# MOVONICS COMPANY

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To Gasperini "graduates":

Welcome to the first issue of *Digital Update*. For some time now I have been considering a publication to provide new information about areas that you may be interested in. There will be technical articles, such as the discussion of Integrated Injection Logic in this issue. Additional articles and service tips will be in subsequent issues.

This will also be a good way to communicate about seminars to be held in your area and new books that are available.

Since I left Hewlett Packard, I find that we are in the need of some salesmen to find individuals wanting technical training. Could you take a minute to think of associates in your company or friends in other companies who would be interested in attending one of the upcoming *Digital Troubleshooting* seminars? If someone attends as a result of your sales effort, I'll be grateful. As a small token of my thanks I'll send you the parts to perform an experiment with ICs--making a digital clock. This includes the IC, transistors, displays, p.c. board and transformer. As long as your company policy does not prohibit it, this experiment can be a valuable extension of the training you went through during the seminar.

To get your box of parts, fill in the other side with the names of the people you have sold on the seminar. After the seminar, I'll send your experiment. (The super-salesmen responsible for getting five people to attend at any of the location(s) can choose between an HP Logic Probe or HP Logic Pulser). I hope to hear from each of you on this.

This issue of *Digital Update* is being sent to individuals who we think would be interested in receiving it regularly. They are being asked to return the reply form on page 3. It is not necessary for you to return it since you are already on our list. Feel free to make photocopies of this issue to pass along to friends, if you like. We are anxious to reach other individuals involved in repair and calibration of electronic products.

Thank you very much for your help.

Best regards,

Dick

Dick Gasperini

p.s. My second book has just come off the press--*Digital Experiments*. It has 25 experiments that can be performed to complement the learning process. The book, which has 192 pages and is 8½ x 11 inches, is available for $8.95 plus 75¢ shipping and handling. California residents please include sales tax. (54 or 58¢, depending where you live). Details about the book will be in the next issue of *Digital Update*.

# DIGITAL UPDATE

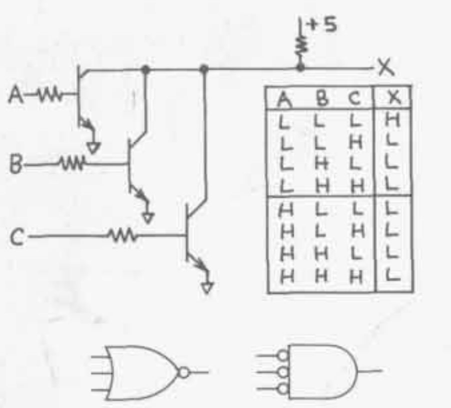
**SERVICE INFORMATION FROM MOVONICS COMPANY**

NOVEMBER 1976

## UNDERSTANDING INTEGRATED INJECTION LOGIC

Integrated Injection Logic (shortened to IIL, or $I^2L$) is one of the newer and promising IC technologies. It offers higher densities and lower power dissipation than many of the present technologies, such as TTL or MOS. $I^2L$ is a very new technology and its operation is not well understood by many individuals. It is being designed into several state-of-the-art products, however, such as Texas Instruments' digital watch and other ICs. While you are probably not going to be called upon to fix a digital watch, $I^2L$ will probably show up soon in something you have to repair, so a firm understanding of $I^2L$ is essential.

While IIL operates somewhat differently than ICs you may be more familiar with, it is easily understood. To examine IIL, let us first review RTL (Resistor Transistor Logic). Figure 1 shows a NOR gate configuration in RTL. Three inputs exist -- A, B, and C -- and a High on any input establishes base-emitter current to turn On that transistor.

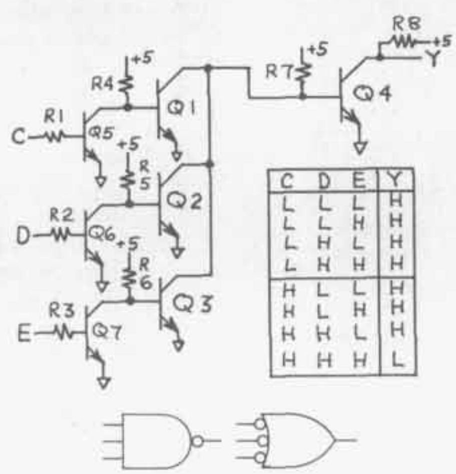



| A | B | C | X |
|---|---|---|---|
| L | L | L | H |
| L | L | H | L |
| L | H | L | L |
| L | H | H | L |
| H | L | L | L |
| H | L | H | L |
| H | H | L | L |
| H | H | H | L |

**Figure 1.**

Notice that if one or more of the transistors turn On, the output X goes Low.

To get an OR gate, it is necessary to only put an inverter in the output. Making other gates is possible using RTL by adding inverters to the inputs or outputs, or both. Figure 2 is what results from adding inverters on the inputs and output. Notice that when inputs C, D, and E are all Low, transistors Q5, Q6, and Q7 are all Off, turning On Q1, Q2, and Q3. This turns Q4 Off and the output Y goes High. Similarly having a Low on any input causes Y to be High. When C, D, and E are all High, transistors Q1, Q2, and Q3 are all Off. This turns On Q4 and Y goes Low.




| C | D | E | Y |
|---|---|---|---|
| L | L | L | H |
| L | L | H | H |
| L | H | L | H |
| L | H | H | H |
| H | L | L | H |
| H | L | H | H |
| H | H | L | H |
| H | H | H | L |

**Figure 2.**

One diagram for this is the familiar NAND gate. Another symbol that can be used is the OR shape with inversion circles on the inputs.

Notice that R4 provides the turn-on current for Q1, and also R5 and R6 supply the base drive for Q2 and Q3, respectively. You may recall that how quickly these transistors turn On will be determined (in part) by the resistor value. Since there is some capacitance from the base of Q1 to common, an RC network exists. Having a small value for R4 will yield a short time delay, but excessive current would flow. Battery life would be very short in a portable product. Increasing the value of R4 would decrease the power consumption but would also drastically slow the speed. The IC designer must decide on the value for the resistors, recognizing that in some cases minimum power consumption is of primary concern, while in other applications maximum speed must be obtained, regardless of the power demands.

This is the familiar speed-power trade-off that exists in ICs. Ideally we would be like to have several versions of an IC available, giving us a selection on the speed and the power consumption of a device. For circuits requiring maximum speed the IC would be manufactured with

(Continued on page 4.)

## WE WELCOME YOU AS A READER

Welcome to the first issue of *Digital Update*. This newsletter has resulted from the need to communicate to our customers on the new items that are available to solve service-related problems. We will publish tips on solving specific problems, such as removing ICs from p.c. boards or cleaning flux from boards. In addition, information will be printed on items of general nature, such as the article on Understanding IIL in this issue. We also hope to keep our customers informed of our services through this newsletter, and in this issue we are highlighting a seminar on *Digital Troubleshooting*.

If you would like to continue receiving this free newsletter, please fill in and return the reply form on page 3.

# DIGITAL TROUBLESHOOTING

## Seminar Scheduled

A series of seminars is being offered that will be of interest to anyone repairing electronic products containing digital ICs. Titled Digital Troubleshooting, this seminar is intended as an introduction to digital for electronic technicians. Students will study all currently used IC technologies, examine basic digital gate circuits, and learn the tools and techniques available to troubleshoot digital circuits.

One of the most beneficial parts of the course is the laboratory sessions where the concepts explained in the lectures are explored in detail through hands-on experience with ICs, troubleshooting tools, and logic experimenting breadboards. One lab station is provided for two students to provide the most effective use of the student's time.

This seminar has a very practical orientation, with heavy emphasis placed on real-world problems such as repairing a circuit in the least amount of time, or how to remove ICs from a multi-layer mother board without damaging the board.

## COURSE OUTLINE

First Day

1. Digital vs Analog.
2. Review of transistors and transistor circuits — bipolar, JFET, and MOSFET, HP Videotapes "Troubleshooting Transistors Faster" and "Troubleshooting MOS Transistors."
3. Comparison of IC technologies - RTL, DTL, TTL, Schottky TTL, Low Power TTL, High Speed TTL, HTL, ECL, EECL, PMOS, NMOS, CMOS, IIL, DMOS. How to identify IC technologies.
4. The troubleshooting implications of these IC technologies. Tools that can be purchased and/or made to troubleshoot ICs.
5. Tools and techniques to troubleshoot gate circuits.
6. Laboratory — three hours of hands-on experience experimenting with gates using a digital logic lab and troubleshooting tools.


Each student will receive a copy of Gasperini's *Digital Troubleshooting* textbook.

Each student gains a personal experience of working with IC circuits in experiments that complement the lectures.

Second Day

1. Analysis of gate circuits — AND, OR, NAND, NOR, exclusive OR, comparators.
2. Decoders and decoding circuitry.
3. Octal, binary and hexadecimal number systems.
4. Flip-flops — D, R-S, triggered, R-S, and JK.
5. One shots and astable multivibrators.
6. Binary and decade counters.
7. Laboratory — three hours of hands-on experience experimenting with decoders, latches, flip-flops, multiplexers, exclusive OR, and recirculating data.

Third Day

1. Serial and parallel methods of transfering data.
2. Shift registers.
3. Recirculating data.
4. Display technologies — nixie tubes, panaplex, dot matrix LED, seven segment LED, incandescent displays.
5. Strobing display circuits vs continuous data display.
6. An analysis of a logical troubleshooting procedure for any problem.
7. Five proven methods of removing ICs from p.c. boards without damaging the board.
8. Laboratory — three hours of hands-on experience experimenting with flip-flops, binary up/down counters, decade up/down counters, plus actually removing ICs from p.c. boards using the recommended procedures.

Fourth Day

1. Read Only Memories (ROM).
2. Read/Write Memories (Random Access Memories — or RAM).
3. How ICs are manufactured. How this knowledge can help when troubleshooting ICs.
4. Comparison of commonly used IC logic symbols — MIL 806 vs other common symbologies.
5. A detailed analysis of the new world standard for IC symbols, American National Standard Y32.14-1973.
6. Laboratory — three hours of hands-on experience experimenting with ROMs, strobed displays, seven segment displays and Read/Write memories.

## TUITION AND REGISTRATION

Tuition for the seminar is $300 per student. This includes seminar material, lunches, and coffee-breaks during the four days. To allow students to get the personal attention of the instructor, class size is limited.

Registration will be handled on a first-come, first-served basis. We suggest registering as soon as possible to avoid disappointment.

A confirming letter is sent to students upon receipt of registration, along with pre-study material and directions to the seminar. The seminar will begin at 8:00 each day and end at 5 p.m. the first three days and about 3:30 the last day (to facilitate student's return trip home).

## SEMINAR DATES AND LOCATIONS

| Location | Date |
|---|---|
| Honolulu, Hawaii | November 15-18, 1976 |
| Atlanta, Georgia | December 6-9, 1976 |
| Paramus, New Jersey | December 13-16, 1976 |
| Chicago, Illinois | December 20-23, 1976 |
| Bellevue, Washington | January 4-7, 1977 |
| Palo Alto, California | January 24-27, 1977 |
| Los Angeles, California | January 31-Feb. 3, 1977 |
| Boulder, Colorado | February 14-17, 1977 |

## THE COMPANY

Movonics is a company specializing in technology training. This includes publishing textbooks on technical subjects, preparing and presenting specialized training programs for specific customers, or offering general training seminars, such as *Digital Troubleshooting*.

## THE INSTRUCTOR

The instructor for this seminar is Dick Gasperini, author of two textbooks on digital electronics. Dick has also published dozens of articles on related areas of servicing electronic products.

Dick has an extensive service background, with over 13 years experience in service-related activities. Prior to joining Movonics, Dick was the Instrument Service Training Manager at Hewlett-Packard, a job that entailed both coordinating training programs and presenting seminars similar to the *Digital Troubleshooting* seminar. Other jobs at Hewlett-Packard included being Editor of the HP service publication *BENCH BRIEFS* and being a Service Engineer for electronics frequency counters, digital recorders and logic testing service tools at a manufacturing division.

Dick has presented this material over forty times in the U.S., Canada, Europe and Australia and is considered an authority in the area of servicing electronic instrumentation.

The instructor for this seminar is Dick Gasperini.

### NO RISK GUARANTEE

We find that most of our business results from the word-of-mouth enthusiasm of our "graduates". Many attendees rate the seminar as the best they have ever attended.

We are so confident of the quality of our seminars that we make this guarantee: If, after attending two days of the seminar, a student feels displeased for any reason, the student may withdraw from the seminar and receive a full tuition refund.

**REGISTRATION FORM** — Digital Troubleshooting

Attach purchase order or check for $300 and mail to:

Seminar Registrar
Movonics Company
Box 1223, 1922 Annette
Los Altos, California 94022

Name ______

Company ______

Address ______

City, State, ZIP ______

Telephone No. ______

Seminar location where student will attend ______

To enroll two or more students, please photocopy this form or attach a list showing names, mailing addresses, and telephone numbers.

PLEASE FILL IN AND RETURN THIS FORM TO CONTINUE RECEIVING YOUR FREE COPIES OF DIGITAL UPDATE.

☐ Also send me the free IC comparison chart.

Name ______

Company ______

Address ______

City ______ State ______ Zip ______

Cut along the dashed line and return to *Digital Update*, Movonics Company, Box 1223, Los Altos, California 94022.

(Continued from page 1.)

low value resistors. Where speed was not important, high value resistors would be used, with the corresponding power savings. But this is impractical.

IIL solves this problem by giving the designer a wide range on control over the speed and power by replacing fixed resistors with adjustable current sources.

You may recall that one way to get a current source is to configure a transistor with a fixed base-emitter drive, such as shown in Figure 3.

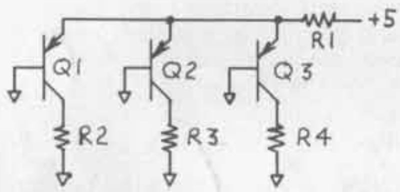



**Figure 3.**

R1 controls the amount of drive in Q1's base-emitter, which controls current flowing through R2 in the collector circuit. Similarly Q2 and Q3 are constant current sources for R3 and R4, respectivley. Let's replace the fixed pull-up resistors of the IC in Figure 2 with current sources (injectors). See Figure 4.

Notice that only one resistor exists,

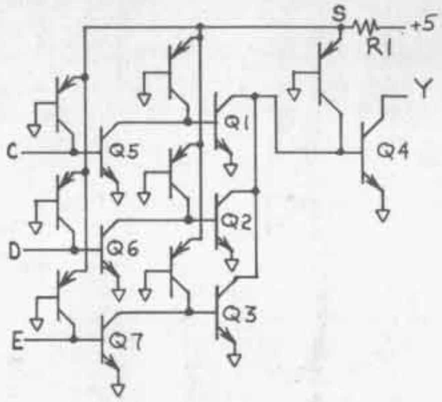



**Figure 4.**

R1, and it controls the amount of current flowing in each current source. Since this resistor is external to the IC package, it is possible to choose a value that will give as much speed as needed for a particular application, and therefore keep power dissipation at a minimum.

IIL is unique in that its power supply is a current (such as 10 mA) and not the familiar fixed voltage used with the other IC families. You might ask how much voltage exists across the IC (that is, from point S to common).

The answer is one diode drop, since a forward-biased base-emitter junction exists on each current source, with the base connected to common. Having only 0.6 volts across the IC is in itself going to imply low power consumption. And this also means that a 5 volt supply is unnecessary since too much power would be wasted across R1. A 2 volt or even 1 volt supply is quite adequate.

There are disadvantages to this, of course. Since the levels are so low, there is very little noise immunity. And the speed presently is slow compared to some of the other more conventional technologies. A ballpark number for maximum speed is about 5 MHz.

$I^2L$ can be identified by the current limit resistor connected to the injector. When examining the inputs and outputs, expect to see about 0.2 volts for a Low and about 0.6 volts for a High.

Fairchild has a variation of $I^2L$ that they call $I^3L$, for Isoplanar Integrated Injection Logic. They have a 4K RAM (read/write memory) that uses TTL logic levels on the inputs and outputs and needs a 5 volt power supply.

$I^2L$ is one of the latest steps in the evolution of ICs that started with RTL and continued with DTL, TTL, Low Power TTL, Schottky TTL, ECL, EECL, PMOS, NMOS, and CMOS.

If you would like a *free* handy chart that compares these IC families and lists power supply requirements, logic levels, tools to troubleshoot, how to identify, etc., check the box on the reply card on page 3.

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*Digital Update* is published several times a year by Movonics Company as a service to customers engaged in the repair and calibration of electronic products. Reader contributions are welcomed. Send them to *Digital Update,* Movonics Company, Box 1223, Los Altos, California 94022.

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