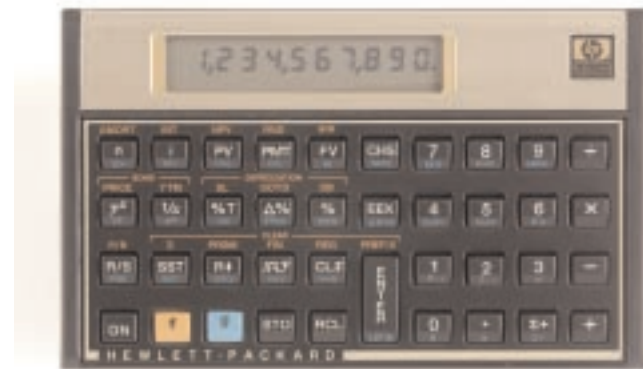




## hp calculators

### HP 12C **Internal Rate of Return (IRR)**



[What IRR Means](#)

[Practice with IRR Situations](#)

[Other Notes on IRR](#)



## HP 12C **Internal Rate of Return (IRR)**

### What IRR Means

Before continuing here, be sure to read the lessons on [Time Value of Money \(TVM\) Basics](#), [Discounted Cash Flow \(DCF\) Analysis Basics](#), and [Net Present Value \(NPV\)](#).

When you compute the Net Present Value of any investment situation, you are asking for a simple dollar value that tells you what the investment is worth to you *under the assumption of a certain discount rate*—the rate at which you assume your money can earn for you.

If that NPV turns out to be a positive number, this means that you could *spend* that amount of money (right now) for the right to that cash flow scenario and *do just as well* as if you had skipped the whole investment scenario and instead put your money to work at your expected discount rate.

If that NPV turns out to be a negative number, this means that you would have to *receive* that amount of money (right now) in exchange for agreeing to that cash flow scenario in order to *do just as well* as if you had skipped the whole investment scenario and instead put your money to work at your expected discount rate.

So, what if NPV turns out to be exactly zero? This must mean that the investment scenario is exactly as good as—exactly equivalent to—what else you could do with your money. It means that this situation exactly matches your assumption as to how well your money earns for you under your assumed discount rate.

In other words, if NPV is zero, *there needn't be any extra cash flowing to you or from you to equalize this deal with what else you could do with your money*. You don't need to buy yourself the chance at a deal that's better than what your money could otherwise do (that would be the case with a positive NPV); nor do you need to compensate yourself for a deal that's not as good as what your money could otherwise do (that would be a negative NPV). "It's neither too hot, nor too cold—it's just right." If the NPV is zero, then the return on the investment scenario exactly matches your assumed discount rate. This return is called the IRR.

The **internal rate of return (IRR)** of any investment scenario is the discount rate that produces a Net Present Value of zero.



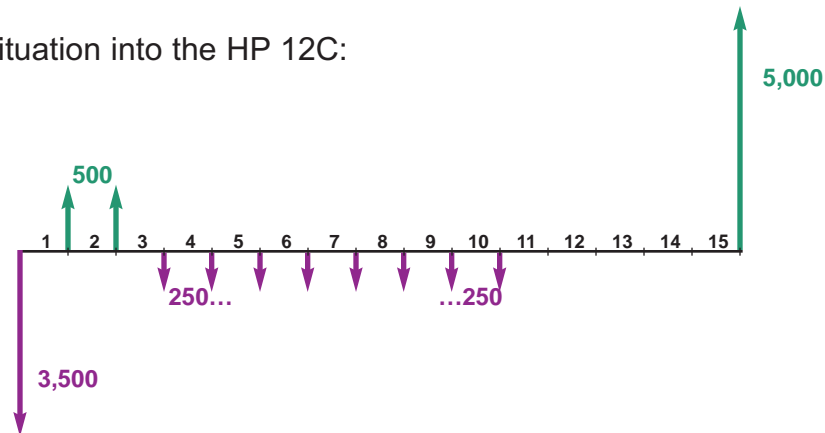
 hp calculators

## HP 12C Internal Rate of Return (IRR)

Look at a simple example. Here's a plausible investment situation:

And here is how you'd key this situation into the HP 12C:

3500 **[CHS]** **[9]** **[CF<sub>0</sub>]**  
500 **[9]** **[CF<sub>J</sub>]**  
2 **[9]** **[N<sub>J</sub>]**  
250 **[CHS]** **[9]** **[CF<sub>J</sub>]**  
8 **[9]** **[N<sub>J</sub>]**  
0 **[9]** **[CF<sub>J</sub>]**  
4 **[9]** **[N<sub>J</sub>]**  
5000 **[9]** **[CF<sub>J</sub>]**



Now, if you were to examine the Net Present Value of this situation under various assumptions as to discount rate, you'd get various results (and be sure to read about [Net Present Value](#) if any of the keystrokes or procedures for doing so are unfamiliar to you). For example:

With an 8% annual discount rate, the NPV of the above scenario is \$100.10.

With a 6% annual discount rate, the NPV of the above scenario is \$195.81.

With a 12% annual discount rate, the NPV of the above scenario is \$-83.28.

This must mean that the IRR is somewhere between 8% and 12%—because the NPV went from a positive value to a negative value when the discount rate went from 8% to 12%. At some rate in between, the NPV must have crossed zero.

Want to keep guessing? You certainly could: With a 10% annual discount rate, the NPV of the above scenario is just \$7.09—getting close to zero (so the IRR is probably pretty close to 10%). And so on—to as fine a precision as you want.



 hp calculators

## HP 12C Internal Rate of Return (IRR)

But why not jump to it exactly? Just press  $\boxed{f} \boxed{IRR}$  and let the calculator do all the trial and error. (And that's exactly what it's doing when it computes an IRR: trying various discount rates with NPV and homing in on the value that gives an NPV of zero—hence the time consuming nature of the calculation.)... You get **0.85**.

But that's nowhere near 10%! What's wrong?

Nothing. Don't forget that the 0.85 is the *periodic* rate—*monthly*, in this case. To see what it looks like on an annualized basis, you must multiply it by 12. You can either do so “manually:” Press 12  $\boxed{\times}$ . Or, since the result of IRR is placed in the *i* register, you could press  $\boxed{RCL} \boxed{9} \boxed{12} \boxed{\div}$ . Either way, you'll get a very likely-looking result: **10.15**

Want to prove that this is the IRR? It's easy to do. Be aware that the (periodic) IRR result you just calculated (**0.85**) is sitting in the *i* register. (Press  $\boxed{RCL} \boxed{i}$  to see it.) Well, that's where you would put any discount rate to compute an NPV, so just press  $\boxed{f} \boxed{NPV}$  now to calculate the Net Present Value of the investment situation at this assumed discount rate... You get **0.00000002** or some extremely small value (not exactly zero only because the machine doesn't carry more than 10 digits).

You just proved it. The calculated IRR value is the discount rate that produces an NPV of zero.

Some notes about IRR:

The TVM calculations done by the financial registers are simply one specific type of cash-flow situation (i.e. where there is a uniform periodic PMT cash flow), but the underlying calculations are the same idea as in the more general DCF case: Instead of NPV (with DCF), the machine computes PV (with TVM)—and both  $\boxed{PV}$  and  $\boxed{f} \boxed{NPV}$  leave their result in the **PV** register. Likewise, instead of IRR (with DCF), the machine computes *i* (with TVM)—and both  $\boxed{i}$  and  $\boxed{f} \boxed{IRR}$  leave their result (a periodic, not annualized, value) in the *i* register.

And, like the TVM tools (financial registers), IRR assumes that the cash flow “picture” you are drawing for the calculator *is a complete investment*. So it requires at least one cash flow going in each direction (negative and positive—investment and return). If you don't satisfy this requirement, the machine will give you an **Error 7** message.



 hp calculators

## HP 12C Internal Rate of Return (IRR)

### Practice with IRR Situations

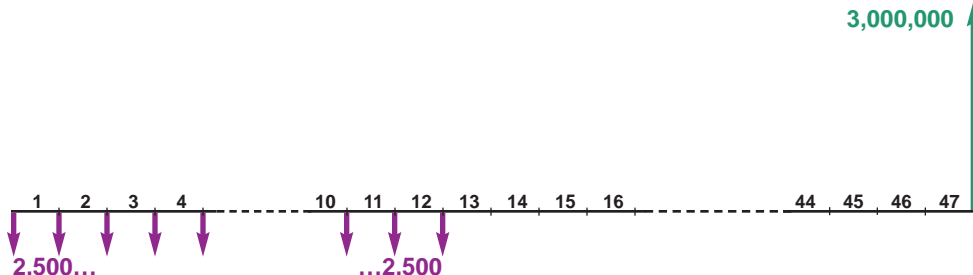
Practice some more with various IRR investment scenarios here.

**Problem:** Find the IRR of this cash flow situation (a retirement account, opened at age 18, with \$2500 annual contributions until age 30, then nothing more until withdrawal at age 65.)

**Solution:**

```

2500 [CHS] [g] [CF0]
2500 [CHS] [g] [CFj]
12 [g] [Nj]
0 [g] [CFj]
34 [g] [Nj]
3000000 [g] [CFj]
[f] [IRR] ... 11.45
  
```



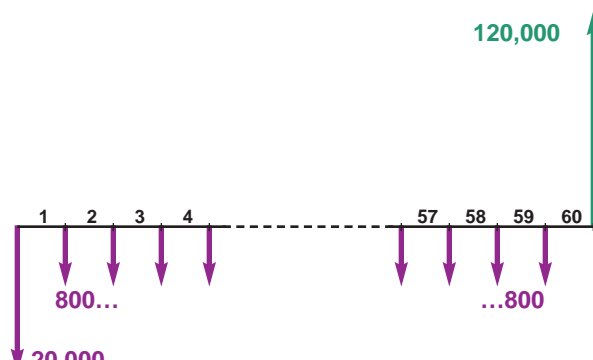
Just twelve early years of investing, at near-average market returns, will leave you a multimillionaire by age 65!

**Problem:** Find the IRR of this cash flow expectation. (This is a \$200,000 house, purchased with 10% down and tax-deductible interest, sold after 5 years in a real estate market whose values are growing at 8% per year.)

**Solution:**

```

20000 [CHS] [g] [CF0]
800 [CHS] [g] [CFj]
59 [g] [Nj]
120000 [g] [CFj]
[f] [IRR] ... 1.41
  
```



Annualize this (by pressing either 12 [X] or [RCL] [g] [12+]): **16.87**  
The leverage of real-estate!



 hp calculators

## HP 12C Internal Rate of Return (IRR)

### Other Notes on IRR

One common assumption is that IRR represents the return or “yield” on your money in a given investment situation. This is reasonable—with certain cautions....

Don't be lulled into thinking that IRR represents the growth of all your invested money for all of the timeline—not true! It is the *internal* rate of return—representing the time value of money only while it is *in* the investment. Once you receive the positive cash flows, that money is out of the picture. IRR has nothing at all to say about how it grows (or shrinks) then. You might put it into another account with an entirely different yield, or you might stuff it under a mattress—or lose it at the track.

Also, there are many scenarios where it works out mathematically that there is more than one discount rate that sets the NPV of the situation to zero. (If this happens to you, you will probably get an Error 3 message.) This can happen, for example, when the cash flow groups have lots of sign changes (i.e. first some negative cash flows, then some positives, then some more negatives, etc.).

In such cases, you can guide the HP 12C toward a solution by giving it an initial guess from which it begins its search:

- Make a guess for the interest rate and key this rate into the i register.
- Press **RCL** **g** **R/S**

Your guess must be a periodic rate—the period matching the cash flows—which is not necessarily an annualized rate. So if your cash flows are monthly, your IRR guess must be monthly, too.

For example, if you think a reasonable annualized guess for IRR would be 12%, then the guess you'd key in would be 1%—the actual monthly rate. (So you'd press 1 **i** **RCL** **g** **R/S**.)

Often your guess will be close enough to help the calculator find an IRR solution. But of course, that doesn't mean it's the only possible solution, so you may need to keep looking. How do you know if you've found them all? Here's the rule of thumb: *If there is any positive solution, it's the only positive solution, but there may be one or more negative solutions, too.*



 hp calculators

## HP 12C Internal Rate of Return (IRR)

So should you care about finding the negative solutions? For that matter, if there is more than one solution to IRR, which is the “correct” one, anyway? Which rate describes what’s really happening to your money in the investment situation? Which rate represents your “yield”?

In such cases, it is always best to go back to NPV calculation instead: Select a reasonable (realistic) assumption for a discount rate—i.e. what else you could do with your money (preferably with risk and liquidity comparable to the investment in question). Then the value returned in the NPV calculation will tell you whether the investment is favorable (higher-yielding—indicated by a positive NPV) or unfavorable (lower-yielding—indicated by a negative NPV) *relative to that assumed discount rate*. That’s as precise as you’ll be able to get: better or worse than your discount rate.

There are, of course, methods other than IRR that will analyze the performance of an investment scenario—tools such as Modified Internal Rate of Return (MIRR) and Financial Management Rate of Return (FMRR). If you find yourself encountering a lot of complex investment scenarios that defy analysis with IRR, you may wish to read more about such alternative tools. (In fact, those tools, while harder to calculate, are actually more realistic models of how you would manage cash in actual investment situations.)