

# Crown's IOC Circuit

Crown® has been known for years as a leader in the world of power amplifiers, starting even before the DC-300® (1966). In December, 1966, Crown introduced the original DC-300 ("300 Watts and a Cloud of Smoke!"). It featured AB+B biasing and VI limiting. Although Crown held the original patents, these technologies are now used in nearly all professional amplifiers on the market today. Later the DC-300A would add the IOC® circuit for monitoring distortion.

Crown has made many advances in amplifier design, but one very important innovation is IOC. This circuit makes Crown unique from other manufacturers.

## IOC CIRCUIT

IOC — Input/Output Comparator. Crown amplifiers, like other amplifiers, use negative feedback to control gain and provide stability. Crown amplifiers also use this negative feedback in the IOC circuitry (see Figure 1). An op-amp senses the input signal and output signal at the same time. If there is any variation in the shape of the two waveforms, then the output does not truly represent the input. If the input and output signals do not match exactly, then the amplifier is producing distortion. Figure 2 shows the undistorted audio input to the amplifier; the clipped output from the amplifier; and finally the output of the Error Amp (full square wave represents comparator output). The IOC circuit is sensitive to better than 0.05% distortion.

If an op-amp's input and feedback signals do not have matching waveforms, the distortion causes a condition called "open loop gain." Open loop gain means that the output of the amplifier will go to maximum power supply voltage on its output. Normally the output of the op-amp will be in proportion to the input, but if, for example, clipping occurs at an audio peak, the op-amp will produce a spike. Since a unique function of this op-amp stage is to sense such an error, it is commonly called an Error Amp.

The IOC circuit senses the output of the Error Amp, comparing it to fixed voltages. These fixed voltages act like a window. If the output of the Error Amp leaves its normal window of operation, the IOC circuit knows that the only reason is

distortion. Once it is determined that an IOC condition (distortion) exists, it illuminates an LED indicator on the front panel of the amplifier.

## "TOO LATE" CLIP LIGHTS VS. IOC

Many competition amplifiers offer what they call a "clip" light. Clip indicators usually watch the audio signal, and if its peaks exceed an arbitrary maximum, the clip indicator will light, whether distortion is present or not.

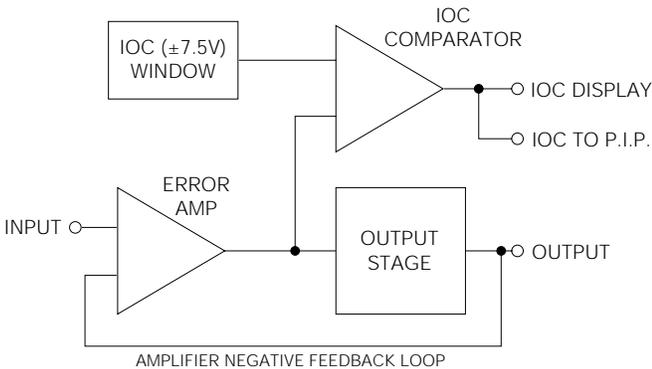


Figure 1 IOC Simplified Block Diagram

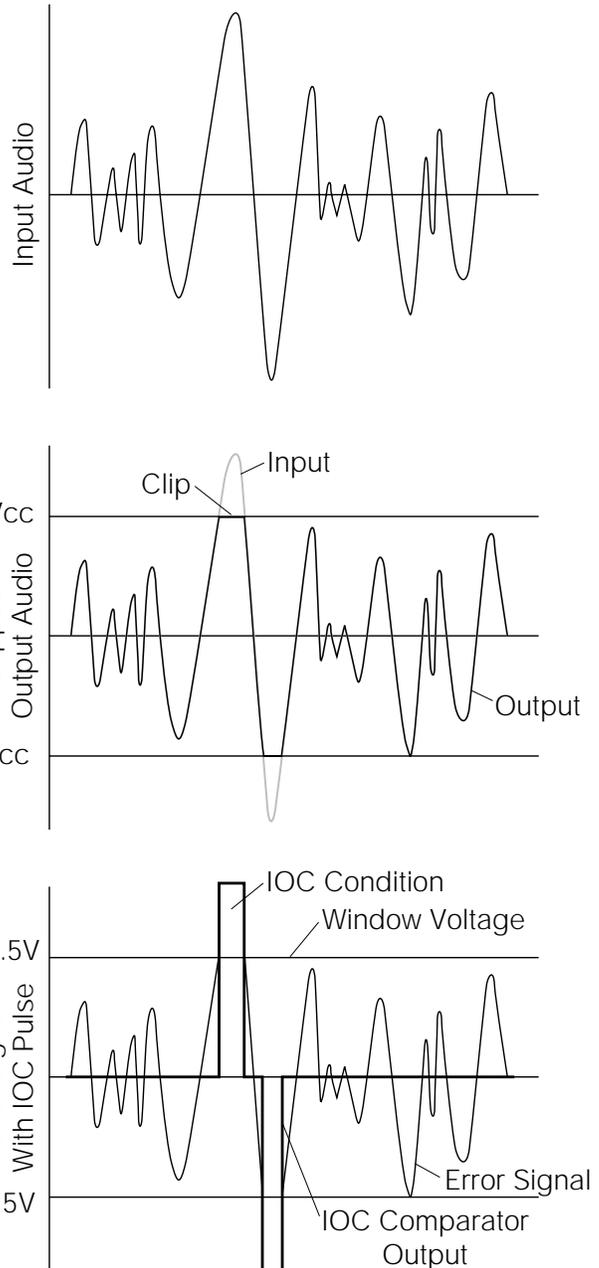


Figure 2 IOC Signals

### What's wrong with a clip light?

Clip indicators do not monitor for actual distortion. When signal level alone is sensed it is usually without regard to load impedance, line voltage, or any other parameter. These and other variable may make a huge difference in the signal level that ultimately results in clipping distortion. When a speaker is shorted or the load impedance goes very low, an amplifier produces less voltage at its output due to sag in the high voltage supply and, if the load impedance is low enough, current limiting. If this happens distortion will occur long before a level sensitive clip indicator will catch it. Low line voltage also reduces the effective size of the amplifier by reducing its high voltage supplies. Again, clipping occurs sooner than it otherwise would—and at a lower level than the clip light is calibrated for. Suppose an amplifier is producing distortion for some other reason. A clip light does not analyze the output waveform, only the output signal size. Ultimately, the common clip light, even under ideal circumstances, does not inform the operator of anything except that clipping is probably in progress. The effects of clipping are already being felt at the speakers.

### How does IOC differ?

IOC is designed to report any form of distortion. IOC not only checks the waveform for distortion, but also reports input overload and even a protective action that mutes or shuts down an amplifier. With all of these features, IOC monitors the entire amplifier. When the IOC indicator is off the amplifier is definitely operational and undistorted. IOC provides an on-line *proof of performance*. No other manufacturer has IOC.

### IOC AS A TOOL

IOC is a powerful tool when used properly. Obviously no single feature or function of any product exists in a vacuum, but for the sake of discussion IOC by itself tells you many things about the status of not only a Crown amp, but also the source and the load.

### Speaker Concerns

A speaker can be blown by either too much instantaneous power or overheating and burnout of the voice coil. The former is comparatively rare. It usually only occurs when there is a severe power mismatch of amplifier to speaker. To avoid such a problem, the best advice is usually to use the right amplifier-speaker combination. Most speaker failures are due to heat build up in the voice coil which results in the voice coil melting, shorting out, or burning open. This may happen if an amplifier is just too big for the speakers being used, but generally it is because an amplifier has been driven into clip over a period of time. Clipping is harmful to speakers.

### Signal Management

The IOC indicator will light to indicate distortion even before clipping is audible or even visible on a measurement scope. Occasional IOC events tell you the amp is reaching maximum output. It may be clipping slightly, but when the speakers are matched to the amp such a small amount of distortion is not usually a problem. The more frequently the IOC indicator lights up, the heavier the clipping. The better the power handling capability of the speakers for the amplifier, the more clipping the speakers can handle for a given power level.

### System Troubleshooting

If there is no audio or distorted audio the IOC lights, in concert with other indicators, can tell you whether the difficulty is with the amp, the load, or the source. If the problem is with the source, the IOC light will be off and the signal presence indicator will also be off (no output) or may be on at or below the expected level (distorted audio). If the speaker is shorted the IOC light will flash on at even low signal levels, getting worse as signal level is increased. If there is no sound from the speakers they are probably blown. When the amplifier IOC light is locked in the amp is in standby due to a protective action. A protective action may occur due to a thermal shut-down or circuit failure. If the amplifier is equipped with an ODEP indicator which is out and the IOC light is flashing with the signal, the amplifier's ODEP thermal management system is protecting the amplifier from excessive heat and, in the process, producing some distortion as it limits output drive. In any event, if the IOC light is not lit the amplifier is operational and not producing distortion.

### IOC AND THE IQ SYSTEM

The IQ System<sup>®</sup> is a product line of computerized audio equipment. Several types of Crown amplifiers are IQ compatible and may be equipped with an IQ System P.I.P. module (there are several models available). The IQ System allows an amplifier to be remotely monitored and controlled. IOC, along with several other parameters, can be monitored on a remote PC via IQ. With the right software and hardware you can even make the amp tell you when it is clipping "too much," according to your definition, even if you are monitoring other system components at the time.

### ADVANCED CROWN TECHNOLOGIES

Crown has been an innovative company in the audio industry since its founding back in the 1940's. Today there are a number of technologies employed in Crown amplifiers that truly set Crown apart from the competition. Some of these include the grounded bridge™ output topology, ODEP<sup>®</sup> thermal management, VZ<sup>®</sup> power supply technology, and a host of other feature benefit technologies. IOC is a powerful tool, but it stands on an impressive list of technology breakthroughs.

### AMPLIFIER REFERENCE

Crown amplifiers equipped with the IOC indication circuitry include: D Series, PS Series, Power-Tech Series, Macro-Tech<sup>®</sup> Series, Com-Tech<sup>®</sup> Series, and the Reference Series.



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