Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

MODELS 77-380 WAVEMETER

In U.S.A.
SIMPSON ELECTRIC LTD.
5200-18 West Kinzie Street
CHICAGO, ILLINOIS

In Canada
BACH-SIMPSON LIMITED
LONDON, ONTARIO

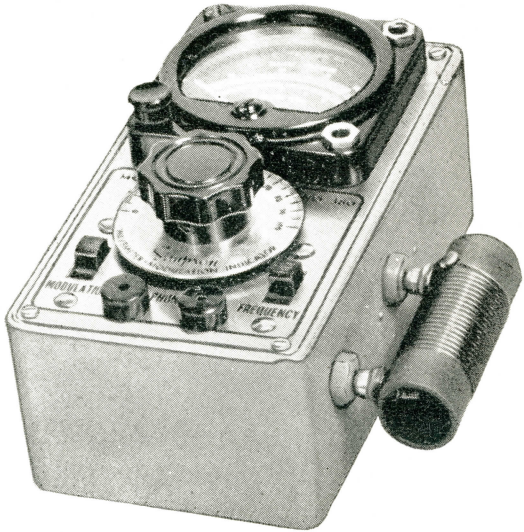
OPERATOR'S MANUAL

MODELS 77-380
WAVEMETER

In U.S.A.
SIMPSON ELECTRIC LTD.
5200-18 West Kinzie Street
CHICAGO, ILLINOIS

~

In Canada
BACH-SIMPSON LIMITED
LONDON, ONTARIO



Simpson Model 77-380 Wavemeter

TABLE OF CONTENTS

FOREWORD

Since its introduction a few years ago the model 77-380 has proved to be one of the most outstandingly successful pieces of measuring equipment ever produced. This fact has been attested by thousands of satisfied users throughout Canada, the U. S. A. and Europe.

In producing this revised version of the 77-380, it has been the intention to improve on the efficiency of the well proven original circuit, and to extend the range of usefulness still further by providing a greater frequency coverage. Stability has been considerably improved by the use of a very fine variable air spaced band setting trimmer, while by the use of a unique coil tapping arrangement, spurious responses have been eliminated but with no sacrifice in the selectivity for which the 77-380 is famous.

The sensitivity of the new unit when used as a modulation indicator has been greatly improved allowing considerably reduced coupling to the transmitter as a result. In addition, modulation checks can now be carried out with the unit in a resonant condition, that is, with appropriate coil in circuit and tuned to the frequency in question. In this condition even greater sensitivity is provided on modulation checks.

Printed in Canada

Continuous coverage of the spectrum from band to band is now provided in the frequency extended position of the circuit, yet this feature has been provided with no sacrifice in the accuracy of reading when used in the band spread condition. The hand calibrated feature for use in the band spread application has been continued in the new model since this is the only practical method by which the inbuilt accuracy of the unit can be fully exploited. In addition, complete non-band spread frequency vs. dial settings for all the coils normally associated with the 77-380 are provided and extend approximately from one megacycle to beyond 63 megacycles per second.

Four hand-calibrated coils are supplied with the unit; and, in addition, as extra items, two coils for the 6 and 160 meter bands are available. For the two meter band, a calibrated sliding antenna providing tuning facilities from 140 to 170 megacycles is also stocked as an extra item.

GENERAL

Each 77-380 comes complete with four plug-in type coils to cover the 80, 40, 20 and 10 meter bands. These coils have been hand calibrated against accurate frequency standards and are impregnated so as to withstand considerable handling. Space wound coils are produced on pre-prooved coil forms for better uniformity and stability. Notwithstanding this, however, reasonable care should be exercised in their use as obviously the calibration of a unit can only be as close as the coil maintains original factory set characteristics. Since the model 77-380 uses an extremely sensitive meter, this together with the method by which the energy is transferred from the tuned circuit to the rectifier provides an absolute minimum of damping. Thus a maximum sharpness of selectivity is obtained which, as a result, provides considerably above normal accuracy in frequency definition. A finely calibrated dial set against a hair line indicator provides for extreme accuracy of reading, which is then translated to frequency by reference to the individual coil charts provided in handy "hang up" form.

This method of frequency reading is selected as being the one most capable of giving highest accuracy in so far as multiple scales on the necessarily compact tuning dial would cause possible confusion and detract from readability. When used as a Wavemeter, even the lowest powered transmitters have sufficient output to operate the meter with the coil only acting as pickup when tuning to resonance.

Under these conditions best accuracy is obtained; but for use in field strength applications an antenna can be inserted in the jack provided to increase the pickup. Proper design allows the addition of the antenna with a minimum change in calibration, while for the absolute maximum sensitivity, the push button can be depressed providing a very substantial increase in output. The lower scale of the meter is calibrated in relative power, thus allowing the effect of tuning, antenna, or other adjustments to be read directly in percent increase of transmitted field.

The 77-380 will also find wide application as a modulation indicator. Calibrated directly in percent modulation, a simple comparison test allows the operator to read his transmitters' modulation depth at any time. If desired, once the level has been set, the unit can serve as a continuous modulation monitor. Because the calibration must be based on pure tone or sine wave modulation, some allowance should be made by the operator for the somewhat lower output of voice modulation. This is covered more completely on page 16.

Many other applications are outlined in detail as to exact procedure and correct method of approach in the pages following—you are urged to study each thoroughly in order to obtain maximum benefit from the instrument.

*The Wavemeter is marketed in Canada as Model 77, in the U.S.A., Model 380.

WAVEMETER APPLICATIONS (BAND SPREAD)

When employed as a Wavemeter, the circuit consists basically of an accurately tuned inductance, part of the output of which is fed to the meter through a 1N34 germanium type crystal diode. Using a highly sensitive meter, in conjunction with a high series resistance, materially reduces the loading on the tuned circuit, therefore a maximum sharpness of resonance indication is a result. Increased sensitivity is available by depressing the push button located on the lower left corner of the meter proper, but since this increases circuit loading most accurate results are obtained by coupling sufficiently close to the transmitter to allow suitable deflection with normal sensitivity. As previously mentioned, even low power transmitters will provide plenty of deflection for this condition by simply placing the unit near the final tank coil, or if inaccessible, adjacent to the antenna feeders or other RF carrying components. The use of the antenna on the model 77-380 when making accurate frequency checks is not recommended, since some detuning, and hence error in calibration, will result.

To locate the unknown frequency, place both toggles in the down position, then rotate the dial for maximum meter deflection. This is done, of course, after having first selected the proper coil for the band in question. The reading obtained is then

translated to frequency by means of the individual coil charts provided (see figure 1). The position of the hands, body, etc., will not cause detuning unless, of course, purposely placed almost on the coil itself. There may be some reduction or possible increase in induced signal, however, and for this reason it is advisable to keep the hands in the same relative position while determining maximum output from the dial. This setting should be derived by careful tuning procedure, swinging through the peak several times as in normal radio tuning. Grounding the unit to the transmitter will in most cases minimize variations of pickup and provides a substantially higher output. This can be best accomplished by the use of the grounding lead illustrated on page 13.

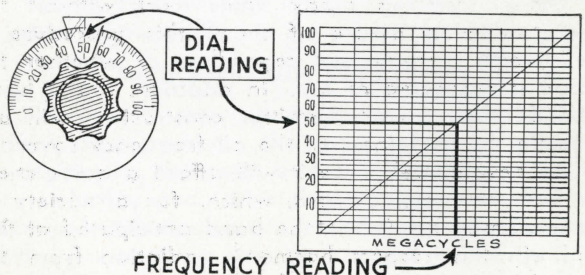


Fig. 1

WAVEMETER APPLICATIONS (Non-Band Spread)

In this application the switch marked "freqency" is operated in the "up" position, allowing the full tuning range to be available to the user. This feature allows the "77-380" to be used for many commercial frequencies outside the ham bands, and for which a very considerable demand has existed. In addition, it is a very useful feature to the Ham himself, in so far as spurious radiation, parasitics, etc., can be readily located by the simple procedure of tuning progressively through the total range provided by the coils available and with the Wavemeter held close to the tube or inductance suspected. For this application, the extra sensitivity afforded by the push button switch will prove invaluable, since often spurious oscillations are of very low power level.

Since parasitics many times exist without the operator being aware of them, this procedure is well worth carrying out regardless of whether the circuit is suspected or not. In addition, many hams who do their own transmitter construction will appreciate the usefulness of the all frequency coverage of the new model, since it will afford a quick check on any new coil designs which, for a variety of reasons, may not fall in the band anticipated at first trial. In this respect harmonic radiation from the stage in question can often lead to incorrect frequency identification, since it should be at once apparent that even a small amount of harmonic output will

be indicated by the "77-380" should a coil and condenser setting be chosen which is resonant at a harmonic frequency.

The proper procedure in a case of this nature is satisfied by always checking for further indications with the wavemeter, using a coil and condenser setting combination which will tune to a frequency one-half that at which the first indication is observed. Obviously if no indication is to be had at the new frequency, then the first reading is the fundamental. If on the other hand a reading is obtained at the lower setting, the first and higher frequency indicated is obviously harmonic in nature. In this case a further one-half frequency check below the last discovered resonance is indicated. Thus the ability of the "77-380" to tune to frequencies well below the amateur bands in question is appreciated.

Tuning data for the entire selection of six coils is listed on page 22.

FIELD STRENGTH INDICATION

As a field strength indicator, or for antenna pattern measurements, the extra sensitivity afforded by depressing the push button will again be found very valuable and, since sharpness of tuning is not essential in this application, no undesirable side effects result. An antenna can be inserted in the jack on the **lower** right corner of the meter proper, which greatly increases the sensitivity of the unit and causes a minimum of detuning as previously indicated.

In measuring transmitting antenna patterns, especially at the higher frequencies, polarization of the radiation will have to be considered if maximum sensitivity is desired. It may be useful, therefore, under certain circumstances, to orient the antenna in various planes until a maximum output is indicated.

From this point procedure can follow several methods. In the case of the increasingly popular rotary or fixed beam antenna, the problem of final adjustment for maximum power in a given direction is always of vital interest. For this reason the scale of the instrument has been calibrated in relative power units so that net power gains are easily recognized when obtained. This scale is designed to indicate most accurately when the push button is depressed—on the assumption that this will be the normal condition when making field measurements.

After preliminary antenna adjustments, the wavemeter should be located a reasonable distance from transmitter (1 wavelength or better) in the approximate centre of the beam, and then further antenna adjustments, — such as spacing of reflector and directors, length, etc., can be carried out until maximum power is indicated. After these correct settings have been established, beam width can also be checked for half power points by either swinging the antenna, in the case of the rotary type, or by moving the wavemeter itself across the beam lobe, for the fixed variety.

Back to front ratios and intensity and shapes of side lobes can also be established by the above procedure, of course, affording additional information as to the antenna's characteristics as a whole.

STANDING WAVE RATIO

A common problem associated with the foregoing antenna adjustments is that of transmission lines, and their proper matching to the antenna itself. In the case of resonant transmission lines, matching is obtained by tuning the line itself, in which case it becomes part of an overall resonant loop, and high standing wave ratio, that is, ratio of maximum RF voltage at any point on the line to minimum, is characteristic.

However, in the case of non-resonant lines, the opposite applies. Here the operator wishes to keep the ratio of maximum to minimum voltage on the line at 1 or as near that figure as possible. In this application the wavemeter serves the very useful function of indicating when proper match has been obtained, since only when this conditions exists will the voltage at all points on the line be equal. To obtain this ratio of reading, it will not be necessary to slide the wavemeter along the full length of transmission line wherever the line is more than two or three wavelengths long. Passing from minimum to maximum on even one wavelength along the line with the wavemeter tuned to resonance will

generally give sufficient information to indicate when the matching adjustments (fanning out of feeders, settings of stubs or quarter wave transformers, etc.) have produced the best results. Properly matched conditions, of course, indicate a further increase of power transfer efficiency, and should show up as an increase in field strength, if properly carried out.

For that reason further field strength checks should be instigated after any transmission line adjustments have been attempted.

QUALITY MONITORING

As a check on quality or even for remote control use, the 77-380 will find considerable favour. Simply plug a pair of reasonably high impedance head phones in the tip jacks provided, and quality checks can be carried out simply and efficiently. While the shunting of the meter is negligible normally, in the push button depressed position there will, of course, be a noticeable drop in headset volume. Conversely—there will be a considerable reduction in meter reading with the head sets inserted—for the same reason.

MODULATION INDICATION — GENERAL

There are two basic methods by which the modulation depth of a modulated carrier may be checked with the 77-380, and it may prove useful to the operator to employ both methods—at least until such time as he has established certain characteristics relative to the transmitter on which the checks are to be made. The first of these two methods will give

an indication of **over** modulation only, while the second will give an actual percentage modulation reading, and is therefore more desirable. Before attempting any modulation measurement it is suggested that a pair of leads with terminals and clips as illustrated be produced. The one lead affords a convenient grounding connection, so as to minimize effects of hands and strays, while the probe ended lead provides a satisfactory and safe method of picking up RF from small entry points on an otherwise completely shielded stage. The amount of RF introduced into the instrument is then quite readily controlled by the amount of penetration and provides the adjustment essential in making the calibration outlined above.

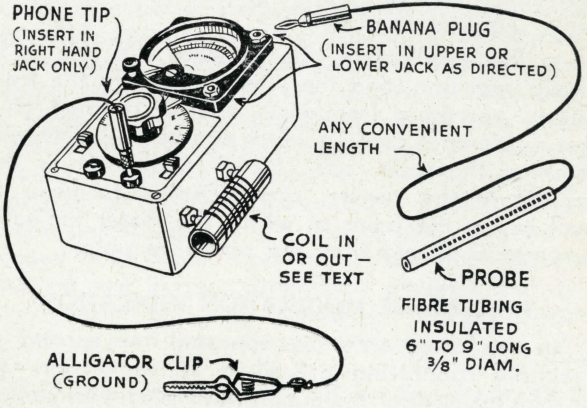


Fig. II

OVER-MODULATION INDICATION

It can be shown that all values up to and including 100% linear modulation will, after rectification, produce an identical average DC reading, when compared to that taken from the same carrier input, but with no modulation applied. If modulation is non-linear, or if more than 100% modulation is applied, then an increase in meter reading will be observed. It must be emphasized that this indication does not necessarily prove over-modulation since non-linear modulation, brought about by improper output stage operation, poor power supply regulation, etc., can produce a similar result. Its chief value lies in its ability to indicate to the operator that improper operating conditions obtain—and that further checking is required as a result.

In this application, the switches are left in the "down" position, and the unit is tuned to the transmitter's operating frequency, and so coupled as to give a reference reading which can be any convenient point on the scale, say 100%. Modulation is then applied to the carrier, and adjusted to keep the level below the point at which the meter indication increases suddenly from the reference point.

PERCENTAGE MODULATION INDICATION

In this case, once the operator has carried out a simple calibrating procedure in connection with his own transmitter the meter will indicate percentage

modulation directly on the scale provided. This is accomplished in a circuit in which are compared the relative values of the rectified carrier, and the rectified modulation component alone, after separation from the DC voltage produced by the carrier. This audio frequency component separation is effected by a blocking condenser, the audio AC component then being fed to a second rectifier and thence to a DC meter.

For 100% modulation, or any increment thereof, it is obvious that this rectified audio DC component will bear a fixed relationship to the rectified carrier DC level. It is also apparent that the rectified modulation component gives rise to a current considerably smaller, even under 100% modulation conditions, than that which flows due to rectification of the carrier in the first instance. Additional losses in the rectifier and coupling circuits reduce the second rectifier output still further, so that to bring the two rectifier outputs to the same level, a hand calibration, or "seriesing" is required. This is carried out at the factory by means of a precision transmitter, modulated at a known percentage at all times. All variables associated with each modulation indicator are compensated for in this calibration process, and once this procedure has been carried out, barring accident, the unit is then permanently calibrated.

The user has only to adjust the input to the

circuit from his own carrier, to the referencing point on the instrument scale —100%— and then by means of the toggle switch transfer the meter to read the second rectifier's output when modulation is applied.

PERCENT MODULATION CHECK — UNTUNED

In this application the RF Probe lead is inserted into the **upper** right hand antenna jack on the instrument, the ground lead connected, but no coil is inserted, so that the device functions as an untuned unit. The probe is located near an RF carrying component and adjusted to bring the meter to 100% on the dial with the modulation switch in the "down" position and no modulation applied. This toggle switch is then thrown to the "up" position, and modulation, when applied, will indicate in terms of percentage of the original carrier level.

PERCENT MODULATION CHECK — TUNED

In this case, the coupling leads may or may not be required, since the increased sensitivity produced by the use of the appropriate coil, tuned to the operating frequency is generally more than is required for all but the lowest powered transmitters. If such additional pickup is required, the antenna jack on the **lower** right hand corner of the meter would be employed for connection.

This method, apart from the increased sensitivity provided over the untuned conditions, follows identical procedure to that outlined above. In this case,

however, some pickup instability may exist, in that the signal induced in the coil is very apt to vary with position of objects in the room, microphone leads, and so on. Providing this is taken into account very satisfactory results can be obtained.

IMPORTANT

(1) It should be emphasized that instruments employing indicators other than cathode ray tube equipment cannot exactly indicate peaks of voice modulation, or, for that matter, any modulation other than pure tone.

This is brought about by the fact that a moving coil instrument requires a finite time to indicate—and will generally tend to average out a series of peaks into some steady value, rather than present them in true form. The ballistics—or "speed" of the movement employed — together with the damping factor, materially enter into the final results when using an instrument of this type to measure waveforms of irregular nature, and in this respect the meter employed in the "77-380" is especially damped for best all around results in this application. Since the type of voice, frequency response of equipment, and rate of transfer of information will all influence the readings to some extent, it is well to establish exact modulation capabilities of your equipment by a steady constant pitch and amplitude note, such as a whistle, into the microphone. Better still, a 400 cycle oscillator with sufficient output to operate a

loud speaker at about voice level and then placed in front of the microphone. A rough, but fairly safe rule of thumb is to assume 80% indicated on voice to be fairly close to 100% actual peak. This is qualified by the factors listed above, of course.

It is in this connection that the **over** modulation check procedure mentioned previously would be of some assistance to the user in establishing relationship between actual peak readings indicated on the instrument, and the true peak modulation values. Once this relationship is established for any transmitter and operator, an almost exact check on modulation depth is assured.

(2) When selecting a pickup point for modulation RF input, it is vitally important that this be well separated from a non-modulated RF field. This follows since readings would be meaningless if a substantial part of the RF reference voltage were to be picked up from a part of the circuit not subject to modulation.

USE OF THE CALIBRATED ANTENNA

At frequencies much in excess of 100 megacycles, series resonance phenomena combined with normal parallel resonance tend to produce unsatisfactory frequency indication, when using a coil and condenser of conventional variety. This is brought about more from internal stray effects, rather than from the difficulty of producing an external coil of sufficiently small inductance, to operate at these frequencies.

For this reason then, tuneable circuits employing the tuning condenser are discarded in the 140-170 megacycle band,—instead a highly selective ¼ wave antenna of adjustable physical length is employed. In order to avoid excessive reaction with the normal tuning components, and so that the antenna will exhibit sharpest selectivity, it is connected directly to the choke coil, from the **upper** right input jack. It is important that this requirement be adhered to, otherwise very erratic operation will result.

When using the variable length antenna, the tuning condenser should be set to approximately maximum capacity (100 on the dial), so as to minimize absorbtion through the small back coupling provided by the 5 mmf impedance matching condensers. Since the antenna carries a clearly marked frequency scale, resonance with the carrier frequency is obtained by adjusting the antenna for maximum meter output and reading off the frequency directly.

The alternative and perhaps more convenient method is that of setting the antenna to the correct physical length, corresponding to the desired frequency, and then tuning the transmitter for maximum indicated output on the wavemeter. This eliminates inconstant signal pickup due to proximity of the hands, body, etc., as adjustments are carried out.

All other functions which apply at the lower frequencies apply in this case, of course, so that the

usefulness of the instrument is in no wise decreased with increase of frequencies well beyond 200 megacycles.

SUGGESTIONS FOR THE CARE OF THE WAVEMETER

(1) Providing reasonable care is exercised in the process, the 77-380 may be removed from its case, and then replaced without loss of calibration. The rigid wiring arrangement permits this, however the practise is not a good one and is to be discouraged.

(2) Under no circumstances make any adjustment to the trimmer which is accessable through the banana jack associated with the plug in coil. Calibration on band soread will be completely destroyed even for the slightest re-setting of this component.

(3) The crystal detector, while extremely rugged will not withstand indefinite overload. Make sure your wavemeter is not subject to intense RF fields or that it accidentally comes in contact with high DC voltage. Burn out or loss of calibration will be the result.

(4) Handle the plug-in coils with reasonable care, insert or withdraw them with thumb and forefinger clamped against the ends of the coil so that a minimum of stress is placed on the winding proper.

WARNING

Because of the high sensitivity of the new unit, plus the use of proper pickup leads as illustrated there should be no need to couple the unit to high potentials in a way which can be considered hazardous.

However, there is always danger present regardless of this, so remember "*always exercise extreme caution wherever coupling to the output of your transmitter.*"

Coil "A" General Coverage

Approximate Frequency	Dial Reading
1040 kc.	100
1100	93
1250	66
1500	40
1750	23
2000	11
2100	5

Coil "B" General Coverage

Approximate Frequency	Dial Reading
2100 kc.	96
2250	80
2500	61
2750	46
3000	35
3300	24
3500	19
4000	8
4200	0

Coil "C" General Coverage

Approximate Frequency	Dial Reading
4110 kc.	100
4300	90
5000	60
5700	41
6250	30
6675	23
7000	19
7500	13
8000	8
8340	4

Coil "D" General Coverage

Approximate Frequency	Dial Reading
8.4 mcs.	100
9.0	83
10.0	63
11.0	48
12.0	36
13.0	27
14.0	20
15.0	14
16.0	10
17.0	3

Coil "E" General Coverage

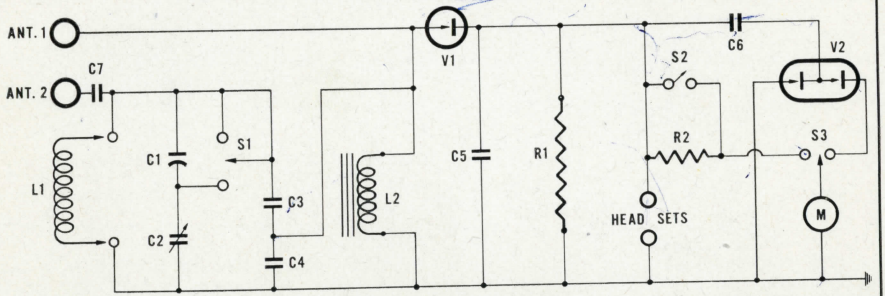
Approximate Frequency	Dial Reading
15.8 mcs.	98
17.0	80
19.0	60
21.0	45
23.0	34
25.0	25
27.0	18
29.0	13
31.0	8
32.8	2

Coil "F" General Coverage

Approximate Frequency	Dial Reading
26.2 mcs.	100
29.0	77
32.0	60
35.0	49
38.0	38
41.0	30
44.0	23
47.0	17
50.0	13
53.0	9
56.0	4

MODELS 77 – 380 WAVEMETERS
MODULATION INDICATOR

CIRCUIT DIAGRAM



PARTS LIST

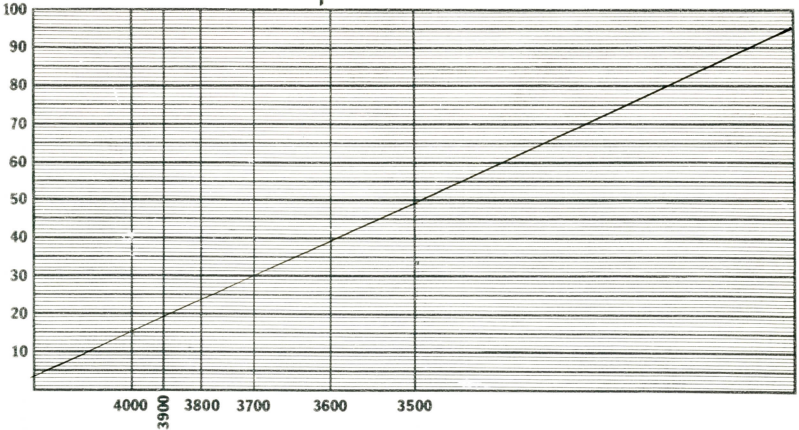
C1 – 3–30 MMF.
C2 – 75 MMF. VARIABLE
C3 – 5 MMF.
C4 – 5 MMF.
C5 – 200 MMF.
C6 – .1 MFD.

C7 – 5 MMF.
R1 – 15,000 OHMS ± 20%
R2 – 30,000 OHMS (APPROX.)
V1 – 1N34 DIODE
V2 – COPPER OXIDE RECTIFIER

L1 – TUNING COIL
L2 – R.F. CHOKE
S1 – BAND SET / SPREAD
S2 – INCREASE SENSITIVITY
S3 – MODULATION
M – 75–100 MICROAMP METER

CALIBRATED 15th June 55 SERIAL NO. 3172 CHECKED E.S.

MODEL 77 Simpson WAVEMETER MODEL 380

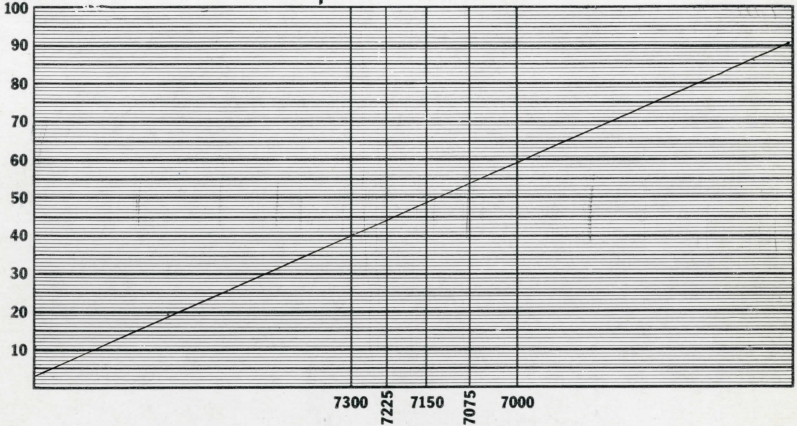


DIAL CALIBRATION

BAND: 3500 TO 4000 KILOCYCLES

CALIBRATED 15th June 55 SERIAL NO. 3172 CHECKED E.S.

MODEL 77 Simpson WAVEMETER MODEL 380

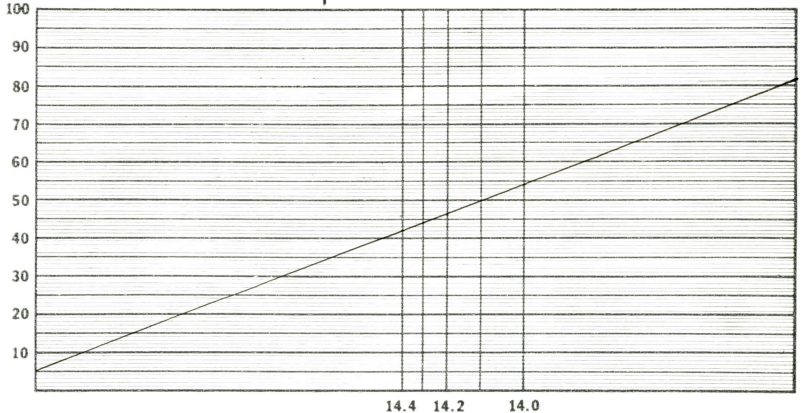


DIAL CALIBRATION

BAND: 7000 TO 7300 KILOCYCLES

CALIBRATED 15th June 55 SERIAL NO. 3172 CHECKED E.S.

MODEL 77 Simpson WAVEMETER MODEL 380

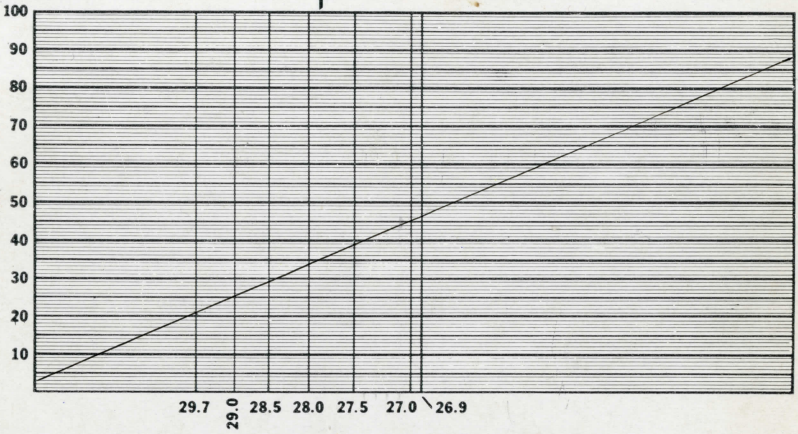


DIAL CALIBRATION

BAND: 14.0 TO 14.4 MEGACYCLES

CALIBRATED 15th June 55 SERIAL NO. 3172 CHECKED E.S.

MODEL 77 Simpson WAVEMETER MODEL 380



DIAL CALIBRATION

BAND: 26.9 TO 29.7 MEGACYCLES