SUPERIOR SYSTEMS FOR EVERY NEED™

Hilger™
Facial Nerve Stimulator,
Model H3

Service Manual,
Version 3.1

WR MEDICAL ELECTRONICS CO.

Hilger Facial Nerve Stimulator, Model H3, *Service Manual, version 3.1,* no. 3024, revised 05/20/03, manual pages #920-W0-23018.

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WARNINGS AND CAUTIONS

- WARNING: Do not allow electrocautery probes and stimulator probes to contact each other or to simultaneously touch tissues or fluids in a surgical field. If the stimulator probes are allowed to touch the patient's tissues or fluids while electrocautery is energized, patient burns can occur. Electrocautery voltages can also damage the stimulator circuits.

- CAUTION: This device is restricted to sale by or on the order of a physician.

- CAUTION: This device is to be operated only by trained personnel under the direction of a physician.

- CAUTION: The Hilger Facial Nerve Stimulator is not explosion-proof and should not be used in the presence of explosive gases.

- WARNING FOR GROUND ELECTRODE PLACEMENT: Do not place any stimulator ground electrodes on the chest or in close proximity to a pacemaker. Interference with the pacemaker could occur. If there is any uncertainty as to stimulator-pacemaker interference, do not use the stimulator on pacemaker patients.

INTRODUCTION

DESCRIPTION OF THE DEVICE

The Hilger Facial Nerve Stimulator is designed for clinical testing of facial paralysis. Low energy, square wave current is applied to the skin overlying the facial nerve trunk (or branches) using the bipolar clinical probe. Nerve response is indicated by twitching of the associated facial muscles. Degeneration of nerve fibers on the paralyzed side is evidenced by a weaker response to a given current intensity than that given by the normal side, or by a higher current being required to produce an equivalent response. Absence of response at high current settings indicates complete nerve degeneration.

In the Minimal Stimulation Test, the current is turned up until the onset of twitching of one or more of the facial muscles. The normal side usually responds at about 3.0 milliamperes (mA), and a higher setting required to produce a response on the paralyzed side indicates nerve degeneration. The difference between the two sides shows the extent of degeneration.

In the Maximal Stimulation Test, the current is set at about 5.0 mA, which is sufficient to fire all of the viable nerve fibers and produce maximum contractions. The observed strength of the muscle contractions on the paralyzed side compared to those of the normal side indicates the relative number of nerve fibers responding to stimulation and the degree of nerve degeneration.

SAFE, LOW ENERGY,
PRECISE CURRENT CONTROL
Constant current, pulsed stimulation eliminates the hazards of non-pulsed or constant voltage stimulation methods.

SHATTERPROOF CASE
High impact ABS material withstands accidental abuse.

EASY-TO-READ
BATTERY STATUS INDICATOR
Low battery monitor lets operator know when batteries need replacing.

SPECIAL SKIN
RESISTANCE COMPENSATING CIRCUITRY
Automatically adjusts for varying skin resistance to provide accurate stimulation levels.

ADJUSTABLE BIPOLAR CLINICAL PROBE
Conveniently adjusts for each patient. Soft-touch tactile button provides additional comfort for the operator.

EASY-TO-READ BACKLIT LCD DISPLAY
Allows the operator to easily and conveniently see and adjust the stimulating current.

ACCESSORIES FURNISHED
Bipolar Clinical Probe
Electrode Cream, 4-ounce (113.4-gram) bottle
Operator's Manual
Service Manual
Carrying Case
Set of Journal Reprints
Electrocautery Warning

CURRENT CHARACTERISTICS
The Hilger Model H3 uses pulsed, constant-current stimulation, which is safer than most constant-voltage or non-pulsed DC stimulators. The Hilger Model H3 allows direct stimulation of nerve tissue without risk of injury. Special circuitry automatically adjusts for varying skin resistance to provide accurate stimulation levels.

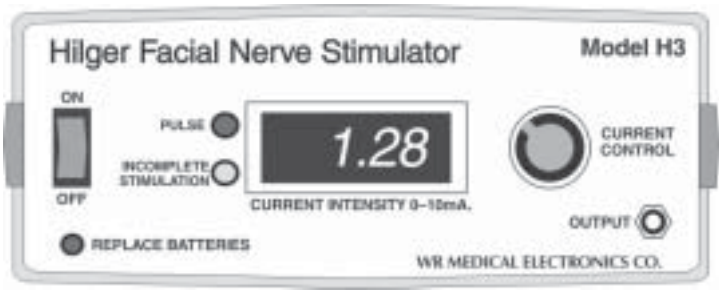
TECHNICAL SPECIFICATIONS
Current output: 0.0 to 10.0 mA, residual current of 0.05 mA at 0.0 indicated
Pulse width: 0.0006 seconds
Pulse off time: 0.1660 seconds
Pulse frequency: 0.1666 seconds
Dial accuracy: Linear down to 0.15 mA, residual current of 0.05 mA at 0.0 indicated
Batteries: four 1.5-volt Alkaline C cells
Battery life: 200 hours continuous use between replacement
Size: 8.5 x 9 x 3 inches (21.6 x 22.8 x 7.6 cm)
Weight: 4 pounds (1.82 kg)

OPERATION OF THE HILGER FACIAL NERVE STIMULATOR

FRONT PANEL DESCRIPTION

ON/OFF SWITCH

The ON/OFF switch turns the instrument on and off.



PULSE LIGHT

The PULSE light, to the right of the ON/OFF switch, flashes whenever the instrument is turned on.

INCOMPLETE STIMULATION LIGHT

The Hilger Facial Nerve Stimulator automatically compensates for changes or variations in tissue or contact resistance in order to maintain the current at a constant level. However, if the resistance is greater than that which the instrument can accommodate, or if there is a faulty connection or a break in the cable, the current reading as shown on the dial will not be valid, and the INCOMPLETE STIMULATION lamp will remain *on*. When the light goes *off,* the current as set on the dial is passing through the tissues. If the INCOMPLETE STIMULATION light stays on, try the following:

1) Check the REPLACE BATTERIES light. If the light is on, the batteries may need to be replaced.

2) Check the cables and connections by shorting the arms of the bipolar clinical probe with a metallic object. If the INCOMPLETE STIMULATION light then goes off, it indicates there is no fault in the probe or cables.

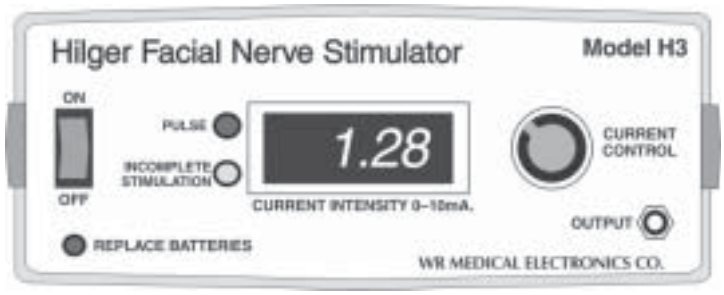
3) Repeat the skin preparation more carefully to lower the resistance. If the lamp stays off at low current settings but comes on as the current is turned up, the instrument was able to accommodate the resistance at the lower current setting but not at the higher settings.

REPLACE BATTERIES LIGHT

This instrument is powered by four manganese-alkaline batteries, size “C,” which have a useful life of about 100 hours of “on” time.

If the REPLACE BATTERIES light is illuminated, the battery voltage is too low for the stimulator to work correctly and the batteries should be replaced immediately. When the REPLACE BATTERIES indicator is on, the instrument may still produce a stimulating current, but the intensity and other parameters are liable to be incorrect, and the current reading would not be valid.

CURRENT INTENSITY DISPLAY



This backlit digital display indicates current intensity and gives the current reading in milliamperes (mA). The current intensity can be adjusted from 0.0 to 10.0 mA using the CURRENT CONTROL knob to the right of the digital display.

The current is linear with respect to the dial readings, down to a setting of 0.15 mA, which is considerably below the settings normally used, especially in clinical testing. At settings below 0.15 mA, the actual current is higher than shown on the display, and at a setting of 0.0 there is a residual current of about 0.05 mA (used to determine excess resistance). Below a setting of 0.15 mA, the display readings must be considered as relative rather than absolute measures of current intensity.

CURRENT CONTROL KNOB

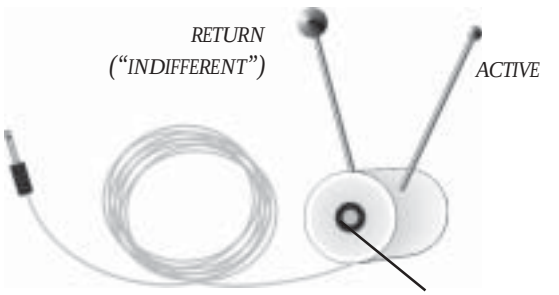
This knob is used to set the output, as shown on the CURRENT INTENSITY display. Turning the knob clockwise increases the output.

OUTPUT JACK

The bipolar clinical probe is plugged into this jack.

BIPOLAR CLINICAL PROBE

The small stainless-steel ball on the bipolar clinical probe is the active electrode, and is applied to the area of the nerve trunk or branches to deliver the stimulating current. The larger ball is the return, or "indifferent," electrode, which must also be in contact with the skin to complete the current path through the tissues. (See page 10, "Evaluating Facial Nerve Excitability," for specific placement instructions.)



The arms of the probe may be closed for storage, but should be fully opened to a distance of about three inches when the probe is used. The large ball (or return electrode) should preferably be applied where it is not directly over one of the nerve branches to avoid any possibility of secondary stimulation of one of the other branches.

The plug on the end of the probe cable goes into the OUTPUT jack on the front of the instrument and must be pushed all the way in. The small push-button switch at the center of the probe body is used to turn the current on and off. When placing the probe on the skin or removing it from the skin, the current switch must be off. Making or breaking the contact with the skin while the switch is on can cause patient discomfort.

After each use, the bipolar clinical probe should be wiped dry. The probe may be wiped with cleaning solutions but must not be immersed in liquids, as this would damage the switch and corrode the cables and connections. The bipolar clinical probe is used only for clinical testing and should not require sterilizing. However, if desired, it may be gas sterilized. It must not be steam autoclaved.

BATTERY REPLACEMENT

The batteries are good until the REPLACE BATTERIES light is illuminated. If the light is on, replace the batteries immediately. The batteries have a shelf life of about two years, irrespective of the amount of use. To extend the battery life, be sure the instrument is turned off when not in use.

The instrument uses four manganese-alkaline, size “C” batteries. Be sure to use manganese-alkaline rather than zinc-carbon batteries.

To replace the batteries, remove the screws from the bottom of the instrument, separate the case, and remove the old batteries from the holder. Insert the new batteries, being sure that the contacts (plus and minus terminals) of each battery are against the contacts of the holder.

Turn the instrument on to check that the REPLACE BATTERIES light is off, and that the PULSE indicator and INCOMPLETE STIMULATION lights come on.

CLINICAL TESTING PROCEDURES

SKIN PREPARATION FOR GOOD CONDUCTIVITY

The Hilger Facial Nerve Stimulator compensates for variations in the resistance of the current path through the skin and tissues in order to maintain a constant current intensity as set on the display. However, it is essential that the contact resistance between the electrode and the skin be kept as low as possible to ensure that the resistance does not exceed the compliance limits of the instrument, especially at higher current settings.

To ensure good skin conductivity, any cosmetics or skin creams must be removed from the areas where the electrodes are to be applied. This can be accomplished by washing with warm water and soap and rinsing thoroughly to remove all of the soap before drying.

Then Electrode Cream is massaged into the skin, working it in thoroughly to break down the natural oils of the skin, which increase its electrical resistance. The cream should be allowed to penetrate for a few minutes, and a second light application should be made, leaving the skin just slightly moist. Note: If an excessive amount of the Electrode Cream is allowed to remain on the skin, a portion of the current may travel through the cream instead of passing through the tissues, invalidating the current readings. Also, apply a small amount of the Electrode Cream to each of the electrode balls.

If, after applying the bipolar clinical probe to the skin, the INCOMPLETE STIMULATION light does not go out, resistance is too high or there may be a break in the cables. If the cables appear to be in order, repeat the skin preparation more carefully.

APPLICATION OF THE BIPOLAR CLINICAL PROBE

As mentioned in the previous chapter, open the arms of the bipolar clinical probe to a distance of about three inches. The large ball (or return electrode) should preferably be applied where it is not directly over one of the nerve branches to avoid any possibility of secondary stimulation of one of the other branches.

The small push-button switch at the center of the probe body is used to turn the current on and off. When placing the probe on the skin or removing it from the skin, the current switch must be off. Making or breaking the contact with the skin while the switch is on can cause patient discomfort.

SQUARE WAVE CURRENT AND NERVE RESPONSE

The current provided by the Hilger Facial Nerve Stimulator for stimulation of the nerve consists of square wave pulses of negative polarity and 0.6 milliseconds (0.0006 sec.) duration, with a pulse frequency of 6.0 pulses per second.

These parameters were determined by testing a large number of subjects, and were selected to give the best response without undue discomfort.

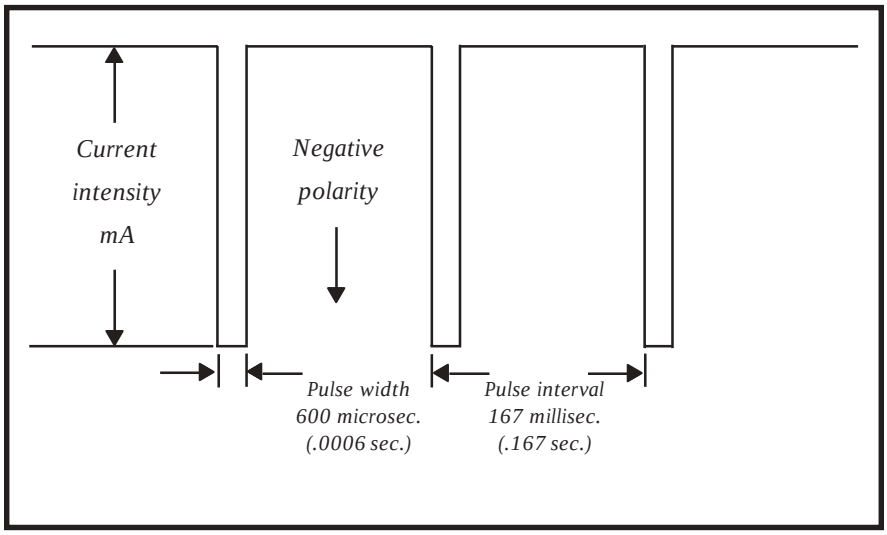


Figure 1: *Square wave pulsed current for nerve stimulation*

The current intensity is adjustable from 0.05 to 10.0 milliamperes (mA) by means of the CURRENT CONTROL knob, and is displayed on a backlit digital display. Current intensity refers to the height of the individual pulses as represented in Figure 1, and not to the average level of current.

When the pulsed current is applied to a normal nerve and the current intensity through the nerve tissue is high enough to reach the stimulation threshold, contractions of the associated muscles is evoked. The muscles contract with each pulse of the current and relax between pulses, resulting in repetitive contractions at a rate of six per second.

When the current intensity is just at the stimulation threshold, minimal and localized contractions are produced. As the current is increased above this level, the contractions become progressively stronger and more extensive until the entire muscle is responding fully.

Nerve response to electrical stimulation is a function of current intensity through the nerve rather than of applied voltage. Consequently, precise control of current intensity is essential for quantitative evaluation of nerve response. In the Hilger Facial Nerve Stimulator, the voltage is automatically adjusted to compensate for any differences in tissue or contact resistance so that the current is constant at any given setting of the CURRENT CONTROL knob. In addition, the INCOMPLETE STIMULATION light gives a visual signal if the resistance should exceed the compliance limits of the instrument.

BASIS FOR NERVE EXCITABILITY TESTING IN FACIAL PALSY

Clinical findings indicate that nerve excitability measurements aid in the evaluation and prognosis of facial palsy (see references). Jerome A. Hilger, M.D., states:

> *Comparison of the level of current required to produce twitching of the facial muscles on the affected side as compared to that required on the normal side was found to indicate the condition of the nerve. Equal response of the two sides at the same current intensity indicates that the block of the affected side is physiologic. Response of the affected nerve, but at higher current levels than on the normal side, indicates partial degeneration of the neuraxones. Lack of response on the affected side, even at high current intensities, indicates complete nerve degeneration.*[1]

The work of Campbell and his associates demonstrated the value of the nerve excitability measurements in the evaluation and prognosis of facial palsy. They state:

> *The distal portion of the nerve maintains its electrical excitability for 48 to 72 hours, after which the axis cylinders fragment with abolition of excitability and conduction. The motor end-plate however, retains its full excitability for a further 5 to 10 days, during which time the last fragments of axis cylinder in the motor end-plate disappear. The excitability of the end-plate then diminishes. Thus the characteristics of reaction of degeneration and the changes of denervation in the intensity-duration curve occur. In practice, therefore, if electrical stimulation is applied directly to recently denervated muscle it may respond with the characteristics of normal muscle for up to 10 days before showing the characteristics of denervated muscle. If, however, the motor-nerve trunk is stimulated, excitability and conduction will generally disappear three days after a denervating lesion has occurred. By this method, therefore, the state of the nerve may be determined earlier than by plotting of intensity duration curves derived from affected muscles.*[2]

EVALUATING FACIAL NERVE EXCITABILITY

In testing facial nerve excitability with the Hilger Facial Nerve Stimulator, the square wave stimulation current is applied first to the normal side and then to the paralyzed side to determine the current intensity in milliamperes (mA) required to produce muscle contractions of comparable strength on the two sides.

The motor-nerve trunk is stimulated by applying the active electrode to the skin overlying the stylomastoid foramen. The proper area is usually within one centimeter beneath the ear lobe and posterior to the ramus of the mandible. Starting with a current setting of about 1.5 mA, the region of the stylomastoid foramen is explored with the active electrode and the current is turned up slowly. Some

sensation will usually be noted by the patient before detectable twitch of the muscles occurs.

When one or more of the facial muscles can be seen to twitch, the area is explored further to find the optimum location that produces muscle contractions at the lowest current setting. This minimum current intensity is the measure of nerve excitability on the two sides.

A variation of this procedure is to start with a high current setting and turn the current down until contractions become minimal. Another approach is to base the comparative current readings on stronger and more complete rather than minimal muscle contractions. However, this involves a greater element of judgment in adjusting the current to produce contractions of the same intensity and extent on the two sides.

The various branches of the facial nerve, such as those controlling the forehead, eye, and mouth, may also be stimulated individually. Comparative current intensities required to evoke contractions of the corresponding muscles on the two sides of the face afford further insights into the condition of the nerve on the paralyzed side.

Serial testing is particularly important until it is established whether the paralysis resulted from a physiologic block or degeneration of the nerve. Nerve excitability should be tested daily if pain was a clinical feature of the onset, or every other day if pain was not a feature. This regime should be followed until either the response is lost entirely or decreasing difference in current intensity indicate definite continuing improvement. The nerve excitability test aids not only in diagnosis and prognosis, but also in monitoring nerve response during and following treatment.

Developmental testing of the stimulator on normal subjects showed a stimulation threshold of around 3.0 mA applied to the nerve trunk to be modal. Thresholds on both sides of the same normal subject were nearly identical, and retesting also showed thresholds nearly identical with the original determinations. A difference of about 2.5 to 3.0 mA between the two sides in stimulating the nerve trunk is generally considered as indicating significant nerve degeneration. The facial nerve branches respond at lower current settings than the nerve trunk, and correspondingly small side-to-side differences are considered significant.

MAXIMAL STIMULATION TESTING

The detailed testing procedure outline below is based on the concept of stimulating the nerve trunk, starting with a low current setting and turning the current up slowly until minimal contractions occur. However, this procedure can readily be adapted to other approaches.

1. Seat the patient comfortably in a position with good lighting so you can readily observe the muscle contractions.
2. Explain that the patient may experience a tingling sensation but that it is completely harmless.

3. Prepare the patient's skin on both sides of the face as explained in the preceding section.
4. Spread the arms of the bipolar clinical probe fully and plug it into the OUTPUT jack, making sure that the plug is all the way in.
5. Using the CURRENT CONTROL knob, set the current intensity to about 1.5 mA for the nerve trunk or 0.3 mA for the branches.
6. With the switch on the front panel, turn the instrument on, being sure that the PULSE light and the INCOMPLETE STIMULATION light are blinking.
7. Check to make sure that the REPLACE BATTERIES light is off. If the REPLACE BATTERIES light is off, there is sufficient voltage for the stimulator to function correctly.
8. With the switch on the bipolar clinical probe *off,* apply the return electrode to an area away from the facial nerve trunk or its main branches and apply the active electrode to the skin overlying the nerve trunk or the particular branch you are testing. Then press the probe switch button to turn on the current.
9. Check that the INCOMPLETE STIMULATION light goes off and remains off, indicating that the current as set on the dial is actually passing through the tissues.
10. Explore the area of the nerve trunk or branch with the active electrode while turning the current up slowly until muscle contractions are observed. Then explore the area further to find the optimum location at which contractions occur with the lowest current setting.
11. Test the normal side first, then the paralyzed side.

REFERENCES AND SUGGESTED READINGS

REFERENCES

1 Hilger, Jerome A. "Facial Nerve Stimulator," trans., *American Academy Opthalmology and Otolaryngology* 64:74–76, Jan.–Feb., 1964.

2 Campbell, E.D.R.; Hickey, R.P.; Nixon, K.H.; and Richardson, A.T. "Value of Nerve Excitability Measurements in Prognosis of Facial Palsy," *British Medical Journal* 2:7–10, July 7, 1962.

SUGGESTED READINGS

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Campbell, E.D.R. "A Simple Prognostic Test in Facial Palsy," *Journal of Laryngology* 77:462–66, June, 1963.

Gates, George A. "Nerve Excitability Testing: Technical Pitfalls and Threshold Norms Using Absolute Values." *Laryngoscope* 103:379–85, Apr., 1993.

Lewis, Brent I.; Adour, Kedar K.; Kahn, Jonathan M.; Lewis, Alison J. "Hilger Facial Nerve Stimulator: A 25-Year Update." *Laryngoscope* 101:71–74, Jan., 1991.

May, M. "Maximum Stimulation Test (MST)." In *The Facial Nerve*. Thieme Medical Publishers, New York: 1986.

Manos-Pujol, Manuel; Adour, Kedar K. "Who's Afraid of the Facial Nerve." Excerpted from *Otology* (Chapter 21), S.E. Lucente, ed. St. Louis: Mosby, 1995.

Ruboyianes, John M.; Adour, Kedar K.; Santos, David W.; Von Doersten, Peter G. "The Maximal Stimulation and Facial Nerve Conduction Latency Tests: Predicting the Outcome of Bell's Palsy." *Laryngoscope* 104:1–6, Jan., 1994.

WARRANTY, SERVICE, AND RENTAL PROGRAM

WARRANTY

The Hilger Model H3 is warranted to be free of defects in material and workmanship for a period of two years from purchase (90 days for the bipolar clinical probe). Warranty is void if the unit has been damaged by electrocautery. All warranty service is to be provided at the WR factory.

SERVICE

Service and technical questions are welcome. Because of the specialized circuitry of this instrument, the need for special test instruments, and our familiarity and experience with this instrument, we recommend that the instrument be returned to the factory for any necessary checking or servicing except routine battery replacement. To return a unit, ship the unit with its Bipolar Clinical Probe via insured parcel post or insured UPS. Be sure to pack with plenty of padding to prevent damage during shipping. If shipping from overseas, please specify that the goods are USA-made, and are being returned for repair.

Ship to:

WR Medical Electronics Co.
Technical Service Department
321 South Main Street
Stillwater, MN 55082 USA

Repair Department:

Phone 651-430-1200
FAX 651-430-9930

Customer Service:

Phone 651-430-1200
FAX 651-439-9733

RENTAL PROGRAM

Rental units are available at a minimal charge. Hospitals are required to issue a purchase order for rental and associated charges. The unit must be returned within 30 days.

CHECKOUT AND ADJUSTMENT

EQUIPMENT

Oscilloscope (HP Series 1200 or equivalent)
Power supply, 0–15 VDC, 400 mA
DC voltmeter/milliammeter (HP 412 or equivalent)
Resistance decade

GENERAL

Current intensity refers to pulse amplitude in milliamperes. Pulse amplitudes are measured with a 1K, ±1% resistor across the output of the instrument so the voltage drop across the 1K resistor is displayed on the scope. The scope therefore measures pulse amplitude directly in milliamperes (1 volt on scope=1 mA).

The center conductor of the OUTPUT jack (corresponds to active electrode) is connected to the (±) scope terminal, and the outer conductor is connected to the ground terminal. The output pulses are negative-going on the scope.

PROCEDURE

1. Visual Inspection
    a. Check circuit board soldering for cold solder joints and solder bridges.
    b. Check interconnections between circuit board and panel components for correctness, soldering and properly tied leads.
    c. Check that indicator light leads are properly separated.
    d. Check that dial is tight on shaft, turns freely, indexes properly and has correct zero adjustment.

2. Set up instrument and scope
    a. With scope triggering mode in automatic or “free running” and without instrument plugged in, position trace precisely on the line one division below top of grid. This is the zero reference line for current and voltage readings.
    b. Scope: DC coupled; sensitivity set at 2.0 volts/division; sweep set at 0.1 ms/division; slope set at (-).
    c. Connect instrument leads to DC power supply. CURRENT CONTROL knob at maximum. Voltage at 6.0 volts.
    d. Instrument: CURRENT INTENSITY display at 10.0, switch off.
    e. Plug connecting cable with 1K, ±1% resistor across output into instrument OUTPUT jack.

3. Adjust voltage regulator
    a. Remove batteries and connect DC power supply to batter holder. Test loop to case of PW trim pot R109. Positive to battery (+).
    b. Turn instrument on, watching for excessive current on power supply ammeter. Instrument should draw approximately 35.0–45.0 mA. If current is over 100 mA, turn instrument off *immediately* and check for fault.
    c. Adjust voltage regulator trim pot R102 for 3.8 ± 0.1 volts.

4. Adjust battery meter.
   Measure power supply voltage with external precision meter.
    a. Set power supply voltage at precisely 5.15 volts (+ 0.05V/–0.15V) and adjust meter trim pot R108 until REPLACE BATTERIES light comes on.
    b. Increase power supply voltage until REPLACE BATTERIES light turns off. Power supply voltage should read no more than 5.0 volts.

   If REPLACE BATTERIES light does not turn off in this range, repeat steps A and B. If REPLACE BATTERIES light cannot be properly adjusted, check U13 and/or REPLACE BATTERIES lead.

5. Check for output.
    a. If pulses do not appear on scope, check that frequency, pulse width, bias and gain trim pots are at approximately mid-range.
    b. Check that indicator light flashes with each pulse.

6. Set pulse amplitude at 10.0 and 0.0 on dial.
   SCOPE: Sensitivity at 2.0 volts/division, sweep at 0.1 ms/division, slope at (–).
   INSTRUMENT: CURRENT INTENSITY display at10.0.
    a. Set gain trim pot R123 for 10.0 mA (10V ±4%) pulse amplitude.
    b. Turn INTENSITY dial to 0.0 and adjust bias trim pot R125 for 50.0 µa (50.0 mV on scope ±10%).
    c. Gain and bias trim pots are interactive. Readjust alternately to get correct readings of 10.0 mA at 10.0 and 50.0 µa at 0.0 on INTENSITY dial.

7. Set pulse width.
   SCOPE: Set sweep at 20.0 ms/division. Align triggered pulse precisely on line at left edge of grid. Reset sweep to 0.1 ms/division.
   INSTRUMENT: Same as step 6. Adjust PW trim pot R109 for pulse width of 0.6 ms (±25 µs).

8. Set pulse frequency.
   SCOPE: Change sweep to 20.0 ms/division.
   INSTRUMENT: Same as step 7. Set frequency trim pot R110 for pulse period of 166 ms (6 pulses per second) ±5 ms.

9. Check output linearity and INCOMPLETE STIMULATION light.

   SCOPE: Change sweep to 0.1 ms/division.

   INSTRUMENT: Same as previous step.

   a. Disconnect output plug and check that INCOMPLETE STIMULATION light flashes.
   b. Reinsert plug, turn display down progressively to settings of 6, 3, and 0, checking the pulse amplitude on the scope against the display reading to verify linearity. At each step also disconnect the output plug to check the functioning of the INCOMPLETE STIMULATION light.

10. Check excess resistance circuit.

   a. Connect 100K variable resistor and a 1K, ±1% resistor in series across the output of the instrument.
   b. Connect scope across the 1K, ±1% resistor to measure pulse amplitude in mA.
      SCOPE: Sensitivity set at 1.0 volt/division; sweep set at 0.1 ms/division; slope set at (-).
      VAR. RES: Set at 0.0.
      INSTRUMENT: Square wave (nerve) setting. CURRENT INTENSITY display at 5.0.
   c. With instrument set at 5.0 mA, align square wave pulse trace precisely on a horizontal line of the grid.
   d. Turn CURRENT INTENSITY display up to 5.5 mA.
   e. Turn 100K variable resistor up until it brings the pulse amplitude on the scope back down to 5.0 mA.
   f. Turn CURRENT INTENSITY display down to below 5.0 mA, then turn it back up and note that up to a setting of 5.0, the current as measured on the scope increases, but above 5.0 the current goes no higher. Note display reading at which INCOMPLETE STIMULATION light comes on, which should be between 4.6 and 5.2 mA.

HILGER FACIAL NERVE STIMULATOR MODEL H3 REPLACEABLE PARTS LIST

ITEM DESCRIPTION	QTY	WR PART #
Case, finished, H3 - assembly	1	11013-A
Batt, holder, 4 C cells	1	11001
Case, finished, H3	1	11013
Decal, bright orange	1	15006
Decal, serial number	1	15010
Decal, batt repl, H3	1	15013
Hdwr, Screw, phil pan hd, #4x1/4	12	15121
Decal, CE	1	15247
H3 front panel - assembly	1	11021-A
Case, panel, front, H3, finished	1	11021
Conn, jack, micro (Scraft TR2A)	1	14081
Hdwr, knob, blue	1	15089
Display, LCD, backlit	1	16005
Lamp, LED, red	1	16009
Lamp, neon, amber	1	16013
Lamp, neon, clear	1	16014
Res, 1/4w, 10K ohm, CF	1	17040
Res, pot, 10K, 10 turn, 2 section	1	17085
SW, rocker	1	21017
H3 circuitboard, v3.2 - assembly	1	14009-A
C.B, H3, v3.2	1	14009
Diode, 1N5267	1	20014
Diode, 1N459A	1	20007
Diode, 1N5240	1	20013
Diode, 1N4005	2	20006
Cap, tant, 1 uf, 35v	1	12024
Res, 1/4w, 100 ohm, CF	1	17038
Res, 1/4w, 4.7K ohm, CF	6	17066
Res, 1/4w, 10K ohm, CF	4	17040
Res, 1/4w, 22K ohm, CF	4	17054
Res, 1/4w, 220 ohm, CF	1	17051
Res, 1/4w, 150K ohm, CF	1	17042
Res, 1/4w, 2.2K ohm, CF	1	17048
Res, 1/4w, 33K ohm, CF	1	17064
Res, 1/4w, 6.8 ohm, CF	2	17074
Res, 1/4w, 1K ohm, CF	1	17046
Res, 1/4w, 3.9M ohm, CF	1	17061
Res, 1/4w, 2.2M ohm, CF	1	17049
IC, socket, 8 pin	1	20056
Res, trimpot, PAN K4A, 1K ohm	1	17114
Res, trimpot, PAN K4A, 20K ohm	2	17115
Res, trimpot, PAN K4A, 100K ohm	1	17112
Res, trimpot, PAN K4A, 300 ohm	2	17116
Transis, 2N3638	2	20065
Transis, NTE-194	4	20068
Transis, 2N6027	1	20069

ITEM DESCRIPTION	QTY	WR PART #
Transis, 2N697	4	20070
Conn, header, .10, 8 pin	1	14038
Conn, header, .10, 6 pin	1	14034
Conn, header, .10, 2 pin	1	14030
Conn, header, .10, 14 pin	1	14029
Cap, disc., 1 uf, 12-25v	2	12005
Cap, elec, 100 uf, 50v	1	12012
Transis, GE-53/Phil ECG 158	1	20074
Cap, elec, 2200 uf, 50v	1	12016
Transformer, MC5086A	1	12028
Res, 1/4w, 120 ohm, CF	1	17041
IC, ICL7665, batt meter	1	20028
H3 wire set - assembly	1	22002-A
Conn, plug, IDC, .10, 12 cond	1	14054
Conn, plug, IDC, .10, 14 cond	1	14056
Conn, plug, IDC, .10, 6 cond	1	14062
Conn, plug, IDC, .10, 8 cond	1	14064