

modulation sciences, inc.

12A World's Fair Drive • Somerset, NJ 08873 USA

Voice (732) 302-3090 • Fax (732) 302-0206

Toll-Free in USA (800) 826-2603

Web Site: www.modsci.com

Technical Manual

Model CP-803

Composite Processor

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FIRST THINGS

HERE IS YOUR MODULATION SCIENCES COMPOSITE PROCESSOR. PLEASE FOLLOW THE UNPACKING INSTRUCTIONS BELOW.

- UNPACK THE UNIT AND SAVE ALL PACKAGING MATERIALS. YOU MAY NEED THEM LATER TO SHIP OR MOVE THE CP-803.
- INSPECT THE CP-803 FOR ANY SIGN OF DAMAGE
- IF YOU FIND ANY DAMAGE TO THE CP-803 REPORT IT IMMEDIATELY TO BOTH THE CARRIER AND TO MODULATION SCIENCES.
- IF THE CP-803 IS UNDAMAGED, FILL OUT THE REGISTRATION CARD YOU WILL FIND INSIDE THE FRONT COVER OF THIS MANUAL AND RETURN IT TO MODULATION SCIENCES.

Chapter 1

Introduction

The Modulation Sciences CP-803 Composite Processor adds a new dimension of flexibility to the broadcast signal processing chain. Used alone, it can increase the RMS modulation of unprocessed material up to 6dB. In combination with conventional compressor/limiters, the CP-803 can increase your station's loudness with none of the breathing, pumping, and swishing ordinarily associated with excessive processing. If you are already processing heavily, the CP-803 will allow you to "back off" on your use of other devices and to achieve a more "open" sound without sacrificing your competitive position. In fact, in cases where transients arising from limiter and/or composite STL overshoot are present, even heavily processed material can be made to sound noticeably louder, since removal of these spurious peaks will permit higher average modulation.

In order to make the best possible use of the CP-803, it is important that you read this manual carefully. In addition to basic technical information, it contains a number of useful hints for determining the best combination of processor settings for your particular application.

1.0 Operation

The CP-803 operates on the stereo baseband signal after all other processing has been completed. The CP-803 allows the user to achieve higher RMS modulation in two ways: first, by eliminating spurious peaks created at earlier stages in the signal chain; second, by truncating high-frequency peaks in the pre-emphasized program material. Since the CP-803 affects only peaks, the "openness" of the sound is maintained. Because high-frequency program peaks are ordinarily of extremely brief duration, little or no audible distortion is produced, even at maximum loudness.

Once the CP-803 is in operation, it should require no readjustment except for an annual trimming of the pilot filter.

Front panel LEDs indicate power on (green), limiting taking place (yellow), and excessive limiting (red). The LED should never be lit in normal operation.

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Chapter 2

Specifications

Size

1-3/4" H x 12" W x 5-3/4" D overall
1-3/4" x 19" rack mount kit available

Power

95 to 130 volts AC, 10 watts max.
90 to 260 volt option available.

Temperature Range

0 to 50 degrees C.

RF Protection

All inputs and outputs RF suppressed. Power supply is RF suppressed and shielded from main circuitry.

Gain Controls

The input and output controls are used to set levels and control the amount of limiting.

Pilot Trim

The pilot filter trim controls are preset at the factory. They should be checked yearly according to the procedure in section 5.1.

Indicators

POWER:	Green LED.
NORM:	Yellow LED - indicates that signal has exceeded limiting threshold.
OL:	Red LED - indicates that limiting duty cycle is too great.

Connectors

INPUT:	BNC connector 0.5 to 4 volts P-P 22k Ω
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OUTPUT:	BNC connector 0.5 to 4 volts P-P 50 to 250 ohms (depending on output gain setting)
PILOT TEST:	RCA jack – used for alignment of pilot filter
J4:	RCA jack – open collector TTL, low when signal is above limiting threshold. 15v/10mA. Max.

TEST CONDITIONS FOR THE FOLLOWING SPECIFICATIONS:

Input and output levels	1 volt P-P
Input frequency range	50 Hz – 15 kHz 23 – 53 kHz
Source impedance	0 to 1k Ω
Load impedance	10k Ω , shunted by 100 pF
Temperature	0 to 50 degrees C

Threshold of limiting set to 100% modulation

<i>Frequency Response</i>	+ 0.03 dB referenced too 1 kHz
<i>Harmonic Distortion</i>	0.02% max. at 95% modulation
<i>IM Distortion</i>	70 dB below 100% modulation, tested with any two frequencies in input frequency range, 1:1 at 95% peak modulation.
<i>Differential Phase</i>	0.1 degree maximum, 19 to 38 kHz 0.2 degree maximum, 15 to 53 kHz
<i>Wideband Noise</i>	75 dB below 100% modulation, measured 20 Hz to 100 kHz unweighted

Stereo Performance

Crosstalk ¹ :	At 100% modulation
Main to Sub ² :	More than 40 dB below 90% modulation.
Sub to Main:	More than 40 dB below 90% modulation.
Stereo Separation:	More than 40 dB below 90% modulation. 400 Hz: better than 48 dB 15 kHz: better than 36 dB
Harmonic Distortion ³ :	50 to 100 Hz: less than 0.4% 100 Hz to 7.5 kHz: less than 0.5% 7.5 to 15 kHz: less than 1.5%

Pilot Modulation Varies less than 0.2% up to 6 dB of limiting.

¹ Note 1: Systems having nonlinear crosstalk of worse than -45 dB before installation of the CP-803 may not meet these specifications at all frequencies.

² Note 2: These figures are for the entire stereo generator/Composite Processor/transmitter system. It is assumed that the system was within the limitations of the FCC rules before installation of the CP-803. All figures are typical and were measured on a system consisting of a Moseley SCG-3T stereo generator and a Belar FMS-1 monitor.

³ Note 3: All noise and distortion components from 20 Hz to 80 kHz were measured.

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Chapter 3

Installation

3.1 Location Signal Chain

The CP-803 should always be placed in the signal chain immediately before the exciter at the transmitter location, even when your transmitter is linked to the studio via composite STL. In fact, the CP-803 will typically produce at least 1.5 dB of increased RMS modulation when connected between composite STL receiver and exciter, regardless of the type of audio processing you use. This is because many composite STLs ring and overshoot, producing modulation-limiting transients that can only be eliminated by composite processing at the composite STL receiver location.

Unlike less sophisticated baseband clippers, the CP-803 is transparent to the 19kHz pilot tone, which means that no readjustment of pilot phase is necessary when installing the unit. Nor is L-R gain adjustment needed due to the processor's extremely flat frequency response.

Setup may be accomplished using only the built-in indicator LEDs, normal program material, and your modulation monitor. For best results, the program material used for setup should be "hot" (rich in high frequency transients). Material featuring prominent acoustic guitars, violins, or snare drums would be ideal. If a particular piece of program material has created overmodulation problems in the past, use that piece to do the setup.

No notification to the FCC is required when installing the CP-803.

Do not install the processor immediately adjacent to a large power transformer or other source of strong magnetic fields. Allow for at least a few inches of separation from such a source.

The ambient temperature of the installation location will usually NOT be an important consideration. However, the CP-803 will perform up to specifications at any temperature from 0 to 50 degrees Centigrade.

3.2 Preparation

Before beginning installation of the processor, the transmitter, stereo generator, and other processing equipment should be set up so that peaks are restricted to 100% modulation under program conditions. Pilot injection should be set to 9%.

3.3 Cabling

The cable length and type used to connect the CP-803 to the stereo generator may have some effect on stereo separation. Some stereo generators and STL receivers have output impedance as high as 1000Ω. With these units, cable lengths should be restricted to 3 to 4 feet unless low capacitance cable such as RG-62 is used. If the existing cable from the stereo generator or STL to the transmitter is more than 4 feet long, it is preferable to use this same cable to connect to the input of the CP-803. Any phase shift caused by the cable has presumably already been compensated for by adjustment of the stereo generator. The following maximum cable lengths are recommended for connecting the output of the CP-803 to the transmitter: RG-58, 4 feet; RG-59, 6 feet; and RG-62, 10 feet. If it is necessary to use cables longer than this, stereo separation should be rechecked after the CP-803 is installed.

3.4 Setting the Gain

Remove the input cable from the transmitter modulator and connect it to the input of the CP-803. Adjust the input gain control on the processor so that the yellow LED lights every few seconds. Turn the output gain control on the processor all the way down (CCW). Connect a new cable from the output of the processor to the transmitter input and adjust the output gain control on the processor for 100% peak modulation. Pilot modulation should now be approximately 9.2%.

3.5 Increasing Loudness

When set up by the above procedure, the CP-803 will do very little peak limiting. To increase the amount of limiting, read pilot modulation on your modulation monitor and adjust the input gain control on the CP-803 to raise pilot modulation. The amount of limiting is equal to the amount the pilot modulation has been raised. It is important to keep in mind that for proper, legal operation, the red overload indicator on the CP-803 must never be on during operation. If the red LED does light, you must reduce the input gain. Now adjust the pilot injection control on the stereo generator to restore pilot injection to 9%.

The amount of limiting that can be achieved depends on several factors, the most important being the amount and type of processing which has been done to the program material earlier in the signal chain. Unprocessed or lightly processed material may be limited up to 6dB. Heavily processed material may only permit between 1 and 2dB of limiting by the CP-803. If you find this to be the case for your application, we recommend that you "back off" on earlier processing devices in order to allow the CP-803 to work to its fullest potential. A certain amount of experimentation may be required to achieve the best possible combination for your market.

3.6 Equipment Performance Measurements

Although no longer required, Equipment Performance Measurements should be done in order to satisfy any possible FCC questions. These should be done in the usual fashion. However, it is necessary to use considerable care in setting the level for tests at 100% modulation, since even a 0.5 dB error over frequency in the modulation monitor reading (an acceptable amount by FCC standards) may cause test results to fall outside acceptable limits at some frequencies.

The installation set-up procedure, if properly done, will have previously set the threshold of limiting to 100% modulation. This means that for a sine-wave signal of 400 Hz, the yellow LED should come on just at 100% modulation. If you are using your modulation monitor to measure modulation percentage, the point at which the yellow LED lights may not agree exactly with 100% on the modulation monitor for higher modulating frequencies, since the indicator in the CP-803 is considerably flatter than most monitors. In order to ensure correct test results, measurements should be made at or below the threshold of limiting (the point at which the yellow LED just lights). Therefore, it is advisable if possible not to use the monitor to measure modulation percentage, but to use some other method with less error, such as observation of the composite signal on a known flat oscilloscope to confirm that modulation has been set accurately to 100% at all frequencies.

For accurate results, the modulation monitor must get its RF feed from the transmitter via a short coax cable. When using a cable longer than 10 feet, its VSWR should be checked to be sure that it is below 1.5 to 1. Off-the-air monitoring will not produce acceptable results due to the many variables involved.

Whatever method of testing is employed, we recommend calibration of the test equipment by the Bessel null method.

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Chapter 4

Operation

The level of RMS modulation that can be achieved in stereo broadcasting is constrained by several factors: the dynamic range of the original program material, the presence of high-frequency transients whose level becomes significant as a result of pre-emphasis, and various types of spurious peaks introduced in processing. Included in this last category are ring modes inherent in high-Q filter and equalizer circuits, limiter overshoot (even in so-called "overshoot-compensated" units), and STL overshoot. Limiters and compressors can significantly reduce the dynamic range of program material, but they are less successful in dealing with high-frequency transients, and are virtually useless in controlling spurious peaks. In fact, in many cases these peaks can be attributed to the limiters and compressors themselves.

The CP-803, in contrast, does virtually nothing to reduce the dynamic range of the program material. Instead, it truncates peaks that would otherwise unnecessarily constrain modulation levels. By operating on the composite signal, the CP-803 can eliminate pre-emphasized high-frequency peaks without the cumbersome procedure of pre-emphasizing, then limiting, then de-emphasizing sometimes used to accomplish the same purpose. Furthermore, the CP-803 will provide symptomatic relief for problems arising from overshoot and ring modes at earlier stages in the signal chain.

The CP-803 is a device that will complement rather than replace most processors now in service.

4.1 Indicators

The yellow LED is a very fast responding indicator which lights when any peak above the limiting threshold has occurred. The red LED responds to the average peak limiting over about a 1 second interval. The instantaneous peak limiting level obtainable before the red LED will light depends on the signals being processed.

For typical program material, the red threshold will fall somewhere in the 2 to 5 dB range, depending on the type and degree of processing performed earlier. With unprocessed program material, it is possible to limit peaks of up to 6 dB before the red indicator lights. For sine wave input (test signals), the red threshold occurs at approximately 0.2 dB of limiting.

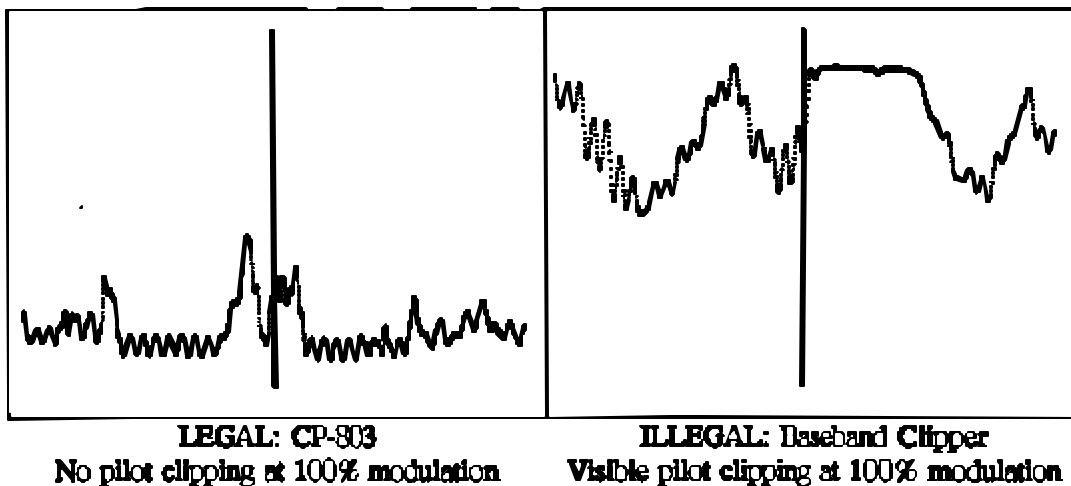
4.2 Excessive Limiting

The red LED should never be on under normal operation. If it is ever on it indicates that you are trying to do an excessive amount of limiting. The yellow LED, on the other hand, may be on most of the time, since this only indicates that some limiting is taking place. If the yellow LED is never on, the processor is merely passing signal and no limiting is taking place.

Output jack "J4" is an open collector, TTL compatible output which indicates when the input signal has exceeded the threshold. It is intended for connection of future accessory devices, and may also be used to implement remote monitoring, should the front panel LED's be difficult to access in your installation.

4.3 Composite Waveform Oscillograms

These oscillograms show the difference between the CP-803 and illegal baseband clipping. The left shows legal operation using the CP-803. Note the 19 kHz sine wave riding the crest of the waveform at 100 % modulation -- proof that the CP-803 does not clip the pilot. Illegal baseband clipping is shown by the square tops of the waveform on the right.



Chapter 5

Maintenance

5.1 *Adjusting the Pilot Trim*

The controls labeled PILOT TRIM are preset at the factory and should not require any adjustment for at least one year after installation. If an excessive amount of pilot modulation is observed, these controls may require adjustment. However, you should first make certain that the pilot modulation is not caused by lack of headroom in the stereo generator. When readjustment is required, proceed as follows:

1. Connect an audio voltmeter to the PILOT TEST jack on the back panel.
2. Stereo generator should be in stereo mode with no audio input.
3. Adjust the PILOT TRIM controls on the front panel alternately for minimum reading on the meter.
4. Connect a sine wave generator to modulate L+R at 1 kHz and adjust to 95% total modulation. Note the pilot level reading on the modulation monitor at this point. Now raise the level of the sine wave 6 dB if possible. If you do not have this much headroom in your stereo generator, apply the maximum signal that the stereo generator can handle. Adjust the right-hand PILOT TRIM control so that the pilot level reading on the modulation monitor is the same as it was at 95% modulation. Now, as the sine wave level is varied between maximum and 95% modulation the pilot level should vary by less than 0.1%.

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Chapter 6

Field Service

6.1 *Factory Service*

Each CP-803 is subjected to an extensive multi-stage test procedure, including a minimum 72-hour burn-in, before leaving the factory. Should any problems arise in the field, the unit should be returned to the factory for service after first determining that the problem is in fact in the CP-803 and not in some other piece of equipment. If you have any doubt as to the cause of any problem which may be associated with the CP-803, the MSI engineering staff will be happy to respond to phone inquiries.

6.2 *Field Repair*

Modulation Sciences recommends that defective units be returned for factory service. If you must attempt field service, the following points should be kept in mind:

1. Many of the CP-803's components are specially tested and/or matched to extremely tight tolerances. Replacing any of these components by an untested equivalent may result in severely degraded performance. It is especially important that matched components be replaced in groups rather than singly. MSI will be happy to supply sets of matched components for a nominal cost, should you require them.
2. When replacing components, care should be taken not to overheat traces in de-soldering. For ease of removal, we suggest cutting component leads flush with the top of the board before attempting de-soldering (from the bottom).
3. Replacement of certain components may require retrimming of the pilot filter or of the internal trimpot. In some cases, components referred to as "selected on test" in the parts list may also need to be changed. This will definitely be the case when the pilot filter, FL1, is replaced.

The above information and any other material relating to servicing of the CP-803 is provided as a courtesy to those who feel that they must do their own repairs. MSI assumes no liability for damage or other problems arising from attempts to service units in the field. **Any attempt at user servicing will void the warranty on that unit.** MSI will, of course, continue to provide non-warranty service at prevailing rates.

The following sections provide information on the CP-803's operation. We will be glad to respond to phone inquiries for additional information relating to particular problems that may arise.

6.3 Circuit Descriptions

INPUT AMP: Consists of U1B and associated components. Gain set by input trimpot, R2.

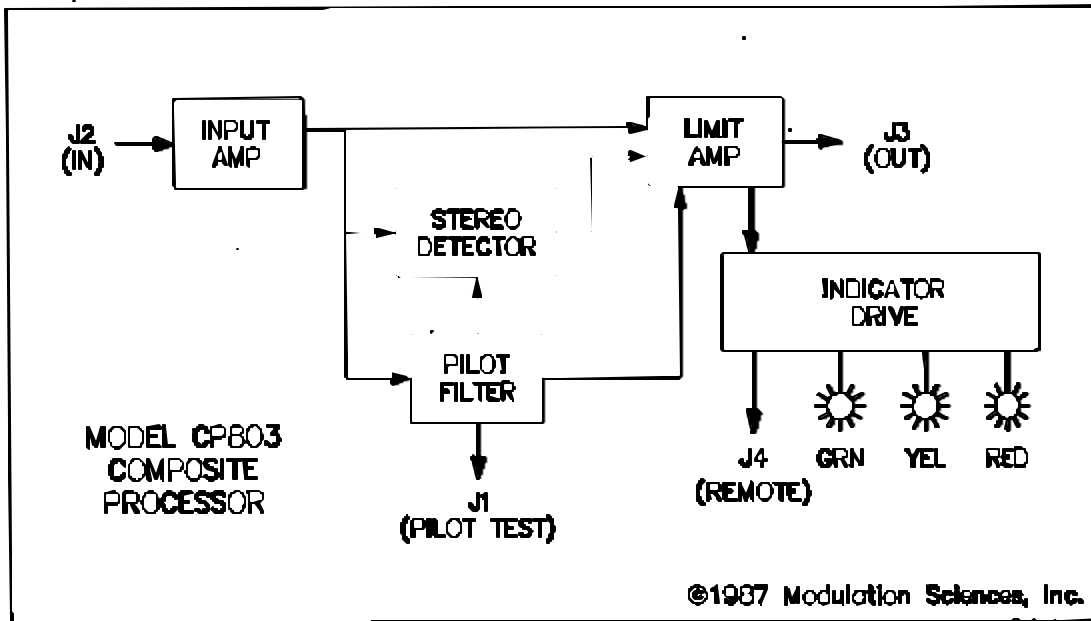
STEREO DETECTOR: Consists of U6, Q3, and associated components. With voltage reference U5 as input, sets threshold of limiting and adjusts for presence/absence of pilot.

PILOT FILTER: Consists of U2, U3A, Q1, Q2, FL1, and associated components. Trimmed by pilot trimpots R15 and R16 and by internal trimpot R19. Additional trimming provided by selected resistors R66, R67, and R68. With voltage reference U5 as input, provides pilot-free composite signal to limiting amp and stereo detector.

LIMITING AMPLIFIER: Consists of U1A, U3B, U4, and associated components. Gain set by output trimpot R9. Truncates program portion of composite at level determined by stereo detector while passing pilot through untouched.

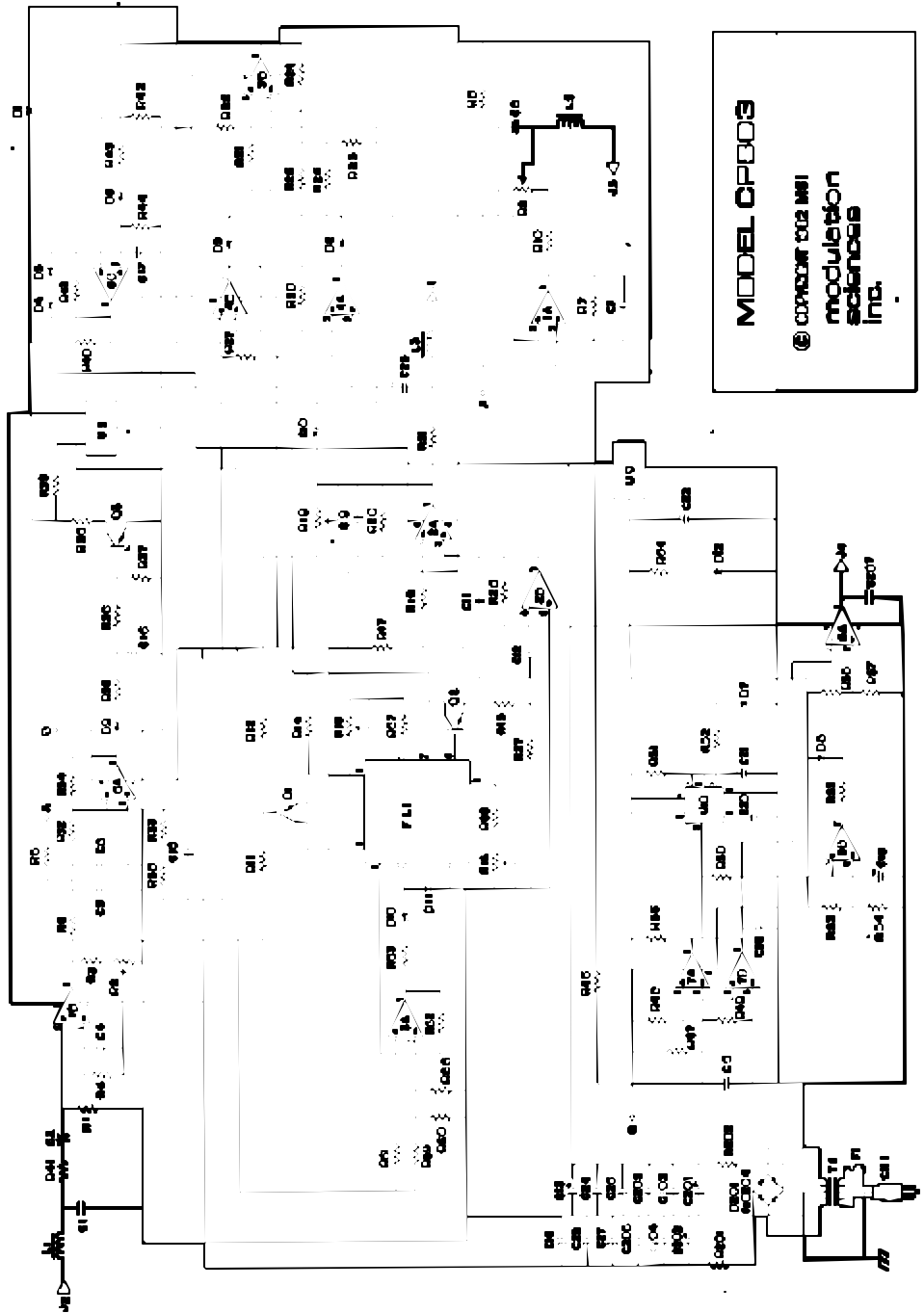
INDICATOR DRIVE: Consists of U7, U8, U9, U10, and associated components. Monitors operation of limiting amp and provides indication as described in section 4.2.

Block Diagram

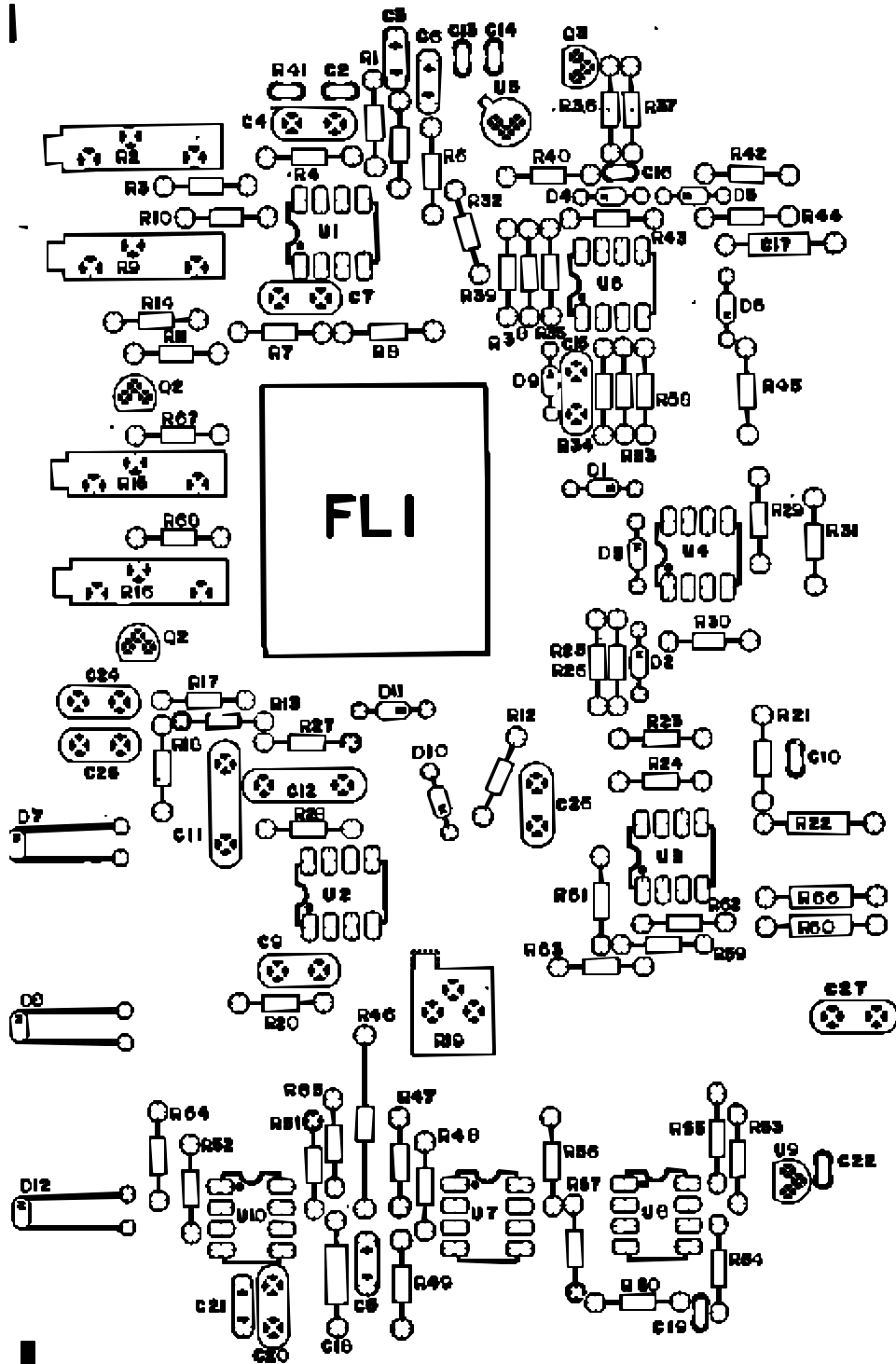


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Schematic Diagram



Parts Layout



Appendix B

Legal Issues

The recent wave of deregulation has not affected the restrictions on composite clipping. The FCC position expressed in the position letter "FCC 80-660" clearly places severe constraints on the operation of conventional baseband clippers. This limitation is caused by the conventional clipper's inability to discriminate between the program portion of the composite signal and the 19 kHz pilot tone. Since the pilot level is not permitted to vary outside the 8-10% injection range even instantaneously [47CFR 73.322 (2)], no significant amount of limiting may be done by the simplistic "diode clipper" method without violating the FCC Rules. Put simply, the FCC position on this type of baseband clipper has been that you may install one, but you may not use it.

Since the FCC does not Type Approve or Type Accept particular processors, Modulation Sciences, Inc. submitted the CP-803 to a well-known firm of consulting engineers for evaluation. Their findings were then submitted to a Washington, D.C. law firm with extensive experience before the FCC. The law firm concluded that, when operated according to manufacturer's instructions, the composite processor complies with all of the pertinent FCC Rules and policies. Opinion letters from both of these firms are reproduced in this Appendix.

What all of this means is that with the CP-803 you can now achieve the maximum possible benefit from composite clipping without having to choose between competitiveness and compliance.

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Appendix C

Manufacturer's Limited New Equipment Warranty and Disclaimer

We warrant the equipment sold shall be free from defects in materials and workmanship under normal use and service for a period of three (3) years from the date of delivery when properly installed. Our sole obligation under this warranty shall be limited to repair or replacement, at our option, of any such part or parts of the product our examination shall disclose to our satisfaction to be defective.

If you wish to have warranty services performed at our facilities, You shall obtain from us, in advance, permission to return the equipment and shall ship it properly packed with transportation and insurance prepaid. Service performed at our facilities under this warranty shall include parts plus labor. It is expressly agreed that our obligation to repair and replace defective parts is your sole and exclusive remedy.

THE WARRANTY TO REPAIR OR REPLACE DEFECTIVE PARTS IS EXPRESSLY IN LIEU OF AND HEREBY IN DISCLAIMER OF ALL OTHER EXPRESS WARRANTIES. AND IN LIEU OF AND IN DISCLAIMER AND EXCLUSION OF ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AS WELL AS ALL OTHER IMPLIED WARRANTIES, IN LAW OR IN EQUITY, AND OF ALL OBLIGATIONS OR LIABILITY ON OUR PART. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION HEREOF.

Our liability does not include any labor charges for replacement of parts, adjustments, repairs or any other work done outside our factory, unless such work is authorized in writing by us. Our obligation to repair or replace shall not apply to any equipment which shall have been repaired or altered outside Our factory in any way, subjected to negligence, misuse, unauthorized alteration or abuse, or damaged in transit.

OUR LIABILITY HEREUNDER SHALL NOT INCLUDE LOSSES OF ANTICIPATED PROFITS OR SPECIAL INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Explanation of Abbreviations Used in Parts Lists

CF:	Carbon Film Resistor
CC:	Carbon Composition Resistor
MF:	Metal Film Resistor
DT:	Dip Tantalum Capacitor
ELECT:	Electrolytic Capacitor
BH:	Binding Head
LW:	Lockwasher
PHIL:	Phillips Head screw

Information relating to specific part numbers and manufacturers is provided only as a courtesy and is subject to change without notice. When ordering from Modulation Sciences Inc., specify component number(s).

Installation Check List

CP-803 COMPOSITE PROCESSOR INSTALLATION CHECK LIST

LOCATION

- At transmitter, within 3 to 4 feet of the exciter*
- After composite STL receiver, if you have one*

PREPARATION

- Connect modulation monitor to transmitter sampler.
Off the air monitoring will not work
- Set existing processors to limit program peaks to exactly 100% modulation.
- Set pilot injection to 9%

CABLING

- Recommended maximum cable lengths:
 - RG58: 4 feet
 - RG59: 6 feet
 - RG62: 10 feet

SIGNAL

- Use "hot" program material, *not* test signals.

INPUT GAIN SET

- Unplug cable from exciter input; plug it into CP803 input
- Adjust CP803 input trim pot so that yellow LED blinks once every few seconds

OUTPUT GAIN SET

- Turn CP803 output trim pot fully counter-clockwise.
- Using new cable, connect CP803 output to exciter input.
- Turn output trim pot clockwise until modulation peaks at exactly 100%.
(At this point, pilot injection should read about 9.2%.)

LIMITING ADJUSTMENT

- Set modulation monitor to read pilot injection.
- Turn input trim pot slowly clockwise to increase limiting.
The amount of increase in pilot injection is equal to the amount of increase in limiting.

WARNING: IF THE RED LED LIGHTS, THE PILOT MAY BE AFFECTED.

Reduce the CP803's input gain level.

(Note that the red LED has a delayed reaction to adjustments. Turn the pot a little at a time, then pause to observe the result.)

PILOT LEVEL CORRECTION

- After the desired limiting level is established, re-adjust the pilot injection control on your stereo generator to restore 9% injection.

Parts List

MSI PART NUMBER	QTY	DESCRIPTION	REFERENCE DESIGNATOR	MANUFACTURER	MANUFACTURER PART NUMBER
V02-CP8H					
A04-100AGANH1	2	1000 UF 35V AE 20%			
A04-1504XHNI1	2	1.5 NF FEED-THRU	C205-C206	TUSONIX	357-001-X5U0-152M
A04-2203UCBG1	2	220 PF CER DISK 0.25 LS	C1,C8	SPRAGUE	10TST22
A04-2703UCBG1	1	270 PF CER DISK, 2KVDC 10% NO DD-271 Too Big!!	C23	CENTRALAB	DD-271
A04-4705JMCH1	2	.047 PF 100V MC			
A06-FBEAD0001	3	FERRITE BEAD	L1-L3	FAIRRITEPR	2743002111
A08-D60102001	1	20V PWR XFORMER DUAL 110/230V	T1	MAGNETICCOIL	4/7/20
A09-S3AG10001	1	FUSE, SLOW BLOW, 1 AMP	F1	LITTLEFUSE	313.1
B01-4003	4	RECTIFIER DIODE			
G04-GBU	1	PC BOARD	PCB3	QUALITYCIR	GBU
G04-UPS6	1	PC BOARD W/SOLDER MASK & SILKS			
H02-002F00001	1	RCA CONNECTOR	J1	SWITCHCRAF	3501-FP
H02-002F00002	2	CONNECTOR, BNC FEMALE, UG1094U	J2-J3	AMPHENOL	31-221
H04-PN0000001	1	FUSE HOLDER	FH1	BUSSMAN	HKP
H11-CRN160401	1	Crimp lug, screw size 6, 22-18 awg		ZIERICKMAN	A3651W/.144"HOLE
J07-P18000001	1	6 FOOT LINE CORD, 1.8 METERS	CH1	BELDEN	17237B
K06-4INCH	1	4 INCH CABLE TIES			
K06-H3510NT90	2	5 1/2 inch long cable tie		HEYMANMANU	3510NT90
N04-000000007	1	GLUE STICK, THERMAL MELT, 1"			
O05-000000001	1	STRAIN RELIEF, 5N-4 BLACK		HEYMANMANU	5N-4BLACK
O09-000000001	7	SMALL POP RIVET	Small Pop Rivet	#1693-0410	Avdel is Mfr.
U05-UPSA	1	ASSEMBLY LABOR, V03-UPSA			
V03-UPSA	1	PWB ASSY, POWER SUPPLY			
Z09-221	2	2.2 OHM,1/2W,5%,CF RESISTOR			

MSI PART NUMBER	QTY	DESCRIPTION	REFERENCE DESIGNATOR	MANUFACTURER	MANUFACTURER PART NUMBER
V01-MSCP					
A01-100250W01	1	RESISTOR, 4K12, 1W .25%	R104	KRL	KRL538-4.12K-.25%-8224
A01-100250W02	2	RESISTOR, 8K25, 1W .25%	R101,R103	KRL	KRL538-8.25K-.25%-8225
A02-M103FS001	1	TRIMPOT, 20T 100R FS SIDE	R16	BOURNS	3006P1-101
A02-M104FS001	1	TRIMPOT, 20T 1K00 FS SIDE	R2	BOURNS	3006P1-102
A02-M203FS001	1	TRIMPOT, 200R 20-T FS SIDE	R15	BOURNS	3006P1-201
A02-M503FS001	1	500 OHM 20-T TRIMPOT	R9	BOURNS	3006P1-501
A02-M503UT001	1	TRIMPOT, 20T 500R UR TOP	R19	SPECTROL	64Y-501
A04-1004HMAD3	2	1.0 NF 50V 1% NPO MC 8.5MM LS	C11-C12	SFETECHNOL	G505BY102F
A04-1004HMAD3	4	1.0 NF 50V 1% NPO MC 8.5MM LS	C101-C104	SFETECHNOL	G505BY102F
A04-1005HMBG1	1	.01 UF 50 V 10% MC	C20	CENTRALAB	CW20C103K
A04-1005IPNG1	2	.01 UF 10% MYLAR	C17-C18	SPRAGUE	192P1039R8
A04-1006HMCH2	4	0.1UF 50V 20% MC	C24-C27	CENTRALAB	CZ20C104M
A04-1007GTNH1	3	1 UF 35 V DT, NO KEMET OR KYACERA	C16,C21-C22	SPRAGUE	199D105X0035BB1
A04-2704MCFG1	1	2.7 NF, 100V,DISC,Y5P,10%	C4	MALLORY	SM272K
A04-3307FTNH1	1	3.3 UF 25 V DT	C19	SPRAGUE	199D335X0025BB1
A04-4708BTNH1	2	47 UF 6 V DT	C2,C10	ITTCAP	TAP47M6.3
A04-5001UCBG1	3	5 PF DISC	C7,C9,C15	MALLORY	CMC050C
A04-5602HCAF1	1	56 PF 5 % COG DISC	C5	MALLORY	CEC560J
A04-6802JMAG1	1	68 PF 100 V 10% MC	C3	CENTRALAB	CN15A680K
A04-6807FTNH1	2	6.8 UF 25 V DT	C13-C14	SPRAGUE	199D685X0025CB1
B01-4148	5	GLASS DIODE	D4-D6,D9,D11	VARIOUS	1N4150
B01-4148	1	GLASS DIODE	D101	VARIOUS	1N4150
B02-750A	1	4.7 VOLT ZENER DIODE	D10	VARIOUS	1N750A
B04-F7000	1	LOW POWER MOSFET TO92	Q3	SILICONIX	2N7000
B04-N5210	1	LOW POWER TRANSISTOR	Q2	VARIOUS	2N5210
B04-P5087	1	LOW POWER TRANSISTOR	Q1	VARIOUS	2N5087
B05-N15202001	1	MED POWER TRANSISTOR	Q101	MOTOROLA	MPSU05
BT1-000000001	3	Schottky diode test foward V. DROP, FXT.DF1	D1-D3 , WE INSTALL !!!	HP# 1N5711	mask over holes D1-D3

C01-2B0000001	4	NE5532P DUAL OP AMP, PLASTIC)	U1-U4	TEXASINSTR	NE5532P (TI ONLY)
C01-2F0000007	1	TL082CP RAYTHEON DUAL OP AMP	U6	TEXASINSTR	TL082CP
C02-1P251L001	1	2.5 V REF	U5	ANALOGDEVI	AD580JH
C02-1P801L001	1	V0LTAGE REGULATOR, T092	U9	TEXASINSTR	UA78L08ACLP
C03-100000001	1	TIMER	U10	SIGNETICS	NE555N
C04-200000001	2	CA3290E RCA DUAL COMPARATOR	U7-U8	RCA	CA3290E
E01-S20000001	1	RED LED	D8	DIALIGHT	521-9240
E01-S40000001	1	YELLOW LED	D7	DIALIGHT	521-9176
E01-S50000001	1	GREEN LED	D12	DIALIGHT	521-9270
N06-184000001	1	SILGUARD 184DOW-CORNING	potting compound		DC18401
U05-MSCP	1	ASSEMBLY LABOR, V01-MSCP	For MSI Use ONLY !!!!		
V03-MSEB	1	PWB ASSY, POTTED, MSCP 'BLOB'		MSI INSTALLS	
Z01-103	2	100 OHM 1/4W 5% CF	R36,R39	VARIOUS	1/4 W 5 % CF
Z01-104	1	1K 1/4W 5% CF	R41	VARIOUS	1/4 W 5 % CF
Z01-105	3	10K 1/4W 5% CF	R43,R54,R65	VARIOUS	1/4 W 5 % CF
Z01-107	1	1 M 1/4W 5% CF	R47	VARIOUS	1/4 W 5 % CF
Z01-108	1	10 M 1/4W 5% CF	R44	VARIOUS	1/4 W 5 % CF
Z01-125	1	12 K 1/4W 5% CF	R56	VARIOUS	1/4 W 5 % CF
Z01-135	1	13 K 1/4W 5% CF	R46	VARIOUS	1/4 W 5 % CF
Z01-154	2	1.5 K 1/4W 5% CF	R35,R42	VARIOUS	1/4 W 5 % CF
Z01-186	1	180K 1/4W 5% CF	R48	VARIOUS	1/4 W 5 % CF
Z01-204	1	2 K 1/4W, 5% CF	R18	VARIOUS	1/4 W 5 % CF
Z01-224	3	2.2K 1/4W 5% CF	R31,R53,R63	VARIOUS	1/4 W 5 % CF
Z01-225	2	22K 1/4W 5% CF	R1,R4	VARIOUS	1/4 W 5 % CF
Z01-226	1	220K 1/4W 5% CF	R50	VARIOUS	1/4 W 5 % CF
Z01-276	1	270K 1/4W 5% CF	R37	VARIOUS	1/4 W 5 % CF
Z01-334	1	3.3K 1/4W 5% CF	R17	VARIOUS	1/4 W 5 % CF
Z01-336	1	330 K 1/4W 5% CF	R34	VARIOUS	1/4 W 5 % CF
Z01-394	1	3.9 K 1/4W 5% CF	R40	VARIOUS	1/4 W 5 % CF
Z01-473	2	470 OHM 1/4W 5% CF	R52,R64	VARIOUS	1/4 W 5 % CF
Z01-474	1	4.7K 1/4W 5% CF	R49	VARIOUS	1/4 W 5 % CF
Z01-475	1	47 K 1/4W 5% CF	R105	VARIOUS	1/4 W 5 % CF
Z01-475	2	47 K 1/4W 5% CF	R20,R51	VARIOUS	1/4 W 5 % CF
Z01-477	1	4.7 M 1/4W 5% CF	R62	VARIOUS	1/4 W 5 % CF
Z01-563	2	560 OHM 1/4W 5% CF	R5,R58	VARIOUS	1/4 W 5 % CF
Z01-683	2	680 OHM 1/4W 5% CF	R45,R55	VARIOUS	1/4 W 5 % CF

Z01-684	2	6.8 K 1/4W 5% CF	R14,R57	VARIOUS	1/4 W 5 % CF
Z01-XXX	1	RESISTOR 5% SELECT AT TEST	R66	1/4W 5% CF	For MSI Use ONLY !!
Z02-1004	2	1.0 K 1/4W 1% MF	R3,R60	VARIOUS	1/4 W 1 % MF
Z02-1005	5	10.0 K 1/4W 1% MF	R6-R8,R11-R12	VARIOUS	1/4 W 1 % MF
Z02-1336	1	133 K 1/4W 1% MF	R28	VARIOUS	1/4 W 1 % MF
Z02-1504	1	1.50 K 1/4W 1% MF	R61	VARIOUS	1/4 W 1 % MF
Z02-2214	1	2.21 K 1/4W 1% MF	R13	VARIOUS	1/4 W 1 % MF
Z02-3244	1	3.24 K 1/4W 1% MF	R59	VARIOUS	1/4 W 1 % MF
Z02-4993	1	499 OHM 1/4W 1% MF	R10	VARIOUS	1/4 W 1 % MF
Z02-6813	1	681 OHM 1/4W 1% MF	R27	VARIOUS	1/4 W 1 % MF
Z02-9533	1	953 OHM 1/4W 1% MF	R38	VARIOUS	1/4 W 1 % MF
Z02-XXXX	1	RESISTOR 1% SELSCT AT TEST	R102	VARIOUS	1/4 W 1 % MF
Z03-XXXX	2	RESISTOR 1% SELECT AT TEST	R67-R68	For MSI Use Only !!!	Does not go to vendor !!
Z07-103	4	100 OHM 5% 1/2W CC EB TYPE	R106-R109	ALLENBRADL	EB TYPE 1/2 W 5% CC
Z14-1005	8	10.0K RN55.1% 1/4W 50 PPM	R21-R26,R29-R30	MILITARY	RN55CF
Z14-2215	2	22.1K RN55 .1% 1/4W 50PPM	R32-R33	RCD	MF55C - SORTED