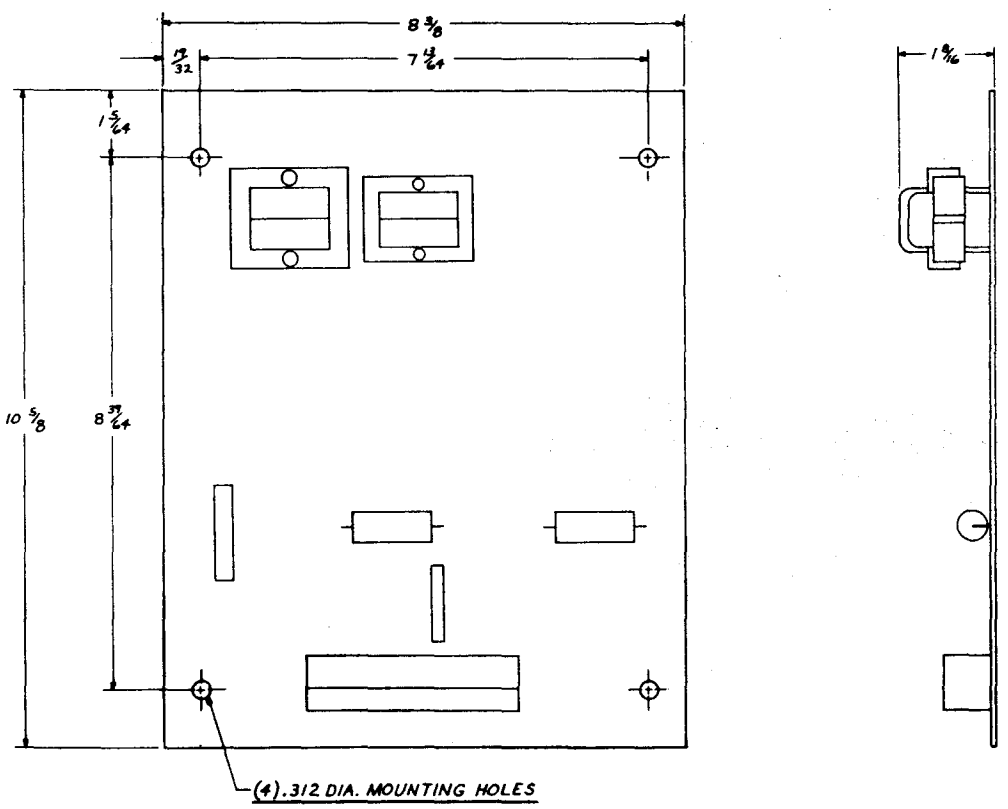
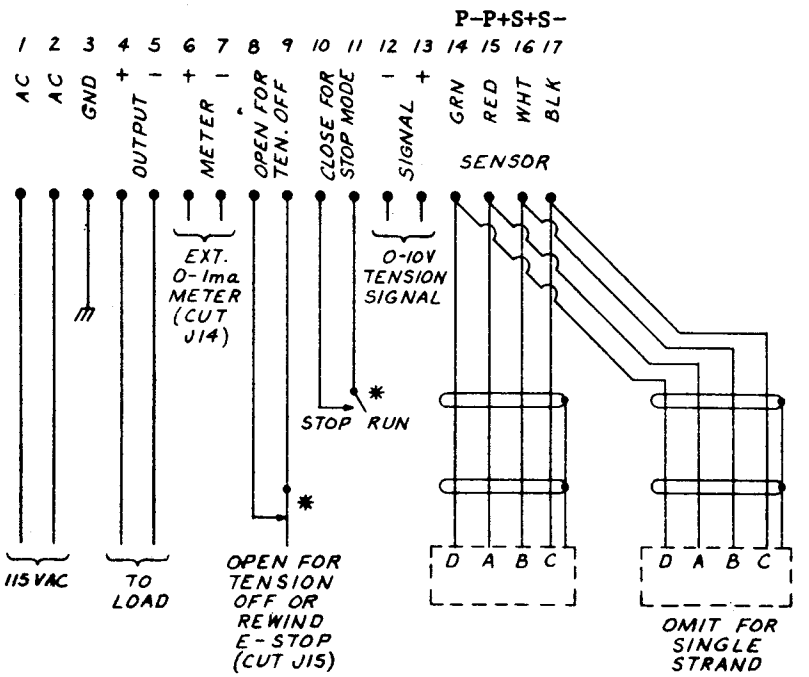

8 3/8
7 13/64
1 5/64
10 5/8
8 37/64
1 9/16
(4).312 DIA. MOUNTING HOLES

TB-1
electrical
connections



✱ – USER SUPPLIED CONTACT

J-5
electrical
connections