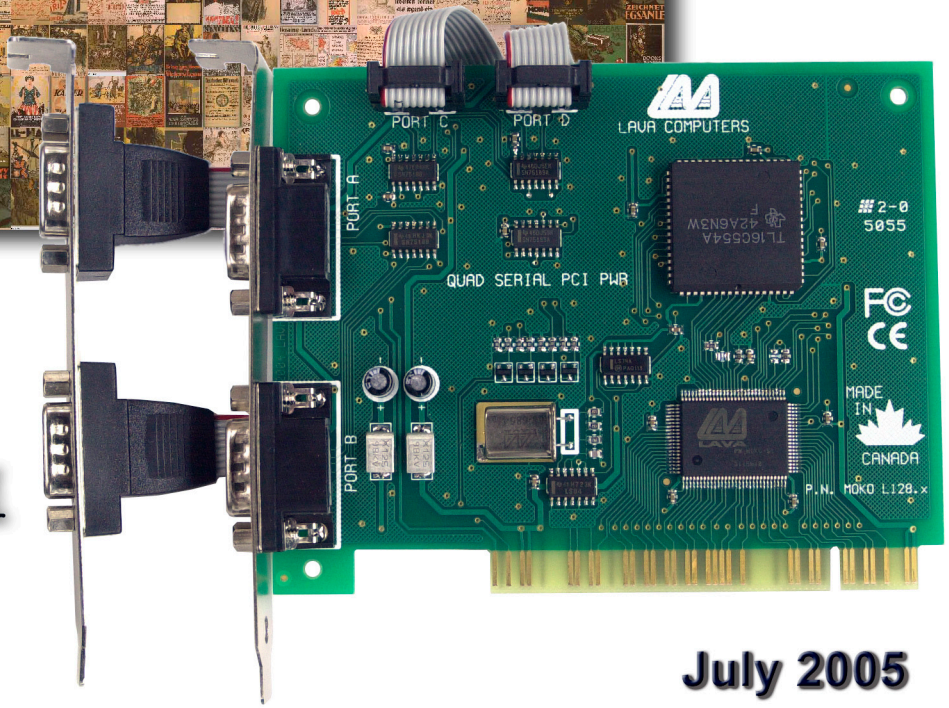
July 2005

Slot Tech Magazine

Slot Machine Technology for the International Gaming Industry



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Slot Tech Magazine

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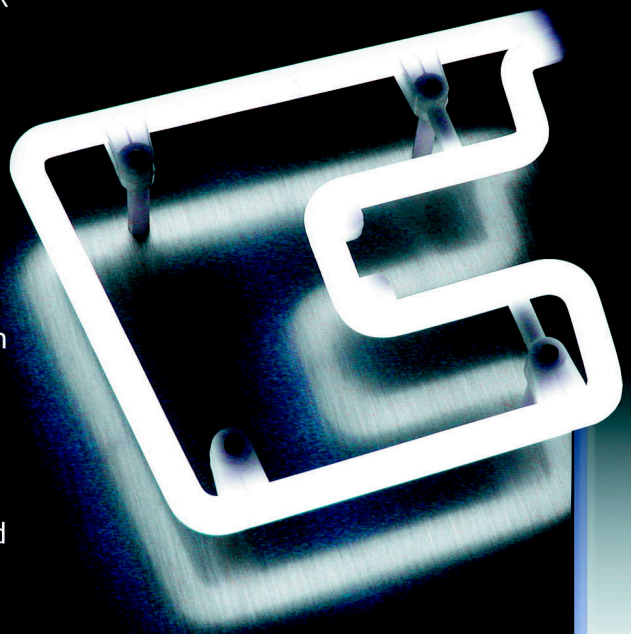

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Above: Pedro (l), Jimmy, Kao and Carlos (r), slot techs from The Palace Casino in Lemoore, California, run through some monitor troubleshooting during their recent two-week training session. See page 24 for more coverage.

July 2005

Slot Tech Editorial

In this issue of Slot Tech Magazine, we're going to spend some time discussing serial communications, UARTs, DUARTs and RS-232. If you don't know what any of that stuff is, this is your issue of Slot Tech Magazine. Herschel Peeler's going to start us off with a little discussion about generating a negative voltage when all you have is positive. What does that have to do with RS-232? Well, just this: One of the goals of RS-232 serial communication is to allow us to send digital signals over long distances, without signal degradation to the point of unreliability. We have to be 100% reliable. One of the ways to accomplish this is to jack the signal strength way up on the sending end, in order to overcome any losses in the wire. Instead of a normal, TTL level signal (from approximately 0 volts to +5 volts) RS-232 uses -12 volts to +12 volts. Instead of a five volt swing, we have a 24 volt swing in voltage, which enables reliable serial communication over long distances and in noisy environments.

TechFest 12 will be held at Robinson Rancheria in Nice, California October 11-13 2005

Randy Fromm's
Slot Tech Magazine

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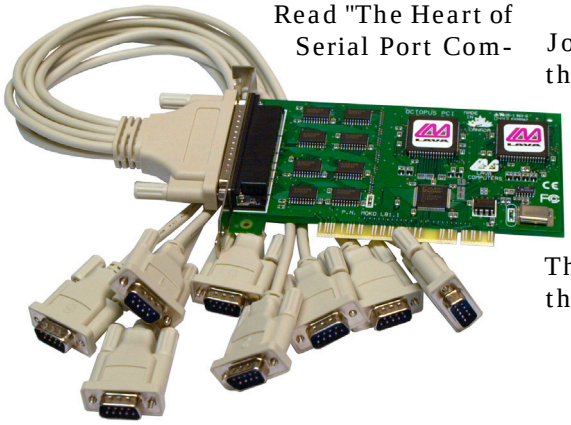
Slot Tech Magazine congratulates Unicum's Yuri Larichev (l), newly appointed as the company's CEO.

But where does this negative voltage come from? It may come from a dedicated, negative power supply of course but since this might be the only device in the entire system that requires a -12 VDC power supply, the negative supply is sometimes derived from the positive power supply. This is an interesting look at just how this is accomplished. The concept applies to other types of DC to DC conversion as well so it's an interesting read from that standpoint alone, regardless of its tie-in with RS-232.

Still wonder just what this RS-232 thingy is all about? Read "The Heart of Serial Port Communications" by comm port guru Ron Jenkins of Lava Link. These are the guys you'd go to if, for example, you want to upload new software to a gang of ticket printers or bill validators and you need four or eight com ports. They make an octopus that allows you to bang out eight at a time. This month's cover features the four port version.



John Wilson is back (hooray!) with the conclusion (HOORAY!) of his look at random number generators. Our continuing series on the Tovis digital monitor continues next month.

That's all for this month. See you at the casino.

Randy Fromm

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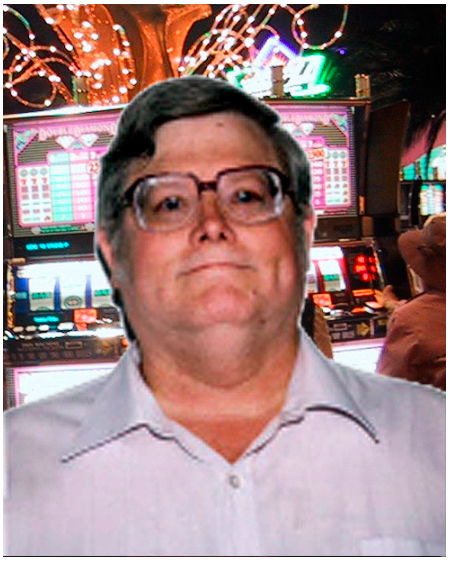


ICL7660
Voltage level Converter

By Herschel Peeler

Occasionally a circuit needs a few milli-Amps of a negative voltage. A typical example of this is an RS-232 Interface where the output must go to a positive as well as a negative voltage (For more about RS-232, see "Serial Ports" on page 14 of this issue). The ICL7660 was made exactly for such a purpose.

The ICL7660 is a fairly simple circuit. It has a 10 kHz oscillator with its own internal components, four switching transistors and a control circuit. The control circuit alternately charges and discharges the capacitors (connected to pins 2, 4 and 5). The transistors steer the discharging of the capacitors so a negative voltage is generated at the pin 5 output.

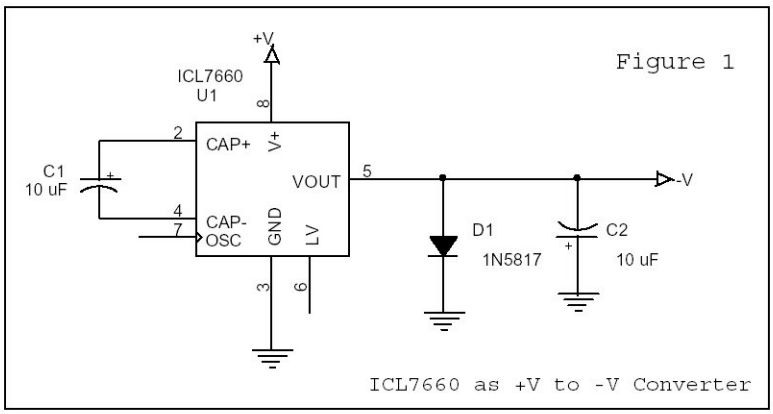
Output voltage is typically the same as the +V on pin 8 but of the opposite polarity. The ICL7660 may operate on any voltage between 1.5 Volts and 10 Volts and supply about 3 milliamps of output current. The ICL7660A can operate at up to 12 Volts and supply up to 10 mA. This is a suitable current level for an interface signal or to provide a negative bias voltage for older MOS logic devices. This era of technology just about coincides with the beginning of gaming devices. Early IGT Keno games were built around the Intel 8080 microprocessor. This is the application the ICL7660 was designed for. The 8080 required +12 Volts, +5 Volts and -5 Volts.

More modern RS-232 Interface chips have a similar circuit built into them and generate their own negative voltage.

(Referring to Figure 1)

Two capacitors are required for basic operation. 10 µF electrolytic capacitors are suggested by the manufacturer's data sheet. The capacitor connected across pins 2 (+) and 4 (-) is part of a Charge Pump circuit. The steering transistors build up a charge across this capacitor then switch the polarity so that when it discharges, it creates a negative voltage at pin 5. The second capacitor at pin 5 (-) to ground (+) is called the reservoir capacitor. The negative voltage is built up across this capacitor. As current is drawn from pin 5 it comes from this capacitor discharging.

D1 protects pin 5 from going more positive than ground and is strictly a safety device. You will not see it in all applications. A 1N4148 Silicon signal diode would probably



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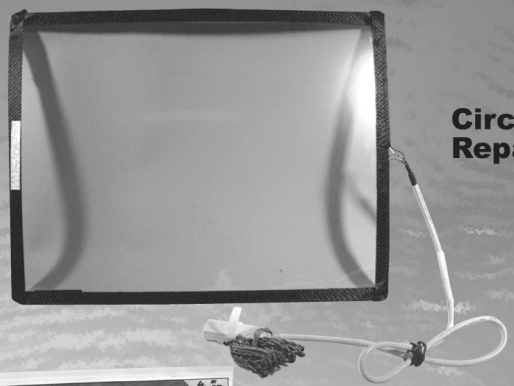

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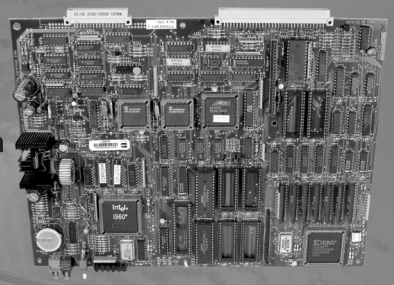

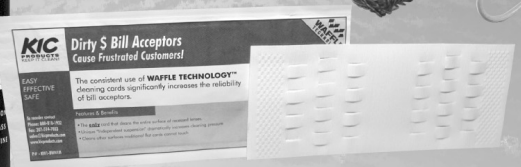

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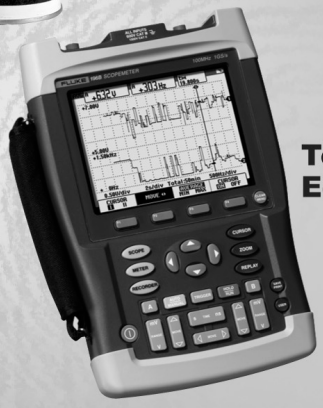

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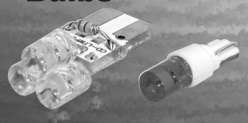

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The MAX1044/ICL7660 combine low quiescent current and high efficiency. Oscillator control circuitry and four power MOSFET switches are included on-chip. Applications include generating a -5V supply from a +5V logic supply to power analog circuitry. For applications requiring more power, the MAX660 delivers up to 100mA with a voltage drop of less than 0.65V.

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Op-Amp Power Supplies
EIA/TIA-232E and EIA/TIA-562 Power Supplies
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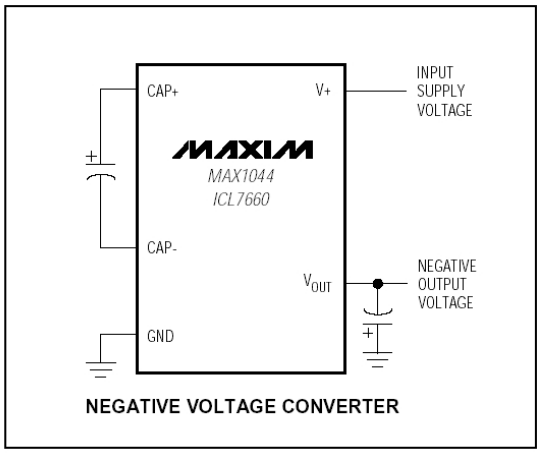
Typical Operating Circuit



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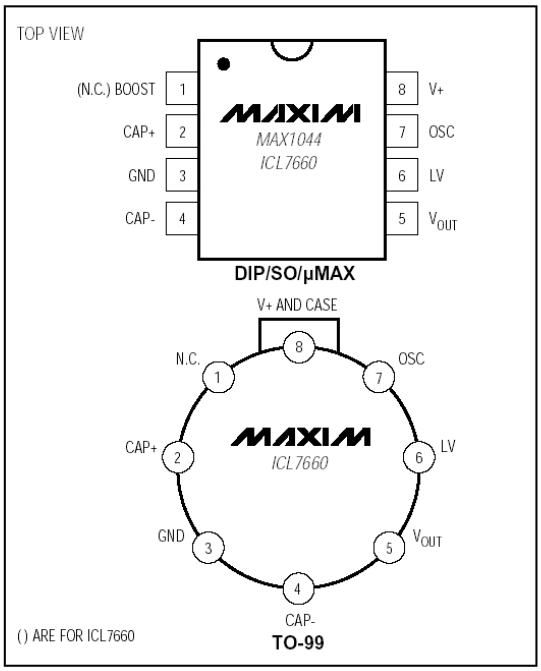
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX1044CPA	0°C to +70°C	8 Plastic DIP
MAX1044CSA	0°C to +70°C	8 SO
MAX1044C/D	0°C to +70°C	Dice*
MAX1044EPA	-40°C to +85°C	8 Plastic DIP

Ordering Information continued at end of data sheet.
** Contact factory for dice specifications.*

Pin Configurations



work. The lower forward voltage of the 1N5817 Schottky diode is suggested. It is not required for speed.

For operation below 3.5 Volts, pin 6 should be connected to ground.

The oscillator section of the ICL7660 may also be used to make a voltage doubler. This generates an output voltage that is twice that of the input voltage, minus the drop across the two diodes. Again, 1N5817s were used for the lower voltage drop. 1N4148 types would work with only a small drop in output voltage. Figure 1 and Figure 2 may be combined to accomplish both a negative voltage generator as well as a voltage doubler, but the total output current must still be below the level of a few milliamps. The limiting factor is how much charge we can develop across the capacitor connected to pin 2. See figure 3.

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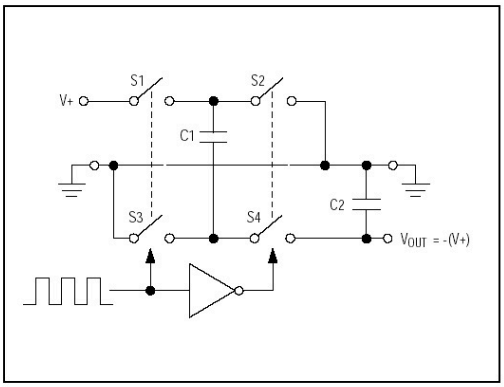
Pin Description

PIN	NAME	FUNCTION
1	BOOST (MAX1044)	Frequency Boost. Connecting BOOST to V+ increases the oscillator frequency by a factor of six. When the oscillator is driven externally, BOOST has no effect and should be left open.
	N.C. (ICL7660)	No Connection
2	CAP+	Connection to positive terminal of Charge-Pump Capacitor
3	GND	Ground. For most applications, the positive terminal of the reservoir capacitor is connected to this pin.
4	CAP-	Connection to negative terminal of Charge-Pump Capacitor
5	V_{OUT}	Negative Voltage Output. For most applications, the negative terminal of the reservoir capacitor is connected to this pin.
6	LV	Low-Voltage Operation. Connect to ground for supply voltages below 3.5V. ICL7660: Leave open for supply voltages above 5V.
7	OSC	Oscillator Control Input. Connecting an external capacitor reduces the oscillator frequency. Minimize stray capacitance at this pin.
8	V+	Power-Supply Positive Voltage Input. (1.5V to 10V). V+ is also the substrate connection.



Detailed Description

The MAX1044/ICL7660 are charge-pump voltage converters. They work by first accumulating charge in a bucket capacitor and then transfer it into a reservoir capacitor. The ideal voltage inverter circuit (left) illustrates this operation.

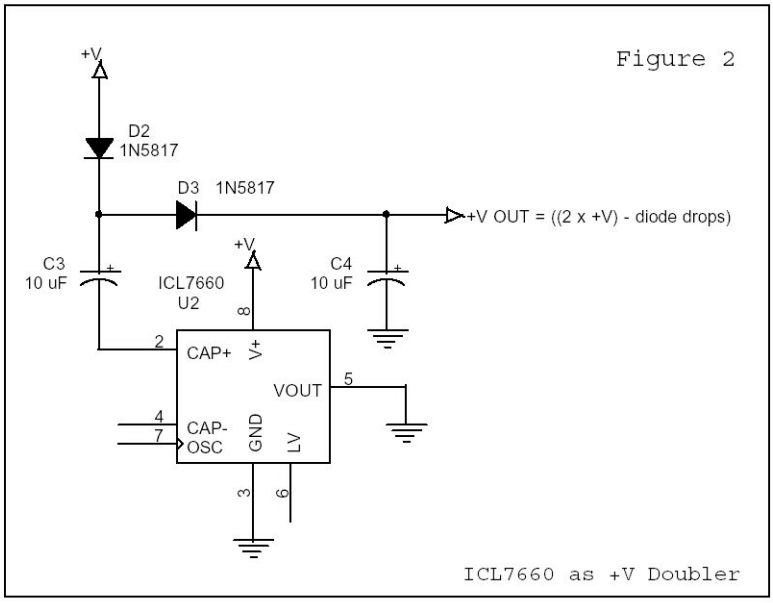
During the first half of each cycle, switches S1 & S3 close and switches S2 & S4 open, which connects the bucket capacitor C1 across V+ and charges C1.

During the second half of each cycle, switches S2 & S4 close and switches S1 & S3 open, which connects the positive terminal of C1 to ground and shifts the negative terminal to VOUT. This connects C1 in parallel with the reservoir capacitor C2. If the voltage across C2 is smaller than the voltage across C1, then charge flows from C1 to C2 until the voltages across them are equal. During successive cycles, C1 will continue pouring charge into C2 until the voltage across C2 reaches - (V+).

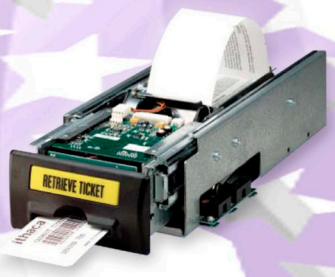
Operating Frequency

An internal R-C oscillator operates at around 10 KHz (when operating from 5 Volts). For faster operation, a CMOS / TTL clock pulse may be applied to pin 7. For slower operation, a capacitor may be connected between pin 7 and pin 8. A 100-pF capacitor will slow the oscillator down to around 1 KHz. At this slower rate, the Charge Pump and Reservoir capacitors must be ten times larger (100 µF).

Figure 2



ICL7660 as +V Doubler



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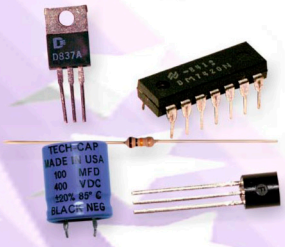

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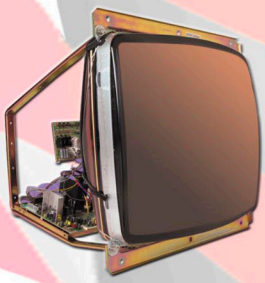

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For intermittent pulses of higher current, the reservoir capacitor connected to pin 5 may be made larger. A 100 µF capacitor here will allow pulses of output current at up to 100 mA, depending on the pulse width.

Devices may be put in parallel for higher currents or cascaded for higher voltages. In this case the output (pin 5) of the first stage connects to pin 3 (ground) of the second stage. Pin 8 (+V In) of the second stage is connected to ground, and the output is taken from pin 5 of the second stage. This simply puts the second stage referenced to ground and -V instead of +V and ground. I see no reason this can't be continued for another (third) stage. Speed of operation might start to be a problem. It would take some time after initial power on before the output finally builds up to the desired voltage.

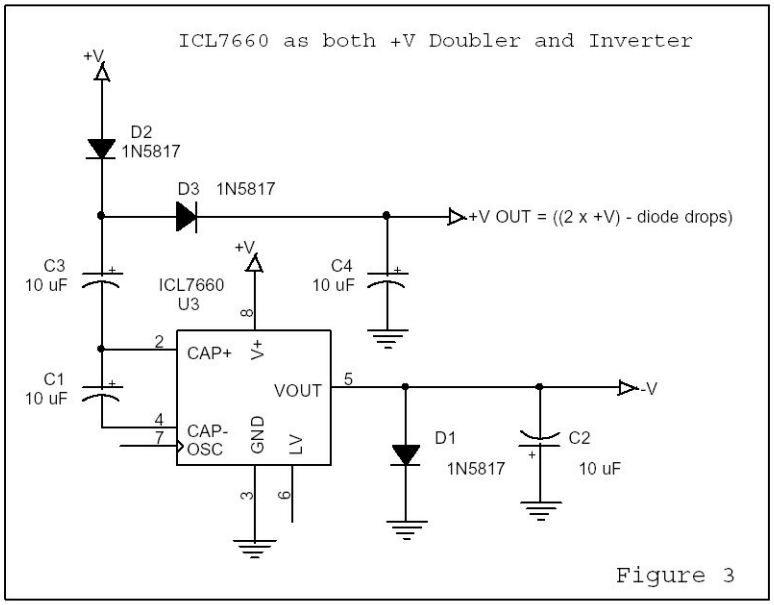

Figure 3

Regulating the Output Voltage

Since the output currents are so low we must regulate the output voltage by controlling +V In on pin 8.

Similar products: MAX1044 (almost same pinout and function, pin 1 is different) Si7661, ICL7662 (similar pinout, works up to 20 V) MAX1680 125 mA output capability

- Herschel Peeler
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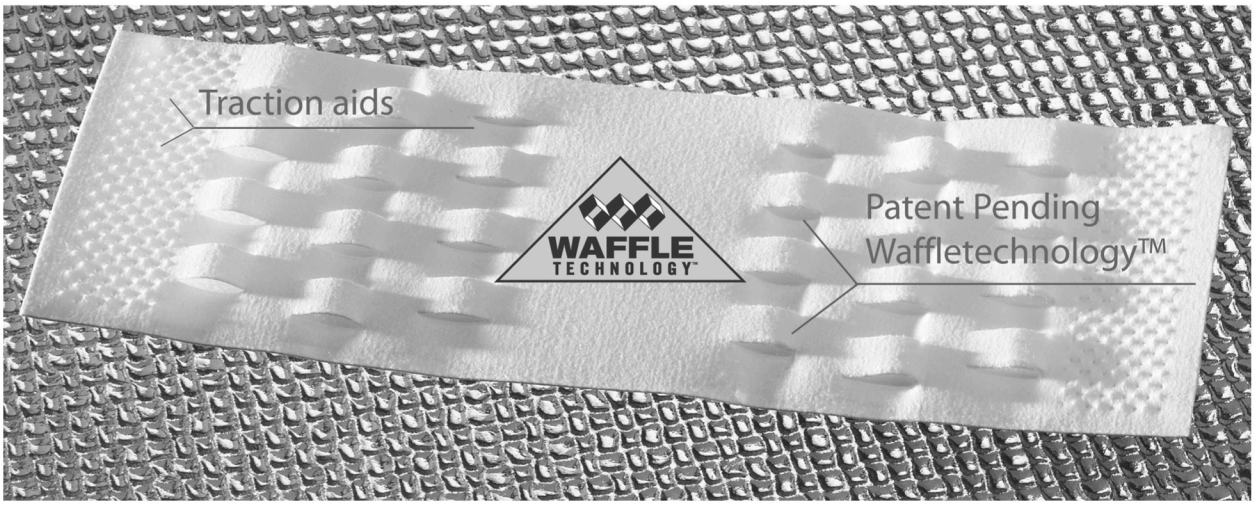

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The Heart of Serial Port Communications

by Ron Jenkins

Slot machines use serial ports to communicate between the CPU and its peripherals (ticket printers, bill validators, network, etc.) but because they are a well-established part of our systems, the sophistication of serial ports is easy to ignore. However, understanding how a serial port works makes troubleshooting and optimizing serial connections a whole lot easier.

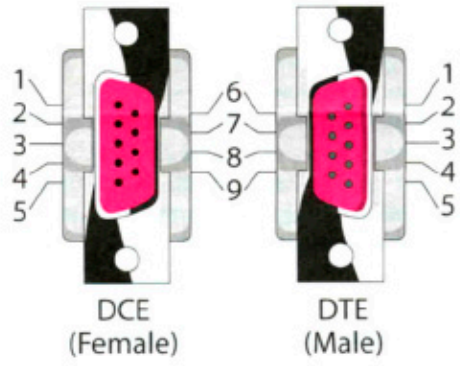
Behind any serial port communication is a UART or Universal Asynchronous Receiver-Transmitter. Put a couple of UARTs in the same package and you have a Dual Universal Asynchronous Receiver-Transmitter or DUART, which is what we use in today's slot machines. A UART is generally an integrated circuit or part of an integrated circuit. It contains the firmware that converts a parallel data stream of 8-bit bytes into a serial format of single bits or vice versa. When transmitting data over a serial line, the UART sends a byte's data one bit at a time. When receiving data from a serial line, the UART converts the serial data back to parallel data for the computer's CPU to use.

Put in the simplest terms, the UART transmits a byte of data by breaking it into its constituent bits, then packaging it so that the byte can be successfully identified and reassembled by the receiving serial port's UART. This process is called "framing" the byte. Next, the UART transmits the byte through the wires of the serial connection. In addition, the UART also manages the way data is handled between the computer's CPU and the UART's transmit and receive buffers. These buffers temporarily store bytes that are in transit so that the CPU receives fewer interrupt requests from the UART and so that the UART has fewer input/output overrun errors.

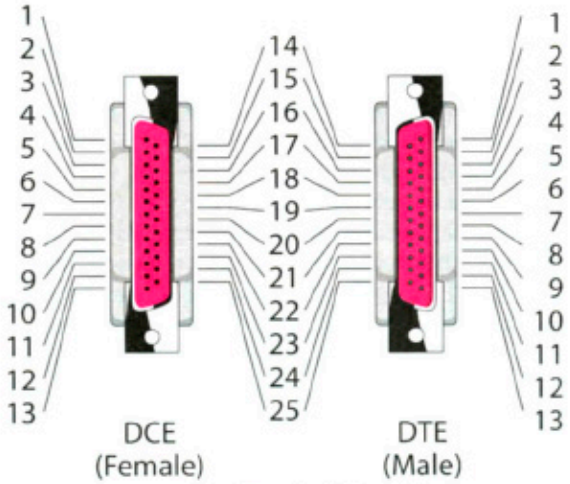
If we were talking about computers (Windows, for example) the Communications Port Properties dialog box has line setting parameters that configure the serial port's UART. This allows users to set the port's speed, the number of data bits framed, the type of parity the port will use, the number of stop bits, and the type of flow control used. Windows' Advanced Port Settings dialog box permits set-

RS-232 Connectors

The diagrams below show standard RS-232 pin assignments for 9 and 25 pin connectors.



9-Pin D-sub (DE-9, often called DB-9)



25-Pin D-sub (DB-25)

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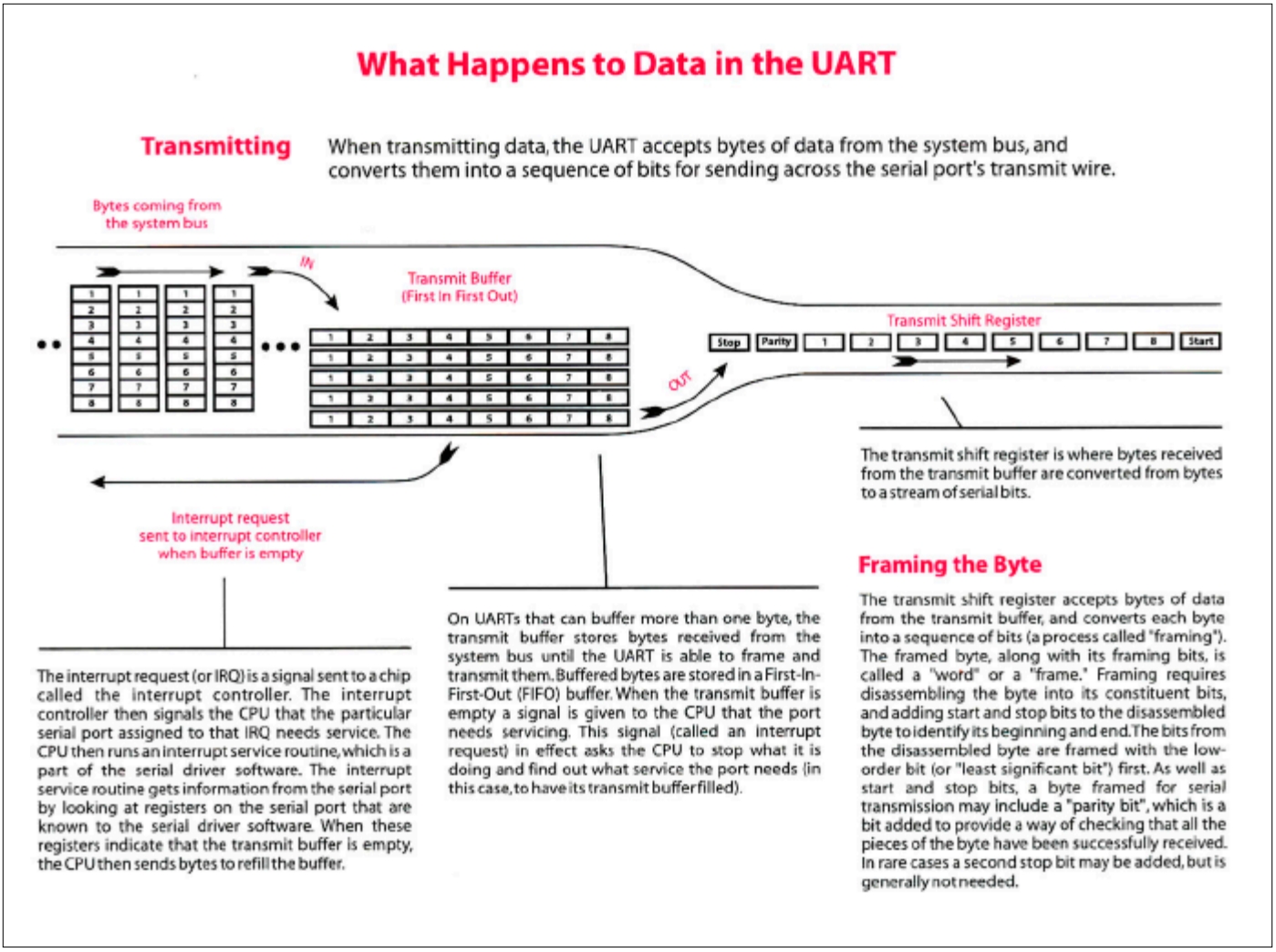


ting the trigger levels on the UART to ensure optimum performance from the serial port. Your slot machine has built-in utilities that allow you to accomplish the same thing. Utility programs for things like ticket printers and bill validators follow the same principle.

Data bits

RS-232 serial data can be configured to specify the number of data bits in a frame. The number of data bits used can be 4, 5, 6, 7, or 8. When the UART sends the data bits, it sends the data bits of the byte in the order of least significant bit to most significant bit. Most of the time, 8 bits can be used.

Parity bits

As it frames a byte for transmission, the UART may also add a bit called a “parity bit” to provide a means of checking that the data received matches the data that was transmitted. RS-232 parity bits can have one of five possible settings: none, even, odd, mark, or space. Without matching parity settings on both sides of a link, the receiving UART will not make sense of the data.

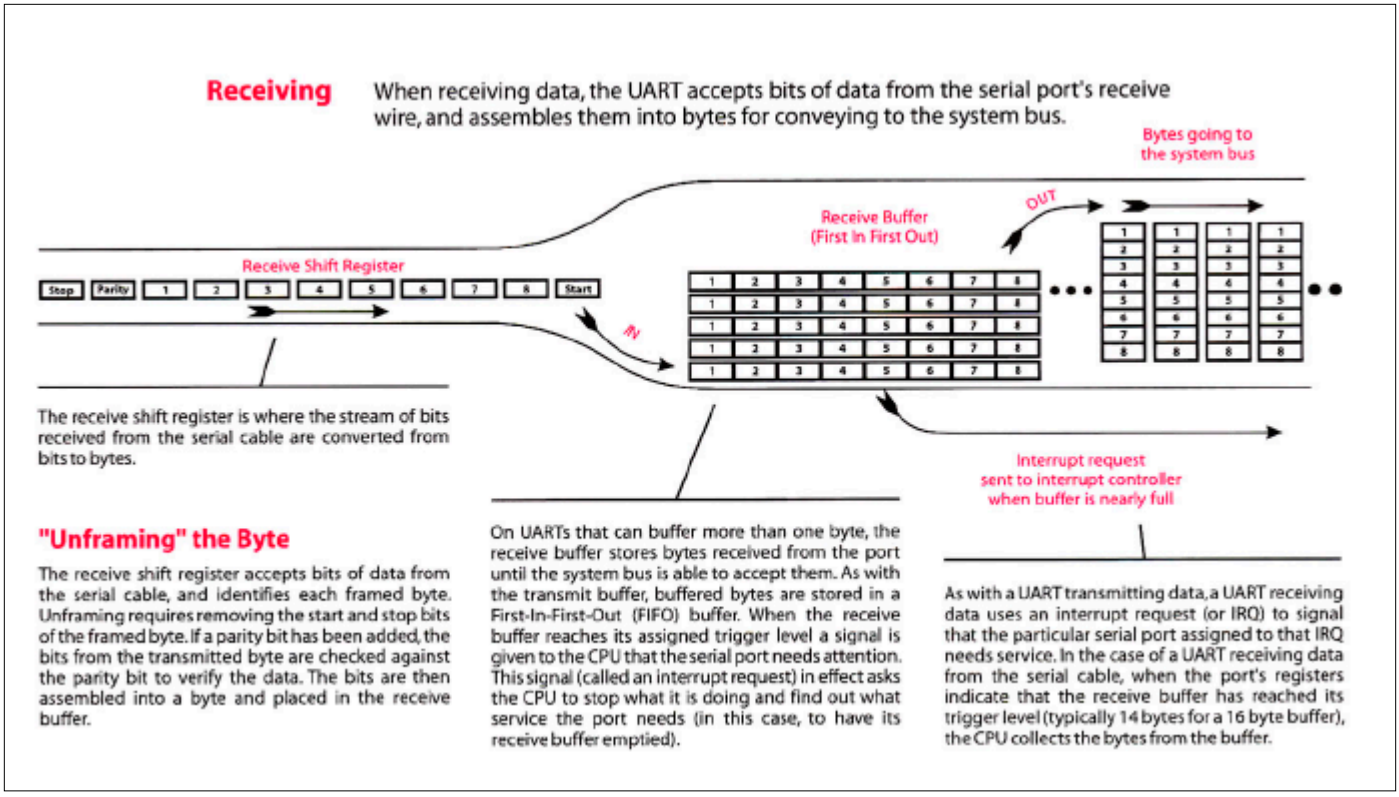
Stop and start bits

When framing a byte, the UART adds bits that indicate the start and stop of a byte. Without these start and stop bits, the flow of serial data would be an undifferentiated stream. The UART adds a start bit and either 1 or 2 stop bits. In rare cases, 1½ stop bits can be used; this setting in effect simply holds the stop bit’s voltage for 1½ times the duration of a single stop bit.

Transmitting

When transmitting data, the UART accepts bytes of data from the system bus and converts them into a sequence of bits for sending across the serial port’s transmit wire.

On UARTs that can buffer more than one byte, the transmit buffer stores bytes received from the system bus until the UART is able to frame and transmit them. Buffered



bytes are stored in a First-In-First-Out (FIFO) buffer. When the transmit buffer is empty, a signal is given to the CPU that the port needs servicing. This signal (called an interrupt request) in effect asks the CPU to stop what it is doing and find out what service the port needs (in this case, to have its transmit buffer filled).

The interrupt request (or IRQ) is a signal sent to a chip called the interrupt controller. The interrupt controller then signals the CPU that the particular serial port assigned to that IRQ needs service. a part of the serial driver software. The interrupt service routine gets information from the serial port by looking at registers on the serial port that are known to the serial driver software. When these registers indicate the transmit buffer is empty, the CPU then sends bytes to refill the

buffer.

The transmit shift register is where bytes received from the transmit buffer are converted from bytes to a stream of serial bits.

Framing the Byte

The transmit shift register accepts bytes of data from the transmit buffer, and converts each byte into a sequence of bits (a process called "framing"). The framed byte, along with its framing bits, is called a "word" or a "frame." Framing requires disassembling the byte into its constituent bits, and adding start and stop bits to the disassembled byte to identify its beginning and end. The bits from the disassembled byte are framed with the low-order bit (or "least significant bit") first. As well as start and stop bits, a byte framed for serial transmission may include a "parity bit", which is a bit added to provide a way of checking that all the pieces of the byte have been successfully received. In rare cases a second stop bit may be added, but is generally not needed. The receive shift register is where the stream of bits received from the serial cable are converted from bits to bytes.

Unframing the Byte

The receive shift register accepts bits of data from the serial cable, and identifies each framed byte. Unframing requires removing the start and stop bits of the framed byte. If a parity bit has been added, the bits from the transmitted byte are checked against the parity bit to verify the data. The bits are then assembled into a byte and placed in the receive buffer.

On UARTs that can buffer more than one byte, the receive buffer stores bytes received from the port until the system bus is able to accept them. As with the transmit buffer, buffered bytes are stored in a First-In-First-Out (FIFO) buffer. When the receive buffer reaches its assigned trigger level a signal is given to the CPU that the serial port needs attention. This signal (called an interrupt request) in effect asks the CPU to stop what it is doing and find out what service the port needs (in this case, to have its receive buffer emptied).

As with a UART transmitting data, a UART receiving data uses an interrupt request (or IRQ) to signal that the particular serial port assigned to that IRQ needs service. In the case of a UART receiving data from the serial cable, when the port's registers indicate that the receive buffer has

RS-232 Signal Descriptions

DTR: Data Terminal Ready - Used by a piece of Data Terminal Equipment to signal that it is available for communication.

DSR: Data Set Ready - The companion signal to DTR, it is used by a piece of Data Circuit-Terminating Equipment to signal that it is available for communication.

CTS: Clear to Send - Used by a piece of Data Circuit-Terminating Equipment to signal it is available to send data. This line is also used in response to an RTS request for data.

RTS: Request to Send - Used by a piece of Data Terminal Equipment to indicate that it has data to send.

DCD: Data Carrier Detect - Used by a piece of Data Circuit-Terminating Equipment to indicate to the Data Terminal Equipment that it has received a carrier signal from the modem and that real data is being transmitted. Sometimes abbreviated as CD.

RI: Ring Indicator - Used by a Data Circuit-Terminating Equipment modem to tell a piece of Data Terminal Equipment that the phone is ringing and that some data will be forthcoming.

TD: Transmit Data - This wire is used for sending data. Sometimes abbreviated as TXD. This wire will also be used to carry flow control information if software flow control is enabled.

RD: Receive Data - This wire is used for receiving data. Sometimes abbreviated as RXD. This wire will also be used to carry flow control information if software flow control is enabled.

GND: Ground - This wire is the same for Data Circuit-Terminating Equipment and Data Terminal Equipment, and it provides the return path for both data and handshake signals.

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reached its trigger level (typically 14 bytes for a 16 byte buffer), the CPU collects the bytes from the buffer.

Flow Control

The Communications Port Settings dialog box has a setting for flow control that allows choosing between hardware or software flow control (called "CTS/RTS" and "Xon/Xoff" respectively). Both methods can control the flow of data between the serial port and a device such as a modem. Hardware flow control uses dedicated lines of the serial connection to send flow control signals. Software flow control places control signals on the same lines that the data uses, and they travel along with the data. In most cases, hardware flow control is preferable because it is more immediately responsive than software flow control. Software flow control can be used when the serial cable does not have dedicated control wires

Buffers and triggers

Most serial ports in slots have UARTs equipped with buffers, or small portions of memory devoted to storing groups of bytes in transit through the UART. Buffers greatly improve the efficiency of CPU/serial port interactions, and help to reduce transmission errors called "overrun errors" that occur when a new byte arrives at a serial port before the previous byte has left the UART.

UARTs have adjustable settings governing when data in the buffers is released. These settings are the "trigger levels" of the UART. The trigger level for the input buffer indicates the number of bytes of data required to be in that buffer before the CPU is asked to collect them; the trigger level for the transmit buffer indicates the number of bytes of data remaining in that buffer before the CPU is asked to refill it.

What is RS-232?

RS-232 is currently the most common mode of serial communication in slot machines. After the serial port's UART has done its work by composing data for serial transmission, the data must be moved across the wires of a serial port. One way of doing so is called "RS-232."

RS-232 is a species of serial connection described in a specification written by the Electronic Industries Association (EIA) which, in conjunction with the Telecommunications Industry Association, defines the standards for traditional serial data transfer. Formally, the RS-232 standard is called EIA/TIA-232-F, reflecting the initials of the organizations that administer it. The RS-232 specification describes RS-232 communications equipment as well as the signaling, electrical, and mechanical characteristics of RS-232 serial ports.

Signaling

The RS-232 standard defines 25 signal lines in its interface, although in practice, slots rarely use more than nine of these lines. In fact, with just three of these lines—receive data (RD), transmit data (TD), and ground (GND)—bi-directional RS-232 communication can occur. The other lines are designated for a variety of control purposes. These include the remainder of the basic nine lines: data carrier detect (DCD), data terminal ready (DTR), data set ready (DSR), request to send (RTS), clear to send (CTS), and ring indicator (RI). These main nine serial signals are those typically used between a PC and a serial device such as a modem.

Electrical

RS-232 signals are indicated by voltage differences with respect to a ground signal, and can vary between +3 to +15 volts and -3 to -15 volts. At the same time, serial receivers must be undamaged by voltages up to ±25 volts. The control lines in an RS-232 link use a "positive" logic to indicate their state. That is, a positive voltage on a wire carrying a control signal (any of DCD, DTR, DSR, RTS, CTS, and RI on a nine-wire serial connection) indicates that the control signal involved can be described as "On," "Asserted," or "True." A negative voltage on a control line indicates that the control signal involved can be described as "Off," "De-asserted," or "False."

The data lines are just the opposite. Data lines use a so-called "negative" logic, meaning that a negative voltage on the wire carrying the data signal (RD or TD) is described as "On," "Asserted," or "True."

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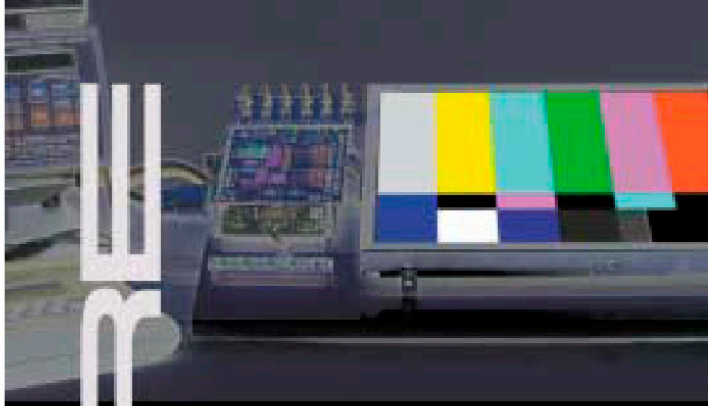

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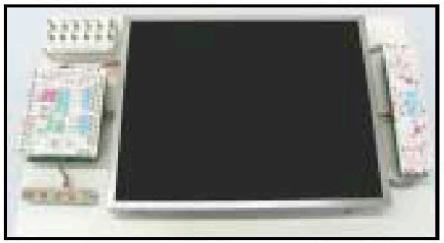
- *Relate SMPS and Inverter power supply block diagram test points to the equivalent schematic test point*
- *Understand multi-mode formats and circuit operation*



- *Understand analog (RGB) and digital signal formats and connectors (DVI)*
- *Explain the advantages and limitations of CRT vs. LCD displays*
- *Understand the theory and operation of fixed pixel displays, including LCD panel operation, signal processing, and backlighting*
- *Perform an LCD backlight replacement*
- *Perform LCD video calibration , including chromaticity (color temperature), black level, white level and geometry*

Course Description:

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The course begins with equipment familiarization and an overview of LCD displays. Students will discover how LCD panels work by learning the major functional blocks of an LCD monitor. Sencore has developed specific LCD trainers for hands –on demonstrations and troubleshooting exercises.

DAY 2

Hands-On LCD Monitor Troubleshooting

The second day of this course provides an introduction to troubleshooting LCD monitors. Entry level technicians and seasoned veterans will learn troubleshooting techniques and short cuts by using block diagrams and hands – on lab exercises.

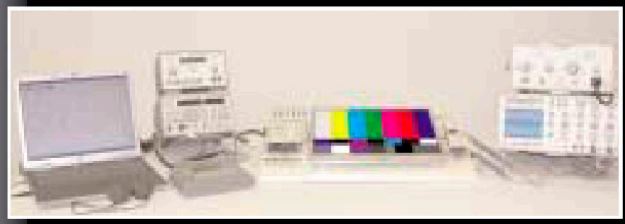
DAY 3

LCD Inverter power supply and SMPS Troubleshooting

The last day of the course provides an introduction to power supplies and their uses. The students then learn how each type of SMPS and inverter power supply works by performing experiments on a working model. This course is truly a hands-on course with approximately 70% devoted to lab time performing tests utilizing an exclusive Sencore power supply trainer.

Students will also be presented with Certificates of Completion following the Tech School.

This course is eligible for Continuing Education Credits (CEU).



Conversely, a positive voltage on the wire is interpreted as "Off," "De-asserted," or "False."

RS-232 also defines the timing of electrical signalling. An RS-232 connection differentiates between the bits of a serial data stream by reading the voltage of its data lines. In the simplest terms, it monitors the lines for a start bit and then reading the line at predefined intervals, with each interval representing the next bit in the stream of data. The timing of these intervals is determined by the data rate of the link. This process in effect makes the serial connection follow a clock within each byte, although the timing between one byte of data and the next is not dictated by a clock.

The number of readings taken within a byte is determined by the settings used by the UART for composing serial data: the number of data bits set for the link, whether the connection has a parity bit, and the configuration of stop bits. Once the stop bit is read, the connection waits for the next start bit to arrive.

Mechanical

Each line in an RS-232 interface is assigned a pin number for the various connectors that RS-232 can use. The nine primary lines, and their assignments in DB-9 and DB-25 connectors, are shown on page 14.

Synchronous vs. asynchronous RS-232

RS-232 signals can be synchronous or asynchronous. Asynchronous RS-232 is by far the most common. Asynchronous RS-232 signals are delineated by voltage changes that will identify the start and stop of any byte of data, as described above. Within any byte of data, the receiver is actually applying a clock to measure the elements of the data transmission, and will sample the voltage level within the byte in a manner corresponding to the number of discrete bits of data it expects the byte, along with its framing and possible parity bits, to have.

Synchronous RS-232 signals are synchronized by a clock that dictates the timing of each bit that is sent. The timing provided by the clock is shared by both sides of the serial connection, so each side is aware of the timing of the next byte of data. Additional control lines beyond the basic nine lines are needed to support synchronous RS-232.

UART History

In the early days of the PC, serial transmissions were handled by the 8250 UART. This early UART had a number of limitations, including having an input register that could hold only one byte at a time. Its successor, the 16450 UART, had the same limitation in its input register. As a result, these UARTs were not usually capable of handling the data from newer modems that had speeds greater than 9600 bits per second. When the data flow was faster than the UART could handle, the chance arose of input data overruns: a character of data would still be left in the input buffer when the next byte of data arrived, and so would be lost. We see this device's updated descendent as the 82150, used in Bally's Gamemaker.

The next advance in UART design was the 16550 UART, and it remains a generally popular UART today. This UART is capable of data speeds that can match the speeds of modems transmitting data across conventional telephone lines. It has two 16-byte buffers (one for transmitting data and one for receiving data) with independently adjustable levels — called "trigger levels" —for emptying and refilling its buffers.

Later UARTs such as the 16650 and 16750 continue this evolution. The 16650 UART, used on all LAVA port serial cards, has a 32-byte buffer; the 16750 has a 64-byte buffer. Each also has adjustable trigger levels.

LAVA Computer MFG headquartered in Toronto, ON, Canada, designs and manufacturers serial, parallel I/O boards and Ethernet-to-serial device servers that are used in the Gaming Industry. Designed for lifetime performance, each LAVA connectivity link is tested by hand and covered by the LAVA Lifetime Warranty.

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Web: www.lavalink.com

Slot Tech Training at The Palace Casino - Lemoore, CA

California's fertile Central Valley is home to The Palace Casino, where a dozen slot techs attended Slot Tech Magazine's two-week "Casino School" for slot machine technicians during the recent Memorial Day holiday season. The class concentrated on monitor repair with most of the second week dedicated to hands-on work. The class was taught by Slot Tech Magazine publisher Randy Fromm.

Roger Cantu, Gabriel Correa, Randy Fromm, Edward Bustillo
Adrian Bella, Francisco Villarreal, Carlos Cota
Pedro Gomez, Kao Saephen, Jimmy Hefner
Connie Garcia, Jo Burkett, Brenda Ray

Below: Carlos Cota doing what he does best (supervising) while teamates Jimmy Hefner and Pedro Gomez work on a monitor during the hands-on monitor repair lab.

Above: Guest instructor David Oldham (Advanced Electronic Systems, Inc) spent a day covering the operation, troubleshooting and repair of both the FutureLogic ticket printer and the MEI SC66 bill validator. While he was at the casino, Oldham installed the casino's first 10 SC66 units as well.

Mohegan Sun Selects FutureLogic's GEN2 Printer for Cashless Slot Machines and Gaming Platforms

FutureLogic, Inc. has announced that Mohegan Sun has selected their GEN2 printer as the standard gaming printer for all of the casino's ticket-in / ticket-out (TITO) slot machines and gaming platforms.

A combined total of nearly 6200 gaming machines, including current games as well as new equipment being installed, will integrate the FutureLogic GEN2 printer. Upon regulatory approval, the ProMatrix and PromoPort functions of the GEN2 printer will be used to implement promotional couponing campaigns through the casino's player tracking system.

"With more than 6000 slot machines on the casino floor we need a printer that is dependable, secure and easy to maintain," said Frank Neborsky, Vice President of Slot Operations for Mohegan Sun. "The FutureLogic GEN2 printer will also enable a variety of promotional initiatives."

"We are excited about this opportunity to help streamline operations, improve the gaming experience and deploy new marketing programs at Mohegan Sun, one of the largest gaming complexes in the world," said Nick Micalizzi, Vice President of Sales and Marketing for FutureLogic, Inc. "The Mohegan Sun installation will demonstrate our printers' exceptional reliability and exercise many of our promotional couponing innovations."

The GEN2 gaming printer has been extensively field-tested for more than a year. It is the only printer to be recognized by industry experts for innovation and productivity enhancement at both G2E 2003 and most recently at the Gaming Technology Summit, where both the GEN2 and GEN2-VST printers received the top honor, a Platinum Award, in the Top 20 Most Innovative Gaming Technology Products 2004 awards.

For further information, contact FutureLogic at 949.487.4829 for sales inquiries, or 702.597.5355 for technical service.

Unicum Appoints New CEO and Chief Operating Officer

Unicum Group has announced two appointments within the Company's structure. Yuri Larichev will take the position of the company's CEO and Aleksey Kuchvalsky will serve as Unicum's Vice President and Chief Operating Officer.

In this capacity, Mr. Larichev will spearhead the Group's management, taking responsibility for overall direction, development, manufacturing and partner relations to expand Unicum's offerings and activities in the domestic and global marketplace. Boris Belotserkovsky, the owner of Unicum Group, will remain Chairman of the Group and will take an active part in Unicum's development strategy and major business decisions.

Mr. Larichev joined Unicum in May 2000 as Marketing & Sales Director and most recently he has been holding the position of Unicum's Vice President and Chief Operating Officer leading the Company's sales and marketing operations, investor relations and corporate counsel.

Prior to joining Unicum Mr. Larichev was Head of the Russian Representative Office at Diamond Multimedia Systems Inc. (USA), a multimedia technology company. In this role, he held P&L responsibilities, established marketing strategies, products allocation and key account sales, directed human resources affairs, finance and accounting functions. Mr. Larichev holds a B.E. degree from the Moscow Technological University and an MBA/MFM from University of Catania.

Aleksey Kuchvalsky has recently joined the company and will be taking Larichev's position of Unicum's Vice President and Chief Operating Officer. Prior to Unicum he served as Vice President of American International Group beginning in 2002. At AIG Kuchvalsky directed business development, managed P&L issues and operational structure. He also served in senior management positions in the Moscow Representative Office of Sony Corporation administering sales, planning and financial control divisions.

A familiar face in Russian (and international) gaming, Yuri Larichev will take the position of the company's CEO.

Kuchvalsky has a Bachelors degree in Management from Moscow City University of Education.

Aleksey Kuchvalsky will serve as Unicum's Vice President and Chief Operating Officer.

"Unicum has always been the company of strong individuals and industry professionals who routed it to success and current leading position," commented Boris Belotserkovsky, Unicum's Chairman. "Yuri has been with the company for the last 5 years, ushering the business through important initiatives and established strategic partnerships with industry makers. Aleksey is a proven leader who brings extensive background and an impressive breadth of administrative experience to the Unicum management team. Their business expertise, market knowledge, creativity and energy will enrich all Unicum's activities and take the company to the next level of its performance."

Unicum Group of Companies

Unicum Group of Companies is a holding entity for the largest East European provider of solutions and products for gaming business and entertainment industry.

Since 1990 the company distributes and manufactures slot machines and equipment for casinos, gaming slot halls and entertainment complexes. In 2002 Unicum started development and manufacturing of slot machines. The company produces Adventures, Atronic, Bally and Celebrity machines manufactured by Unicum at a factory in Saint Petersburg, which today manufactures over 2 000 video slots per month.

For the past 15 years, Unicum has been the trusted partner in production and product distribution for the entertainment industry. The company has worked in partnership with the leading supplying companies, AGT, Atronic, Bally Gaming, WMS Gaming, Konami, Namco and other manufacturers worldwide to develop and deploy technologies that serve the interests of both the operators and consumers, delivering solutions which provide an optimum balance between business effectiveness and playability.

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Quick & Simple Repairs #5

By Pat Porath

If you still have some older Universal slots on your gaming floor, here are some quick repairs for them.

We still have four Universal dollar machines on our floor and we do not plan on getting rid of them any time soon. The games are called "Double Nutty Jackpot." Our customers still love the games and play the heck out of them.

We used to have many of the Universal slots, in all common denominations and our customers loved them. One problem (and the main reason we got rid of them) is that ours didn't have bill acceptors in them. They are very cool machines. I would love to have one of my own sometime. The games are tough, reliable and fun to play.

If I recall correctly, Universal slot machines were one of the first ones that had the "near miss feature." The near miss feature is when a two winning symbols are on the pay line and the other symbol just misses it. The major manufacturers couldn't figure out why customers enjoyed playing the Universal so much, and come to find out, the near miss feature was part of it. (Editor's note: This feature is now VERBOTEN as it was misleading to the customer.)

The games also have cool sounds (especially for the time of their manufacture) and they run great. The player buttons, handle assembly, the hopper, even the coin-in assembly were all heavy duty. Not very much plastic in these games.

When the games did break down, a lot of the time they were very simple to get up and running again. They used about the same error codes as the other manufactures of slots. Code 12 = battery low, 21 = coin in tilt, code 30s = hopper tilts, code 40s = reel tilts, code 50 = door open, etc.

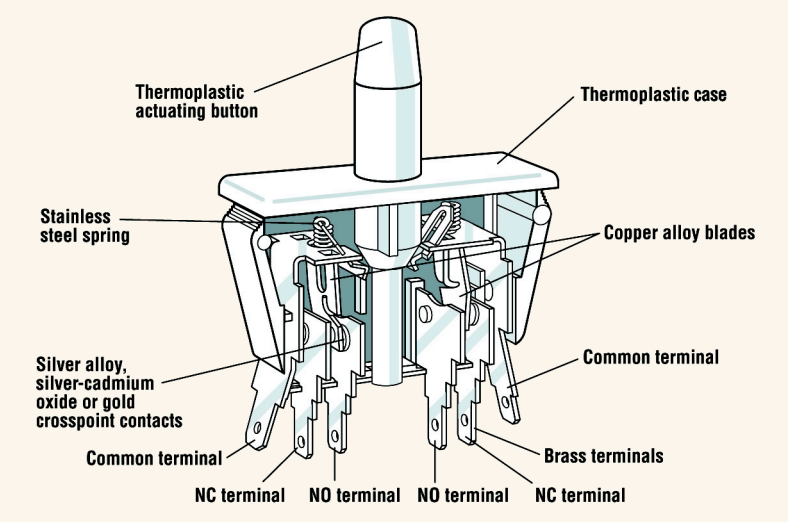
The handle assembly of the game is very strong and heavy duty. Once in a great while the solenoid would need to be replaced or the large bolt may have come loose and needed to be tightened.

I don't have much experience with the "popcorn" style hopper that Universal used in some games, but with the regular type, they were all steel. They have kind of a unique type of coin-out counter that would rarely need adjustment. The coin-out assembly also used a solenoid and a "coin kicker" type linkage. If there are problems with coin-out tilts, or hopper over pays, it could be that the linkage is worn. I have seen some where the pins that go through the steel are worn down and the holes where the pins go though are rounded out. If there is a lot of extra movement in the assembly, it won't work properly. Simply replace the bad parts with good ones.

Does the game have a RAM error or did the display lock up? It is usually very easy to fix this problem with these games. On the processor board, there is a small access door. Make sure the door is open and locate the round black reset button (the hopper needs to be removed). Power down the game and push the reset button on the processor. While leaving the reset button pushed in,

power up the game and leave it pushed in for about five seconds. Release the button and this fixes quite a few problems. I have found even if the game won't accept coins, won't spin, or won't bet the credits, a processor board reset does the trick.

Another neat thing about the Universal slot machines is that they use a lot of fuses in their main power supply. No power to the Coin Comparator? It may be a blown fuse. Of course, if something isn't working in the game, check the fuses. If the handle isn't working or buttons, etc., check all the fuses and of course, replace them ONLY with the correct amperage.



All slot machines have interlocks that tell the machine when the door is open. Some use optics, others use switches. Universal uses interlock switches.

If there isn't a display on the game, it may be a bad power supply. Some of the items to check on these are the bridge rectifier, the solder connections, and the caps.

All slot machines have interlocks that tell the machine when the door is open. Some use optics, others use switches. Universal uses interlock switches. The cherry switches that are used on these games are the push-pull type. If a test needs to be done on something, pull on the two switches and the machine will think that the slot door is closed. For example, if the coin diverter is not working properly and it needs to be tested, make sure the hopper probe is grounded and pull out the two cherry switches. The diverter should open if working properly. Remove the ground from the hopper probe and the diverter should close. This technique works similarly for other games as well.

The Universal slot machine also has a "coin-in" test button. This works great for testing the handle, the spin button, the reels, etc. It is located next to the test button. With the slot door open, press the button once to make the machine think that a coin has been inserted. Bally and IGT also have the "coin-in" test buttons. Once the slot door is closed, the credits that you have in test mode are erased and it is back in regular game mode. On the IGT S-plus games, the button is located on the coin-in optic board. It is a very small white button.

Another example how the coin-in test button can be used is if there is a periodic problem with a reel. Instead of testing with actual coin, the button can be used with the slot door open to see what is going on. Maybe there is an obstruction on the backside of a reel or the reel basket wobbles a little. If there isn't a problem with the reels when the door is open, it may be an obstruction on the door that may be touching the reels, just enough to make it tilt once in a while.

Universal coin-in optics are unique in my opinion, they are gray in color and if something isn't working correctly with them, a red light will appear. Once in a great while, the optics may go out of alignment. The machine will show a code 21 and one of the coin-in optics will show a red light on the exterior of it. It may need adjustment or there may be dust, a bent coin or some other foreign matter in it. Remove the obstruction or align the optics and the game should be back operating again.

- Pat Porath
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Random Ramblings - Part 4

By John Wilson

This month we'll conclude our study of random number generators with an overview of how to test an RNG and see if it works properly. In the May 2005 issue of Slot Tech Magazine, we attempted to come up with our own version of an RNG which failed miserably. It wasn't very difficult to see that it didn't work. However, an RNG may appear to function properly but still have problems with it. An RNG that doesn't work properly means that your machine may pay out too much, too little, or be vulnerable to fraud. In all of these instances, it isn't good.

We have learned that we need numbers that are "unpredictable" rather than numbers that are truly random. We use the term "entropy" to describe the degree of randomness or disorder. Generally speaking, the higher the level of entropy, the harder it is to predict any particular sequence of numbers. This isn't the same as randomness, however. Suppose we take this article in electronic form and apply an algorithm on it. If we were to create a ZIPped file we would likely determine that the compressed file has a high degree of entropy. However, the file does follow a predictable pattern. It isn't random, but instead follows a (hopefully) logic process.

In order to test a random number generator, we need to perform an empirical test. An empirical test means that we study the actual output from the random number generator rather than studying the formula in theory. In an experiment, we can run the formula through several billion iterations and then examine the entire group of numbers as a whole. This is what happens in labs where random number generators are developed and at gaming test labs, such as GLI.

The most common test performed is called a Chi Square. You may have heard of this before. Professor Jeff Connor-Linton at Georgetown University defines the chi square as "a non-parametric test of statistical significance for bivariate tabular analysis." Well, now, that certainly clears things up for us, doesn't it? Basically, it tells you the degree of confidence you have in accepting or rejecting the formula. If we study two separate samples of random numbers generated from our formula and they are different enough that we can generalize that our first sample is different from our second sample, then we will feel confident in our formula. If we have a 50% confidence in our formula, we're not going to accept our random number generator.

RNGs are not just tested with one method, however. The more ways that we can test our formula, the more confident we will be in stating that our formula produces pseudo-random numbers that do not follow a specific pattern that can be determined. Let's study a few other tests and then see if we can come up with some tests on our own, too.

ACME RANDOM NUMBER GENERATOR

Fourier Transforms
A "fast Fourier transform" will test our random numbers for patterns that repeat. That would indicate a deviation from our assumption of randomness. In other words, this would tell us if there is a specific pattern of numbers that occurs at least twice. Remember, we want our random numbers to be unpredictable. If we have a pattern of 100 numbers that repeats several times, we have a situation that might lead to someone predicting the numbers that are going to come up in the future.

Monte Carlo Simulation
Named for Monte Carlo, Monaco (the second smallest country in the world) this process calculates multiple scenarios of a model repeatedly. It is perfect for gaming devices. This test will tell us the long-term confidence that we have in our RNG. After all, we will generate billions and billions of numbers over the life of a game, so the long-term is of primary importance.

Frequency Test
We compare a sequence of random numbers in binary. By comparing the number of '1' bits to '0' bits, we can see how frequently each occurs. This will usually be done in large blocks of numbers.

Autocorrelation Test
This process examines our random numbers in a binary format. This test compares bits to their adjoining bits to see if there is some form of logical relationship between them. Again, this relationship would mean that the numbers being generated might be predictable.

Runs Test
The entire sequence of our random numbers is studied and the number of runs of binary '1' bits and '0' bits is studied. Is the number of runs what we expect? Do they oscillate between 1 and 0 in a predictable manner?

Longest Runs of binary '1's
In this test, we take a predetermined block of numbers. Is a run of '1's as we would expect? By comparing this to other blocks, we can see if each block contains the same runs, more or fewer.

Overlapping Patterns
A predetermined pattern of bits is selected. We examine a different block of bits to see if this pattern is found. We move through the list by shifting 1 bit at a time and continue looking for a match. Do we find a match? How many? Are the matches a specific number of bits apart?

Lempel-Ziv Complexity Test
Apart from a difficult-sounding name, this is actually a very interesting test. In this test, the sequence of random numbers is studied to see if the sequence can be compressed. You find the number of cumulatively distinct patterns in the sequence. How far can these sequences be compressed? Remember that earlier we stated that a group of numbers may be considered random if there is no shorter way to represent the group than to actually list the entire group.

This test is similar to the process used in a ZIP file. The file is studied for a sequence to see if it can be replaced with a smaller sequence. Does a 40 MB file compress to 1 MB? If so, then there are a number of sequences that exist. If a 40MB file is zipped down to just under 40 MB, then there aren't very many sequences.

A zip file looks for sequences and replaces them with tokens or symbols. For example, in your document, there will be the word 'the' frequently. If you can replace 'the' with a single character, you have reduced 3 digits down to 1. Perhaps there's a phrase like 'Slot Tech Magazine' in your document a number of times. Each time the phrase 'Slot Tech Magazine' occurs, replace these 16 letters with a single character and you have an even better reduction in size. Some file types, like a bitmap graphic image, contains long runs of the same value. If a black pixel is '00000000' and there are hundreds of black pixels together, then you can take the hundred black pixel blocks (100 groups of '00000000') and replace this block with a smaller code. This saves a great deal of space! It also identifies definite patterns which repeat frequently. The larger the pattern, the easier it is to discover.

This space-saving algorithm works by identifying blocks of repeatable sequences of values. The sequence is replaced with a smaller code. With our output from the random number generator, if we could compress the numbers by locating a 'sequence' then we know a repeatable pattern that can be identified. In this manner, if you know that three triple bars occurs twice in succession exactly 100 games before the jackpot, all you have to do is watch for the tell-tale sign and wait for your jackpot.

Consider the example output from our random number generator:

00101111010001011101001110
01010010101100101010101000
01010101011001010101010001
01

Locate all occurrences of '00101' and replace with "x."
x11010x110100111xx011x0
101010x0101011x0101010x

Locate '11010' and replace with "y."
xyxy0111xx011x0101010x0
101011x0101010x

Locate '0111' and replace with "z ."
xyxyz1xxzx0101010x0101z
x0101010x

locate '0101' and replace with "a."
xyxyz1xxzxa010xazxa010x

locate '010' and replace with "b." xyxyz1xxzxabxazxabx

locate 'xyxy' and replace with "c." cz1xxzxabxazxabx

locate 'bx' and replace with "d." cz1xxzxadazxad

locate 'xa' and replace with "e." cz1xxzedazed

locate 'ed' and replace with "f." cz1xxzfazf

locate 'af' and replace with "g." cz1xxgag

There! We started with a sequence of 78 bits and could reduce it to 9 symbols. Obviously, there were many small patterns within the sequence. This could lead to the sequence being predictable at times, or perhaps there's an uneven distribution of numbers. What if the jackpot values exist a dozen times within a short amount and then don't occur for millions of numbers? We'll pay out 12 jackpot amounts in one day and then never pay them again for a year. In the long run, the jackpots will be paid the appropriate number of times. However, paying them all at once isn't good for business or our cash flow.

In the previous example, we simply reverse the process to get the original sequence back. Find all 'g' symbols and replace them with 'af'. Next find 'f' and replace with 'ed'. Continue until you get to the top of the list. In our example, we are replacing binary values with letters, which won't really happen. We would replace it with a distinct sequence of binary bits to identify the original values. In our simple example, however, it illustrates our point very well.

Continured . . .

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Brian Rankin - Slot Technical Manager

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THE DIGITAL MULTIMETER

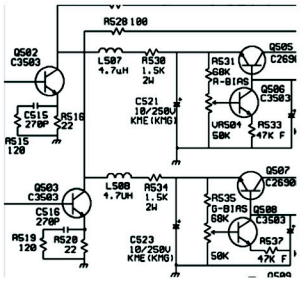
This relatively inexpensive piece of test equipment is easy to operate. Casino School students learn to use the digital multimeter to perform tests and measurements that will pinpoint the cause of a failure down to a single component.

ELECTRONIC COMPONENTS

The individual components used in games are introduced. Parts such as resistors, capacitors, diodes, potentiometers and transistors are covered individually. Students learn how the components work and how to test them using the meter.

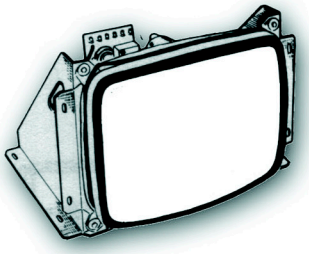
SCHEMATIC DIAGRAMS

Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



POWER SUPPLIES

Power supply failure is a common complaint in many different types of systems.. Power supply failures are discussed during the class, along with shortcuts for troubleshooting and repairing them.



MONITOR REPAIR

The monitors used in video slots are designed for quick, easy, and safe repair. Students will learn the theory of operation of all types of monitors and how to repair monitors down to the component level. Of course, monitor safety will also be discussed.

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$$Q(a,x) \equiv 1 - P(a,x) \equiv \frac{\Gamma(a,x)}{\Gamma(a)} \equiv \frac{1}{\Gamma(a)} \int_x^\infty e^{-t} t^{a-1} dt$$

where Q(a,0) = 1 and Q(a,∞) = 0.

Why would I possibly care about this?

In keeping with the tone of my articles, formula like that shown above won't enter into our study. This means that we won't get into the real heart of the theory because you don't need to as a slot tech. You will never have to verify the random number generator. Why learn about this, then? The answer is simple: knowledge, confidence and accountability.

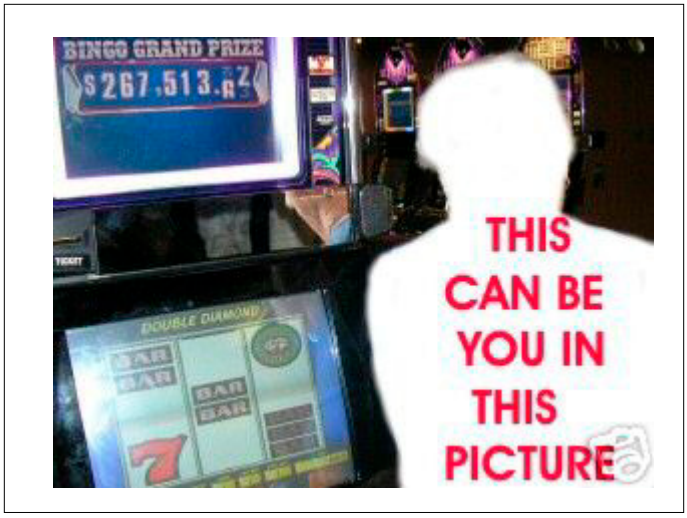
Firstly, the more knowledgeable you are about your job, the better it is for you. Being able to answer technical questions for your supervisors can put you in good favour and identify you as a person who knows their job well and can get the answers. Secondly, having confidence in your machines is very important. The confidence leads us to accountability. Suppose you get a person complaining that the machine is fixed or that it has been changed in some manner so that it doesn't pay out as much as it used to (This would never happen to you, would it?). By having the confidence in the machine and how it works you can provide a confident response to these people. No, you don't have to explain to them how a random number generator works, or how they are verified by testing labs. However, the more confident you are in the knowledge of how the machines work, how they are programmed and more importantly, how they are verified, the more convincing you can be to your patrons.

Caveats (Warnings)

This is not a complete examination of the random number generators or their verification techniques. In fact, we only studied one type of RNG, the linear congruential generator. There are many other types. As far as verification goes, you don't have enough information on the procedures, such as Chi Squared and Fourier Transformation, to actually perform them and analyze the results. If you can think of a way to analyze an RNG to determine how it works, you can come up with a test to study this. Some tests use poker-hand rules, examining the output to see if they follow any predictable rule. For example, are you more likely to get 3 of a kind of numbers than a straight?

The studies and testing is done to ensure fairness. They ensure that the long-term confidence in the numbers generated is high. In the short-term, it also provides enough variance to afford a player a chance to win. And it also ensures that in the short-term, the same player can't manipulate the game to their advantage. Remember, we're never concerned with the short-term variances. It's the long-term variances that concern us. Of course, this isn't absolute, as a Thrillions jackpot on the first spin creates a very LARGE variance.

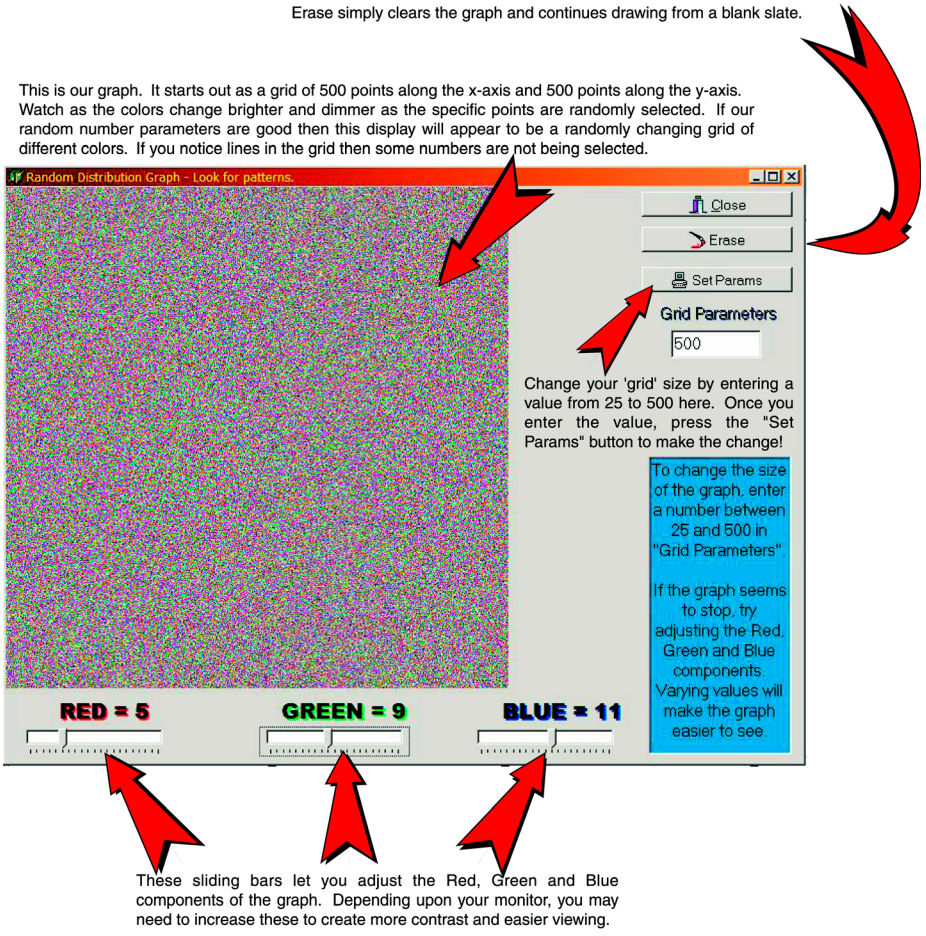
Players will always believe that the game can be manipulated. Some look for methods to manipulate the game in their favour, but believe that the casino has a method of manipulating it in the casino's favour. A recent ad on eBay promised a secret technique reported by a "former programmer" who was fired for making his knowledge public. The book, it claimed, was hated by casinos. This book claims that it will tell you "how to trigger a jackpot". In reality, there is only one way, and we all know it. Simply play the game enough so that the jackpot happens.



The auction included a photograph to entice the unsuspecting bidder. A silouette of a person is shown in front of a slot machine. It's a Double Diamond 3-reel video game. Above the reel section is a video jackpot marquee saying "Bingo Grand Prize $267,513.62". The caption reads "This can be you in this picture." The game, if it were a 5-line game, would have mixed bars winning on the 4th payline. If it's a 1 or 3-line game, then it was a non-winning game. Hmm, that could be you. You could win 5 credits sitting in front of a game with a $267,000 jackpot. Sure, you could also win nothing on a $1,000,000 progressive game, too. Unfortunately, you have to deal with the patrons that believe there are special "techniques", a large dial inside to adjust the payouts, someone sitting in a control room determining what you win, and a computer analyzing your players' card to see if you "deserve" a jackpot. Properly armed with knowledge and confidence, you can slowly chip away at these urban legends and erode the myth that the games are anything but random. As long as people continue to propagate these myths, you have to deal with the result of them.

The Software Update

This month, we take the previous random number generating software and make an addition to it. On the main screen there is a new button, "Graph." Once you start the generator, click on this button. A second screen will appear. The random numbers will be plotted in a 'grid' of 62,500 points with 250 points along the x-axis and 250 points along the y-axis. The specs you enter into the random number parameters (Refer to Slot Tech Magazine, May 2005) are used to generate this graph. The raw numbers that come out of the RNG are scaled down to fit in the range of the grid. Each time a number occurs, a point is set on the corresponding grid location. As the numbers are continually generated, a display appears. Each time a number is picked that has been previously picked, the point becomes slightly brighter. Once it reaches maximum brightness, it fades until it becomes black and then repeats. As a result, you will see small dots of varying intensity that continually change.



Try adjusting the colour component (red, green, blue) by sliding the bar below each colour. Sometimes subtle, try adjusting numbers as it runs. If you enter a new value under "Grid Parameters," your new grid will be scaled accordingly. Entering 125 generates a grid 125 pixels x 125 pixels and the random numbers are in the range of 1 to 15,625 (125 x 125).

If the RNG is fairly even in its selection of numbers, you shouldn't see a particular pattern. Use the numbers: m=411200680 a=3107 c=705

Start the generator and press GRAPH. You will see a definite pattern emerge. The display shows a thin horizontal line, followed by a thick empty space, another thin line, a thin empty space and then a thick horizontal line. Now take a look at the numbers in the box on the main screen. It would be difficult to determine a pattern just by looking at these numbers. However, if we can display them in a different format (like our graph), or come up with some other test ourselves, we can see the pattern emerge. In this case, the blank space indicates numbers that are not selected by the generator.

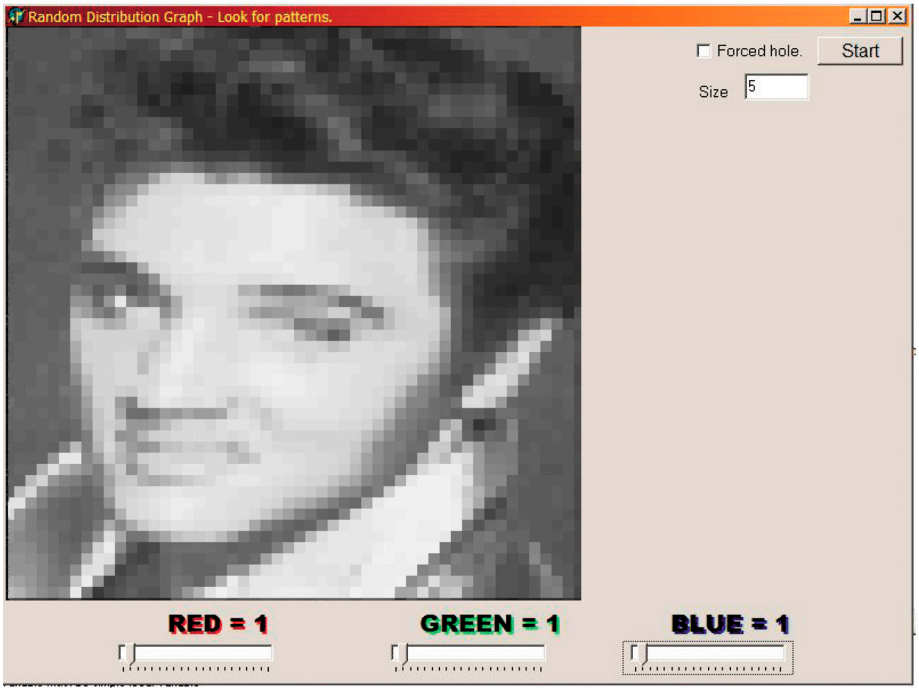
Next try m=214748403, a=160, c=0. You see a more subtle pattern with diagonal lines. Every now and then the graph appears to freeze and then restart. Setting the "grid parameters" to 200 causes the pattern to be quite clear at the beginning. Afterwards, the graph seems to be starting & stopping. This indicates a pattern that occurs in the number generation.

Finally, try m=231474123, a=16092, c=0. At a grid of 500, the pattern appears random. Set it to 350. The graph is drawn faster due to the smaller size and still looks pretty random. But, set it to 327 and we clearly see a problem. The graph consists of dots and lines which appear anything but random. Is this a problem with our random number generator, or the mathematics of converting the numbers to a cycle of this specific size? Obviously, there are more factors involved than could be covered in the scope of these articles. Indeed, random numbers is a science unto itself!

At one point I had the numbers entered where a definite pattern emerged. Unfortunately, I forgot to write down the parameters I had used, but I did manage to copy the screen. The pattern is shown below.

Remember, not only is random number generation very complex, but so is the testing. If only one number is missing out of a set of 16 million, there is a problem! Patterns and situations that make the numbers predictable or with a low level of entropy means our random number generator is far from random. Also, if our period is 4 billion and we scale the number down to 64, we might be generating some form of anomaly in our conversion. It's very important to test every aspect of a random number generator right down to the application where it is used.

During early testing, certain numbers created a definite pattern suggesting an underlying order or lack of randomness. If you hold the image of the screen at a certain angle under good lighting you may be able to see the pattern that emerged.



Exit, stage left . . .

Well, that's it for now on our study of random number generators. As you can see, a complete study would fill several volumes. However, we've learned that there are two kinds of RNGs - pseudo and real. Pseudo RNGs are simulated through software using mathematical algorithms. Far from random, they are unpredictable. Real random number generators use external hardware devices to sample some quantifiable item (such as the level of background radiation, or the thermal disturbance inside your slot machine) and return a random value. In the future, perhaps each casino will have one hardware random number generator connected to the network of slot machines and they will all retrieve random numbers from this central device?

Perhaps the most important discovery is that a lot of time, effort and research goes into the creation of these devices and the verification of them. By understanding how the RNG works, how it applies to you, and how it is verified, you will gain more confidence in the workings of your gaming machine.

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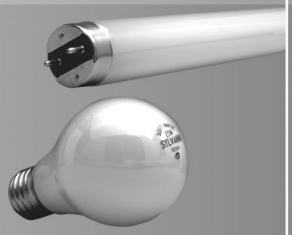

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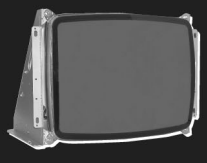
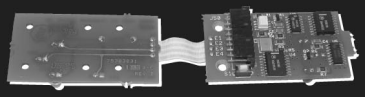


Monitor Repair

Keno Pen Exchange



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