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AC ANALOG VOLTMETERS

by Harry Logan

AC Analog voltmeters are one of the most popular electronic measuring instruments in use today. They are used to measure the RMS voltage of the many waveforms commonly found in electronics.

This article will provide you with the basics of AC analog voltmeters. It will give you a better understanding of their operation, allowing you to select the right one for your particular measurement.

The RMS or root-mean-square voltage is measured because this value gives us the most information about the waveform. The RMS voltage is equivalent to a DC voltage which produces the same heating effect as the AC signal being measured. For example, 1 volt of DC across a 1 ohm resistor will dissipate 1 watt. If we substitute any periodic waveform in place of the DC source and adjust its amplitude so that we again have 1 watt of power dissipated in the load, then our AC signal has an RMS or effective value of 1 volt.

In addition to its RMS value, a waveform also has a peak and average voltage value. See Figure 1.

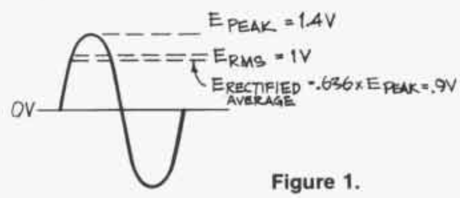

Figure 1.

This sine wave has an RMS value of 1 volt. Its peak value is 1.4 times its RMS value, or 1.4 volts. Its rectified average or DC value is .636 times the peak or .9 volts in the above example.

AC voltmeters are designed to respond to one of these three values. This classifies the meters into *true RMS* responding, *average* responding and *peak* responding. The average and peak responding voltmeters are designed to measure only sine waves.

Average Responding

With an average responding voltmeter, a sine wave being measured is fed through a DC blocking capacitor, amplified or attenuated, rectified by the diode bridge and fed to the meter. The meter then responds to this rectified average or DC value.

The average value of a sine wave is zero, so when we say average responding we mean the rectified average or DC component after rectification. This DC component deflects a d'Arsonval (moving coil) meter to indicate the RMS value of a sine wave. See Figure 2.

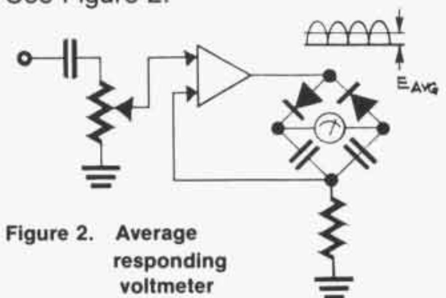

Figure 2. Average responding voltmeter

The average responding meter is the most popular and economical type of AC voltmeter. Its voltage scale has been made to indicate the RMS value of a sine wave. If any other waveform is measured, the meter will read incorrectly. Typical average responding voltmeters are the HP 400 D/H/L, 403A/B and 400E/EL.

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Peak Responding

Peak responding voltmeters are also designed to indicate the RMS value of a sine wave.

A capacitor in the probe charges through a rectifying diode to the positive peak of the applied sine wave. The voltmeter then responds to the DC output from the probe.

The peak responding meter has its rectifier in the probe instead of inside the voltmeter, so we convert from AC to DC as close to the signal as possible. Because the cable carries DC only, cable capacity does not affect the measurement. This greatly increases the high frequency response of the instrument. See Figure 3.

The AC probe can be switched out of the circuit and the voltmeter can then be used to measure DC voltages. By adding shunt resistors and an internal DC voltage source, we can also measure current and resistance. Typical peak responding voltmeters are the HP 410B and 410C.

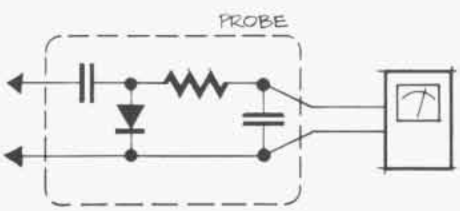

Figure 3. Peak responding voltmeters

RMS Responding

True RMS voltmeters are unique because they are the only type that accurately measure non-sinesoidal waveforms. They respond to the RMS or heating value of the impressed signal. See Figure 4.

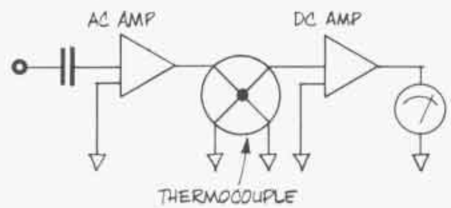

Figure 4. True RMS voltmeter

The input signal is AC coupled, amplified or attenuated and heats a thermocouple. The thermocouple produces a DC output proportional to the RMS value of the AC input. This DC voltage is amplified and deflects the meter needle to the RMS value. The response of the thermocouple is not dependent on the waveshape and thus true RMS voltmeters can accurately measure non-sinesoidal waveforms.

A limitation on the waveforms that can be measured with a true RMS voltmeter is crest factor. Crest factor must be considered when measuring pulse type signals — signals with a high peak and low RMS voltage. Crest factor is defined in terms of duty cycle or as the peak voltage divided by the RMS voltage. See Figure 5.

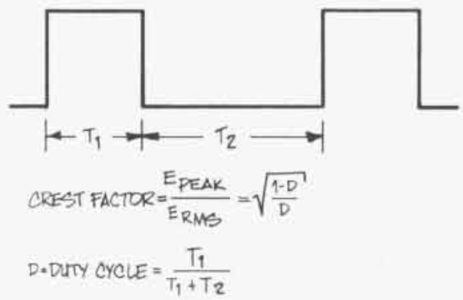

Figure 5. Crest factor

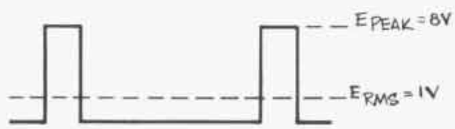

Figure 6.

The pulse in Figure 6 has a crest factor of 8. To measure it accurately, a true RMS Voltmeter with a specified crest factor of at least 8 is required. Crest factor limitation of a voltmeter is determined by its dynamic range. For example, because the pulse in Figure 6 has

RMS VOLTAGE

RMS stands for root-mean-square. We can use this definition to calculate the RMS or heating value of any waveform. Let's apply it to the 10v p-p square wave of Figure A. This will give us an insight into the meaning of RMS.

Figure A.

Applying the definition of RMS, we take the square root of the average value squared.

$$E_{RMS} = \sqrt{(E_{AVERAGE})^2\ \tfrac{1}{2}\text{cycle} + (E_{AVERAGE})^2\ \tfrac{1}{2}\text{cycle}} =$$

$$\sqrt{(5)^2\ \tfrac{1}{2} + (5)^2\ \tfrac{1}{2}} = \sqrt{25} = 5\text{v RMS}$$

Figure B.

Now suppose our 10v p-p square wave looked like the one in Figure B. Does it have the same RMS value as the square wave of Figure A? Note that the waveform is not symmetrical around 0v or ground. This means the waveform has a DC component, +5v in this case. So we really have two signals, +5v DC and a 10v p-p square wave superimposed on it. The square wave in Figure A has no DC component. Therefore the square wave of Figure B must have a greater RMS value. Again applying the definition of RMS we get:

$$E_{RMS} = \sqrt{(10)^2\ \tfrac{1}{2} + (0)^2\ \tfrac{1}{2}} = \sqrt{50} = 7.07\text{v}$$

Most true RMS voltmeters are AC coupled and would block the +5v DC component, thus measuring only the RMS value of the square wave. So when measuring any non-symmetrical waveform (one with a DC component), we must measure both the AC and DC components separately and use this formula:

$$E_{RMS} = \sqrt{DC^2 + AC^2}$$

For the waveform of Figure B we would get:

$$E_{RMS} = \sqrt{5^2 + 5^2} = \sqrt{50} = 7.07$$

This is the same value as was obtained applying the definition of RMS.

an RMS value of 1 volt, we should measure it on the 1 volt range. But the voltmeter's amplifier must also be able to handle the 8 volt level without saturation even though we're on the one volt range.

Of course, true RMS voltmeters can also measure sine waves since their crest factor is only 1.4. See Figure 7.

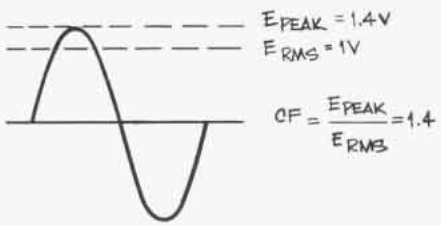

Figure 7.

Typical true RMS voltmeters are the HP 3400A, 3403C, 3480/3484A and 3450A/B.

Distortion Effects

All three types of meters will read correctly with a sine wave. With a distorted sine wave, only the true RMS meter will read correctly. The average responding and peak responding meters will be in error.

Table 1 lists the inaccuracies resulting from distortion. The table shows that a given amount of harmonic distortion may result in a wide range of possible inaccuracies, a consequence of the fact that the phase as well as the amplitude of a harmonic component affects the readings. This is illustrated by Figure 8, which shows two waveforms both with identical amounts of fundamental frequency and added 3rd harmonic. In the diagram at left, the fundamental crosses the zero baseline in phase with the harmonic waveform and in the diagram at right they are out of phase.

The peak responding meter would show a range of readings between "a" and "b", depending upon the phase of the harmonic. The range of amplitudes that would be shown by the average responding meter is more difficult to diagnose, but note that in the left diagram two half-cycles of the third harmonic add to the fundamental while one half-cycle subtracts whereas in the right diagram, only one half-cycle adds while two half-cycles subtract. The waveform in the right diagram therefore has a lower average value than the left waveform.

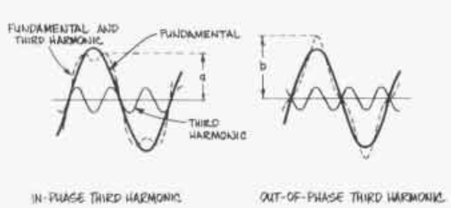

Figure 8. Phase of harmonics in waveform affect shape and thus the peak value of a complex wave.

HARMONIC CONTENT	TRUE RMS VALUE (VOLTS)	AVERAGE RESPONDING METER (VOLTS)	PEAK RESPONDING METER (VOLTS)
0	100	100	100
10 percent 2nd	100.5	100	90 to 110
20 percent 2nd	102	100-102	80 to 120
50 percent 2nd	112	100-110	75 to 150
10 percent 3rd	100.5	96-104	90 to 110
20 percent 3rd	102	94-108	88 to 120
50 percent 3rd	112	90-116	108 to 150

Table 1. Measurement errors from harmonic voltages.

Thus, the desired accuracy in the measurement determines the amount of distortion, (meaning departure from true sine wave), that can be tolerated in the measured waveform. The RMS voltmeter is unaffected by waveform shapes excepting, of course, those cases when harmonic components lie outside the passband of the voltmeter circuits or beyond the crest factor.

The RMS responding meter is especially useful, for example, in the monitoring of the line power fed to a resistive load where the line regulator distorts the waveform; another application is measurement of the frequency response of a communication system, where modulation and demodulation processes may be non-linear to an unknown degree. Again, the average responding meter tolerates relatively large amounts of distortion, while the peak responding meter is most sensitive to distortion.

Voltmeter Accuracy

The accuracy of AC voltmeters is often specified as a percentage of full scale. For example, if our voltmeter is specified as 1% of full scale and we are on the 100 volt range, any measurement would be in error by ±1% of 100 volts or ±1 volt. If the input signal were 10 volts, it would be measured with ±1 volt, an accuracy of ±10% of our reading. However, by downranging to the 10 volt range, the measurement can be made to ±1% of reading. For greatest accuracy, we should make our measurements as close as possible to full scale.

There are other items that contribute to total error. Refer to the operating manual for your voltmeter's accuracy specifications.

AC Measurements with a DC Component

Another accuracy consideration when using AC voltmeters is whether the signal contains a DC component. For example, if we wanted to measure the power dissipation in the load resistor in Figure 9, we must consider both the AC and DC voltage components.

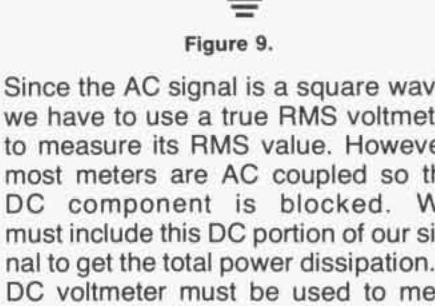

Figure 9.

Since the AC signal is a square wave, we have to use a true RMS voltmeter to measure its RMS value. However, most meters are AC coupled so the DC component is blocked. We must include this DC portion of our signal to get the total power dissipation. A DC voltmeter must be used to measure the DC component. The RMS value of the waveform can then be calculated using both meter readings and the formula: $E_{RMS} = \sqrt{(DC)^2 + (AC)^2}$

The trend in voltmeters is toward digital readouts. Some digital voltmeters can be direct coupled when measuring an AC signal with a DC component. This allows you to make the above measurement without any calculations.

SUMMARY AND HINTS

I. Peak and average responding AC voltmeters accurately measure pure sine waves only. The more we deviate from a pure sine wave, the greater the error. Peak responding are affected the most by distortion. As a rule of thumb, average responding meters can tolerate up to 10% harmonic distortion and peak responding 5%. True RMS meters are unaffected by distortion.

2. RMS voltage is measured because it gives us the most information about the waveform; it is equivalent to a DC voltage which produces the same heating effect as the AC being measured.

3. For a quick workbench check of your AC voltmeter, you can use your scope's square wave calibrator output. For a 1v peak to peak signal, the true RMS meter will read 0.5v; the average responding 0.55v and the peak responding 0.35v.

4. Peak responding voltmeters can measure the highest frequencies, typically up to 0.5 to 1 GHz.

5. If you measure pulses, know the crest factor limitation of your voltmeter.

6. Any time you measure a signal that is non-symmetrical, you must measure both the AC and DC components and compute the RMS value from this formula:

$$E_{RMS} = \sqrt{(DC)^2 + (AC)^2}$$

7. For maximum accuracy, use your voltmeter as close as possible to full-scale deflection.

Reference material for the article included HP Application Note 60 "Which AC Voltmeter;" HP Application Note 124 "True RMS Measurements;" and HP Videotape No. 90030B Opt. 605, "Choosing the Right AC Voltmeter."

SCALE FACTORS

The reason peak and average responding voltmeters are accurate only on sine waves is because of the scale factors designed into them. Consider the waveform in Figure A. An RMS responding voltmeter will measure the true RMS value of 10 V and it will deflect the meter to 10 v (that is, its scale factor is exactly 1.0). A peak responding meter will respond to the 14 v peak but will apply a scale factor of 0.707, and therefore it will also deflect its meter to the desired 10 volts reading, (14 × 0.707 = 10). An average responding meter will respond to the 9 v rectified average value and multiply by its scale factor of 1.11 to read 10 volts. Therefore all three meters read 10v for this sine wave, which is correct.

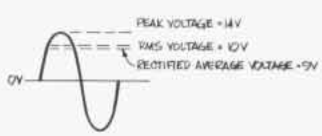

Figure A. 10V RMS Sine wave

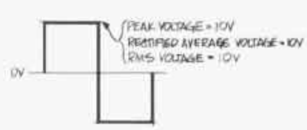

Figure B. 10V Square wave

Consider now the waveform in Figure B. An RMS responding meter will measure and display 10 v, which is the correct RMS voltage for this waveform. A peak responding meter will respond to the 10 v peak but *will still apply the correction factor for a sine wave* of 0.707 and thus display 7.07 v. An average responding voltmeter will respond to the rectified average of 10 v but it will also apply its scale factor for a sine wave of 1.11, displaying 11.1 v.

Since peak and average responding voltmeters are designed to measure sine waves, each has a scale factor for sine waves. Measuring any other wave shape requires a different scale factor and therefore these meters read incorrectly.

Harry Logan is currently working in HP Corporate Television producing several new video tapes. He joined the Company eight years ago and has spent most of that time in the Training Department teaching customers and HP personnel on low frequency instrumentation.

Harry is an avid photography enthusiast; he enjoys woodworking and gardening, in addition to playing the accordion and organ.

REPLACEMENT PART CROSS REFERENCE

When selecting replacement parts for your HP products, you may notice that many manuals list only an HP part number for the part, even though it appears that this part is manufactured by one of the large semiconductor manufacturers. Service personnel often ask why only HP part numbers are listed.

It is recommended that HP replacement parts be used to ensure that the original performance of the product will be obtained. While some parts used in HP instruments are identical to that which can be purchased at a local electronics distributor, many times parts will be selected for certain characteristics, such as gain, bandwidth, capacitance, etc. There may also be slight mechanical differences, such as the shaping or length of leads. In some cases special quality checks are employed to ensure that high reliability parts are used at the factory and at HP field offices.

Therefore, we suggest obtaining replacement parts from HP to maintain the quality that you have paid for in your instrument. There may be situations however where HP replacement parts are not in stock and substituting parts will allow you to return the product to service immediately. In these cases it may be worthwhile to see if a substitute part will work in the circuit. Perhaps an HP part could be ordered and installed at some later date.

To help you in these situations, here's a cross-reference of HP part numbers to JEDEC numbers for transistors and diodes, plus a listing of manufacturer and manufacturers' part numbers for ICs. While every attempt was made to ensure the accuracy of the list, it is advisable to compare the description of the device being replaced with the description of the substituted part. For example, if the service manual describes the device being replaced as a "dual J-K flip-flop", check this against the description of the replacement part.

HP P/N	JEDEC NO.
0122-0004	1N4809
0122-0005	1N4810
0122-0017	1N4804
0122-0025	1N4811A
0122-0062	1N5468A
0122-0070	1N5456A
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1854-0286	2N5217
1854-0287	2N915
1854-0289	2N730
1854-0301	2N3261
1854-0302	*2N3405
1854-0304	2N2483
1854-0308	2N3553
1854-0311	2N4240
1854-0313	2N3771
1854-0315	2N3633
1854-0323	2N2857
1854-0324	2N3739
1854-0325	2N3478
1854-0327	*2N3416
1854-0345	2N5179
1854-0347	2N4923
1854-0349	2N2913
1854-0350	2N3724A
1854-0352	2N2405
1854-0361	2N4239
1854-0363	2N5262
1854-0365	*2N4410
1854-0368	2N5191
1854-0370	2N5294
1854-0371	*2N3391
1854-0378	2N5109
1854-0379	2N4298
1854-0382	2N4348
1854-0384	2N5184
1854-0386	2N5070
1854-0389	2N4922
1854-0390	2N5181
1854-0392	*2N5088
1854-0397	2N4996

*=ELECTRICALLY EQUIVALENT TO JEDEC NO. (LEAD FORMED ONLY)

1854-0398 --	2N5301	1855-0357 --	3N142	1901-0032 --	1N3209	1901-0655 --	1N3290R	1902-1174 --	1N4106
1854-0399 --	2N4912	1855-0371 --	2N4092	1901-0048 --	1N3210	1901-0678 --	1N3899R	1902-1175 --	1N4107
1854-0409 --	2N5210	1855-0379 --	2N5474	1901-0057 --	1N2525	1901-0684 --	1N3890R	1902-1176 --	1N4108
1854-0411 --	2N2972	1855-0380 --	2N4351	1901-0058 --	1N628	1901-0693 --	1N4934	1902-1177 --	1N4109
1854-0416 --	2N3426	1855-0386 --	2N4392	1901-0059 --	1N629	1901-1015 --	1N4531	1902-1178 --	1N4110
1854-0418 --	*2N3563	1855-0387 --	2N3993	1901-0060 --	1N1116	1901-1052 --	1N4154	1902-1179 --	1N4111
1854-0431 --	2N5179	1855-0390 --	2N3382	1901-0061 --	1N816	1901-1058 --	1N1186	1902-1180 --	1N4112
1854-0432 --	2N3646	1855-0393 --	2N3330	1901-0062 --	1N1563A	1901-1065 --	1N4936	1902-1181 --	1N4113
1854-0453 --	2N5192	1855-0398 --	2N5519	1901-0071 --	1N625	1901-1080 --	1N5817	1902-1182 --	1N4114
1854-0454 --	2N5496	1855-0400 --	2N5905	1901-0129 --	1N647	1902-0003 --	1N754A	1902-1183 --	1N4115
1854-0467 --	2N4401	1855-0402 --	2N5115	1901-0132 --	1N660	1902-0018 --	1N941	1902-1184 --	1N4116
1854-0474 --	*2N5551	1855-0414 --	2N4393	1901-0151 --	1N2242	1902-0021 --	1N2992RB	1902-1185 --	1N4117
1854-0476 --	2N3879	1855-0420 --	2N4391	1901-0164 --	1N4721	1902-0028 --	1N2999A	1902-1194 --	1N2976B
1854-0477 --	2N2222A	1855-0421 --	2N5114	1901-0305 --	1N2158	1902-0030 --	1N3028B	1902-1195 --	1N1362
1854-0478 --	2N4046	1884-0002 --	2N684A	1901-0306 --	1N2158R	1902-0033 --	1N823	1902-1196 --	1N3047A
1854-0518 --	2N5877	1884-0003 --	3N58	1901-0307 --	1N3289	1902-0035 --	1N3008B	1902-1198 --	1N2973B
1854-0519 --	2N3772	1884-0004 --	2N1595	1901-0308 --	1N3289R	1902-0039 --	1N1597A	1902-1199 --	1N1604A
1854-0534 --	2N5838	1884-0010 --	2N4170	1901-0309 --	1N1347A	1902-0088 --	1N3003B	1902-1200 --	1N2980B
1854-0547 --	2N3725	1884-0012 --	2N3528	1901-0310 --	1N250C	1902-0089 --	1N3004B	1902-1201 --	1N3998A
1854-0548 --	2N5963	1884-0015 --	2N685	1901-0311 --	1N3260R	1902-0094 --	1N705A	1902-1203 --	1N2974RA
1854-0556 --	2N4237	1884-0016 --	2N688	1901-0312 --	1N3262	1902-0095 --	1N746	1902-1204 --	1N2984B
1854-0557 --	2N2432A	1884-0018 --	2N4186	1901-0313 --	1N3262R	1902-0105 --	1N468	1902-1205 --	1N2979RB
1854-0568 --	2N5845A	1884-0019 --	2N3669	1901-0314 --	1N1206A	1902-0111 --	1N753A	1902-1213 --	1N3037B
1854-0570 --	2N5189	1884-0021 --	3N83	1901-0315 --	1N1183A	1902-0156 --	1N2986B	1902-1215 --	1N2984B
1854-0572 --	2N5805	1884-0022 --	2N4172	1901-0316 --	1N1183AR	1902-0157 --	1N2620	1902-1216 --	1N938A
1854-0576 --	2N6258	1884-0023 --	2N4190	1901-0317 --	1N1184A	1902-0166 --	1N2986B	1902-1218 --	1N2992
1854-0577 --	2N6259	1884-0026 --	2N2322	1901-0318 --	1N1184AR	1902-0178 --	1N3004RA	1902-1219 --	1N2980RB
1854-0586 --	2N5429	1884-0027 --	2N1771A	1901-0319 --	1N1186AR	1902-0183 --	1N2995B	1902-1223 --	1N2982RB
1854-0590 --	2N3054	1884-0028 --	2N1774	1901-0320 --	1N1187A	1902-0191 --	1N2971RB	1902-1225 --	1N2971RA
1854-0596 --	2N5427	1884-0040 --	2N2024	1901-0321 --	1N1187AR	1902-0193 --	1N979B	1902-1226 --	1N3996A
1854-0597 --	2N5943	1884-0044 --	2N4102	1901-0332 --	1N3289	1902-0205 --	1N973A	1902-1228 --	1N2988RB
1854-0598 --	2N6249	1884-0051 --	2N1846	1901-0333 --	1N3736	1902-0245 --	1N4099	1902-1229 --	1N2979
1854-0599 --	2N6078	1884-0065 --	2N3670	1901-0334 --	1N3736R	1902-0246 --	1N4105	1902-1232 --	1N3997R
1854-0600 --	2N4233	1884-0066 --	2N4443	1901-0335 --	1N3736	1902-0509 --	1N823	1902-1234 --	1N4000A
1854-0611 --	2N6055	1884-0070 --	3N81	1901-0337 --	1N3261R	1902-0522 --	1N5340B	1902-1244 --	1N3034B
1854-0613 --	2N1701	1884-0071 --	2N4188	1901-0338 --	1N3261	1902-0528 --	1N5524D	1902-1245 --	1N752A
1854-0623 --	2N6306	1884-0074 --	2N5060	1901-0343 --	1N3491R	1902-0549 --	1N5365A	1902-1246 --	1N759
1854-0624 --	2N6308	1884-0080 --	2N5445	1901-0346 --	1N3209R	1902-0569 --	1N941	1902-1259 --	1N5357B
1854-0637 --	2N2219A	1884-0082 --	2N4441	1901-0370 --	1N4530	1902-0581 --	1N944	1902-1260 --	1N5525C
1854-0639 --	2N6178	1884-0088 --	2N3228	1901-0383 --	1N2565	1902-0625 --	1N829	1902-1276 --	1N2809B
1854-0643 --	2N3585	1884-0091 --	2N4990	1901-0398 --	1N2148	1902-0630 --	1N5236B	1902-1278 --	1N5348B
1855-0001 --	2N1671A	1884-0201 --	2N5061	1901-0406 --	1N3491	1902-0631 --	1N5351B	1902-1286 --	1N5342B
1855-0005 --	2N3436	1884-0204 --	2N5168R	1901-0409 --	1N4719	1902-0632 --	1N5354B	1902-1288 --	1N5358B
1855-0010 --	2N2646	1884-0209 --	2N5445	1901-0410 --	1N4720	1902-0680 --	1N827	1902-1290 --	1N5384A
1855-0021 --	2N1671B	1884-0211 --	2N5171	1901-0412 --	1N4722	1902-0686 --	1N825	1902-1291 --	1N5338B
1855-0027 --	2N2647	1884-0213 --	2N4441	1901-0414 --	1N4723	1902-0759 --	1N2983B	1902-1292 --	1N5372B
1855-0040 --	2N3819	1884-0218 --	2N5446	1901-0421 --	1N3208	1902-0761 --	1N821	1910-0002 --	1N388
1855-0052 --	2N4360	1884-0219 --	2N3899	1901-0422 --	1N3211	1902-0763 --	1N2163A	1910-0003 --	1N55A
1855-0055 --	2N4339	1900-0001 --	1N218	1901-0423 --	1N3212	1902-0772 --	1N935	1910-0014 --	1N277
1855-0056 --	2N4342	1900-0004 --	1N76	1901-0424 --	1N3492	1902-0777 --	1N825	1910-0023 --	1N270
1855-0065 --	2N4891	1900-0005 --	1N82	1901-0425 --	1N3493	1902-0785 --	1N936	1910-0024 --	1N191
1855-0077 --	2N1671C	1900-0006 --	1N4168	1901-0426 --	1N3494	1902-0786 --	1N937	1910-0025 --	1N995
1855-0081 --	2N5245	1900-0007 --	1N26	1901-0427 --	1N3495	1902-0787 --	1N938	1910-0031 --	1N34A
1855-0099 --	2N4853	1900-0008 --	1N53	1901-0428 --	1N3659	1902-0788 --	1N3154	1910-0033 --	1N279
1855-0204 --	2N4852	1900-0009 --	1N4158	1901-0429 --	1N3660	1902-0789 --	1N3155	1910-0039 --	1N55A
1855-0301 --	2N5198	1900-0010 --	1N218MR	1901-0430 --	1N3661	1902-0790 --	1N3156	1910-0041 --	1N2326
1855-0305 --	2N4117A	1900-0011 --	1N4168M	1901-0431 --	1N3662	1902-0791 --	1N942	1911-0001 --	1N91
1855-0306 --	3N128	1900-0012 --	1N23B	1901-0432 --	1N3663	1902-0792 --	1N943	1912-0002 --	1N3716
1855-0307 --	3N153	1900-0015 --	1N415C	1901-0478 --	1N3958	1902-0793 --	1N944	1912-0006 --	1N3718
1855-0309 --	2N4352	1900-0016 --	1N4603	1901-0491 --	1N4724	1902-0795 --	1N928B	1912-0007 --	1N3714
1855-0314 --	2N6027	1900-0017 --	1N21B	1901-0492 --	1N5002	1902-0796 --	1N989B	1912-0009 --	1N3712
1855-0322 --	2N5105	1900-0018 --	1N23C	1901-0493 --	1N4725	1902-1169 --	1N4100	1912-0014 --	1N3720
1855-0327 --	2N4416	1900-0019 --	1N831	1901-0494 --	1N5003	1902-1170 --	1N4101	1912-0015 --	1N3717
1855-0332 --	3N138	1900-0020 --	1N76A	1901-0511 --	1N3889R	1902-1171 --	1N4102	1912-0016 --	1N3713
1855-0341 --	2N4338	1901-0002 --	1N1200A	1901-0536 --	1N3289R	1902-1172 --	1N4103	1912-0017 --	1N3719
1855-0346 --	2N6028	1901-0005 --	1N603A	1901-0578 --	1N1184R	1902-1173 --	1N4104	1912-0019 --	1N3721

MFG. Abbreviations

Advanced Micro Devices	AMD
American Micro Systems, Inc.	AMI
Analog Devices, Inc.	ANAL
Computer Microtechnology, Inc.	CMT
Teledyne Crystalonics	CRYS
Dickson	DICK
Dynamic Measurements Corp.	DMC
Fairchild Semiconductor	FAIR
General Electric	GE
General Instrument	GI
Harris Semiconductor	HRIS
Hybrid Systems Corp	HBC
Intech, Inc	INTC
Intersil	INSL
ITT	ITT
Microsystems International, Ltd.	MIL
Monolithic Memories, Inc.	MMI
Motorola	MOT
Mostek	MOS
National	NATL
Precision Monolithics	PMON
Raytheon	RAY
RCA	RCA
Signetics	SIG
Silicon General	SGEN
Siliconix	SILX
Solitron	SOLT
Sprague	SPRG
Stewart Warner	SW
Sylvania	SYLV
Teledyne-Philbrick	PHIL
Teledyne Semiconductor	TELD
Texas Instruments	TI
Transitron	TRAN

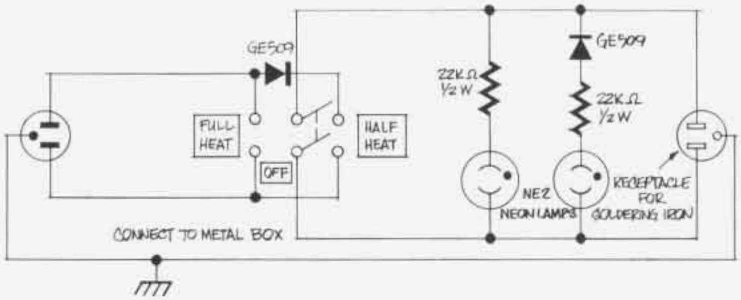
HP P/N	MFG	MFG P/N
1813-0012	VDYN	DAC-I128I
1813-0015	INTC	A-2419
1813-0016	BUB	3112/12C
1813-0034	INSL	IH5010CPD
	CRYS	IH5010CPD
1813-0036	HBC	DAC372-12-BCD
1813-0039	ZEL	ZD441
1813-0040	ZEL	ZD440
1813-0041	NATL	LH0042CH
1813-0048	ANAL	751N
1813-0049	TELD	2740CE
1816-0015	HRIS	HPROM1024
1816-0016	MMEM	MM6331
1816-0053	INSL	IM5600CPE
1816-0129	MMEM	MM6300
1816-0217	INSL	IM5610CPE
1816-0348	MMEM	MM6330
1816-0355	MOS	MK 2302P
1818-0061	NATL	MM5241ABLN
1820-0044	GE	RA1A
1820-0046	RCA	CA3005
1820-0047	RCA	CA3010
1820-0050	MOT	MC 1531G
1820-0051	FAIR	702 HC
1820-0052	FAIR	9 23 EC
1820-0054	TI	SN74 00 N
	MOT	MC74 00P
	NATL	DM74 00N
1820-0055	TI	SN74 90 N
	NATL	DM74 90N
	MOT	MC74 90P
1820-0056	TI	SN74 92 N
1820-0058	FAIR	709 HC
	NATL	LM709C
1820-0063	TI	SN74 51 N
	MOT	MC74 51P
	NATL	DM74 51N
1820-0065	TI	SN74 70 N
1820-0067	SIG	SP 631A
1820-0068	TI	SN74 10 N
	MOT	MC74 10P
	NATL	DM74 10N
1820-0069	TI	SN74 20 N
	MOT	MC74 20P
	NATL	DM74 20N
1820-0070	TI	SN74 30 N
	MOT	MC74 30P
	NATL	DM74 30N
1820-0071	TI	SN74 40 N
	MOT	MC74 40P
	NATL	DM74 40N
	FAIR	74 40PC
	SIG	N74 40A
1820-0072	TI	SN74 50 N
	MOT	MC74 50P
	NATL	DM74 50N
	FAIR	74 50PC
1820-0074	TI	SN74 54 N
	MOT	MC74 54P
1820-0075	TI	SN74 73 N
	MOT	MC74 73P
	NATL	DM74 73N
1820-0076	TI	SN74 76 N
	MOT	MC74 76P
	NATL	DM74 76N
	FAIR	74 76PC
	SIG	N74 76A
1820-0077	TI	SN74 74 N
	MOT	MC74 74P
	NATL	DM74 74N
	FAIR	74 74PC
	SIG	N74 74A
1820-0078	SIG	SP 620A
1820-0081	FAIR	9 11 HC
1820-0083	TI	SN75 10L
1820-0084	TI	SN74 53 N
	MOT	MC74 53P
	NATL	DM74 53N
1820-0085	TI	SN74 60 N
	MOT	MC74 60P
1820-0086	TI	SN158 30N
	MOT	MC 830P
	FAIR	9 30 DC
1820-0087	FAIR	9 50 DC
	MOT	MC 850P
1820-0088	MOT	MC 851P
	TI	SN158 51N
	FAIR	9 51 PC
1820-0094	TI	SN158 46N
	MOT	MC 846P
	FAIR	9 46 PC

1820-0095	MOT	MC 848P
	TI	SN158 48N
	FAIR	9 48 PC
1820-0096	MOT	MC 832P
	TI	SN158 32N
	FAIR	9 32 DC
1820-0099	TI	SN74 93 N
	NATL	DM74 93N
1820-0100	TI	SN74 41AN
	NATL	DM74 41AN
	MOT	MC74 41AP
1820-0101	MOT	MC 1034P
1820-0102	MOT	MC 1013P
1820-0104	NATL	LM201H
1820-0106	MOT	MC 816P
1820-0110	FAIR	9 59 DC
1820-0111	FAIR	93 01 DC
1820-0113	TRAN	TOA3709V
1820-0121	SIG	N8T90A
1820-0122	MOT	MC 853P
	FAIR	9093DC
1820-0123	NATL	LM300
1820-0125	FAIR	711 HC
	NATL	LM711C
1820-0127	FAIR	9002DC
1820-0128	FAIR	9 37 DC
	TI	SN158 37N
	MOT	MC 837P
1820-0129	FAIR	9003DC
1820-0130	FAIR	9004DC
1820-0131	FAIR	9009DC
1820-0132	FAIR	9016DC
1820-0134	FAIR	93 00 DC
1820-0137	RCA	CA3028B
1820-0138	PHIL	S52
1820-0140	MOT	MC 3026P
1820-0141	MOT	MC 3001P
1820-0142	MOT	MC 1004P
1820-0143	MOT	MC 1027P
1820-0144	MOT	MC 1018P
1820-0145	MOT	MC 1010P
1820-0146	MOT	MC 1017P
1820-0147	MOT	MC 1007P
1820-0157	MOT	MC 1023P
1820-0158	NATL	LM302
1820-0160	MOT	78 06 KC
1820-0162	NATL	LM709H
1820-0174	TI	SN74 04 N
	MOT	MC74 04P
	NATL	DM74 04N
	FAIR	74 04PC
	SIG	N74 04A
1820-0175	TI	SN74 05 N
	FAIR	74 05PC
1820-0180	MOT	MC 1015P
1820-0181	MOT	MC 1433L
1820-0186	FAIR	98 56 DC
1820-0187	FAIR	98 52 DC
1820-0192	RCA	CA3001
1820-0195	SIG	N8T80A
1820-0196	FAIR	723 HC
1820-0197	NATL	LM709AH
	FAIR	709A HM
1820-0200	MOT	MC 1030P
1820-0201	MOT	MC 1439G
1820-0202	SIG	SP 322B
	PHIL	741CE009
1820-0204	MOT	MC 3006P
1820-0205	MOT	MC 3003P
1820-0207	FAIR	96 01 PC
	MOT	MC 8601P
1820-0208	SIG	N8826A
1820-0211	TI	TMS3002LR
1820-0212	MOT	MC 1020P
1820-0213	MOT	MC 1014P
1820-0214	TI	SN74 42 N
	NATL	DM74 42N
1820-0218	ANAL	106A
1820-0223	NATL	LM301AH
1820-0224	NATL	NH0002C
1820-0231	FAIR	93 16 DC
1820-0233	TI	SN74 193 N
	NATL	DM74 193N
1820-0235	MOT	MC 1031P
1820-0238	MOT	MC 1810P
	SW	SW 1810M
	FAIR	1810PC
1820-0239	MOT	MC 3002P
1820-0247	NATL	LM305
1820-0249	RCA	CA3051
1820-0252	MOT	MC 1026P
1820-0253	MOT	MC 1035P
1820-0256	MOT	MC 858P
	TI	SN158 58N
1820-0257	MOT	MC 857P
1820-0258	MOT	MC 852P
	TI	SN158 82N
	FAIR	9099DC
1820-0259	MOT	MC 840P
1820-0260	MOT	MC 839P
1820-0261	TI	SN74 121 N
1820-0262	NATL	DM85 90N
	TRAN	TIC62018V
1820-0269	TI	SN74 03 N
	FAIR	74 03PC
	NATL	DM74 03N
	MOT	MC74 03P
1820-0270	FAIR	733 HC
1820-0272	MOT	MC 1022P
1820-0273	MOT	MC 1806P
	SW	SW 1806M
	FAIR	1806PC
1820-0274	MOT	MC 1808P
	SW	SW 1808M
	FAIR	1808PC
1820-0275	MOT	MC 1039P
1820-0276	MOT	MC 1033P
1820-0277	MOT	MC 1460R
1820-0279	TI	TIXL105
1820-0281	TI	SN74 107 N
	MOT	MC74 107P
1820-0282	TI	SN74 86 N
	FAIR	74 86PC
	NATL	DM74 86N
1820-0287	MOT	MC 672P
1820-0288	MOT	MC 662P
1820-0294	NATL	DM85 70N
1820-0297	RCA	CA3000
1820-0298	RCA	CA3020
1820-0301	TI	SN74 75 N
	MOT	MC74 75P
	NATL	DM74 75N
	FAIR	74 75PC
1820-0302	SIG	SP 670A
1820-0303	SIG	SP 680A
1820-0304	TI	SN74 72 N
	MOT	MC74 72P
1820-0305	TI	SN74 83 N
1820-0306	RCA	CA3028A
1820-0307	FAIR	9 36 DC
	MOT	MC 836P
	TI	SN158 36N
1820-0308	TI	SN158 45N
	MOT	MC 845P
	FAIR	9 45 DC
1820-0309	FAIR	9 60 DC
1820-0310	TI	SN158 62N
	MOT	MC 862P
	FAIR	9 62 DC
1820-0313	FAIR	9 31 HC
1820-0316	MOT	MC 1433G
1820-0317	MOT	MC 1433P
1820-0318	SIG	SP 616A
1820-0319	SIG	SP 629A
1820-0320	SIG	SP 659A
1820-0321	FAIR	710 HC
	TI	SN72 710L
	NATL	LM710CH
1820-0322	SIG	N8280A
	NATL	DM82 80A
1820-0323	MOT	MC 889P
1820-0324	MOT	MC 824P
1820-0325	MOT	MC 815P
1820-0326	RCA	CA3029
1820-0327	TI	SN74 01 N
	MOT	MC74 01P
	NATL	DM74 01N
1820-0328	TI	SN74 02 N
	MOT	MC74 02P
	NATL	DM74 02N
1820-0341	FAIR	9094DC
	MOT	MC 856P
	TI	SN158094N
1820-0342	FAIR	9097DC
	MOT	MC 855P
	TI	SN158097N
1820-0346	FAIR	9 33 DC
	MOT	MC 833P
	TI	SN158 33N
1820-0348	FAIR	9 44 PC
	TI	SN158 44N
	MOT	MC 844P
1820-0349	FAIR	9 49 PC
	MOT	MC 849P
	TI	SN158 49N
1820-0350	FAIR	9 61 DC
	MOT	MC 861P
	TI	SN158 61N
1820-0351	FAIR	9 63 DC
	TI	SN158 63N
	MOT	MC 863P
1820-0352	RCA	CA3018
1820-0357	FAIR	93 04 DC
1820-0361	TI	SN49 35N
1820-0362	TI	SN74 80 N
1820-0363	TI	SN74 82 N
1820-0364	TI	SN74 91AN
1820-0365	TI	SN74 81 N
1820-0366	TI	SN74 94 N
1820-0367	TI	SN74 95AN
	MOT	MC74 95P
1820-0368	TI	SN74 96 N
	NATL	DM74 96N
1820-0370	TI	SN74H 00 N
	MOT	MC 3000P
	FAIR	74H 00PC
1820-0371	TI	SN74H 10 N
	MOT	MC 3005P
	FAIR	74H 10PC
	NATL	DM74H 10N
1820-0372	TI	SN74H 11 N
	MOT	MC 3006P
	FAIR	74H 11PC
	NATL	DM74H 11N
1820-0373	TI	SN74H 20 N
	MOT	MC 3010P
	FAIR	74H 20PC
1820-0374	TI	SN74H 21 N
	MOT	MC 3011P
	FAIR	74H 21PC
1820-0375	TI	SN74H 30 N
	MOT	MC 3016P
	FAIR	74H 30PC
1820-0376	TI	SN74H 40 N
	MOT	MC 3024P
	NATL	DM74H 40N
	FAIR	74H 40PC
1820-0377	TI	SN74H 50 N
	MOT	MC 3020P
	FAIR	74H 50PC
	NATL	DM74H 50N
1820-0378	TI	SN74H 51 N
	MOT	MC 3023P
	FAIR	74H 51PC
1820-0379	TI	SN74H 52 N
	MOT	MC 3031P
	FAIR	74H 52PC
1820-0380	TI	SN74H 53 N
	NATL	DM74H 53N
	FAIR	74H 53PC
1820-0381	TI	SN74H 54 N
	MOT	MC 3033P
	FAIR	74H 54PC
1820-0382	TI	SN74H 55 N
1820-0383	TI	SN74H 60 N
	MOT	MC 3030P
1820-0384	TI	SN74H 61 N
	MOT	MC 3019P
	FAIR	74H 61PC
1820-0385	TI	SN74H 62 N
	FAIR	74H 62PC
	MOT	MC 3018P
1820-0386	TI	SN74H 71 N
	MOT	MC 3054P
1820-0387	TI	SN74H 72 N
1820-0391	TI	SN74H 73 N
1820-0396	TI	SN72 702N
1820-0397	TI	SN72 709N
	MOT	MC 1709CP
	FAIR	709 DC
1820-0398	TI	SN72 710N
	MOT	MC 1710P
	FAIR	710 PC
1820-0400	SIG	N8281A
1820-0408	FAIR	727 HL
1820-0410	NATL	MM 507
	MIL	MF1507
1820-0411	MOT	MC 817P
1820-0417	RCA	CA3002
1820-0418	MOT	MC 1812P
1820-0419	SIG	S8280A
1820-0424	TI	SN74H 04 N
	MOT	MC 3008P
	FAIR	74H 04PC
1820-0425	TI	SN74 100 N
1820-0427	MOT	MC 1496G
	NATL	LM1496H
1820-0429	NATL	LM309H
1820-0430	NATL	LM309K
	FAIR	LM 309 K
1820-0433	RCA	CA3023
1820-0435	TI	SN74 180 N
1820-0437	MOT	MC 4015P
1820-0439	FAIR	723 PC
1820-0440	MOT	MC 1016P
1820-0441	MOT	MC 1801P
	FAIR	1801PC
1820-0443	TI	SN74L 93 N
1820-0444	MOT	MC 1025P
1820-0445	TI	SN54 02 N
	FAIR	54 02PM
	MOT	MC54 02P
1820-0446	TI	SN54 74 N
	MOT	MC54 74P
	FAIR	54 740M
1820-0447	TI	SN54 10 N
	FAIR	54 10PM
	MOT	MC54 10P
1820-0448	TI	SN54 00 N
	FAIR	54 000M
	MOT	MC54 00P
1820-0449	MOT	MC 3060P
1820-0450	SIG	N8290A
1820-0451	MOT	MC 3062P
1820-0453	GI	SL-6-2050
1820-0454	MOT	MC 1805P
1820-0455	SIG	N8288A
	NATL	DM82 88N
1820-0456	SIG	N8855A
1820-0457	SIG	N8162A
1820-0458	SIG	N8816A
1820-0459	SIG	N8440A
1820-0460	SIG	N8480A
1820-0461	SIG	N8880A
1820-0462	SIG	N8251B
1820-0463	SIG	N8H70A
1820-0464	SIG	N8H90A
1820-0465	SIG	N8H80A
1820-0466	SIG	N8825A
1820-0467	SIG	N8881A
1820-0468	TI	SN74 45 N
1820-0469	TI	SN74H 102 N
	FAIR	74H 102PC
1820-0470	ANAL	118A
1820-0471	TI	SN74 06 N
	FAIR	74 06PC
	NATL	DM74 06N
1820-0472	MOT	MC 1001P
1820-0473	MOT	MC 1048P
1820-0474	RCA	CA3012
1820-0475	NATL	LM306H
1820-0476	FAIR	715 HC
1820-0477	NATL	LM301AN
1820-0478	NATL	LM308H
1820-0479	MOT	MC 835P
1820-0482	FAIR	98 38 DC
1820-0484	TI	SN74 84 N
1820-0485	FAIR	98 16 DC
1820-0486	FAIR	98 34 DC
1820-0488	FAIR	98 42 DC
1820-0491	TI	SN74 145 N
1820-0492	SIG	N8291A
1820-0493	NATL	LM307N
	TI	SN72 307P
1820-0494	INTL	C3101
	CMT	2100
1820-0495	FAIR	93 11 DC
	TI	SN74 154 N
	AMD	93 11 DC
1820-0497	TI	SN74L 95 N
1820-0498	SPRG	UM1500
1820-0505	NATL	DM82 20N
1820-0506	SIG	N8266B
1820-0507	SIG	N8263B
1820-0508	SIG	N8202N
1820-0509	MOT	MC 1488L
1820-0510	MOT	MC 1489L
1820-0511	TI	SN74 08 N
	FAIR	74 08PC
	NATL	DM74 08N
1820-0512	TI	SN74H 74 N
	FAIR	74H 74PC
	NATL	DM74H 74N
1820-0513	TI	SN74 09 N
1820-0514	TI	SN74 26 N
1820-0515	FAIR	96 02 DC
1820-0516	FAIR	9112DC
1820-0517	FAIR	98 65 DC
1820-0518	FAIR	98 53 DC
1820-0519	FAIR	98 22 DC
1820-0520	FAIR	98 06 DC
1820-0533	MOT	MC 838P
1820-0535	TI	SN75 451BP
	NATL	LM75 451AN
	SIG	N75 451V
1820-0536	SIG	N8284A
1820-0537	TI	SN74 13 N
	FAIR	74 13PC
1820-0538	TI	SN74 23 N
	FAIR	74 23PC
1820-0539	TI	SN74 37 N
1820-0542	SIG	N8234B
1820-0543	SIG	N8233B
1820-0544	TI	SN74H 103 N
	FAIR	74H 103PC
1820-0545	TI	SN74 191 N
1820-0546	TI	SN74 192 N
1820-0567	MOT	MC 4024P
1820-0568	TI	SN75 325N
1820-0569	SIG	N8243N
1820-0574	NATL	DM85 51N
1820-0575	SIG	N8235B
1820-0577	TI	SN74 16 N
	FAIR	74 16PC
1820-0578	MOT	MC 1024P
1820-0579	TI	SN74 123 N
	SW	SW74 123N
	SIG	N74 123B
1820-0581	MOT	MC 1032P
1820-0582	MOT	MC 1011P
1820-0583	NATL	DM74L 00N
1820-0584	NATL	DM74L 02N
1820-0585	NATL	DM74L 03N
1820-0586	NATL	DM74L 04N
1820-0587	NATL	DM74L 10N
1820-0588	NATL	DM74L 20N
1820-0589	NATL	DM74L 30N
1820-0590	NATL	DM74L 51N
1820-0591	NATL	DM74L 54N
1820-0592	NATL	DM74L 55N
1820-0593	NATL	DM74L 71N
1820-0594	NATL	DM74L 72N
1820-0595	NATL	DM74L 73N
1820-0596	NATL	DM74L 74N
1820-0597	NATL	DM74L 78N
1820-0598	NATL	DM74L 86N
1820-0599	NATL	DM74L 95N
1820-0600	NATL	DM85L 90N
1820-0601	NATL	DM74L 93N
1820-0602	NATL	DM86L 70N
1820-0603	NATL	DM82L 85N
1820-0604	MOT	MC 3025P
1820-0605	TI	SN74H 01 N
	MOT	MC 3004P
	FAIR	74H 01PC
1820-0606	TI	SN74 181 N
	FAIR	93 41 PC
1820-0607	MOT	MC 4012P
1820-0608	MOT	MC 4006P
1820-0609	MOT	MC 3061P
1820-0610	MOT	MC 8309P
	FAIR	93 09 DC
1820-0611	TI	SN74 182 N
	FAIR	93 42 PC
1820-0612	FAIR	9030DC
1820-0613	TI	SN74H 05 N
	MOT	MC 3009P
	FAIR	74H 05PC
1820-0614	FAIR	93L 08 DC
1820-0615	MOT	MC 8312P
	FAIR	93 12 DC
1820-0616	FAIR	93 22 DC
1820-0617	MOT	MC 3022P
1820-0618	TI	SN74 17 N
1820-0619	TI	SN74H 22 N
	MOT	MC 3012P
1820-0620	TI	SN74 153 N
1820-0621	TI	SN74 38 N
	SPRG	SN74 38N
	FAIR	74 38PC
1820-0622	TI	SN74 151 N
	MOT	MC74 151P
	NATL	DM74 151N
1820-0623	NATL	DM82 00N
1820-0625	MOT	MC 666P
1820-0626	FAIR	93 14 DC
1820-0627	FAIR	93L 01 DC
1820-0628	TI	SN74 89 N
	FAIR	93 403 DC
	NATL	DM74 89N
	MOT	MCM 4064L
1820-0629	TI	SN74S 112 N
	FAIR	74S 112PC
	SIG	N74S 112A
1820-0630	MOT	MC 4044P
1820-0631	TI	SN74H 108 N
1820-0637	SIG	N8875A
1820-0639	MOT	MC 4001P
1820-0640	TI	SN74 150 N
1820-0655	TI	SN74 25 N
	SW	SW74 25N
1820-0656	TI	SN74L 98 N
1820-0657	FAIR	93 18 DC
1820-0658	FAIR	93L 12 DC
1820-0659	FAIR	93L 00 DC
1820-0661	TI	SN74 32 N
	NATL	DM74 32N
1820-0665	MOT	MC 1814P
1820-0666	MOT	MC 1006P
1820-0667	MOT	MC 1040P
1820-0668	TI	SN74 07 N
	FAIR	74 07PC
	MOT	MC74 07P
1820-0669	FAIR	93L 10 DC
	AMD	93L 10 DC
1820-0681	TI	SN74S 00 N
	FAIR	74S 00PC
1820-0682	TI	SN74S 03 N
	FAIR	74S 03DC
1820-0683	TI	SN74S 04 N
	FAIR	74S 04PC
1820-0684	TI	SN74S 05 N
	FAIR	95 05 DC
1820-0685	TI	SN74S 10 N
1820-0686	TI	SN74S 11 N
1820-0687	TI	SN74S 15 N
1820-0688	TI	SN74S 20 N
	FAIR	74S 20PC
	SIG	N74S 20A
1820-0689	TI	SN74S 22 N
	FAIR	74S 65DC
1820-0690	TI	SN74S 40 N
	FAIR	74S 40PC
1820-0691	TI	SN74S 64 N
	FAIR	74S 64PC
1820-0692	TI	SN74S 65 N
1820-0693	TI	SN74S 74 N
	FAIR	74S 74PC
1820-0694	TI	SN74S 86 N
1820-0695	TI	SN74S 113 N
	FAIR	74S 113PC
1820-0696	TI	SN74S 114 N
1820-0697	TI	SN74S 140 N
	FAIR	74S 140PC
	SIG	N74S 140A
1820-0700	MOT	MC 3029P
1820-0701	FAIR	93L 14 DC
1820-0702	FAIR	93L 11 DC
1820-0703	SIG	N8292A
1820-0704	TI	SN74 122 N
1820-0705	FAIR	93 10 DC
1820-0706	FAIR	93 24 DC
1820-0707	TI	SN74 141 N
1820-0708	FAIR	93L 09 DC
1820-0709	FAIR	93L 28 DC
1820-0710	FAIR	93L 22 DC
	AMD	93L 22 DC
1820-0713	TI	SN74 163 N
1820-0715	TI	SN74H 106 N
	FAIR	74H 106PC
1820-0716	TI	SN74 161 N
1820-0717	NATL	MM5052
1820-0718	NATL	NH0025CN
1820-0719	MOT	MC72 42P
	SIG	N8242A
1820-0720	NATL	DM88 30N
1820-0721	NATL	DM88 20AN
1820-0722	TI	SN75 109N
1820-0723	TI	SN75 107N
1820-0724	MOT	MC 4007P
1820-0725	TI	SN74 170 J
	SIG	N74 170F
1820-0726	TI	SN74 199 N
	SIG	N74 199N
1820-0727	FAIR	93 21 DC
1820-0730	FAIR	96L 02 DC
	AMD	96L 02 DC
1820-0733	INTL	P1402
1820-0734	TI	SN74 190 N
1820-0737	FAIR	93 48 DC
1820-0738	TI	SN74 155 N
1820-0739	TI	SN74H 101 N
1820-0740	TI	SN74H 87 N
1820-0741	FAIR	93 28 DC
	AMD	93 28 DC
1820-0742	FAIR	93 08 DC
	MOT	MC 8308P
1820-0743	TI	SN74 194 N
1820-0744	TI	SN74 97 N
1820-0745	FAIR	9015DC
1820-0751	TI	SN74 196 N
1820-0752	TI	SN74H 76 N
1820-0762	TI	SN74 157 N
1820-0763	INTL	M1404A
1820-0765	TI	SN74 197 N
1820-0770	NATL	MM5006H
1820-0774	SIG	SP 374A
1820-0777	TI	SN74L 42 N
1820-0778	FAIR	93L 16 DC
1820-0780	NATL	DM88 31N
1820-0781	INSL	IN5013CDD
1820-0782	TI	SN74 27 N
1820-0783	TI	SN74 200 N
1820-0786	MOT	MC 7250P
	SIG	N8250A
1820-0788	TI	SN74 174 N
1820-0789	SIG	N8293A
1820-0790	MOT	MC 1660L
1820-0791	MOT	MC 1068P
1820-0792	MOT	MC 1043P
1820-0793	MOT	MC 1674L
1820-0794	MOT	MC 1670L
1820-0795	MOT	MC 1664L
1820-0796	MOT	MC 1662L
1820-0797	MOT	MC 1672L
1820-0799	TI	SN75 452P
1820-0801	MOT	MC10101L
	SIG	10101B
1820-0802	MOT	MC10102L
	SIG	10102B
1820-0803	MOT	MC10105L
	SIG	10105B

1820-0804	MOT	MC10106L
	SIG	10106B
1820-0805	MOT	MC10107
	SIG	10107B
1820-0806	MOT	MC10109L
	SIG	10109B
1820-0807	MOT	MC10110L
	SIG	10110B
1820-0808	MOT	MC10111L
	SIG	10111B
1820-0809	MOT	MC10115
	SIG	10115B
1820-0810	MOT	MC10116L
	SIG	10116B
1820-0811	MOT	MC10117L
	SIG	10117B
1820-0812	MOT	MC10118L
	SIG	10118B
1820-0813	MOT	MC10119L
	SIG	10119B
1820-0815	MOT	MC10121L
	SIG	10121B
1820-0816	MOT	MC10130L
	SIG	10130B
1820-0817	MOT	MC10131L
	SIG	10131F
1820-0818	MOT	MC10133L
1820-0819	MOT	MC10134L
1820-0820	MOT	MC10135L
1820-0821	MOT	MC10136L
1820-0822	MOT	MC10137L
1820-0824	MOT	MC10140AL
1820-0825	MOT	MC10141L
1820-0826	MOT	MC10160L
1820-0827	MOT	MC10161L
	SIG	10161B
1820-0828	MOT	MC10162L
	SIG	10162B
1820-0829	MOT	MC10164L
1820-0830	MOT	MC10179L
1820-0831	MOT	MC10181L
1820-0832	NATL	NH0007C
1820-0833	FAIR	93 34 DC
1820-0834	MOT	MC 4038P
1820-0835	SIG	N8267B
1820-0836	MOT	MC 4010P
1820-0837	SIG	N8815A
1820-0839	TI	SN74 175 N
1820-0842	MOT	MC 4008P
1820-0843	MOT	MC 4002P
1820-0844	MOT	MC 426
1820-0845	SIG	N8220B
1820-0846	NATL	DM80 94N
1820-0847	TI	SN74H 183 N
1820-0856	TI	SN74 00 J
	FAIR	74 00DC
	MOT	MC74 00L
1820-0857	TI	SN74 20 J
	FAIR	74 20DC
	MOT	MC74 20L
1820-0858	TI	SN74 76 J
	FAIR	74 76DC
1820-0859	TI	SN74 74 J
	FAIR	74 74DC
1820-0860	MOT	MC 8516
	FAIR	9 51 DC
1820-0861	MOT	MC 846L
	FAIR	9 46 DC
1820-0862	MOT	MC 848L
	FAIR	9 48 DC
1820-0863	FAIR	9158DC
	MOT	MC 858L
1820-0864	TI	SN74 03 J
	FAIR	74 03DC
1820-0865	MOT	MC 844L
	FAIR	9 44 DC
1820-0866	MOT	MC 849J
	FAIR	9 49 DC
1820-0867	TI	SN74H 40 J
	FAIR	74H 40DC
1820-0868	MOT	MC 1801L
	FAIR	1801DC
1820-0869	MOT	MC 835L
	FAIR	9 35 DC
1820-0870	TI	SN74 08 J
	FAIR	74 08DC
1820-0875	FAIR	96 00 DC
1820-0876	TI	SN74L 75 N
1820-0894	TI	SN74 04 J
	FAIR	74 04DC
	MOT	MC74 04L
1820-0897	MOT	MC 1047P
1820-0898	FAIR	93 05 DC
1820-0899	TI	SN74 160 N
1820-0900	SIG	SP 370A
1820-0902	TI	SN75 450AN
1820-0903	TI	SN74L 164 N
1820-0904	FAIR	93L 24 DC
1820-0906	NATL	DM82 14N
1820-0907	TI	SN74 12 N
1820-0908	MOT	MC74 79P
1820-0909	TI	SN74 167 N
1820-0910	TI	SN74LS 83 N
1820-0911	TI	SN74L 192 N
1820-0912	TI	SN74L 193 N
	NATL	DM74L193N
1820-0913	TI	SN74L 122 N
1820-0914	FAIR	93 07 DC
	MOT	MC 8307P
1820-0916	MOT	MC 1062P
1820-0917	MOT	MC 1065P
1820-0919	MOT	MC 1650L
1820-0920	MOT	MC 1692L
1820-0921	TI	SN74 85 N
1820-0923	SIG	N8885A
	MOT	MC 3002P
1820-0924	RCA	CD4038AE
1820-0925	RCA	CD4032AE
1820-0926	RCA	CD4008AE
1820-0927	RCA	CD4028AE
1820-0928	RCA	CD4041AE
1820-0929	RCA	CD4022AE
1820-0930	RCA	CD4026AE
1820-0931	RCA	CD4029AE
1820-0932	RCA	CD4033AE
1820-0933	RCA	CD4017AE
1820-0934	RCA	CD4018AE
1820-0935	RCA	CD4020AE
1820-0936	RCA	CD4024AE
1820-0937	RCA	CD4040AE
1820-0938	RCA	CD4027AE
1820-0939	RCA	CD4013AE
1820-0940	RCA	CD4044AE
1820-0941	RCA	CD4043AE
1820-0942	RCA	CD4000AE
1820-0943	RCA	CD4023AE
1820-0944	RCA	CD4025AE
1820-0945	RCA	CD4037AE
1820-0946	RCA	CD4001AE
1820-0947	RCA	CD4030AE
1820-0948	RCA	CD4002AE
1820-0949	RCA	CD4011AE
1820-0950	RCA	CD4012AE
1820-0951	RCA	CD4019AE
1820-0952	FAIR	9 52 DC
	ITT	MIC 952
1820-0953	FAIR	9 53 DC
	ITT	MIC 953
1820-0954	FAIR	9 54 DC
	ITT	MIC 954
1820-0955	FAIR	9 55 DC
	ITT	MIC 955
1820-0956	FAIR	9 56 DC
	ITT	MIC 956
1820-0957	FAIR	9 57 DC
1820-0958	RCA	CD4042AE
1820-0959	RCA	CD4036AE
1820-0960	RCA	CD4039AE
1820-0961	RCA	CD4021AE
1820-0962	RCA	CD4006AE
1820-0963	RCA	CD4031AE
1820-0964	FAIR	9 64 DC
	ITT	MIC 964
1820-0965	FAIR	9 65 DC
	ITT	MIC 965
1820-0966	FAIR	9 66 DC
	ITT	MIC 966
1820-0967	FAIR	9 67 DC
	ITT	MIC 967
1820-0968	FAIR	9 68 DC
	ITT	MIC 968
1820-0969	RCA	CD4035AE
1820-0970	RCA	CD4014AE
1820-0971	FAIR	9 71 DC
1820-0976	RCA	CD4015AE
1820-0977	RCA	CD4034AE
1820-0978	RCA	CD4007AE
1820-0979	RCA	CD4009AE
1820-0980	RCA	CD4010AE
1820-0981	RCA	CD4016AE
1820-0984	MOT	MC72 70P
	SIG	N8270A
1820-0985	MOT	MC 1800P
1820-0986	NATL	DM86L 75N
1820-0987	FAIR	93L 18 PC
	AMD	93L 18 DC
1820-0988	FAIR	93 410 DC
1820-0989	SIG	N8271B
1820-0990	MOT	MC 1489AL
1820-0992	TI	SN54 90 N
1820-0995	TI	SN74 47AN
1820-0998	TI	SN74S 153 N
1820-0999	TI	SN74S 181 N
1820-1002	TI	SN74 104 N
1820-1004	MOT	MC74 04F
	TI	SN74 04 W
	NATL	DM74 04W
1820-1005	FAIR	96 24 DC
1820-1006	INTL	C1101A
	MTL	MF1101A
1820-1007	SIG	N8T23B
	RAY	RC8T23MP
1820-1008	INTL	C3207
1820-1009	FAIR	95H 90 DC
1820-1015	TI	SN74S 158 N
1820-1016	TI	SN75 453P
1820-1017	FAIR	93L 21 DC
1820-1020	INTL	C3107
	MOT	MCM 4256AL
	NATL	DM85 82N
1820-1021	NATL	DM88 00H
1820-1022	TI	SN54 04 N
	NATL	DM54 04N
	MOT	MC54 04P
1820-1023	TI	SN54 93 N
	NATL	DM54 93N
	MOT	MC54 93P
1820-1024	TI	SN54 160 N
	SIG	554 160B
1820-1025	MOT	MC 1210L
1820-1026	MOT	MC 1213L
1820-1027	TI	SN74 195 N
1820-1030	SIG	N8T24B
	RAY	RC8T24MP
1820-1031	MOT	MC 3007P
1820-1032	TI	SN74 198 N
1820-1036	MOT	MC 1019P
1820-1037	TI	SN74 46AN
1820-1038	TI	SN74 48 N
1820-1042	TI	SN74 165 N
	FAIR	74 165PC
1820-1043	NATL	DM54 06N
1820-1044	FAIR	96 21 DC
1820-1045	SIG	N8273B
1820-1046	TI	SN74 156 N
1820-1047	TI	SN74L 42AN
1820-1048	SIG	N8T20B
1820-1049	NATL	DM80 97N
1820-1050	TI	SN75 454P
1820-1052	MOT	MC10125L
	SIG	10125F
1820-1053	TI	SN74 14 N
1820-1056	TI	SN74 132 N
1820-1057	NATL	DM86L 76N
1820-1062	INTL	P2401
1820-1063	FAIR	93 13 PC
1820-1064	TI	SN74 164 N
	FAIR	74 164PC
1820-1065	NATL	MH0026CG
1820-1066	FAIR	74 11PC
	NATL	DM74 11N
1820-1067	TI	SN54H 11 J
	MOT	MC 3106L
	NATL	DM54H 11J
1820-1068	TI	SN54H 30 J
	MOT	MC 3116L
	NATL	DM54H 30J
1820-1069	TI	SN54H 40 J
	MOT	MC 3124L
	NATL	DM54H 40J
1820-1070	TI	SN54 30 J
	MOT	MC54 30L
	NATL	DM54 30J
1820-1071	TI	SN54H 74 J
	NATL	DM54H 74J
	FAIR	54H 74DM
1820-1072	TI	SN74S 139 N
1820-1073	SIG	N82S42A
1820-1074	TI	SN74 128 N
1820-1075	TI	SN75 150P
1820-1076	TI	SN74S 174 N
1820-1077	TI	SN74S 157 N
1820-1079	MOT	MC14501CL
1820-1080	SIG	N8T13B
1820-1081	SIG	N8T26B
1820-1082	TI	SN74 147 N
1820-1083	TI	SN54 199 J
1820-1084	SIG	N8T09B
1820-1085	FAIR	9L 24DC
1820-1086	SPRG	UHP408
1820-1087	INTL	P3208A
1820-1089	TI	SN74 279 N
1820-1091	TI	SN54 13 J
	NATL	DM54 13J
	FAIR	54 13DM
1820-1092	TI	SN54 121 J
	NATL	DM54 121J
	MOT	MC54 121L
1820-1093	TI	SN54 00 J
	NATL	DM54 00J
	MOT	MC54 00L
1820-1094	TI	SN54 10 J
	NATL	DM54 10J
	MOT	MC54 10L
1820-1095	TI	SN54 74 J
	NATL	DM54 74J
	MOT	MC54 74L
1820-1096	TI	SN54 196 J
	SIG	S8290F
1820-1097	TI	SN54 04 J
	NATL	DM54 04J
	MOT	MC54 04L
1820-1098	SIG	S8292F
1820-1099	TI	SN54 08 J
	NATL	DM54 08J
	MOT	MC54 08L
1820-1100	TI	SN74 298 N
1820-1101	TI	SN54 02 J
	NATL	DM54 02J
	MOT	MC54 02L
1820-1106	INTL	3101A
1820-1107	TI	SN74 166 N
1820-1108	MOT	MC 1648P
1820-1109	MOT	MC 4022P
1820-1110	TI	SN75 110N
1820-1111	FAIR	93L 40 DC
1820-1112	TI	SN74LS 74 N
1820-1113	NATL	DM85 53N
1820-1114	MOT	MC14516CL
1820-1115	NATL	DM88 22N
1820-1116	TI	SN74 109 N
	FAIR	90 24 DC
1820-1117	FAIR	9L 86PC
1820-1119	MOT	MC 1648L
1820-1120	SPRG	UHP-402
1820-1121	NATL	DM80 93N
	TI	SN74 125 N
1820-1122	MOT	MC14518CL
1820-1123	MOS	MK 5009P
1820-1124	TI	SN74 33 N
1820-1129	TELD	334CJ
1820-1130	TI	SN74S 133 N
1820-1131	NATL	DM81 60N
1820-1137	MOT	MC 1809P
	TI	SN158 09N
	FAIR	1809PC
1820-1140	SIG	82S62A
1820-1141	TI	SN74 185AN
1820-1142	TI	SN74L 46 N
1820-1143	NATL	DM85 52N
1820-1144	TI	SN74LS 02 N
1820-1145	RCA	CD4049AE
1820-1146	RCA	CD4050AE
1820-1148	NATL	DM80 90N
1820-1149	NATL	MM5260N
1820-1150	MOT	MC14520CP
1820-1155	SIG	N82S90A
1820-1156	MOT	MC 2257L
1820-1157	MOT	MC 2259L
1820-1158	TI	SN74S 51 N
1820-1162	NATL	MM5057N
1820-1163	TI	SN74L 153 N
1820-1165	NATL	MM5013N
1820-1166	NATL	DM85L 51N
1820-1167	NATL	DM81L 23N
1820-1170	MOT	MMH 0026L
1820-1171	TI	SN74 143 N
1820-1172	FAIR	54 160M
1820-1173	MOT	MC10124L
1820-1174	TI	TMS4024NC
1820-1175	MOT	SC14522CP
1820-1176	MOT	MC14015CP
1820-1178	TI	TMS3122NC
	SIG	2518B
1820-1181	MOT	MC14522AL
1820-1183	MOT	MC 4016P
1820-1184	TI	SN74 28 N
	ITT	ITT74 28 N
1820-1185	TI	SN74 162N
	SIG	N74 162B
1820-1186	TI	TMS3113
1820-1187	SIG	SP 380
1820-1188	RCA	CD4046AE
1820-1189	MOT	MC14510CL
1820-1190	NATL	MM74C173N
1820-1191	TI	SN74S 175 N
1820-1192	TI	SN74 173 N
1820-1193	TI	SN74LS197 N
1820-1194	TI	SN74LS193N
1820-1195	TI	SN74LS175 N
1820-1196	TI	SN74LS174 N
1820-1197	TI	SN74LS 00 N
1820-1198	TI	SN74LS 03 N
1820-1199	TI	SN74LS 04 N
1820-1200	TI	SN74LS 05 N
1820-1201	TI	SN74LS 08 N
1820-1202	TI	SN74LS 10 N
1820-1203	TI	SN74LS 11 N
1820-1204	TI	SN74LS 20 N
1820-1205	TI	SN74LS 21 N
1820-1206	TI	SN74LS 27 N
1820-1207	TI	SN74LS 30 N
1820-1208	TI	SN74LS 32 N
1820-1209	TI	SN74LS 38 N
1820-1210	TI	SN74LS 51 N
1820-1211	TI	SN74LS 86 N
1820-1212	TI	SN74LS112 N
1820-1213	TI	SN74LS113 N
1820-1214	TI	SN74 126 N
1820-1215	TI	SN74LS136 N
1820-1216	TI	SN74LS138 N
1820-1217	TI	SN74LS151 N
1820-1218	TI	SN74L 157 N
1820-1219	WDC	TR 1602B
1820-1220	SIG	2532B
1820-1221	INTL	C8008-1
1820-1222	FAIR	95 04 DC
1820-1224	MOT	MC10216P
1820-1225	MOT	MC10231P
1820-1236	NATL	MM5040H
1820-1237	NATL	MM5050AH
1820-1239	MOS	MK 5007P
1821-0001	RCA	CA3046
1821-0002	RCA	CA3045
1821-0005	SPRG	TD 604
1821-0006	FAIR	SH65 01 PC
	SPRG	UHP012
	MOT	SPQ 1600
1826-0002	MOT	MC 1510G
1826-0003	MOT	MC 1456CG
	SIG	N5556T
1826-0004	NATL	LM304H
1826-0006	MOT	MC 1469G
1826-0008	FAIR	725 HM
	PMON	SSS725BJ
1826-0009	FAIR	725 HC
	PMON	SSS725CJ
1826-0010	FAIR	723 HM
1826-0011	FAIR	741 HM
	NATL	LM741H
	MOT	MC 1741G
1826-0014	MOT	MC 1595L
1826-0015	RCA	CA3060D
1826-0016	NATL	LM204H
1826-0017	NATL	LM205H
1826-0019	MOT	MC 1437L
1826-0020	PMON	DAC-01CP
1826-0021	NATL	LM310H
1826-0022	MOT	MC 1439L
1826-0023	MOT	MC 1496L
1826-0024	MOT	MC 1469R
1826-0025	NATL	LM208AH
1826-0026	NATL	LM311H
1826-0028	MOT	MC 1550G
1826-0029	SPRG	ULN2111A
1826-0031	FAIR	726 HM
1826-0032	MOT	MC 1463R
1826-0033	MOT	MC 1463G
1826-0035	NATL	LM308AH
1826-0036	MOT	MC 1494L
1826-0037	MOT	MC 1590G
1826-0038	MOT	MC 1436G
	SGEN	SG1436T
1826-0040	SIG	S5733A
1826-0041	RCA	CA3059
1826-0042	MOT	MCC 1741
1826-0043	NATL	LM307H
	PMON	SSS307J
1826-0044	FAIR	739 DC
1826-0047	SIG	NE 562B
1826-0048	MOT	MCC 1456
1826-0049	FAIR	723 DC
1826-0051	MOT	MC 1414P
1826-0055	FAIR	711 DC
1826-0056	FAIR	740 HC
1826-0058	SIG	NE 501A
1826-0059	NATL	LM201AH
1826-0060	MOT	MC 1438R
1826-0061	SGEN	SG3501D
1826-0064	FAIR	733 DC
1826-0065	NATL	LM311N
1826-0066	FAIR	777 HM
1826-0067	SIG	NE 531T
1826-0069	NATL	LM301AD
	FAIR	LM 301A D
1826-0070	FAIR	741 DC
	MOT	MC 1741CL
1826-0071	MOT	MC 1456G
1826-0072	NATL	LM208H
1826-0075	RCA	CA3079
1826-0077	NATL	LM311F
1826-0078	RCA	CA3030
1826-0079	HRIS	HA2-2625-5
	PHIL	1321
1826-0081	NATL	LM318H
1826-0082	ANAL	AD741LH
1826-0086	FAIR	776 HC
1826-0087	RCA	CA3004
1826-0089	HRIS	HA-2525
	PHIL	1322
1826-0091	DICK	DRAM6.8810
1826-0094	TI	SN75 235N
1826-0098	NATL	LM211H
1826-0099	FAIR	78 12 UC
1826-0100	FAIR	747 DC
	TI	SN72 747J
	NATL	LM747CD
1826-0101	NATL	LM565CH
	SIG	NE 565K
1826-0102	NATL	LM312H
1826-0103	MOT	MC 1545G
1826-0104	NATL	LM371H
1826-0105	SILX	DG 172BK
1826-0106	FAIR	78 15 UC
	MOT	MC78 15 CP
	NATL	LM340T-15
1826-0108	NATL	LH0062CH
1826-0110	NATL	LM212H
1826-0111	MOT	MC 1458G
	SIG	N5558T
1826-0112	NATL	LM316AH
1826-0113	NATL	LM207H
1826-0114	FAIR	710 HM
	NATL	LM710A
1826-0115	SIG	NE 526A
1826-0116	PMON	CMP-01-CJ
1826-0117	FAIR	78 12 KC
	NATL	LM340K-12
1826-0119	SIG	NE 555T
1826-0120	NATL	LM3900N
1826-0121	INSL	8007C
1826-0122	FAIR	78 05 UC
1826-0123	NATL	LM320K-12
1826-0124	SIG	NE 529K
1826-0125	MOT	MC 1514L
1826-0126	FAIR	78 18 KC
1826-0127	PMON	DAC100BCT1
1826-0128	MOT	MC 1468L
1826-0129	INSL	ICL8001CTZ
1826-0130	SIG	NE 550L
1826-0131	INSL	ICL8008CTY
1826-0132	FAIR	760 DC
1826-0135	NATL	LM747D
	FAIR	747 DM
1826-0137	SIG	NE 550A
1826-0138	NATL	LM339N
1826-0139	MOT	MC 1458P1
	NATL	LM1458N
1826-0140	MOT	MC 1468R
1826-0141	NATL	LM319D
1826-0142	MOT	MC 1458CP1
1826-0144	FAIR	78 05 UC
	MOT	MC78 05 CP
	NATL	LM340T- 5
1826-0145	FAIR	78 06 UC
	MOT	MC78 06 CP
	NATL	LM340T- 6
1826-0146	FAIR	78 08 UC
	MOT	MC78 08 CP
	NATL	LM340T- 8
1826-0149	FAIR	78 18 UC
	MOT	MC78 18 CP
	NATL	LM340T-18
1826-0150	FAIR	78 24 UC
	MOT	MC78 24 CP
	NATL	LM340T-24
1826-0152	CRYS	CDR 125 BK
	SILX	D 125BK
1826-0153	RCA	CA3075
1826-0154	SILX	DG 200BA
1826-0155	MOT	MC 1406L
1826-0159	MOT	MC 1350P
1826-0160	FAIR	UGJ78 06393
1826-0161	NATL	LM324N
1826-0162	NATL	LM 321 H
1826-0164	FAIR	742 PC
1826-0165	NATL	LM4250CH
1826-0167	RCA	CA3094AT
1826-0169	NATL	LM320K-15
1826-0172	NATL	LM308N
1826-0173	NATL	LM320K-5.2
1826-0177	TELD	723 BE
1826-0178	NATL	LM320H-12
1826-0179	NATL	LM320H- 5.2
1826-0181	NATL	LM323K
1826-0182	ANAL	A540J
1826-0183	FAIR	734 HC
1826-0184	FAIR	749 DC
1826-0185	RCA	CA3080
1826-0188	MOT	MC 1408L-8
1826-0189	SIG	NE 566T
1858-0004	RCA	CA3049
1858-0008	MOT	MHQ 6001
1858-0009	MOT	MHQ 2221
1858-0010	MOT	MHQ 2906
1858-0020	FAIR	SH64 01 PC
1858-0021	RCA	CA3083
1858-0022	SGEN	SG3821
1858-0023	RCA	CA3081
1858-0032	RCA	CA3146E
1858-0034	MOT	MPQ 3725
1858-0037	SPRG	ULN2082A

SOLDERING IRON TIP SAVER

by Bryson Nishimura and Michael A. Caughey



Here is a simple but very useful gadget that makes your solder iron more useful in addition to extending the life of the tips.

The materials needed are:

interlocking chassis 4" × 2¼" × 2¼"
silicon rectifier 1A 400V
DPDT - Center off switch 3A 125vac
misc. - plugs, outlet, wire, grommet

Total parts cost, which is about $4.00, may be reduced by using locally available parts, since parts selection is not critical. Construction is easy and should require about an hour. Layout is not critical, but care should be taken to maintain adequate spacing of all leads from the metal box. Using a three wire cord is recommended since this allows grounding of the metal box. Neon lamps can be added as shown in the schematic for visual indication of full or half heat. One lamp lights for half heat and both light for full heat.

Operation of the tip saver is simple. When the switch is placed in the position without the diode, full line voltage is connected to the solder iron and full temperature is reached. This is useful for fast warmup in the morning and for soldering tasks where a large amount of heat is needed, such as large chassis ground connections or ground planes on a P.C. board.

When the diode is switched in the circuit, the effective voltage is cut in half and the temperature is therefore also reduced. This prevents overheating of the tip when the solder iron is not being used. This half-heat position also works well for soldering and unsoldering IC's, transistors, diodes, etc. where high temperatures are undesirable.

Having a three position center off switch makes a convenient method of turning off the solder iron at night, rather than unplugging it as was done previously.

We use the Ungar 777 iron with a 1235 element and PL333 tip in most of our applications. We have been using the tip saver in our Calibration Lab and other shops now for about two years and the results are very good. In one case, a tip lasted about 14 months without replacement even though it was on all day, five days a week. This has resulted in considerable savings.

Editor's Note: A number of methods can be used to vary solder iron power, including several available commercially.

Additional control would be possible with a design using a triac and potentiometer, (or using a variable line voltage control available on many service benches). Many people feel that the simple circuit above is sufficient, however. Your comments are invited.

Bryson Nishimura has been with the Hawaiian Telephone Company in Honolulu for 4 years, working as a Calibration Laboratory Technician. This entails repair and calibration of about 400 different models of test equipment. He attended the Electronics Institute of Hawaii. As might be expected of someone from Hawaii, Bryson enjoys surfing, as well as photography.

Michael A. Caughley is the Electronic Shop Supervisor at the Hawaiian Telephone Company. This shop is a repair facility for multiplex carrier and traffic data systems. Michael received his electronics training at the Navy Electronics School and he also is a part-time student at the University of Hawaii. In addition to photography, his outside interests include automobile rallying.

THE CONTRIBUTIONS OF EDSEL MURPHY TO THE UNDERSTANDING OF THE BEHAVIOR OF INANIMATE OBJECTS

Readers may be familiar with an oft quoted basic principle called Murphy's Law. This states that "If anything can go wrong, it will."

Some time ago, samples of the application of this principle were printed in EDN/EEE, an electronics publication intended for design engineers. For your enjoyment, some of these are reprinted here, courtesy of EDN/EEE.

General Engineering

- Dimensions will always be expressed in the least usable term. Velocity, for example, will be expressed in furlongs per fortnight.
- An important Instruction Manual or Operating Manual will have been discarded by the Receiving Department.

Prototyping and Production

- Any wire cut to length will be too short.
- Tolerances will accumulate unidirectionally toward maximum difficulty of assembly.
- Identical units tested under identical conditions will not be identical in the field.
- The availability of a component is inversely proportional to the need for the component.
- If a project requires n components, there will be n-1 units in stock.
- If a particular resistance is needed, that value will not be available. Further, it cannot be developed with any available series or parallel combination.
- A dropped tool will land where it can do the most damage. (Also known as the law of selective gravitation.)
- The probability of a dimension being omitted from a plan or drawing is proportional to its importance.

- Interchangeable parts won't.
- Probability of failure of a component, assembly, subsystem or system is inversely proportional to ease of repair or replacement.
- If a prototype functions perfectly, subsequent production units will malfunction.
- Components that must not and cannot be assembled improperly will be.
- Graphic recorders will deposit more ink on humans than on paper.
- An instantaneous power-supply crowbar circuit will operate too late.
- A transistor protected by a fast-acting fuse will protect the fuse by blowing first.
- If an obviously defective component is replaced in an instrument with an intermittent fault, the fault will reappear after the instrument is returned to service.
- After the last of 16 mounting screws has been removed from an access cover, it will be discovered that the wrong access cover has been removed.
- After an access cover has been secured by 16 hold-down screws, it will be discovered that the gasket has been omitted.
- After an instrument has been fully assembled, extra components will be found on the bench.

PLOTTER HAVE THE JITTERS?

by Vern Hudson

A symptom of jitters in X-Y plotters or strip chart recorders is one that sometimes causes consternation. The pen will appear jumpy or noisy in a certain position. This erratic operation can be repeated by using the zero control or signal input to move the pen to the erratic position.

The solution is to clean the slide wire, the variable resistor in the feedback loop that determines the position of the pen. The slidewire should be cleaned with a cotton swab moistened with freon degreaser.

After cleaning the slidewire, which is a precision resistor, be sure to lubricate it to ensure proper operation and normal life. It is *extremely* important to use the correct lubricant.

The majority of HP plotters have a wirewound slidewire; these need slidewire lubricant HP p/n 5080-3635.

Many of the new plotters, such as the 7123-7143 series, have a film slidewire mixed in with a plastic base. This looks something like a composition resistor. Film slidewires require grease that can be obtained by ordering HP p/n 07143-69134.

Wirewound and film slidewires each have a unique appearance that makes them easily distinguishable.

If the plotter is in daily use, HP recommends cleaning the slidewire once each month. After cleaning, the standard calibration procedure should be used to verify proper operation. Refer to the service manual of your instrument for details.

A CLEAN HEAD HELPS

Many people using analog or digital tape recorders are surprised to learn that the heads should be cleaned before *each* use.

As the tape passes over a head, two things happen that are detrimental to performance: The tape slowly wears metal away from the head and oxide from the tape is deposited on the head.

As the oxide coating increases in thickness, the separation between tape and head increases, reducing the high frequency response and degrading the signal to noise ratio. If further oxide build-up is allowed, it causes increased and irregular tape wear, which causes increased oxide deposits, etc.

To keep this from happening to your tape recorder, clean the heads before each use with cotton swabs and Freon TF Degreaser. Moisten the cotton with freon and wipe the tape head with a sideways motion. It is important that the heads be wiped in the *same direction that the tape travels*. Continue this process, using several additional clean cotton swabs, until no more oxide is visible on the cotton.

Often times the oxide on a head is not easily visible. I once repaired a unit that had one channel dead. The customer insisted that he had cleaned the heads and they indeed looked clean. Examination under a microscope showed a substantial oxide layer that was the cause of his problem. This was removed by scrubbing with the freon.

Freon degreaser is commonly available in liquid or spray form. Liquid freon tape head cleaner is available from HP under p/n 8500-1251. Cotton swabs mounted on a thin wooden stick can be purchased locally or ordered through HP p/n 8520-0023. Care must be taken to avoid excessive freon in the tape recorder. Do not apply freon directly to the head; moisten the cotton swab and then gently wipe the head.

Clean heads and proper preventive maintenance procedures help you retain the performance designed into your recorder. Refer to the maintenance section of your manual for details of these procedures.

Editor's note: This procedure is also a good idea for your home stereo recorder, if you happen to be a stereophonic sound enthusiast.

Vern Hudson has been with HP for fourteen years, working initially on a production line, testing finished products. He soon moved to the repair bench at the HP Customer Service Center in Mountain View, California, servicing recorders and printers.

He recently accepted a position at the San Diego (California) Division of HP, working as a Service Engineer. Vern is one of the product experts that provide technical assistance to the HP Field Service Organization.

NEW
SERVICE NOTES
NEW VIDEOTAPES
NEW PRODUCTS
NEW DEVICES
BOOKS

When a lot of fine people work together, something good usually happens. This aptly describes the story of Bench Briefs, since this publication relies on participation from you, the reader. While stopping to reflect on the past year, it became evident that a large number of people have helped make a successful year for Bench Briefs. I would like to extend my thanks and Christmas wishes to all of you.

The most visible group on any publication is the people writing articles. Contributing Editors and Contributing Authors involved during 1973 were Rod Dinkins, Chris Franks, Marv Willrodt, George Stanley, Dan Struckmann, Harry Logan, Vern Hudson, Bryson Nishimura and Michael Caughey. Bryson and Michael are with the Hawaiian Telephone Company. All others are with H.P.

The difference between a Contributing Editor and Author is the degree of involvement. A Contributing Editor is a person selected at an HP facility to regularly coordinate Bench Briefs activities and to submit articles for publication. A Contributing Author can be anyone from any company with a suitable article.

In addition to the people writing material, there are a great number of additional people involved in making Bench Briefs possible and I would like to take this opportunity to express my thanks and best wishes.

After the material is written for an issue, it must be prepared for the printing process, then printed and distributed.

Gary Welden of The Graphic Circle has been a great help with the planning, design, and graphics. Many of his ideas are evident in each issue. The cartoon illustrations have been the work of Vance Locke, of Vance Locke Illustrations, Budd Cady and Roy Anderson. Typing has been done by Dolores Owen, Donnita Arnold and Barb Cummins. Photo type-setting is the work of Anne LoPresti and Jodi Montgomery. Hal Netten provided editorial assistance.

Printing has been handled very well by Bruce Woodd of the National Press. In fact, Bruce and his people have occasionally worked remarkably fast to ensure that Bench Briefs was mailed on schedule.

Distribution of the printed copies is a very important area and there are many people working behind-the-scenes who share in this Christmas Greeting. Doris Brunelli and Jim Kinney keep the mailing list current and Les Considine of Coast Mailing Corporation handles the addressing and mailing of Bench Briefs. Distribution to HP factories and offices is handled by Gloria Frazier and Walt Cavaness. Requests for Service Notes are also handled by Walt and he is assisted by Eleanor Jimenez. Peter Tacx directs distribution of Bench Briefs and Service Notes for Europe. Peter is located in Amsterdam.

And, of course, I would be remiss to neglect mentioning you, the reader, without whom all of the above would be unnecessary.

I wish all of you a very special and joyous Merry Christmas.

Have a challenging and prosperous New Year.

Dick Gasperini
Editor

NEW TOOLS
MORE SERVICE TIPS
TUTORIAL ARTICLES
APPLICATION NOTES
MODIFICATIONS
ADJUSTMENTS

5326/5327 SERIES UNIVERSAL COUNTER MODIFICATIONS

A modification for the 5326/5327 series Universal Counters is recommended to improve reliability of the power supplies. This is done by adding two transistor insulators to the series regulator transistor for the +5 and −5 volt power supplies.

This change applies to instruments with these serial numbers and below:

Model	Serial Number
5326A	1312A 02005
5326B	1312A 02265
5326C	1312A 00500
5327A	1312A 00410
5327B	1312A 00620
5327C	1312A 00595

The parts required are -

Item	HP-P/N
Kapton Insulator - 2 Each	0340-0765
#8 Washer - 2 Each	3050-0001
Bushing - 2 Each	1200-0081
Heat Sink Compound	8500-0269

When ordering the parts, request Service Note 5326A/B/C/5327A/B/C-4. This gives details and the installation procedure.

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