TEKTRONIX®

MEDICAL MONITOR TEST UNIT

067-0706-99

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ADDENDUM TO TEST UNIT CAL PROCEDURE

The following test unit procedure was written for an unmodified 408/412/414 test unit. After the test unit is modified to accomadate the 413, you will still be able to use this procedure. All adjustments are physically in the same approximate location and should be adjusted as per the procedure.

The "Pressure" amplitudes are different then those indicated, but can be attained by pushing any number of buttons together to add to the total necessary. One switch on top of the Press/Pulse test board will give you the 25 mmhg offset needed for the 413, 25-75 mmhg range. The other switch will give you 59 mmhg offset, in anticipation of a future offset range. The switches should be returned to zero for all other ranges and medical monitors.

The ECG test board has three new switches at its top. The slide one provides selection of the ECG input window, ±250 mV for 413's and ±100 mV for all older medical monitors. The two momentary switches provide selection of respiration source inpedance. Both up is the normal calibration impedance of 750 Ω, one in gives you zero ohms and the other one in gives 1.5 kΩ. Both in will result in respiration lead fault only.

CALIBRATION FIXTURE: 067-0706-99
408/412 TEST UNIT
INSTRUCTION MANUAL

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Manual by
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SECTION 1
408/412/414 TEST UNIT DESCRIPTION

General

The test unit is designed to facilitate the test and calibration of a completed monitor, and to functionally test the individual plug-in boards for the monitor. In the first mode, the unit supplies input signals to the monitor and measures leakage currents. As an individual board tester, the unit supplies input signals and power to the board under test, and monitors output signals to verify board functioning.

The unit contains no batteries and will operate on 115/230 VAC power within the same limitations as the monitor. Construction is almost identical to the 412 in that the same mechanical package, main circuit board, CRT, power supply, and plug-in system are used. The main differences are the front and rear panels, the plug-in test boards, and the top opening to accept the boards under test.

Calibration of the test unit itself is fairly simple and does not need to be a process traceable to NBS. Parameters critical to monitor calibration are controlled either by standard test instruments used with the test unit or by precision resistors in the test unit.

Controls and Indicators

POWER ON SWITCH	Energizes entire test unit.
MAINS POLARITY LAMP	When ON, indicates that AC mains are correctly connected to test unit.
POWER ON TO UNIT UNDER TEST	Applies mains power to monitor connected to rear panel AC power connector.
POLARITY TO UNIT UNDER TEST	Controls polarity of AC mains to rear panel AC connector.
SWEEP SPEED	Controls CRT sweep display.
DISPLAY OFFSET	Applies OTHER–CHANNEL–ON signal to ECG or PRESS/PULSE board under test to check automatic display positioning circuits. OUT position connects ECG and PRESS/PULSE boards as in the 412 so that positioning is automatic; no board plugged in is sensed as OTHER–CHAN–OFF.
LEAKAGE	Applies output of line leakage amplifier to CRT display. OUT position allows automatic delection of ECG or PRESS/PULSE display (or both) according to which board is plugged in.

RATE ON	Activates BPM rate generator; HZ RATE output is always running independently of this switch.
PRESS/PULSE SELECTOR SWITCH	Determines the state of balance of resistance bridge connected to PRESSURE input of unit under test. Activates PULSE SENSOR signal simulator when in any other than ZERO position. 25, 50, 150, 250 – Unbalances bridge with square wave of magnitude indicated (equivalent to mm Hg for a pressure transducer). Referenced at zero. LIMITS TEST – Unbalances bridge with square wave, not referenced at zero, for checking pressure limits of the monitor. Simulates pressure waveform with SYSTOLIC, MEAN, and DIASTOLIC values controlled by HI/LO positions of ALARM LIMITS switch. CAL – Unbalances bridge continuously at magnitude selected above. VARIABLE PRESSURE – Unbalances bridge continuously at magnitude set by PRESSURE control.
PRESSURE	Controls magnitude of bridge unbalance in VAR PRESS mode thru 0-300 mm Hg range.
RATE	Controls speed of rate generator thru 30-330 BPM range. Control range is 30-330 Hz with respect to Hz RATE OUT signal on rear panel.
TRIG OUT LAMP	Indicates occurrence of PRESS/PULSE channel trigger signal.
ALARM LIMITS SELECTOR SWITCH	Controls functions related to alarm limits testing. ALARM RESET – Resets alarm circuit on LIMITS board under test. RATE/PRESS LIMITS – Selects RATE or PRESSURE limits function on board under test.

ALARM LIMITS SELECTOR SWITCH (cont)	HIGH/NORMAL/LOW – (1) Sets limits test signal to PRESSURE channel; (2) Sets limits test signal to LIMITS board under test; (3) Sets RATE generator rate when VAR RATE is not pushed. SYST/MEAN/DIAST – (1) Determines mode of pressure limits function on board under test; (2) Programs pressure limits pot inputs on board under test. VARIABLE RATE – Allows RATE generator rate to be controlled by RATE control thru 30-330 BPM range. Hz RATE output is also controlled thru 30-330 Hz range.
ECG SELECTOR SWITCH	Selects input signals to ECG board under test. EXT SIG – Selects rear panel EXT ECG INPUT thru a X1000 divider. QRS – Selects ECG test signal which has basic characteristics of QRS complex. QRS + PACER – Selects ECG test signal mixed with simulated pacer pulse signal. PACER – Selects pacer signal only. SQUARE WAVE – Selects square wave signal for checking low frequency bandwidth limit of ECG channel. CMRR/LEAKAGE – Connects hot side of AC power line to all three ECG input lines to test CMRR and front end leakage. OPEN LA, OPEN RA – Opens designated ECG line to check LEAD FAULT circuit.
QRS LAMP	Indicates that QRS signal has been detected on board under test.
PACER LAMP	Indicates that PACER signal has been detected on board under test.

LEAD FAULT LAMP	Indicates that LEAD FAULT circuit is activated on board under test.
ALARM LAMP	Indicates that ALARM condition has been detected on board under test.
RATE GENERATOR LAMP	Indicates that BPM rate generator in test unit is running. Hz rate generator is always running.

SECTION 2
408/412/414 TEST UNIT CIRCUIT DESCRIPTION

Main Board

Since the test unit is deisgned around the components of the 412, much of the mainframe operation is identical to that instrument. Thus, for description of power supply, CRT circuits, vertical and horizontal amplifier, sweep generator, and vertical switching, refer to the 412 manual.

In the test unit, operation is from 115/230 VAC only, with no provision for internal battery or 12 V automotive operation. On the main board, therefore, the DC circuit power on/off switch and power change-over relay are deleted, with jumpers in their place. Power switching is done in the AC line with a toggle switch on the front panel, in order to maintain full control of the AC power to the unit under test.

Correct AC mains polarity in the test unit is verified by a neon lamp connected between the hot line and chassis ground. This is necessary for the tests involving monitor line leadage, CMRR and line polarity.

The audio circuits in the main board are not used in the test unit, since lamps indicate QRS and alarm detection. Thus, the beat and alarm loudness controls and speaker are deleted.

Test Boards

All of the test circuits are located on the three plug-in boards which also accept standard monitor boards, piggy-back style, for individual board testing. Pressure, pulse, and ECG test signals are brought out of the unit by rear panel connectors identical to their counterparts on the monitor. These signals may be connected with special male-to-male cables to the monitor under test, or they may be connected with special male-to-harmonica cables to an individual board under test.

When testing an individual board in the test unit, cable connections directly to the test unit plug-in board simulate the front panel controls which would normally connect to the board when installed in a monitor.

PRESSURE/PULSE TEST BOARD – This board contains a 0.1% resistance bridge (4 x 301 Ω) to simulate the pressure transducer, along with a bridge unbalancing relay RY1 and switches to simulate pressure signals from an actual transducer. There is also a pulse sensor simulator consisting of a relay RY2 and two resistors.

A lamp driver Q30 gives front panel indication of pressure/pulse trigger output. Another lamp driver Q40 indicates that an alarm condition has been sensed on the limits board under test. Relay drivers Q10 and Q20 operate RY1 and RY2, and also drive the RATE GENERATOR lamp on the front panel.

The 25, 50, 125, 250 and LIMITS TEST buttons unbalance the bridge through RY1, thereby giving a square wave pressure display. In the CAL and VARIABLE PRESSURE modes, unbalance is continuous, giving either a constant display selected above, or a continuous, variable pressure display, adjustable with the PRESSURE pot.

LIMITS TEST BOARD – This board performs several functions. It contains the switches and fixed resistors which simulate the monitor front panel limits controls when testing the limits board. High and low rate and pressure signals are set by the HIGH/NORMAL/LOW switches. The test signal rate generator U65 and U75, frequency divider U15 and U25, and rate distribution buffers are on this board, along with miscellaneous other circuitry including the X100 leakage amplifier U85B, display control gate U35, and pressure limits signal generator U85A.

Note that the basic rate generator runs at a speed which is read as Hz on the front panel RATE dial. This goes to a rear panel output called Hz RATE OUT, and may be used to drive a frequency counter. Since this frequency is divided by 60 to produce the BPM RATE OUT, which is then used to drive test signal circuits, the BPM rate may be accurately and quickly set by observing the counter at the Hz rate.

A further frequency division by 2 produces a BPM ÷ 2 signal which goes to the ECG test board to produce alternate polarity pacer simulation signals.

Power line leakage is sensed across a 1K resistor in series with the ground lead of the unit under test at the test unit rear panel AC power connector. This is amplified by 100 in U85B and fed to a rear panel BNC connector, resulting in a 100 mV/μA signal suitable for driving a multimeter of DVM. This signal is also fed to the CRT display at 10 μA/DIV when the LEAKAGE button is pushed.

The limits board pressure limits signal is generated in U85A with information from the HIGH/NORMAL/LOW switch. The pressure board pressure limits signal is determined by another portion of the HIGH/NORMAL/LOW switch which affects the bridge unbalancing circuitry on the pressure test board in the LIMITS TEST mode. In both cases the signal generated is equivalent to a pressure change of 100 mm Hg from a base of 25 mm Hg (LOW), 75 mm Hg (NORMAL), or 125 mm Hg (HIGH). In medical terms, this is written SYSTOLIC/DIASTOLIC in mm Hg. The MEAN value for the square symmetrical waveform used here is (SYSTOLIC + DIASTOLIC)/2.

HIGH range – 225/125; MEAN 175

NORMAL range – 175/75; MEAN 125

LOW range – 125/25; MEAN 75

The rate generator speed is controlled either by the HIGH/NORMAL/LOW switches for limits testing or by the RATE pot when the VARIABLE RATE button is pushed.

ECG TEST BOARD – This board contains the QRS simulation signal (ECG test signal) generator U95, pacer simulation signal generator Q80 and Q90, CMRR/LEAKAGE test circuitry, and lamp drivers for QRS and PACER indication.

U95 generates a trapezoidal waveform with controlled rise and fall times in order to activate the QRS detector. The flat top allows amplitude calibration by comparison of the ECG TEST SIGNAL OUT (1 V) with the X1000 output from the unit under test in the lead II mode. The 1 V test signal is divided down (by 1000 in lead II), and a DC offset is added (±100 mV in leads I and III) to test the ECG input calibration and dynamic range.

Pacer pulse artifact is simulated by generating a large (±100 to ±300 mV) 2 ms wide signal with Q80 and Q90 and summing this signal with the test signal.

Pacer detection on the board under test is sensed by Q50 which feeds the PACER lamp driver Q60. The QRS detected signal drives QRS lamp driver Q70.

Common mode rejection ratio (CMRR) and line frequency leakage thru the floating input amplifier are checked by applying line voltage from the hot side of the line (by way of two 1 M resistors) to all three ECG input leads. Electrode resistance unbalance is simulated by the 5.1K, 10K and 15K resistors in the ECG connector in the test unit.

The SQUARE WAVE button applies a square wave signal (1 mV in lead II) to the ECG input for checking low frequency cutoff of the ECG channel.

OPEN LA and OPEN RA buttons open the corresponding input lines to check the lead fault sensing circuitry.

SECTION 3
408/412/414 TEST UNIT CALIBRATION

POWER SUPPLIES

Adjust −12 V supply (R737) for −12 V ±0.1 V.

Check +12, ±7 supplies.

CRT AND DISPLAY CIRCUITS

Rotate CRT yoke for horizontal trace.

Remove yoke connector and adjust spot to graticule center with slip rings. (±2 mm VERT, ±1 mm HORIZ.)

Adjust FOCUS (R841) for smallest spot. Replace yoke connector.

Adjust HORIZONTAL POSITION (R671) to align left end of trace with left end of graticule lines.

Connect jumper from Pin 6 to Pin 13 (−7) on both PRESSURE and ECG board sockets at top of instrument.

Short TP631 to TP632 and adjust VERTICAL BOOST INTERVAL for a 75 μs POS PULSE at TP637. Remove short.

Adjust CHOPPED BLANKING INTERVAL (R631) for a 120 μs POS PULSE at TP633.

Remove jumpers added in Step 5.

LEAKAGE TEST CIRCUIT

Check AC power outlet polarity. After noting that MAINS POLARITY lamp is ON, set UUT PWR to ON and NORMAL. Check for mains voltage between narrow slot in AC power outlet and chassis ground.

Check leadage test circuit functioning. Connect a 10 Meg 5% resistor from ECG CONNECTOR Pin A to ground terminal of AC PWR TO UUT outlet. With ECG CMRR/LEAKAGE button IN and LEAKAGE button IN, check for a 2.8 cm mains frequency display on TU and a 2.8 V peak-to-peak (1 V RMS) mains frequency signal at LEAKAGE OUT connector.

ECG TEST CHANNEL

Adjust ECG TEST SIGNAL CAL for a 1.00 V change at ECG TEST SIG OUT while switching between EXT SIG and QRS with RATE GEN button OUT (rate generator OFF).

With ECG EXT SIG button IN, check for approximately one half of mains supply (60 V with 120 V mains) at ECG TEST board connector Pin 10 on TEST UNIT main board. Use X10 probe for 10 M or higher load resistance.

LIMITS TEST CHANNEL

Set TU at VAR RATE.

Adjust 330 CAL for 330 Hz at Hz RATE OUT with RATE dial at 3.30.

Adjust 30 CAL for 30 Hz at Hz RATE OUT with RATE dial at 0.30.

Check that BPM RATE OUT frequency is Hz RATE ÷ 60 at all dial settings.

Set TU at NORMAL rate: VAR RATE-OUT, HIGH-OUT, LOW-OUT.

Check for a 1 V square wave at limits board test socket Pin 1. Positive and negative peaks should be at +1.75 V and +0.75 V. Rate should be 120 BPM (2 Hz).

Check HIGH and LOW limits test: With HIGH button IN (LOW-OUT), square wave DC level should rise 0.5 V and rate should increase to 180 BPM (3 Hz). With LOW button IN (HIGH-OUT), square wave DC level should drop 0.5 V and rate should decrease to 60 BPM (1 Hz).

PRESSURE TEST CHANNEL AND DISPLAY

Install calibrated PRESSURE/PULSE board in PRESS/PULSE test position and connect pressure input cable.

Set TU PRES/PULSE at ZERO and UUT at 50.

Adjust BRIDGE NULL for 0 V at UUT board Pin 1.

Set TU at VAR PRESS and PRESSURE dial at 0 (full CCW). Adjust PRESS POT ZERO ADJ for 0 V at UUT board Pin 1.

Set TU PRESS/PULSE at 250 and UUT at 250. Set TU at VAR RATE and RATE at 120.

Adjust VERTICAL SENSITIVITY (R647, main board) for a 5 cm square wave display.

Adjust HORIZONTAL WIDTH (R667 main board) for square wave leading edges at 120 and 60 on heart rate scale with sweep at 50.

Set TU HIGH/LOW buttons at NORMAL (both buttons OUT). Set TU PRESS/PULSE at LIMITS TEST. A 2 cm square wave is displayed with positive and negative peaks at 175 and 75 on 250 scale.

Check HIGH and LOW limits test: With HIGH button IN (LOW-OUT), square wave should move up 1 cm. With LOW button IN (HIGH-OUT), square wave should move down 1 cm.

Set TU at 250 and RATE GEN button OUT (OFF). Check for 5 cm trace deflection when CAL button is pushed.

Set TU at VAR PRESS and rotate PRESSURE dial. Dial readings (0-250) should position trace to corresponding readings on 0-250 pressure scale.

FINAL CHECK

Test one known operating board of each of the three types (PRESS/PULSE, LIMITS, ECG) and verify functioning of all lights and test signals.

Test one known operating monitor in CMRR/LEAKAGE mode to verify functioning of leakage test circuitry.

SECTION 4
408/412/414 PLUG-IN BOARDS FUNCTIONAL TESTS

OPERATION	OBSERVATION
Start PRESSURE/PULSE Board Test	
Test Unit Pwr-OFF	
Install Press/Pulse Board – connect input csbles and harmonica cable to P413	
Test Unit Pwr–ON	
DISPLAY OFFSET–OUT	
LEAKAGE–OUT	
RATE ON–IN	
SWEEP–50	
VAR RATE–IN	
RATE–150	
ZERO–IN	
Press/Pulse–OFF	Trace mid screen
Press/Pulse–PULSE	
TU 50–IN (414) 25-IN.	Approx 2 cm square wave display; TRIG OUT Lamp indicates
DISPLAY OFFSET–IN	Trace moves down 2 cm
DISPLAY OFFSET–OUT	Trace mid screen
Press/Pulse–50 (414) 25-IN	TRIG OUT Lamp indicates
Adjust PRESSURE POSITION (R495)	Square wave negative peak at ZERO graticule line
Adjust GAUGE FACTOR	Square wave positive peak at No. 5 graticule line
(412) Press/Pulse–125	TRIG OUT Lamp indicates
(414) Press/Pulse–150	TRIG OUT Lamp indicates
TU 150–IN	5 div square wave from ZERO graticule line on the 414. 6 div on the 412.
Press/Pulse–250	TRIG OUT Lamp indicates
TU 250–IN	5 div square wave from ZERO graticule line
DISPLAY OFFSET–IN	No change in Display
DISPLAY OFFSET–OUT	
ZERO–IN	Trace at ZERO graticule line
(412) Press/Pulse 2 DIV CHK-Push	Trace moves up 2 cm
(414) Press/Pulse 100 mm CHK-Push	Trace moves up 100 mm Hg
Finish PRESS/PULSE Board Test	

408/412/414 PLUG-IN BOARDS FUNCTIONAL TESTS (cont)

OPERATION	OBSERVATION
Start ALARM LIMITS Board Test (408/412)	
Test Unit Pwr—OFF	
Install Limits Board — connect harmonica cables to P510, P541, P561	
Test Unit Pwr—ON	
RATE ON—IN	
VAR RATE—OUT	
RATE LIMITS—IN	
HIGH/LOW—OUT	
SYST/DIAST—OUT	
Subroutine A	Delay X:2-6 sec Delay Y:1-3 sec
ALARM RESET—Push	ALRAM Lamp OFF
Wait 15 seconds	ALARM Lamp OFF
HIGH—IN	ALARM Lamp indicates after Delay X
HIGH—OUT	ALARM Lamp OFF
Wait 15 seconds	ALARM Lamp OFF
LOW—IN	ALARM Lamp indicates after Delay Y
LOW—OUT	ALARM Lamp ON
ALARM RESET	ALARM Lamp OFF
Wait 30 seconds	
RATE ON—OUT	ALARM Lamp indicates in 3-11 seconds
RATE ON—IN	ALARM Lamp ON
ALARM RESET—PUSH	ALARM Lamp OFF
The remainder of ALARM LIMITS test procedure applies only to limits boards for 412 Mod 735B.	
VAR RATE—IN	
RATE—150	
PRESSURE LIMITS—IN	
Subroutine A	Delay X:6-12 sec Delay Y:6-12 sec. Wait 5 seconds after removing HI/LO Violation before resetting Alarm.
SYST—OUT DIAS—IN	
Subroutine A	Delay X:2-6 sec Delay Y:3-11 sec
DIAST—OUT	
Finish ALARM LIMITS Board Test	

408/412/414 PLUG-IN BOARDS FUNCTIONAL TESTS (cont)

OPERATION	OBSERVATION
Start ECG Board Test	
Test Unit Pwr—OFF	
Install ECG Board – connect input cable and harmonica cable to P200 and TP318	
Test Unit Pwr—ON	MAINS POLARITY Lamp must be ON
DISPLAY OFFSET—OUT	
LEAKAGE—OUT	
RATE ON—IN	
SWEEP—50	
VAR RATE—IN	
RATE—150	
EXT SIG—IN	
ECG—OFF (Delete for 408 board with full lead selector)	Trace mid screen
ECG—II	
Adjust OFFSET NULL (R170)	0 V ±200 mV at TP178
Adjust DC LEVEL (R185)	Trace mid screen
ECG—I	
OPEN LA—IN	LEAD FAULT + PACER Lamps ON
OPEN RA—IN	LEAD FAULT + PACER Lamps ON
OPEN LA—OUT	LEAD FAULT + PACER Lamps ON
OPEN RA—OUT	LEAD FAULT + PACER Lamps OFF
ECG—II	
DISPLAY OFFSET—IN	Trace moves up 1 cm
DISPLAY OFFSET—OUT	Trace mid screen
QRS—IN	+QRS Test sig displayed QRS Lamp indicates at approx. 50% duty cycle
Adjust GAIN (R184)	2 cm display
ECT—I	LEAD FAULT + PACER Lamps on briefly; QRS Test sig displayed in approx 1 sec (1 cm inverted); QRS Lamp indicates within 15 sec.

408/412/414 PLUG-IN BOARDS FUNCTIONAL TESTS (cont)

OPERATION	OBSERVATION
ECG–III	LEAD FAULT + PACER Lamps on briefly; QRS Test sig displayed in approx 1 sec (3 cm); QRS Lamp indicates within 15 sec
ECG–II	
QRS + PACER–IN	
RATE–60	QRS and PACER signals displayed; baseline disturbance by Pacer less than 2 mm; QRS Lamp indicates only on QRS sig; PACER Lamp indicates only on Pacer Pulse.
PACER–IN	PACER Lamp only indicates
Wait 15 sec	PACER Lamp only indicates; QRS Lamp does not light.
SWEEP–25	
RATE–30	
SQUARE WAVE–IN	Square wave displayed with 55% (±10) tilt for 0.2 Hz LF BW; 15% (±5) tilt for 0.05 Hz LF BW.
RATE ON–OUT	
SWEEP–100	
CMRR/LEAKAGE–IN	Mains Freq Displayed
ECG–L,II,III	Max peak-to-peak Amplitude must be less than: 1.3 cm with 120 V mains 2.6 cm with 240 V mains

The remainder of this procedure applies only to ECG boards with full lead selector.

ECG–STD	
QRS–IN	
SWEEP–50	
RATE ON–IN	
RATE–150	
ECG 1 mV–PUSH and RELEASE	1 mV CAL signal displayed
ADJUST 1 mV CAL (R119)	CAL signal positive and negative edges are 2 cm amplitude
ECG–aVR	0.5 cm neg. signal displayed
ECG–aVL	2 cm neg. signal displayed
ECG–V	1.3 cm neg. signal displayed

408/412/414 PLUG-IN BOARDS FUNCTIONAL TESTS (cont)

OPERATION	OBSERVATION
CMRR/LEAKAGE—IN	Mains frequency displayed
RATE ON—OUT	
SWEEP—100	
ECG—aVR, aVL, aVF, V	Max. peak-to-peak amplitude must be less than: 1.3 cm with 120 V mains 2.6 cm with 240 V mains

Finish ECG Board Test

The 414 DVM and readout conditioner board can be tested in the 414 monitor using the extender kit (020-0188-00) and the monitor calibration procedure.

SECTION 5
408/412/414 CALIBRATION PROCEDURE

408/412/414 CALIBRATION PROCEDURE

Preparation

With Pwr OFF, position BATTERY METER to indicate at left edge of scale.

Set LIMITS Controls and ECG SIZE knobs on their respective pots so that index marks align with index marks on panel.

Set BEAT LOUDNESS, ALARM LOUDNESS, and PULSE SIZE knobs on their pots so that index marks are straight up at pot mid-range.

Set all calibration adjustments at mid-range.

General Notes

Complete control preset schedule is given only at beginning of main procedure; within each succeeding subsection, only those presets for that section are given.

Abbreviations: TU—Test Unit; UUT—Unit Under Test, unless noted, steps apply to Unit Under Test.

All pushbuttons on Test Unit and on UUT are assumed to be OUT (not pushed) unless otherwise noted in procedure.

OPERATION	OBSERVATION
Main Frame Calibration	
For 408 main frame calibration, delete items marked *.	
Connect UUT to variac set at 115 VAC	
LINE SEL—115	
PWR—ON	
SWEEP—50	
ALARM LOUDNESS—Mid range	
BEAT LOUDNESS—Mid range	
ALARMS—OFF	
* PRESS/PULSE—OFF	
* ECG—OFF	Trace mid-screen
Adjust −12 V (R737)	−12.0 V ±120 mV at −12 TP
Variac—OFF, ON	−12 V ON Continuously
Subroutine B	
PWR—OFF, ON	−12 V OFF, ON
Variac—OFF	Subroutine B
Variac—100 VAC	Subroutine B
Variac—136 VAC	Subroutine B
LINE SEL—230	
Variac—230 VAC	Subroutine B
Variac—115 VAC	
LINE SEL—115	
PWR—OFF	
Variac-OFF	
Monitor Battery charging current with suitable meter in series with battery connector, P711 Pin 1.	
Variac—ON	
Check Current	340—420 mA Charge Current
PWR—ON	
Check Current	340-420 mA Charge Current
Variac—OFF	Reverse leakage from battery is 40-160 μA.
Disconnect charging current checker. Connect test power supply to battery connector P711 (Pos to pins 1 and 4; Neg to pins 2 and 3)	
Set power supply to 6 V	
Power Supply—ON	

OPERATION	OBSERVATION
PWR—ON	UUT Operates
Wait 30 seconds	
Decrease power supply voltage slowly	Voltage at TP714 is 5.1 to 5.4 V when BATTERY METER reads at right edge of black area. Voltage at TP714 is 4.35 to 4.65 V and BATTERY METER reads at left edge when instrument shuts down.
Power supply—OFF	
PWR—OFF	

Remove test power supply and reconnect battery.

PWR—ON	
Rotate deflection yoke	Horizontal Trace (no tilt)
PWR—OFF	

Disconnect Yoke (P641)

PWR—ON	
Adjust yoke slip rings	CRT spot at center (±1 mmH; ±2 mmV)

Note that orientation of UUT with respect to the compass points affects vertical trace position.

Adjust FOCUS (R841)	Minimum spot size
PWR—OFF	

Reconnect yoke (P641)

Disconnect variac. Connect UUT to Test Unit with ECG, Pressure*, Pulse*, and AC Power cables.

TU: PWR—ON	MAINS POLARITY Lamp must be ON
UUT PWR—ON	
UUT POLARITY—NORMAL	
SWEEP—50	
RATE ON—IN	
VAR RATE—IN	
RATE—120	
PRESS/PULSE—ZERO	
ECG—QRS	
ECG SIZE—20 mm/mV	
PWR—ON	Trace mid screen; no signal
ECG—III	ECG test sig displayed; AUDIO beeper indicates; SWEEP is triggered
Adjust BEAT LOUDNESS	Beat loudness is variable from zero to full level
RATE LIMIT LOW—150	ALARM sounds
Adjust ALARM LOUDNESS	Alarm loudness is variable from minimum level (not zero) to full level
RATE LIMITS—OFF	

OPERATION	OBSERVATION
Instrument must be fully horizontal for horiz position and width adjustments.	
Adjust TU RATE	180 Hz at TU HZ RATE OUT
Adjust HORIZ POS (R671)	Trace starts at left edge of graticule
Adjust WIDTH (R667)	Fourth pulse starts at 60 BPM on heart rate scale
Check heart rate scale	1st pulse—trace start 2nd pulse—180 BPM 4th pulse—60 BPM 6th pulse—36 BPM
SWEEP—25 (408/412 only)	7th pulse—60 BPM
SWEEP—100	2nd pulse—90 BPM
TU ECG—EXT SIG	SWEEP stops and then free runs within 6 sec; AUDIO beeper does not indicate
SWEEP—50	
*The remaining portion of main frame calibration applies only to the 412/414.	
ECG—II	
TU ECG—QRS	ECG test sig displayed
PULSE SIZE—mid range	
PRESS/PULSE—PULSE	ECG test sig moves up 2 cm; PRESS/PULSE trace displayed with no signal; SWEEP is triggered: AUDIO beeper indicates.
TU PRESS/PULSE—250	PULSE test sig displayed
Short TP631 to TP632	
Adjust VERT BOOST INT (R634)	75 μs ±5 μs pos pulse at battery TP637
Remove short	120 μs ±5 μs pos pulse at TP633
Adjust CHOP BLANK INT (R631)	
TU ECG—EXT SIG	No signal on ECG trace; sweep stops and then free runs within 6 sec; AUDIO beeper does not indicate.
ECG—OFF	PULSE sig moves up 2 cm; ECG trace disappears; SWEEP is triggered; AUDIO beeper indicates.
TU PRESS/PULSE—ZERO	
(412) PRESS/PULSE—125	
(414) PRESS/PULSE—150	
Adjust ZERO control	Trace on screen below ZERO graticule line
TU PRESS/PULSE—VAR PRESS	
SWEEP—100	
Adjust TU PRESSURE	Trace curvature, when viewed at 90° to graticule surface at trace position, is less than 2 mm at all positions from ZERO TO No. 5 graticule lines
Finish Main Frame Calibration	

OPERATION	OBSERVATION
Pressure/Pulse Channel Calibration	
SWEEP—100	
ECG—OFF	
TU RATE ON—OUT	
TU PRESS/PULSE—ZERO	
UUT PRESS/PULSE—250	
Adjust ZERO control	Approximately 4 cm total range (partially off screen)
TU PRESS/PULSE—250	
Adjust ZERO control	0 V ±25 mV at PRESS 0.5 V/cm OUTPUT
TU CAL—IN	
Adjust GAUGE FACTOR	2.50 ±25 mV change at PRESS 0.5 V/cm OUTPUT
Sweep—50	
TU RATE ON—IN	Approximately 5 div square wave displayed; AUDIO beeper indicates
Check PRESS 0.5 mV/cm OUT	2.5 mV square wave signal
Adjust PRESSURE POS (R495) and VERTICAL GAIN (R647)	Square wave with peaks at ZERO and No. 5 graticule line
TU PRESS/PULSE—150	
(412) PRESS/PULSE—125	Square wave: 6 cm (412)
(414) PRESS/PULSE—150	Square wave: 5 cm (414)
TU PRESS/PULSE—50 (414)-25	
(412) PRESS/PULSE—50	Square wave with peaks at ZERO and No. 5 graticule line
(414) PRESS/PULSE—25	
TU PRESS/PULSE—ZERO	
(412) 2 DIV CHECK—Push	Trace deflects upward 2 cm
(414) 100 mm CHECK—Push	Trace deflects upward 100 mmHg
TU PRESS/PULSE—50	
PRESS/PULSE—PULSE	
PULSE SIZE—Full CW	Square wave with approximately 4 cm edges and approximately 1 cm tilt; SWEEP is triggered; AUDIO beeper indicates
PULSE SIZE—Full CCW	Approximately 2 mm square wave; SWEEP free runs; no AUDIO beeper indication
PULSE SIZE—Adjust CW	SWEEP begins triggering and AUDIO beeper indicates at 5 mm amplitude or less.
Finish Press/Pulse Channel Calibration	

OPERATION	OBSERVATION
(408/412) Rate Alarm Limits Calibration	
TU: PRESS/PULSE—ZERO	
ECG—QRS	
VAR RATE—OUT	
HIGH—OUT	
LOW—OUT	
SWEEP—50	
* PRESS/PULSE—OFF	
ECG—II	
* PRESS ALARM—OFF (412 MOD 375B ONLY)	
RATE LIMIT HIGH—150	
RATE LIMIT LOW—90	
ALARM RESET—Push	ALARM OFF
Wait 30 seconds	
TU RATE ON—OUT	ALARM sounds after 3-11 sec
TU RATE ON—IN	ALARM ON
ALARM RESET—Push	ALARM OFF and stays OFF
Wait 30 seconds	
TU RATE ON—OUT for 1 sec, IN, then OUT after 5 sec	ALARM sounds within 1 sec after last operation
TU RATE ON—IN	ALARM ON
ALARM RESET—Push	ALARM OFF
Subroutine C	Delay X:2-6 sec; Delay Y:1-3 sec
ALARM RESET—Push	ALARM OFF
Wait 15 seconds	
TU HIGH—IN	ALARM sounds after Delay X
TU HIGH—OUT	ALARM ON
ALARM RESET—Push	ALARM OFF and stays OFF
Wait 15 seconds	
TU LOW—IN	ALARM sounds after Delay Y
TU LOW—OUT	ALARM ON
ALARM RESET—Push	ALARM OFF and stays OFF
Remove speaker connector (P691)	
TU VAR RATE—IN	
TU RATE—120	TP522 switching
Adjust TU RATE slowly CW	Rate at which TP522 stops switching must be 135-165 BPM
TU RATE—120	TP523 HI level
Adjust TU RATE slowly CCW	Rate at which TP523 starts switching must be 80-99 BPM
RATE LIMITS—OFF	
Replace speaker connector (P691)	
Finish Rate Alarm Limits Calibration	

OPERATION	OBSERVATION
Pressure Alarm Limits Calibration	
TU: RATE ON–IN PRESS/PULSE–LIMITS TEST RATE–30 HIGH–OUT LOW–OUT VAR RATE–IN SWEEP–25 RATE ALARM–OFF ECG–OFF PRESS/PULSE–250 ALARM LIMITS–MEAN	Voltage at TP557 is approximately 1.25 V with less than 10 mV p-p ripple at 30 BPM (0.5 Hz)
TU RATE–150 SWEEP–50 PRESS LIMIT HIGH–3 PRESS LIMIT LOW–2 Subroutine C	Delay X:6-12 sec Delay Y: 6-12 sec. Wait 5 seconds after removing HI/LO violation before resetting ALARM.
SYST–IN PRESS LIMIT HIGH–4 PRESS LIMIT LOW–3 Subroutine C	Delay X:2-6 sec Delay Y: 3-11 sec
DIAST–IN PRESS LIMIT HIGH–2 PRESS LIMIT LOW–1 Subroutine C	Delay X:3-11 sec Delay Y:2-6 sec

(414) ALARMS CALIBRATION

Preset: Test Unit ECG–QRS, PRESSURE–250, RATE–ON.

Connect: Test Unit cables, ECG–Pressure–pulse, and temperature simulator to monitor.

Preset: 414 ECG–II, PRESSURE–250, Adjust ZERO to position trace near bottom of screen.

Adjust test unit VAR RATE for 120 B/M on 414 readout.

Ad

PRESS PULSE	PRESS PULSE	PULSE ALARM	Readout Selector	LOW RATE LIMIT	HIGH RATE LIMIT	Readout	RESET	Alarm
25	PULSE-IN Size-cw	IN	SYST DIAS	OFF	ccw	Blank	IN	None. Wait 30 sec.
	Size-ccw		MEAN			Blank		ON in 5 to 15 sec.
	250			ccw	cw	–20 to –50	IN	None. Wait 15 sec.
ZERO								ON in < 30 sec.
		OUT						None.
			RATE	Push and set to 116 on readout	Push and set to 124 on readout	120 (±1)		ON in 5 to 15 sec.
				Push and set to 124 on readout		120 (±1)		ON in 5 to 15 sec.
250		IN		ccw		120 (±1)	IN	None.
					Push and set to 116 on readout	120 (±1)		ON in 5 to 15 sec.
		OUT		OFF				None.

Push in LOW LIMIT knob and compare front panel settings against the readout. Check that both ends of the pot are within ±c counts and middle settings are within ±15 counts.

Repeat the same test with the HIGH LIMIT pot.

(414) READOUT

Calibration (requires a DM 501 multimeter or equivilant and DC 503 counter or equivilant)

Connect: DM 501 HI INPUT to TP1012 and LO INPUT to TP1022. Set range to 2 VDC.

Preset: Test Unit VAR PRESS—0.00.

Preset: 414 PRESS—25, Readout—MEAN.

Adjust: 414 ZERO for 0.000 volts on DM 501.

Adjust: R2344 for 414 readout count of 1, then adjust same pot ccw until readout changes to 0 and the polarity sign just changes.

Set: 414 readout to temp and C/F switch to F.

Set: Temp box to 113°.

Adjust: R2332 until readout corresponds to DM 501, rounding off last digit.

Repeat: Adjustments due to interaction.

Move: HI INPUT lead from TP1012 to 1.76 V TP.

Adjust: R1410 for +1.759 (±0.005 V) on DM 501.

Return: HI INPUT lead to TP1012.

Set: Temperature box to 77° F, 25° C.

Adjust: R1424 for 0.770 V on DM 501.

Set: C/F switch to C.

Adjust: P1420 for 0.250 V on DM 501.

Set: 414 readout—RATE, ECG—II.

Set: Test unit VAR RATE—150.

Connect: DC 503 frequency counter to test unit Hz RATE OUT.

Adjust: R1215 until DM 501 reading corresponds to DC 503 frequency count.

RATE TEST

Preset: Test unit VAR RATE RATE—ON, ECG—QRS.

Preset: 414 ECG—II, Readout—RATE.

Set the VAR RATE to 30 and check that the 414 BPM RATE is within ±2 counts of the Hz rate displayed on the DC 503. Check also that the 414 readout doesn't change more than ±2 counts.

Set the VAR RATE to 60 and check the 414 BPM RATE is within ±2 counts of the DC 503 Hz rate.

Set the VAR RATE to 250 and check for ±5 counts of DC 503 rate.

Set the VAR RATE to 300 and check that readout flashes overrange.

TEMPERATURE TEST

Preset: 414 readout — TEMP C/F — F.

Switch the temperature box through the ranges +23° through +113° F and check that the readout is ±0.2° of the temperatures set on the temp box.

Check that readout flashes overrange at +14 and +122° F.

Switch 414 C/F switch to C.

Repeat step 2 and check readout is within ±0.1° C of +5° through +45° C.

Check that −10°, −5°, and +50° C flash overrange.

Check for + and − polarity signs.

Remove the temp box plug from the 414 and check that the display is blanked.

PRESSURE/PULSE TEST

Preset 414 ECG—OFF.

Test unit RATE—OFF.

Connect phone-plug cable from 414 (.5 V/cm) output (rear) to multimeter input.

READOUT (cont)

Press/Pulse	TEST UNIT Press/Pulse	Display	414 Readout SYST	DIAS	MEAN	MULTIMETER
Zero	250	Push zero for fast update & adjust zero cw.			> +75	
		Adjust zero ccw.	Flashing	Flashing	> –75	
		Adjust zero pot for minimum trace shift while changing pressure ranges from 250 to 25.	0 (±2)	0 (±2)	0 (±2)	Check: 0.00 V (±25 mV)
		Check: Trace is on zero graticule line (±1 mm).				
		Move the pressure cable & check for no jitter.				
250 and CAL	250	Check: Trace is at graticule line 5	+250 (±1)	+250 (±1) In 5 to 20 sec.	+250 (±1)	Check: +2.50 V (±50 mV) change.
150 and CAL	150	Check: Same.	+150 (±2)	+150 (±2)	+150 (±2)	Check: Same.
Zero	250 100 mm Check	Check: +2 cm (±1 mm).			+100 (±2)	Check: 1.00 V (±25 mV) change.
LIMITS TEST			+175 (±2)	+75 (±2)	+125 (±2)	

PRESSURE/PULSE TEST (cont)

Preset test unit RATE—ON. 35 B/M.

TEST UNIT Press/Pulse	Press/Pulse	414 Display	Readout SYST	DIAS	MEAN
250	250	Check: 5 cm p-p signal (±1 mm) with no abnormal rolloff or baseline shift.	250 (±2)	0 (±2)	125 (±2)
150	150	Check: Same.			
25	25	Check: Same.			
	PULSE and Rotate Pulse Size cw.	Check: > 4 cm p-p pulse signal.			
	Rotate Pulse Size ccw.	Check: < 3 mm p-p pulse signal.			
VAR PRESS	250	Push & adjust ZERO to position. trace at bottom of screen.	Set: Readout to MEAN only. Flashes overrange at —50 to —80.		
	150	Same.	Flashes overrange at —30 to —50.		
	25	Same.	Flashes overrange at —5 to —8.		
		Adjust VAR PRESS to position trace at top of screen.	Flashes overrange at +35 to +55.		
	150	Same.	Flsahes overrange at +210 to +245.		
	250	Same except push 10 mm check also.	Flashes overrange at +350 to +390		
		Return trace out of O/R.	Stop flashing in 2 to 4 sec.		

SECTION 6
PARTS LIST
408/412/414 TEST UNIT 067-0706-99
MAIN FRAME

PART NUMBER	DESCRIPTION	LOCATION
016-0560-00		
119-0468-01	Yoke	
120-0866-01	Transformer	
131-0775-00	Terminal, Post	Standoff (yellow)
131-0884-00	Plug, AC Power (modified)	Take off silver plate and replace w/board & 202 solder lug
131-0955-00	Connector, BNC	
131-1703-00	Plug, Brynnt	Power plug
131-1375-00	Connector	Pressure Input
131-1376-00	Connector	Pulse Input
131-1644-00	Connector	ECG Input
136-0551-00	CRT Socket Ass'y	
150-0035-00	Neon	
150-1004-00	L.E.D.	
151-0349-00	Transformer	Q746, Q748
152-0180-00	Diode	Rear Panel
152-0406-00	Diode	CR794-rear panel
154-0508-01	CRT	
159-0032-00	Fuse, .5 Amp SLO-BLO	
162-0581-00	Insulation, (Clear)	¼" per LED-gold lead (Anode lead)
175-1415-01	Cable, Elec. (Power)	
195-0125-00	Anode Lead	

408/412/414 TEST UNIT 067-0706-99
MAIN FRAME

PART NUMBER	DESCRIPTION	LOCATION
200-0072-00	Cap. Binding Post	
200-0237-01	Cover, Fuse (clear)	
200-0609-00	Cap., Lampholder	
200-0860-00	Nipple, (Strain-relief)	Powercord Plug end
200-0935-00	Cap., Lampholder	
200-1547-01	Bezel, CRT	
200-1561-00	Cable, Nipple Elec.	
210-0010-00	Washer, Lock Int. No. 10	Binding Post
210-0071-00	Washer, No. 6 (black)	Trans Brkt
210-0201-00	Solder Lug No. 4	(1) Front Casting—(2) Plug AC (1) Power coard & (1) ECG Connector
210-0202-00	Solder Lug No. 6	(1) AC Power Plug
210-0410-00	Nut, 10-32X 5/16	Binding Post
210-0457-00	Nut, Kep No. 6	(2) Trans Brkt—(1) Diode on rear panel
210-0551-00	Nut, No. 4	Power Cord Gnd
210-0562-00	Nut, ¼-32X 5/16	2 per Sw's on front panel
210-0586-00	Nut, Kep No. 4	(8) F&R Panels to chassis (2) Pressure Conn—(4) AC Plug (4) Main Frame to chassis
210-0940-00	Washer, Flat	Sw's on Front Panel
211-0007-00	Screw, 4-40X 3/16	(2) ECG Conn. Shield (2) Volt/Selector Sw.
211-0008-00	Screw, 4-40X 1/4	(8) Foot on bottom cover
211-0018-00	Screw, 4-40X .875	Power Cord
211-0021-00	Screw, 4-40X 1.25	CRT shield to front casting
211-0038-00	Screw, 4-40X 5/16 FHS	Main frame to chassis
211-0097-00	Screw, 4-40X 5/16	(4) AC plug—(1) Yoke clamp (2) Pressure Conn.
211-0101-00	Screw,	
211-0105-00	Screw, 4-40X 3/16 FHS	(2) Trans. Brkt (4) Snaps on top cover
211-0107-00	Screw, 1-72X.312	Implosion Shield
211-0116-00	Screw, 4-40X 5/16 ECB	Main Brd to chassis
211-0186-00	Screw, 0-80X 1/8 Slot/HS	Nut Block to Display Rate Sw. Brd.

408/412/414 TEST UNIT 067-0706-99
MAIN FRAME

PART NUMBER	DESCRIPTION	LOCATION
211-0541-00	Screw, 6-32X	Nut Block to front casting
211-0552-00	Screw, 6-32X 2"	Cord Warps
211-0565-00	Screw, 6-32X¼ Truss	Bottom cover to main frame
211-0578-00	Screw, 6-32X.437	Trans. Brkt to main brd.
212-0518-00	Screw, 10-32X.312	Handle Clips
213-0267-00	Screw, 4-24X.375 THF	ECG Conn. & insulator
214-1867-00	Bracket, Trans. (Heat sink)	
252-0571-00	Extrusion (Black rubber)	CRT shield
255-0334-00	Plastic Ahennel (Nylon)	Volt/Selector Sw. shield
260-0834-00	Sw. Toggle	
260-1300-01	Sw. Volt/selector	S701
283-0178-00	Cap. .1 μfd 100 V	Rear panel
311-1150-00	Res. Var. 10K 3T	Var. Rate
311-1684-00	Res. Var. 1K 3T	Var. Pressure
315-0104-00	100 K ¼W 5%	Front Panel
315-0105-00	1 M ¼W 5%	Volt/Selector—Rear Panel
321-0193-00	1 K 1/8W 1%	Rear Panel
331-0247-00	Dial	
333-1897-00	Panel, Front	
334-2124-00	Tag, Serial No.	on back of transformer
334-2149-00	Label, Inf. (caution in Red)	Warning to plug brds in right

408/412/414 TEST UNIT 067-0706-99
MAIN FRAME

PART NUMBER	DESCRIPTION	LOCATION
337-1812-01	Shield, Volt/Selector	
337-2291-00	Shield, Implosion	(412)
337-1865-00	Shield, ECG Conn. (Top)	
337-1866-00	Shield, ECG Conn. (bottom)	
342-0189-00	Insulator, ECG Conn.	gray plastic under conn.
342-0194-00	Insulator, Trans.	under Trans.
342-0235-00	Insulator, AC Plug	Board
343-0427-00	Retainer, CRT	
343-0428-00	Clamp, Yoke	
343-0429-00	Cushion, CRT (Rear)	Yoke Clamp
343-0439-00	Retainer, Cable to Cable	
343-0440-00	Retainer, Cable Nipple	Power Cord
344-0098-00	Clip, Handle	
348-0055-00	Grommet (gray plastic)	ECG Shield
348-0089-00	Bumper, (plastic cushion)	Bottom Cover
348-0282-00	Flip Stand	Bottom Cover
348-0352-00	Pad, Cushioning (CRT)	Black
348-0359-00	Cord Wrap	
348-0414-00	Foot (push-in) grey	Top and Bottom cover
348-0380-01	Foot, cabinet bottom	
352-0084-01	Holder, Neon (gray)	
352-0157-00	Holder, Neon (white)	
352-0239-00	Lamp Holder (nut block)	Display Rate Sw. Brd.
352-0362-00	Fuse Holder	
355-0184-00	Snap	Top cover
355-0503-00	Stem	Binding Post
366-1161-00	Knob, Pushbutton (large)	No markings
366-1257-00	Knob, Pushbutton (small)	No markings
367-0037-00	Handle, Carrying	
378-0541-00	Lens, Neon	
378-0741-00	Lens, LED (Red)	

408/412/414 TEST UNIT 067-0706-99
MAIN FRAME

PART NUMBER	DESCRIPTION	LOCATION
384-1099-00	Extension Shaft	
385-0014-00	Rod Nylon 5/16"	Main Brd—Hold-off cover
386-3047-00	Subpanel, Front	
386-3048-00	Panel, Rear	
390-0363-00	Cabinet, Bottom	
390-0426-00	Cabinet, Top	
426-0568-00	Bezel, Frame (large)	Pushbutton Sw's
426-0681-00	Bezel, Frame (small)	Pushbutton Sw's
426-1034-00	Frame Ass'y	
441-1159-02	Chassis Monitor (main)	
670-2701-	Board, Main	388-3232-00
670-3379-00	Board, Pressure/Pulse	388-3898-01
670-3380-00	Board, ECG Test	388-3899-01
670-3381-00	Board, Limits Test	388-3900-01
670-3382-00	Board, Display Rate Sw.	388-3901-00

408/412/414 TEST UNIT 067-0706-99
DISPLAY RATE Sw. BRACKETS 670-3382-00

PART NUMBER	DESCRIPTION	LOCATION
131-0589-00	Terminal, Berg Sq. Pin	
260-1656-00	Sw. Pushbutton Ass'y (set of 3)	
361-0542-00	Spacer, Sw.	
388-3901-00	Board, E. C. (raw)	

408/412/414 TEST UNIT 067-0706-99
PRESSURE/PULSE BOARD 670-3379-01

PART NUMBER	DESCRIPTION	LOCATION
131-0589-00	Terminal, Berg Sq. Pin	3 on back of board
131-1261-00	Pin, F-Shaped	
136-0252-04	Socket, Berg Pin	
136-0547-00	Socket, side entry 6-pin	
136-0548-00	Socket, side entry 10-pin	
136-1882-00	Socket, side entry 3-pin	
148-0076-00	Relay	Ry1, Ry2
151-0302-00	Trans.	Q10, 20, 40, 45
152-0141-02	Diode	
260-1657-00	Sw. Pushbutton Ass'y (set of 7)	

RESISTORS

311-1859-00	Res. Var.	200 Ω, 20T	
311-1860-00	Res. Var.	10K, 20T	
315-0150-00	15 Ω	¼W	5%
315-0201-00	200 Ω	¼W	5%
315-0511-00	510 Ω	¼W	5%
315-0513-00	51K	¼W	5%
315-0623-00	62K	¼W	5%
315-0750-00	75 Ω	¼W	5%
315-0102-00	1K	¼W	5%
315-0104-00	100K	¼W	5%

408/412/414 TEST UNIT 067-0706-99
PRESSURE/PULSE BOARD 670-3379-01

PART NUMBER	DESCRIPTION			LOCATION
321-0966-03	40.0K	1/8W	¼%	
321-0143-07	301 Ω	1/8W	.1%	
321-0189-00	909 Ω	1/8W	1%	
321-0319-00	20.5K	1/8W	1%	
321-0756-03	50.0K	1/8W	¼%	
321-0385-00	100K	1/8W	1%	
321-0402-00	150K	1/8W	1%	
321-0414-03	200K	1/8W	¼%	
321-0720-03	60.0K	1/8W	¼%	
321-0431-01	301K	1/8W	½%	
361-0384-00	Spacer, Sw. (red)			
388-3898-01	Board, E. C. (raw)			

408/412/414 TEST UNIT 067-0706-99
LIMITS TEST BOARD 670-3381-01

PART NUMBER	DESCRIPTION	LOCATION
131-0589-00	Terminal, Berg Sq. Pin	
131-1261-00	Pin, F-Shaped	
136-0269-02	Socket, I. C. 14-pin	
136-0514-00	Socket, I. C. 8-pin	
136-0547-00	Socket, side entry 6-pin	
136-0548-00	Socket, side entry 10-pin	
152-0141-02	Diode	
	I. C.	
156-0150-00	LM301	U65
156-0158-00	5558	U75, 85
156-0349-00	4001	U35, 45
156-0350-00	4011	U55
156-0366-00	4013	U25
156-0532-00	CD4024	U15
260-1658-00	Sw. Pushbutton Ass'y (set of 8)	
	CAPACITORS	
283-0000-00	.001 μfd	
285-0175-00	.1 μfd	
290-0662-00	220 μfd 10 V	
	RESISTORS	
311-1236-00	Res. Var. 250 Ω	
311-1239-00	Res. Var. 2.5K	
315-0104-00	100K ¼W 5%	

PART NUMBER	DESCRIPTION				LOCATION
131-0589-00	Terminal, Berg Sq. Pin				
131-1261-00	Pin, F-shaped				
136-0252-04	Socket, Berg Pin				
136-0514-00	Socket, I. C. 8-pin				
136-0547-00	Socket, side entry 6-pin				
136-0548-00	Socket, side entry 10-pin				
151-0188-00	Trans.				
151-0190-00	Trans.				
151-0302-00	Trans.				
152-0141-02	Diode				
152-0166-00	Diode	1N753A	6.2 V		
156-0158-00	I. C.				
260-1659-00	Sw. Pushbutton Ass'y (set of 8)				
			CAPACITORS		
283-0067-00	.001 μfd		200 V		
283-0187-00	.047 μfd				
283-0339-00	.22 μfd		50 V		
290-0523-00	2.2 μfd				
			RESISTORS		
311-1248-00	Res Var.		500 Ω		
315-0103-00		10K	¼W	5%	
315-0104-00		100K	¼W	5%	
315-0105-00		1M	¼W	5%	
315-0123-00		12K	¼W	5%	
315-0153-00		15K	¼W	5%	
315-0302-00		3K	¼W	5%	
315-0303-00		30K	¼W	5%	
315-0393-00		39K	¼W	5%	
315-0511-00		510 Ω	¼W	5%	
315-0512-00		5.1K	¼W	5%	
315-0623-00		62K	¼W	5%	
315-0683-00		68K	¼W	5%	
321-0097-07		100 Ω	1/8W	.1%	
321-0181-00		750 Ω	1/8W	1%	
321-0265-00		5.62K	1/8W	1%	
321-0267-00		5.9K	1/8W	1%	
321-0385-00		100K	1/8W	1%	
321-0644-00		100K	1/8W	1%	
321-0751-06		50 Ω	1/8W	1%	

408/412/414 TEST UNIT 067-0706-99
E. C. G. TEST BOARD 670-3380-01

PART NUMBER	DESCRIPTION	LOCATION
323-0491-00	1.27 M ½W 1%	
361-0384-00	Spacer, Sw. (Red)	
388-3899-01	Board, E. C. (Raw)	

408/412/414 TEST UNIT 067-0706-99
MAIN BOARD 676-2701-

PART NUMBER	DESCRIPTION	LOCATION
120-0868-00	Transformer	T801
131-0589-00	Termina, Berg Sq. Pin	
136-0252-04	Socket, Berg Pin	
136-0269-02	Socket, I. C. 14-pin	
136-0514-00	Socket, I. C. 8-pin	
136-0558-00	Conn. ECB mtg. 6-pin	on back of board
136-0559-00	Conn. ECB mtg. 10-pin	on back of board
		TRANSOFRMERS
151-0188-00	2N3906	Q633, 635, 637, 672, 676, 726, 744, 844
151-0190-00	2N3904	Q631, 639, 652, 666, 670, 674, 734, 736, 742
151-0301-00	2N2907	Q634
151-0302-00	2N2222A	Q644
151-0347-00	2N5551	Q630, 632, 646
151-0350-00	2N5401	Q636, 640, 642, 842
151-0406-00		Q648
151-0407-00		Q638
		DIODES
152-0107-00		CR641, 642, 643, 644, 811, 812, 815, 816, 817, 818, 821, 822, 825, 826, 827, 828, 831, 832
152-0141-02		CR617, 624, 625, 628, 657, 687, 722, 727, 842, 843, 844, 845, 846, 847, 848, 629
152-0166-00	6.2 V	VR733
152-0170-00	1N4441	CR802, 803, 804, 805, 806, 807
		I. C.
156-0158-00	5558	U628, 664, 668
156-0289-00	4016	U624
156-0349-00	4001	U620, 622, 626, 652, 656, 662, 686
162-0014-00	Tubing, Vinyl	Transformer Leads
260-1572-00	Sw. Pushbutton (set of 3)	S661

408/412/414 TEST UNIT 067-0706-99
MAIN BOARD 676-2701-

PART NUMBER		DESCRIPTION			LOCATION
			CAPACITORS		
281-0525-00		270 pf			C624, 625, 628, 629, 633, 637, 652
283-0003-00		.01 μfd	150 V		C732, 739
283-0006-00		.01 μfd	500 V		C811, 812
283-0067-00		.001 μfd	200 V		C626, 632, 635, 639, 649, 686
283-0111-00		.1 μfd	50 V		C615, 733, 746, 843
283-0238-00		.01 μfd	50 V		C653, 658
283-0280-00		.022 μfd	2 kV		C802, 803, 804, 805, 806, 807
285-0784-03		10 μfd	25 V		C663
290-0436-00		10 μfd	10 V		C722
290-0519-00		100 μfd	20 V		C817, 828
290-0525-00		4.7 μfd	50 V		C815, 832
290-0531-00		100 μfd	14 V		C745
290-0534-00		1 μfd	35 V		C656
290-0536-00		10 μfd	25 V		C685, 723
290-0662-00		220 μfd	10 V		C821, 822, 825, 826
			RESISTORS		
307-0114-00		6.2 Ω	¼W	5%	R817, 828 leave up off of board
308-0574-00		10 Ω	2W	3%	R648
311-1222-00	Var.	100 Ω			R647
311-1227-00	Var.	5K			R737
311-1231-00	Var.	25 K			R667
311-1235-00	Var.	100K			R671
311-1251-00	Var.	200K			R631, 634
311-1255-00	Var.	2Ω			R841
315-0101-00	Res.	100Ω	¼W	5%	R732, 739
315-0102-00	Res.	1K	¼W	5%	R644, 649, 673, 678, 744, 812
315-0103-00	Res.	10K	¼W	5%	R628, 723, 727, 734, 745
315-0104-00	Res.	100K	¼W	5%	R622, 623, 624, 625, 637, 654, 655, 697, 842, 843

408/412/414 TEST UNIT 067-0706-99
MAIN BOARD 676-2701-

PART NUMBER	DESCRIPTION				LOCATION
315-0105-00	Res.	1M	¼W	5%	R615, 620, 626, 627, 651, 652, 653, 683, 682
315-0153-00	Res.	15K	¼W	5%	R684
315-0154-00	Res.	150K	¼W	5%	R632
315-0203-00	Res.	20K	¼W	5%	R731, 735
315-0222-00	Res.	2.2K	¼W	5%	R659, 815, 832
315-0224-00	Res.	220K	¼W	5%	R621
315-0225-00	Res.	2.2M	¼W	5%	R803, 804, 805, 806, 807
315-0330-00	Res.	33Ω	¼W	5%	R642, 643, 746
315-0333-00	Res.	33K	¼W	5%	R726
315-0335-00	Res.	3.3M	¼W	5%	R658
315-0392-00	Res.	3.9K	¼W	5%	R811
315-0395-00	Res.	3.9M	¼W	5%	R616, 686
315-0471-00	Res.	470Ω	¼W	5%	R643
315-0472-00	Res.	4.7K	¼W	5%	R640, 641, 733
315-0473-00	Res.	47K	¼W	5%	R633, 637, 638, 639, 657, 743
315-0475-00	Res.	4.7M	¼W	5%	R848
315-0625-00	Res.	6.2M	¼W	5%	R656
315-0683-00	Res.	68K	¼W	5%	R802
315-0684-00	Res.	680K	¼W	5%	R617
315-0754-00	Res.	750K	¼W	5%	R687
316-0825-00	Res.	8.2M	¼W	10%	R844
321-0142-00		294Ω	1/8W	1%	R646
321-0330-00		26.7K	1/8W	1%	R738
321-0333-00		28.7K	1/8W	1%	R736
321-0356-00		49.9K	1/8W	1%	R668
321-0385-00		100K	1/8W	1%	R662, 674, 676, 677
321-0431-00		301K	1/8W	1%	R661, 663, 664, 665, 666
321-0452-00		499K	1/8W	1%	R672, 675
361-0542-00	Spacer, Sw. (clear)				
388-3232-	Board, E. C. (Raw)				

414 TEMP READOUT TEST FIXTURE
067-0787-99 YSI 700 SERIES PROBE SIMULATOR

PART NUMBER	DESCRIPTION
129-0097-00	Post 4-40 X .555L
134-0069-00	Plug 3 Cond
175-0306-01	Wore 2 Cond SHLD
210-0202-00	No. 6 Solder Lug
210-0407-00	No. 6 Nut
210-0457-00	No. 6 Nut
211-0008-00	4-40 X .250 PAN HD
211-0504-00	6-32 X .250 PAN HD
213-0082-00	4-40 X .500 PAN HD
343-0037-00	Feet
358-0091-00	Strain Relief
366-1559-00	Knobs
380-0471-00	Housing Wraparound
386-3017-00	Side panel housing left
386-3018-00	Side panel housing right
390-0170-01	Plate, housing bottom
426-1072-00	Bezerl frame (knobs)

414 TEMP READOUT TEST FIXTURE
E C B 670-4414-00

PART NUMBER	DESCRIPTION		
		RESISTORS	
321-0339-07	33.20KΩ	1/8W	.10% T9
321-0404-07	158.0KΩ	1/8W	
321-0685-07	30.0KΩ	1/8W	
321-1684-07	2.162KΩ	1/8W	
321-1685-07	9.428KΩ	1/8W	
321-1686-07	10.97KΩ	1/8W	
321-1687-07	13.28KΩ	1/8W	
321-1688-07	15.24KΩ	1/8W	
321-1689-07	19.74KΩ	1/8W	
321-1690-07	25.40KΩ	1/8W	
321-1691-07	74.44KΩ	1/8W	
321-1692-07	122.1KΩ	1/8W	
321-1693-07	46.67KΩ	1/8W	
321-1694-07	2.620KΩ	1/8W	
321-1695-07	2.918KΩ	1/8W	
321-1696-07	6.00KΩ	1/8W	
260-1838-00	Switch Pushbutton 2 pole 8 button interlock with MTG ears 10 MM spacing		
361-0384-00	Spacer Sw. Red		
388-4946-00	C. B. DA 4946		

408/412/414 TEST UNIT ACCESSORY
TRANSDUCER SIMULATOR 670-4681-00

PART NUMBER	DESCRIPTION			LOCATION
131-0787-00	Square pins			
311-1319-00	10K			
321-0143-07	301 Ω	1/8W	1/10% T9	
321-0385-00	100K	1/8W	1% T0	
321-0319-00	20.5K	1/8W	1% T9	
388-5262-00	E. C. B.			

408/412/414 TEST UNIT 067-0706-99
LIMITS TEST BOARD 670-3381-01

PART NUMBER	DESCRIPTION			LOCATION
321-0189-00	909 Ω	1/8W	1%	
321-0193-00	1K	1/8W	1%	
321-0222-00	2K	1/8W	1%	
321-0231-00	2.49K	1/8W	1%	
321-0277-00	7.5K	1/8W	1%	
321-0289-00	10K	1/8W	1%	
321-0315-00	18.7K	1/8W	1%	
321-0327-00	24.9K	1/8W	1%	
321-0332-00	28K	1/8W	1%	
321-0339-00	33.2K	1/8W	1%	
321-0348-00	41.2K	1/8W	1%	
321-0356-00	49.9K	1/8W	1%	
321-0366-00	63.4K	1/8W	1%	
321-0369-00	68.1K	1/8W	1%	
321-0375-00	78.7K	1/8W	1%	
321-0385-00	100K	1/8W	1%	
321-0393-00	121K	1/8W	1%	
321-0399-00	140K	1/8W	1%	
321-0443-00	402K	1/8W	1%	
361-0384-00	Spacer, Sw.			
388-3900-01	Board, E. C. (Raw)			

EXT. SIG. IN

TO LIMITS BOARD

ECG TEST SIG OUT

BPM ÷2

TO RESP TEST CKT

EXT SIG

QRS

QRS + PACER

PACER

SQUARE WAVE

CMRR/ LEAKAGE

OPEN LA

OPEN RA

100K, 1%

100K 1/8W, 0.25% 321-644

PACER ± 5ma

1.27M 1%, 1/2W

INPUT OFFSET TEST RANGE

100 1/8W, 0.1% 321-0097

±100mv

±250mv

2.37K 1%

5.9K 1%

50 1/8W 0.25% 321-0151

-12V

+7V

5.6K

1.2K

-0188

-0190

1K

Q80

Q90

62K

-7V

.047µf 283-0187

39K, 5%

.001 283-0067

100K, 5%

10K, 5%

U95A

0.22µf 283-0339

39K, 5%

±6.2V

62K, 5%

152-0280 6.2V

68K, 5%

U95B

5.62K 1%

ECG TEST SIG CAL 50Ω 311-1248

750 1%

EXT OUT

GND

.001µf, 283-0599-00

10mhy 108-0324-00

120VAC

1M, 5%

10 120 VAC THRU 1M FROM MAINS HOT LINE

(413 RESP INPUT XFMR)

P106

RA 5.1K, 5%

.001

LA 10K, 5% 10mhy

LL 15K, 5%

C 10K, 5%

RL 10K, 5%

GUARD

A (WHT)

B (BLK)

C (RED)

D (BRN)

E (GRN)

F (SHIELD)

GUARD PLANE

OPTIONAL

FROM LIMITS BOARD CONN PIN 2

148-0076-00

200, 5%

BPM ÷2

62K

90.9 1%

10, 1%

1.5K 1%

1% 750

-0302

62K, 5%

-0190

1K, 1%

470pf

NC

413 RESP ISOLATION XFMR

0 - 750 - 1.5K RESP SOURCE

Z

BOTTOM VIEW (PLASTIC CASE)

267, 1%

+2.5V TO 413 DVM REF

249, 1%

+5V TO 413 ECG & RESP

+12V

78L05 +5V REF

2 ECG SIG

2 ECG VA INPUT

7 ECG P/O ON INPUT

6 ECG OFF OUT PUT

8 BPM RATE

4 BPM ÷2

1 EXT OUT

3 GND

8 QRS OCCUR

+12V

-12V

GND

PACER OCCUR

SIZE POT

LEAD FAULT OUTPUT

62K, 5%

-0188

Q50

2.2µf 290-0523

510 5%

30K 5%

12K 5%

10K 5%

-0302

Q60

Q70

QRS LITE DIODE

PACER LITE DIODE

LEAD FAULT LITE DIODE

BU 2-22-77

413 / 414

408 / 412 TEST UNIT

ECG TEST BOARD

ALL 5% RES. ARE 1/4W

ALL 1% RES. ARE 1/8W

ALL DIODES ARE 152-0141-02

OP AMPS ARE 5558 (×2) 156-0158

1

PUSH BUTTON SWITCH
ASS'Y: 260-1657-00

ALL BUTTONS OUT = ZERO

25
50
150
250
LIMITS TEST
CAL
VARIABLE PRESSURE

PP

602K 1/8W, 0.1% 321-976-04
301K 1/8W, 0.1% 321-431-04
150K 1/8W, 0.5% 321-402-01
100K 1/8W, 0.1% 321-385-07
150K 1% 14 8 RY 1
50.0K 1/8 W, 1/4%, T2 321-0756-03

PRESS. OFFSET 0-25 0-50
602K 0.1% 301K 0.1%

RATE LITE DIODE
ALARM LITE DIODE
PRESS TRIG LITE DIODE
VAR PRESS POT

+7
510 5%
510 5%

TO LIMITS BOARD

P/P ON OUTPUT
ECG ON INPUT

909 1%
200 0 PRESS ADJ ZOT 311-1859-00

BRIDGE NULL 10K ZOT 311-1860-00
100K 1%
*301

* 1/8 W, 1/10%, T9 321-0193-07

20.5K, 1%

TO PRESSURE CONNECTOR P401
(F) (B) (E) (A) (D) (C)

RY 1
RY 2
62K 5%
Q10 Q20 Q30 Q40 151-0302
152-0141-02

200 5%
75 5%
100K, 5%
1K, 5%
15 5%
Q45 151-0302
TO PULSE CONNECTOR P403
(D) (C) (A)

8 BPM RATE
4 ALARM
414 DVM TEST SOCKET: 1 CONV PWR, 2 GND
8 P/P TRIG
6 P/P ON
7 ECG ON

P413 PULSE SIZE POT
5K 5%
5K 5%

10 10 DUAL TRACE CHOP BLANK
5 5 DUAL TRACE CHOP SIG
1 1 EXT OUT
3 3 GND
2 2 P/P DISPLAY

+12 11 11 +12
+7 12 12 +7
-7 13 13 -7
-12 14 14 -12
15 15 GND
16 16 GND

REVISED 7-27-73 RJB 12-16-75
8-17-73 RJB
11-12-73 RJB
9-11-74 RJB
10-28-74 RJB

408/412 TEST UNIT
PRESSURE / PULSE
TEST BOARD
5-11-73 DICK BALLARD

ALL 5% R ARE 1/4 W
ALL 1% R ARE 1/8 W
ALL DIODES 152-0141-02
RY 1, RY 2 148-0076

CKT BOARD, RAW: 388-3898-01
CKT BOARD ASS'Y: 670-3379-01

2

PUSH BUTTON SWITCH ASS'Y: 260-1658-00

ALARM RESET — MOM

RATE LIMITS

PRESSURE LIMITS

PRESS ALARM OFF

RATE ALARM OFF

33.2K, 1%

90 BPM

LO RATE LIM POT

41.2K, 1%

49.9K, 1%

150 BPM

HI RATE LIM POT

24.9K, 1%

PS10

68.1K, 1%

-12

28K 1%

HIGH — PP

121K 1%

78.7K 1%

63.4K 1%

OUT: NORMAL

402K 1%

2K, 1%

2K, 1%

LOW — PP

2K, 1%

18.7K 1% ×4

HI PRESS LIM POT

SYSTOLIC — PP

PS61

OUT: MEAN

DIASTOLIC — PP

LOW PRESS LIM POT

18.7K 1% ×4

VARIABLE RATE — PP

909 1%

250

311-1236

Ø 30 CAL

RATE POT

PS41

SYST/DIAST MEAN SWITCH

REVISED

7-27-73	RJB
8-17-73	RJB
8-28-73	RJB
9-5-73	RJB
11-12-73	RJB
12-4-73	RJB
12-10-73	RJB
9-11-74	RJB

408/412 TEST UNIT
LIMITS TEST BOARD
5-10-73 DICK BALLARD

CKT BOARD, RAW: 388-3900-01
CKT BOARD ASSY: 670-3381-01

TO DISPLAY / RATE SWITCH

TO ECG TEST BRD

TO REAR PANEL

ALARM RESET

TO PRESS/PULSE TEST B'RD

P/P ECG ON INPUT

P/P ON

ECG SIG

ECG VA IN

ECG P/P ON INPUT

TEST SIG OUT

LEAK OUT

EXT IN

100K 5%

+7

-7

7.5K, 1%

2.49K 1%

U35A

U35B

U35C

U35D

1K, 1%

220 µf 290-0662

U85B

.001 µf 283-0000

100K 1%

ECG ON

P/P ON

BPM ÷ 2

190K 1%

10K, 1%

U85A

BPM RATE OUT

U55B

LIM PRESS SIG

BPM RATE GEN ON/OFF

100K 5%

U45A

HZ RATE OUT

U15

+Vcc

IN

CD4024 ÷30

RESET

-Vcc

U55D

U45C

U55C

U45B

U45D

HZ RATE

U25A

CD4013

U25B

BPM RATE

U55A

P/P TRIG

ECG TRIG

GND

ALARM OUT

DUAL TRACE CHOP SIG

SEL TRIG

+12

+7

-7

-12

GND

GND

0.1µf 285-1075

U75B

U75A

7.5K 1%

RATE GEN CAL:

1) SET 330 CAL WITH RATE POT FULL CW
2) SET 30 CAL WITH RATE POT FULL CCW

2.5K 311-1239

10K, 1%

Ø 330 CAL

U65

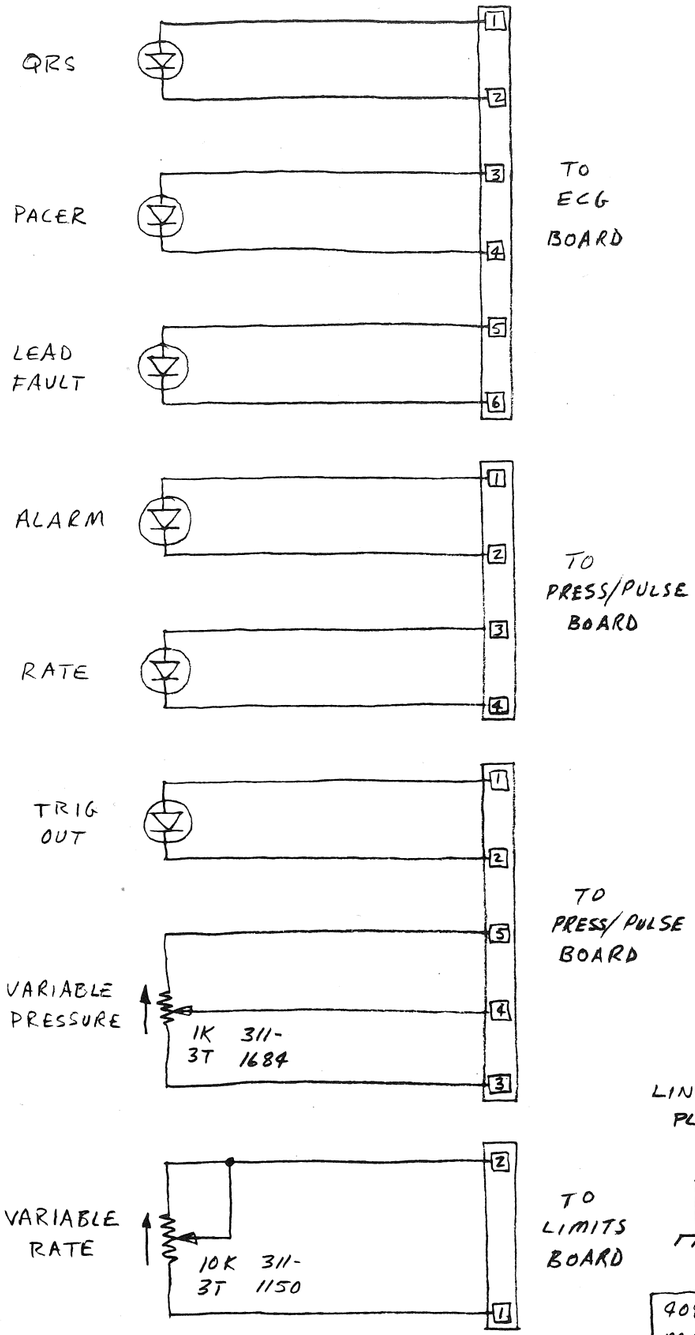
10K 1%

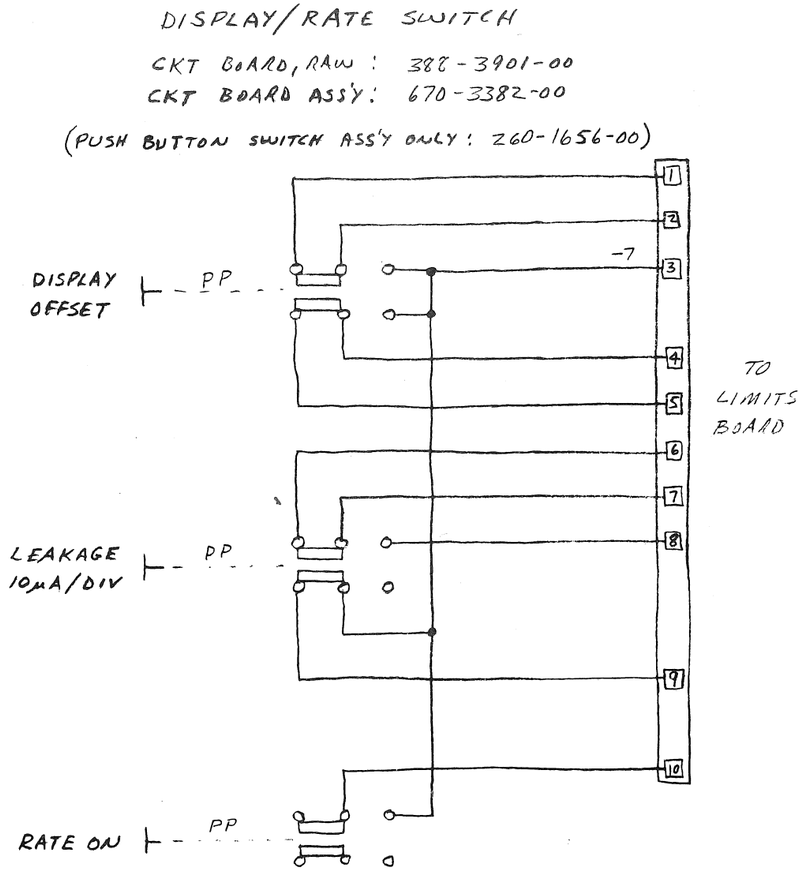
10K 1%

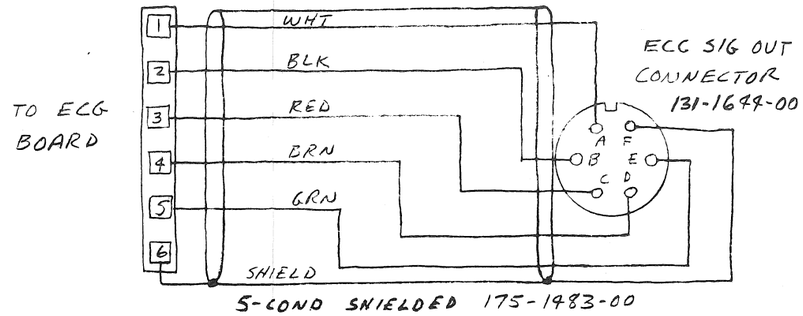
COUNTER	CD4024AE	156-0523
NOR GATES	CD4001AE	156-0349
NAND GATES	CD4011AE	156-0350
DUAL D FLIP-FLOP	CD4013AE	156-0366
U15, U85	5558	156-0158
U65	LM301	156-0105

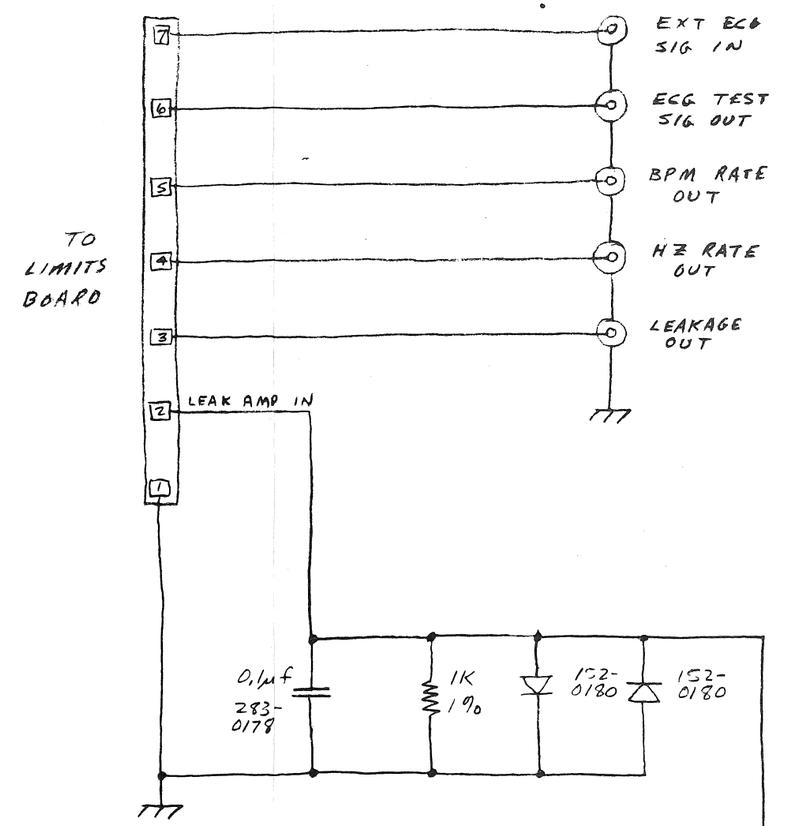
ALL 1% R ARE 1/8W; ALL 5% R ARE 1/4W
ALL DIODES 152-0141-02

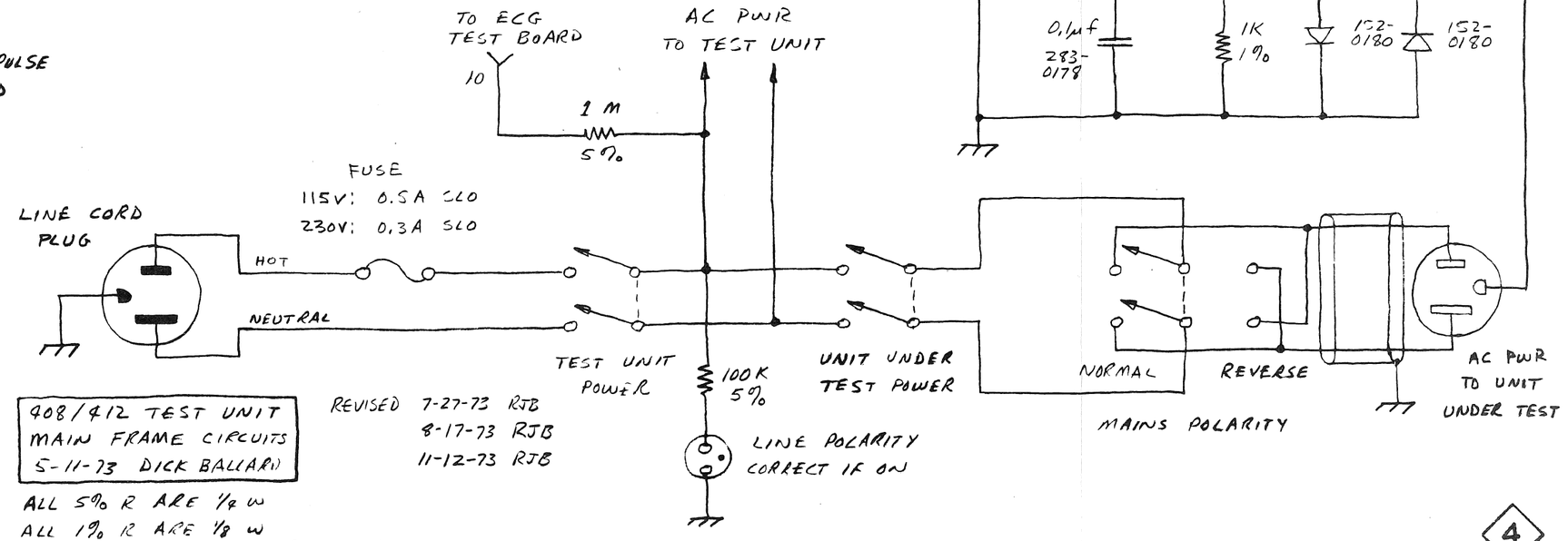
3











408/412 TEST UNIT
MAIN FRAME CIRCUITS
5-11-73 DICK BALLARD

ALL 5% R ARE 1/2 W
ALL 1% R ARE 1/8 W

REVISED 7-27-73 RJB
8-17-73 RJB
11-12-73 RJB