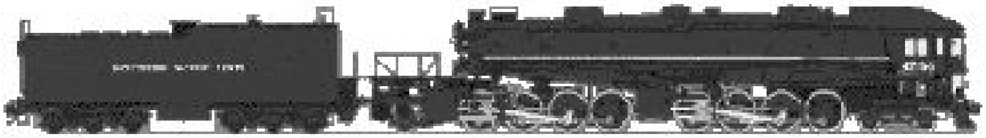

RAILROADER'S

C/MRI
APPLICATIONS

HANDBOOK

Volume 1 – System Extensions

Version 3.0(1)

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Chapter 3: OD TRACK OCCUPANCY DETECTOR

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Chapter 3

OD TRACK OCCUPANCY DETECTOR

If your railroad is pure DC then the best detector to use is the straight DC Optimized Detector, the OD. In fact, for DC railroaders, installing the JLC provided OD cards is a great way to start building toward a more complete computer interface. You can use ODs to indicate occupancy status of hidden trackage, to drive LEDs on your track diagram as trains progress around your layout, to control grade crossing signals and to control automatically the polarity in reverse blocks. With detectors installed it's a natural step forward to use the C/MRI for signaling.

Although I strongly recommend using ODs for DC-based railroads, if you are starting from scratch on a DCC equipped railroad, I recommend using the newer special DCC version of the OD – the DCCOD. If this is your situation, you may wish to skip ahead to the next chapter, which features the DCCOD.

OCCUPANCY DETECTION WITH DC

The originally designed OD was created specifically for railroads using straight DC. In fact, I consider the detector so good that I call it the Optimized Detector. My friend Paul Zank, who is an N-scale model railroader and an award winning aerospace electronics engineer, helped in its design. Here are a few of its important properties:

- Its sensitivity is easy to adjust with a trim potentiometer.
- Its built-in turn-on delay of .25s and turn-off delay of 3.5s greatly reduces problems from dirty track and other causes of intermittent contact.
- Its monitor LED is activated before the time delays, giving instant occupancy indication to help in setting sensitivity.
- It has only two active components, one IC and one transistor, so it is easy to debug and maintain.
- Its open-collector transistor output allows easy connection to LEDs, TTL logic circuits, relays, and C/MRI inputs.
- It works with conventional DC, AC, pulse power, sound systems and all forms of command control including DCC. (However, if you are not already OD equipped, then selecting the DCCOD is the preferred choice for all pulse type command control systems, including DCC.)
- The design handles currents from microamps up to three amps and more if you substitute higher-current diodes.
- It's a small, modular unit (one per block), so it is ideal for plug-in, circuit-card construction. This eases system debugging and maintenance, but alternate connection methods are also provided.
- Its price is very reasonable. Assembling your own ODs, where you purchase your own parts at quantity discount, costs approximately $8 to $9 per block for a medium to large size layout. At reduced quantities the cost for Do-It Yourselfers increases to approximately $11 to $12 per block.

Tens of thousands of these Optimized Detectors (ODs) have been placed in service around the world and experience shows their performance to be exceptional.

OD-REV K SCHEMATIC

The OD's schematic, for the newest Rev. K version, is shown in Fig. 3-1. Readers seeking details concerning the earlier Rev. J version of the OD, or how to update Rev. J detectors to Rev. K, should consult Appendix D. The track current capacity of the OD is determined by diodes D1 and D2. For most DC applications, I recommend 3A diodes that have a surge capability of 50A. If more is required you can substitute 5A, 6A or 10A diodes.

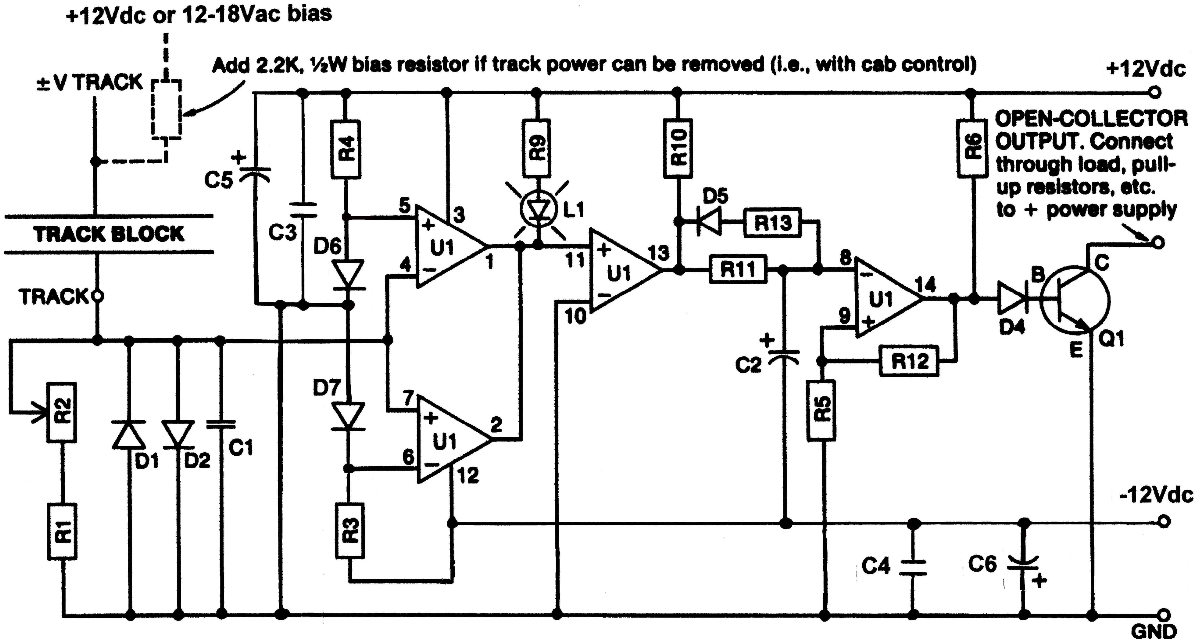

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Fig. 3-1. Optimized detector schematic (Rev. K)

The OD Rev. K is an update from the previous classic Rev. J design. The Rev. K includes several improvements submitted by David Gibbons, the creator of the C/MRI User's Group. The changes also reflect modifications suggested by Rich Weyand, the owner of TracTronics and a frequent contributor to the C/MRI User's Group, to move the power supply decoupling capacitors, previously located on the ODMB, to each OD.

The main advantages provided by the Rev. K modifications are increased sensitivity, more operational independence from unbalance between the ±12Vdc supplies and power input decoupling capacitors, enabling detectors to be mounted remote from the detector power supply, without the need to add the two 2.2µF capacitors on the ODMB as explained in Appendix D.

For both Rev. J and K, the product of R11 and C2 determines the turn-off delay, and the product of R13 and C2 determines the turn-on delay, as long as R13 is considerably smaller than R11. Thus delay times can be changed as desired. I enjoy the rather long 3.5s turn-off delay, which helps to solve the problem of intermittent contact as well as simulating the massive, slow-moving relays in prototype detection circuits.

The value of R6 can be varied to select the level of detector drive capability. I selected 3.6kΩ for reasonably high drive capability from the output transistor, to handle loads as high as .3A and still maintain a good logic low for TTL connections. For example, I've used a single detector to drive parallel loads of 10 LEDs and 4 TTL logic gates, a total load of about .2A, but still with a logic low around .7Vdc. Reducing R6 to a lower value, such as 1kΩ, would take more current from the power supply, but would allow driving output loads up to .3A at 40V, the ratings of the 2N4401 transistor. For values of R6 of 3.6kΩ or lower, use a ½W resistor.

ASSEMBLING THE OD REV K

Figure 3-2 shows the parts layout for the OD Rev. K, and Table 3-1 lists the parts required.

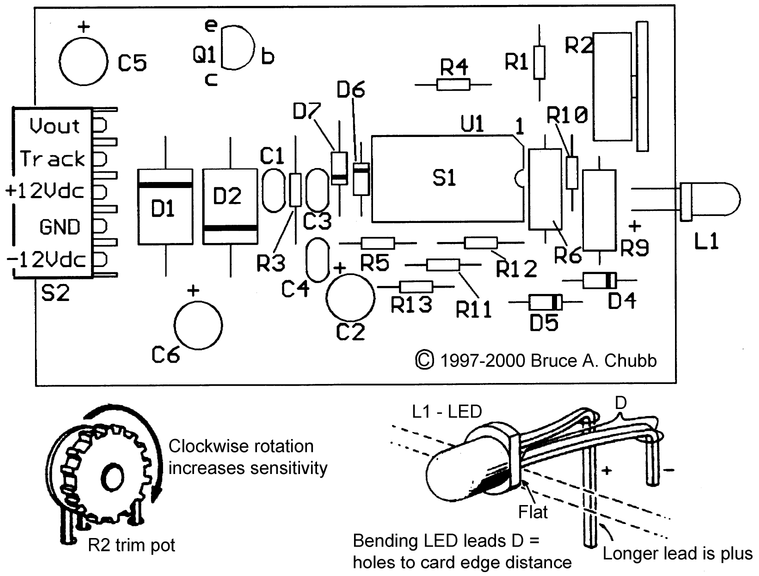


Fig. 3-2. Parts layout for optimized detector Rev. K.

Ready to assemble OD circuit boards are available from JLC Enterprises or you can purchase either complete kits or assembled and tested boards from SLIQ Electronics.

Do-It Yourselfers assembling a large number of detectors using boards purchased from JLC Enterprises, and then providing their own electronic parts, can achieve costs at around $8 to $9 per detector. With smaller quantities, a more typical cost is $10 to $12 per detector. Complete kits as well as assembled and tested ODs have higher prices. For example, effective January 2016, SLIQ Electronics lists the kit price at $10 and assembled and tested at $17.

Typically the kit route is the most economical approach for a small number of cards. Also, purchasing kits saves time from not having to place orders for electronic parts plus it saves on shipping and handling charges and minimum quantity fees which can mount up very quickly to $30, or significantly more, when ordering from multiple suppliers.

For those wishing to assemble their own, the basic skill required is PC-card soldering. If this is new for you, make doubly sure that you have thoroughly digested the information on PC card soldering in Chapter 1 of the C/MRI User's Manual.

Although the order of parts assembly is not critical, but for the sake of having a plan, I do recommend that you follow the steps in order and check off the boxes as you complete each one. I have included a [+] after the symbol for each part where polarity of assembly is important. As a further aid to assembly, the positive pad for polarity sensitive capacitors, the LED and pin-1 of the IC socket are square. Also, the longer lead on capacitors and the LED is the positive lead. Once you have one OD assembled and operating correctly, you can use it as a pattern for assembling additional cards.

Table 3-1. Optimized Detector (OD-Rev. K) Parts List
(in order of recommended assembly)

Qnty.	Symbol	Description
1	R1	10Ω resistor [brown-black-black]
3	R3-R5	10KΩ resistors [brown-black-orange]
1	R6	3.6KΩ ½ W resistor [orange-blue-red]
1	R9	2.2KΩ ½ W resistor [red-red-red]
1	R10	10KΩ resistor [brown-black-orange]
1	R11	2.2MΩ resistor [red-red-green]
1	R12	220KΩ resistor [red-red-yellow]
1	R13	330KΩ resistor [orange-orange-yellow]
2	D1,D2	For regular DC or AC track power select from: 3A, 50V diodes (Mouser 821-1N5400) 6A, 50V diodes (Mouser 625-P600M-53) For command control, e.g. DCC or Railcommand, select from: 3A, 40V fast recovery diodes (Mouser 78-BYT78) 5A, 50V fast recovery diodes (Mouser 583-RCB24-B)
2	D4,D5	1A, 100V diodes 1N4002 (Jameco 76961)
2	D6,D7	Fast Schottky barrier rectifiers (Mouser 625-SD103C)
1	S1	14-pin DIP socket (Jameco 112214)
1	S2	5-pin Waldom side entry connector (Mouser 538-09-52-3051))
3	C1,C3,C4	.1µF monolithic capacitors (Jameco 332672)
3	C2,C5,C6	1.5µF, 35V tantalum capacitors (Mouser 581-TAP155K035SCS)
1	R2	10KΩ potentiometer (Jameco 94714)
1	Q1	2N4401 small signal transistor (Jameco 38421)
1	L1	Red diffused size T1 LED (Jameco 333850)
1	U1	LM339N quad voltage comparator (Jameco 23851)

Author's recommendations for suppliers given in parentheses above with part numbers where applicable. Equivalent parts may be substituted. Resistors are ¼W, 5 percent unless otherwise noted and color codes are given in brackets. Note: R7, R8 and D3 are not used with OD Rev. K

Because this may be your first card assembly, I will go into more detail in the following assembly steps:

□ **R1, R3-R13.** Make 90-degree bends in the leads of each resistor so it is centered between its two holes and the leads just fit. Insert and solder while holding the part flat against the card, then trim the leads. Note that R2 is a potentiometer, to be installed later, R6 and R9 are ½W resistors, and R7 and R8 are not used with the OD Rev. K detector. Additionally, if you are unsure of the resistor values or have difficulty in reading the color coding bands, as might be the case if substituting 1% resistors which have extra bands or because color recognition may not be clear, it is a good idea to use a VOM set to its resistance range to check the resistor values before insertion.

□ **D1, D2[+].** Use needle-nose pliers to bend the heavy leads of these power diodes at right angles so they drop into the holes. The banded ends must face in opposite directions as shown in Fig. 3-2. Slip a 1/8-in spacer between the card and the diodes as they are soldered, then remove the spacer. The space helps ventilate the diodes and protects the card.

□ **D4, D5[+].** Install in the same manner as above, making certain that the banded end of each diode is oriented as shown in Fig. 3-2. Note that D3 is not used with the OD Rev. K.

□ **D6, D7[+].** Install in the same manner as above making certain that the banded end of each diode is oriented as shown in Fig. 3-2. Note that the banded ends of these fast Schottky barrier rectifiers, special glass diodes, are sometimes hard to see. Take special care in locating the band and if required use a magnifying glass to double check the band orientation.

□ **S1[+].** Making certain that you have all 14 pins located properly in their respective holes with the correct orientation for Pin 1, hold the socket tight against the board as you solder the pins. If you are not sure of the correct orientation for Pin-1, see Fig. 1-7 of the V3.0 User's Manual. As with any multi-pin part, solder only a couple pins first, those on opposite corners of the socket. Reheat as necessary to make certain that the socket is firmly against the board, then solder the remaining pins.

□ **S2.** Install this 5-contact side-entry connector by first hooking the nylon retaining fingers over the card edge, then feeding the metal contact pins through the card holes. Make sure all five pins pass through the holes. Hold the connector shell tightly against the card as you solder.

□ **C1, C3, C4.** Insert these capacitors standing perpendicular to the card, solder, and trim the leads.

□ **C2, C5, C6 [+].** Insert these components with the capacitor standing perpendicular to the card making sure that the + leads, the longer of the two leads and denoted by a small + sign, go into the + holes as shown in Fig. 3-2. Incorrect polarity will damage these capacitors. Solder and trim the leads.

□ **R2.** Install this potentiometer as in Fig. 3-2, push the three prongs all the way into the holes as you solder. You may need to adjust the back, single, prong a little so the potentiometer dial stands up perpendicular to the card.

□ **Q1[+].** Spread the leads of this transistor slightly to fit the three holes, making sure the center (base) lead goes into the hole closest to P1, and that the flat side of Q1 faces the direction shown in Fig. 3-2. Push it in only far enough to fit snugly without stressing the leads. Solder and trim the leads.

□ **L1[+].** Note the orientation of the flat side and + hole (longer lead) in Fig. 3-2. With needle-nose pliers, hold the leads securely next to the housing and bend at right angles as shown in Fig. 3-2 detail. The LED sticks out over the edge of the card so you can see it when the detectors are plugged into their motherboard. Once they are bent and properly fitted to the cards, solder and trim the leads.

□ **U1[+].** Insert the LM339 IC making sure you have the correct Pin-1 orientation and that all pins go into the socket. If unsure of the correct procedure for inserting and extracting ICs, see Fig. 1-7 in the C/MRI User's Manual.

□ **Cleanup and inspection.** For a professional-looking job and to help ensure that your card functions properly, follow the specific steps covered in Chapter 1 in the C/MRI User's Manual, cleanup and inspection. This is an important step, so don't cut it short!

That completes the assembly steps for the OD. To test your detector follow the procedure defined in the ***Testing Detector Operation*** section in Chapter 2 of this Handbook. In particular, **using the clip lead assembly illustrated in Fig. 2-9 is important because simply observing correct operation of the LED built into the detector DOES NOT verify that the overall detector is operating correctly.**

The OD card layout uses wide traces and spacing between traces so soldering problems should be minimized. There are only two active components, the IC and the transistor, so debugging is easy, particularly because the IC is fitted in a socket.

CONNECTIONS TO ODMB WHEN USING OD

Fig. 3-3 shows how to connect ODMBs when using the OD. Simply run the detector power bus to each ODMB, whether located together or distributed around your layout.

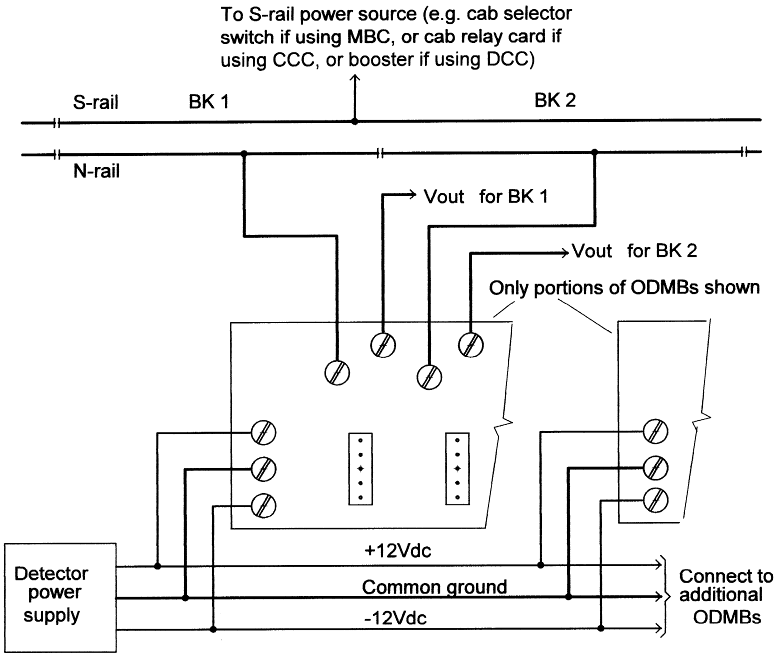


Fig. 3-3. Connecting ODMBs when using ODs

To power the ODs you need a power supply that provides both +12Vdc and -12Vdc regulated outputs as well as ground. Most surplus computer power supplies provide these three connections as well as +5Vdc. For connecting the detector's output (V_{out}) to different devices (such as lamps, LEDs, relays and C/MRI inputs), consult Fig. 2-10 in the previous chapter. Additional connection information is also provided in Chapter 9.

SETTING DETECTOR SENSITIVITY

One of the greatest attributes of the OD is its super high sensitivity and we will see shortly why this property is so tremendously important when applied to straight DC train control. To take full advantage of this capability, we need individually to adjust each OD to as high a sensitivity setting as can be achieved without it being so high that it will respond to the leakage resistance between the two rails, thereby falsely indicating a clear block as occupied. Such indications are frequently referred to as "false occupieds."

Adjusting each detector to reach this "optimum sensitivity setting" requires two simple steps:

1. With the OD installed and wired to its appropriate block, and with the block clear, turn the detector's sensitivity adjustment potentiometer fully clockwise. This should cause the clear block to show up as occupied.

2. Then, rotate the potentiometer back counterclockwise until you just reach the point where the block shows up as clear, i.e. the test LED on the detector goes dark, and then continue the counterclockwise rotation for another 3 to 5 degrees.

That is all there is to optimally set detector sensitivity. Repeating the procedure for each detector will result in you achieving the maximum possible usable sensitivity for each section of detected track on your whole railroad. Pretty neat, huh?

Now let’s dwell just a moment on each of the two steps. Step 1 sets the detector to its maximum possible sensitivity level which, with the OD and the DCCOD, is typically so high that the detector responds to the leakage resistance between the two rails causing the “false occupied” condition.

If this full-clockwise setting — maximum sensitivity — does not result in lighting the detector’s LED, then either the detector itself is faulty or the leakage resistance of your block is extremely high which results in an extremely low value of leakage current – in fact so low that even the OD can not detect it. The latter condition has been reported, by C/MRI user Dave Gibbons, to exist under extremely dry climate conditions. To take advantage of even greater detector sensitivity under these conditions Dave increased the value of the R2 potentiometer from 10kΩ to 50kΩ. If you suspect a detector problem then you can check its functionality and measure its actual sensitivity following the procedures defined in Chapter 2.

Assuming that Step 1 lights the LED, then what we accomplish in Step 2 is to reduce the detector’s sensitivity so that it is just fractionally below the level of responding to the leakage resistance. **You just cannot do better than this when setting optimum detector sensitivity!**

If over a period of time, you find that a particular detector shows a clear block to be occupied, simply rotate its sensitivity potentiometer fractionally more counterclockwise. To summarize, the normal setting for every detector should be about a 3 to 5 degree turn counterclockwise from the point where an unoccupied block shows up as occupied. Such settings yield maximum possible sensitivity response to blocks actually becoming occupied.

Figure 3-4 demonstrates the sensitivity range of the OD as a linear function of the potentiometer position. With the sensitivity potentiometer set to maximum (fully clockwise) the detector triggers with 1mΩ or less across the track.

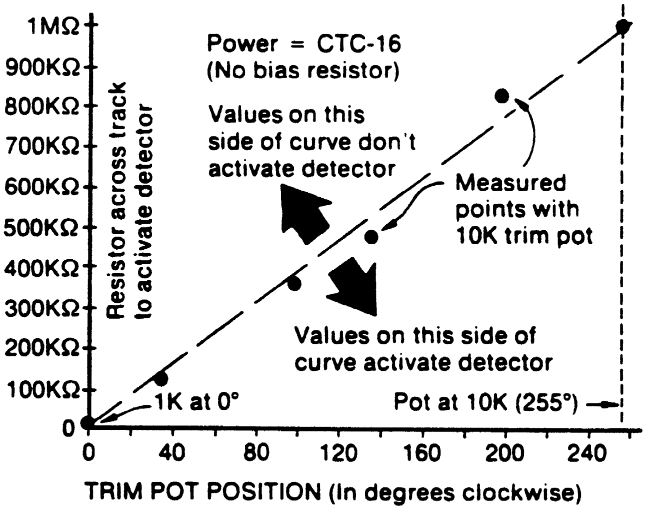


Fig. 3-4. Linear control of detector sensitivity

Set to minimum sensitivity the detector requires 1kΩ, or less, across the track before the detector activates. Thus, the OD’s potentiometer provides a 1000-to-1 linear range in sensitivity adjustment!

Now let’s take a look at why setting detector sensitivity to its maximum possible value for every section of detected track is so very important.

NEED FOR ESPECIALLY HIGH DETECTOR SENSITIVITY WITH DC CONTROL

Conventional DC powered trains provide the greatest challenge to any current sensing detector.
To function, the detector must sense current flowing through the block and with DC trains the track voltage is adjusted between zero and maximum to control train speed. With the throttle turned completely off, or the block toggle being set to open circuit, there is zero voltage going to the track and thus zero current flows through the detector – even when the block is occupied by a locomotive! This is why we add a bias resistor and a bias voltage as illustrated in Fig. 3-5. These bias resistors are built right into the JLC cab motherboard, the CMB, for railroaders using Computer Cab Control.

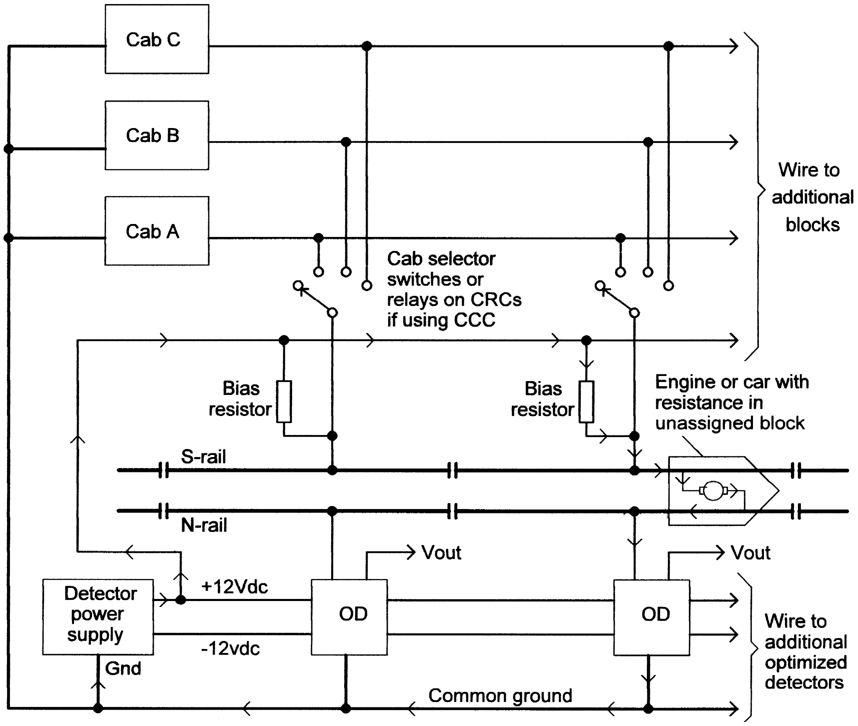


Fig. 3-5. Adding a bias resistor to provide detection when block power is turned off

With the block selector toggle open circuited, the bias resistor allows a very small current to flow through the locomotive, or a resistor equipped car, and through the detector. The arrows in Fig. 3-5 show the current path. The current is so small that it has no affect on the locomotive but it is adequate to activate the Optimized Detector. For those that like to get into the details, I'll present a few calculations. If this provides more detail than you desire, then simply skip ahead to the last three paragraphs of this section.

Assuming a +12V bias level and the recommended 2.2kΩ bias resistor, the current level flowing through the locomotive, and therefore through the detector, is calculated at about 12/2200 or .0055A or 5.5mA. I did not include the motor resistance in the calculation because it is very small compared to the 2.2kΩ. The 5.5mA is more than adequate to cause the OD to show the block as occupied but not sufficient to cause any motion of the motor.

A more severe case, as far as detection is concerned, is when a single car is sitting in a block. Assuming an 11kΩ resistor wheel set, the corresponding current is calculated as being 12/(2200 + 11000) or about .0009A or .9mA. Many brands of commercial detectors will not detect a current as low as this but it is still enough to trigger the OD. However, as we will soon see, this situation is still far from the worst case so that even greater sensitivity is required to provide reliable detection.

Consider a locomotive in one block and a single car in a second block with both blocks connected to the same cab but the cab direction switch is set in the center-off position, i.e. open circuited. Fig. 3-6 illustrates this situation.

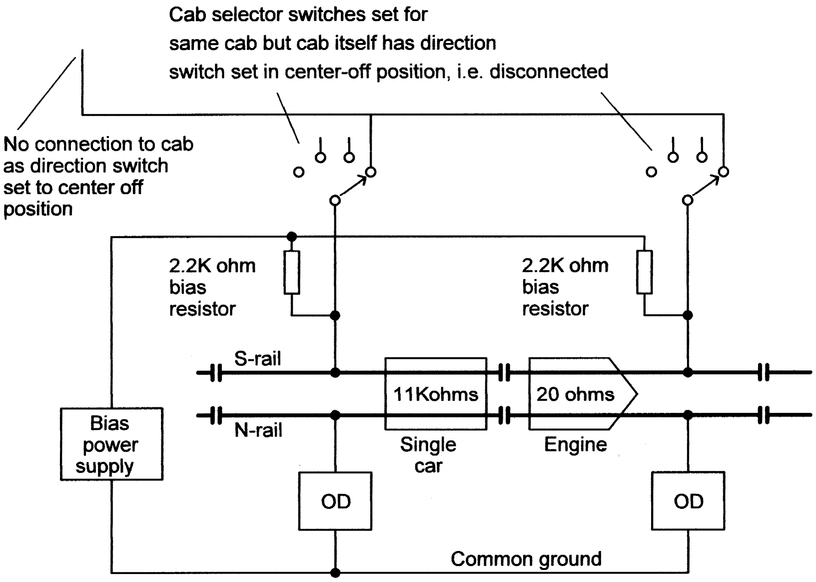


Fig. 3-6. Detection current shunting through adjacent blocks demands high sensitivity detection

Most of the bias current is shunted by the lower resistance path provided by the motor and only a minute current passes through the detector connected to the block occupied by the single car. For example, assuming a typical motor resistance of say 20Ω, representing a stall current of .6A at 12V, we have the equivalent circuit shown in Fig. 3-7.

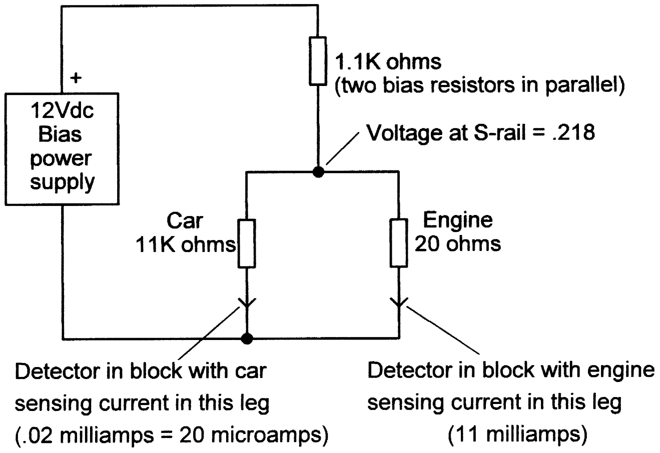


Fig. 3-7. Equivalent circuit for detecting an engine in one block and a single car in another

The track voltage and the current through the motor are calculated as .216V and .011A respectively. The resulting current through the detector connected to the block containing the single car calculates to approximately .00002A or .02mA or 20µA. It needs a very sensitive detector, like the OD, to be able to sense such minute track current and yet still be able to handle track currents of many amperes.

Unless you have a highly sensitive detector, you will very likely have blocks occupied that show up as clear. This situation is totally intolerable on the prototype and neither should they be tolerated on our model railroads. In order to depend upon a signal system you need a very highly sensitivity detector! This is exactly why it is very important to purchase detectors for your railroad that are capable of being set to very high sensitivity levels. The OD is designed to work reliably with a resistance as high a 1MΩ across the track. This is equivalent to having 12µA flowing through the block and the detector.

****Conclusion****

Even if you didn’t follow using Ohm’s law with the associated math, always use a detector that has the highest possible sensitivity and also includes a built-in sensitivity adjustment. Both these properties, along with many other advantages, are inherent in the design of the JLC provided OD and DCCOD detectors.

NEED FOR BUILT-IN SENSITIVITY ADJUSTMENT

The only way to insure that a detector can be pushed up to the limit of useable sensitivity is to design the detector with super high sensitivity such that when set to its maximum value it will always respond to the leakage resistance between the rails to indicate a clear block as occupied. This is exactly the approach taken with the OD as well as the DCCOD. Using this approach you are assured that track conditions are what is limiting the detection sensitivity and not the detector’s design.

As we saw in Chapter 2, the leakage resistance between the rails can have a very wide variation depending upon such factors as what you use for ballast and roadbed, what glue you use, any foreign material that creeps into the ballast, the cross-tie material, the humidity level and very importantly the length of the block being detected.

To take full advantage of every situation with the sensitivity of each detector set to its “maximized useful level,” all the user needs to do is back-off the sensitivity setting until it is fractionally below the level that indicates a clear block as being occupied. For each given set of track conditions, you just can’t get a better sensitivity setting.

IMPROVING DETECTOR PERFORMANCE ON DC EQUIPPED RAILROADS

Although minimized by the OD's high sensitivity design, certain types of DC power pack throttles can cause difficulty with any current sensing detector, including the OD. One question often asked is, *"How do I avoid a problem when my throttle is turned fully off (or on) but still connected to an occupied block that my detector shows the block unoccupied?"* It is very seldom a problem but some throttles go to zero effective resistance across their output terminals when either full “off” or full “on”. This condition can shunt all the current away from flowing through the detector, thereby showing an occupied block as unoccupied.

Adding two opposing diodes in series with each cab output will circumvent this problem as illustrated in Fig. 3-8. Use the same diodes as used for D1-D2 in the OD. Since this problem is very rare, add the diodes only if you find this to be your problem and no other steps cure the problem.

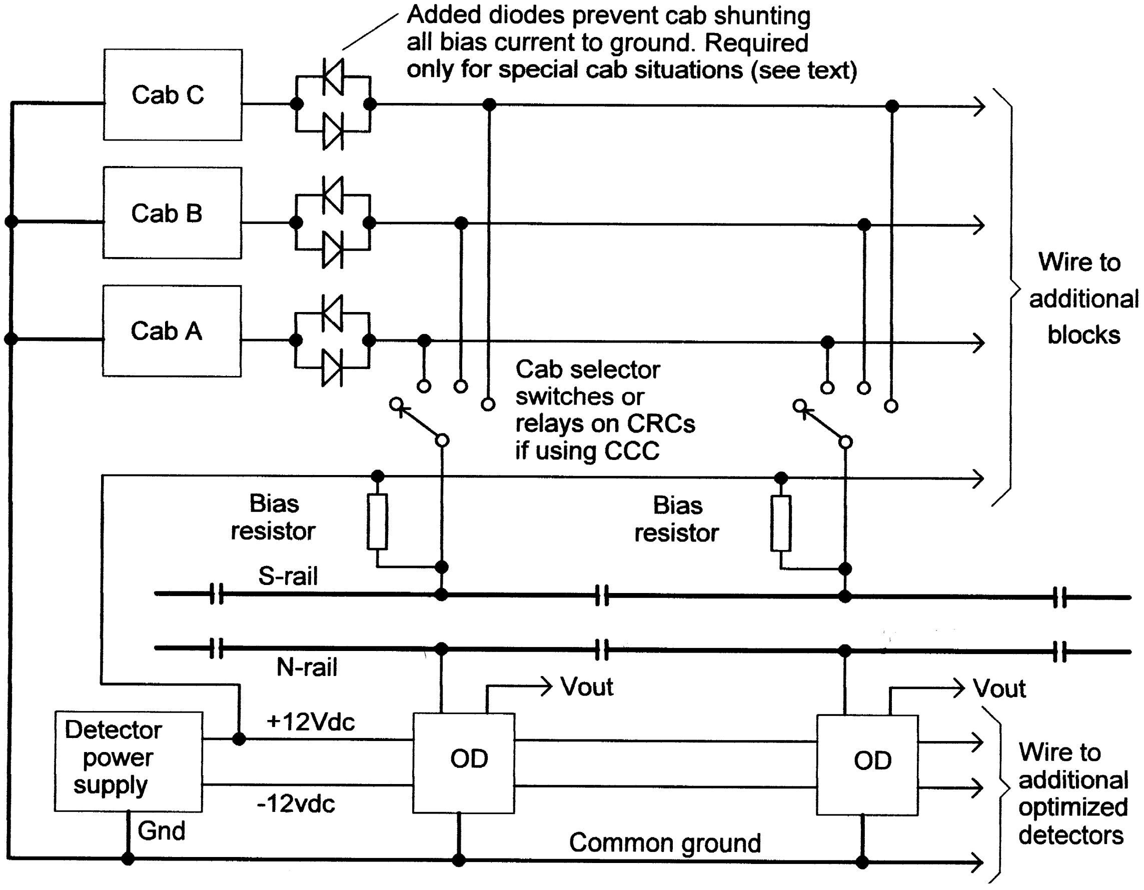


Fig. 3-8. Add diodes in cab outputs for special situation where cab shunts detector bias current

Another question I sometimes receive is, *"How do I avoid a problem when my throttle is turned on a small amount in one direction only, it causes the detector to show the block as clear?"* With certain cabs, in particular transistorized packs that can put out a very low DC voltage, you may find that a particular low throttle setting in one direction precisely cancels out the bias resistor current causing an occupied block to show up as unoccupied. If this happens you can circumvent the problem by driving all the bias resistors with 12 to 24Vac rather than the more typical hookup to the +12Vdc supply terminal used to power the detectors. This alternate arrangement is illustrated in Fig. 3-9.

When using any current sensing detector that includes series diodes, you need to place equivalent diodes in series with the track feeders to undetected track sections. These diodes keep track voltage the same when engines move between detected and undetected track sections. They also prevent extra bleeding off of the detection bias current when an engine is in the undetected section while cars are still in the detected section.

Fig. 3-10 shows the arrangement for adding the extra diodes. Again, use the same power diodes used in the detectors.

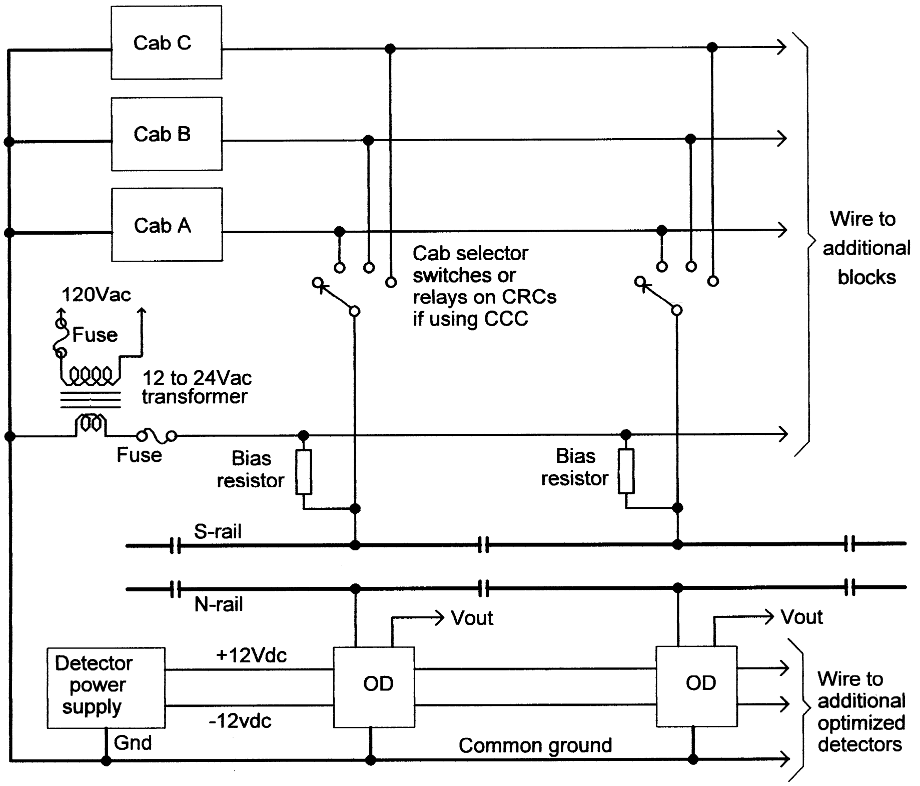


Fig. 3-9. Using AC for driving block detection bias resistors

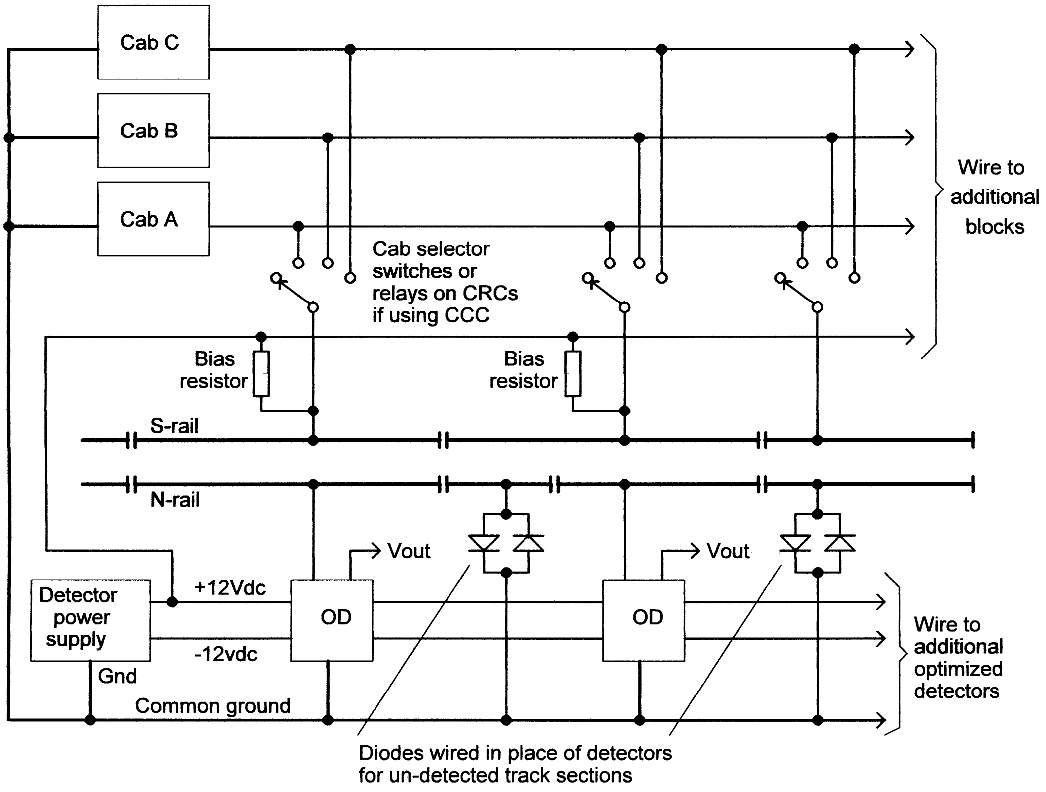


Fig. 3-10. Including diodes in series with undetected track sections

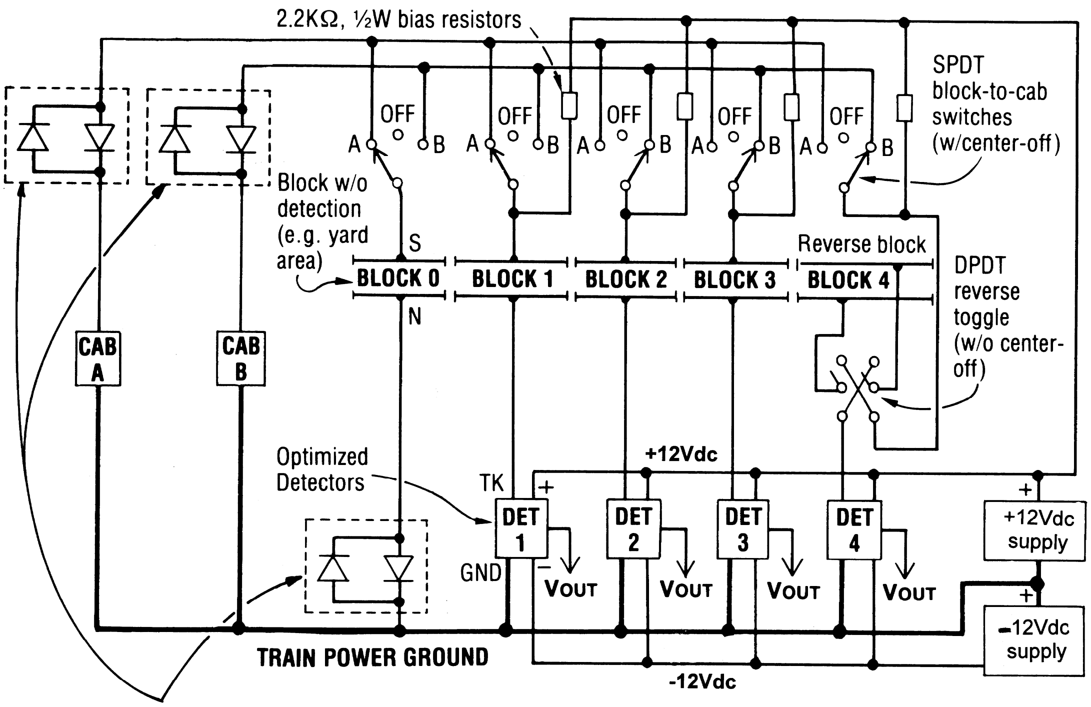
With Command Control applications using the OD, or other brands of detectors that are based upon diode-drop inputs, you can eliminate the bias circuit completely since full voltage is always on the track. You still should keep the diodes in series with undetected trackage to avoid experiencing a shift in track voltage, approximately .7Vdc, each time you move between detected and undetected trackage.

USING ODs WITH MANUAL CAB CONTROL INCLUDING REVERSING SECTION

Fig. 3-11 summarizes the track power and occupancy detection wiring for a typical Manual Block Control (MBC) system employing two cabs and a reversing section. It is a simplification of Fig. 3-5 in that SPDT center-off toggles can be used in place of the rotary switches which are required when using more than 2 cabs.

For completeness, a DPDT direction toggle has been added to handle a reversing section and handling a fully undetected “block” has been illustrated as would likely be the case for a yard where you want separate cab selection but without any detection. The figure assumes that DC bias is used. However, it is very easy to add in a transformer to supply AC bias as indicated in Fig. 3-9.

If signaling is to be employed with MBC it is important to check for cab consistence across each block boundary. This requires an extra contact set on the block toggles, making them DPDT. By wiring the added center pole to logic ground and then each side to an input card, the computer can read which cab is connected to which block. Using this information, it easy for the C/MRI software to check that the cab assignment across block boundaries is consistent before clearing a signal into an adjacent block.



NOTE: Use back-to-back diodes in any blocks without detectors and at each cab to keep high-level sensitivity in detector blocks when connected to same cab and undetected block is occupied. Diodes are the same as used in optimized detector circuit.

Fig. 3-11. Dual cab wiring with reversing section and occupancy detection

It is extremely important to note that when using the ODs there is one common ground that feeds the whole layout.

****Important Point****

Using the ODs the detector ground is the same as the track ground, which is the same as the signal logic ground. This is in stark contrast to the situation with the DCCOD where the track wiring is totally isolated from the signal logic ground.

Under these circumstances it is extremely important that all the grounds from the various power supplies used to power the railroad, such as track power, signal logic, detection power and power for driving switch machines, be tied together at a single common point close to each supply. Fig. 3-12 shows a typical recommended arrangement with the single common ground tie point.

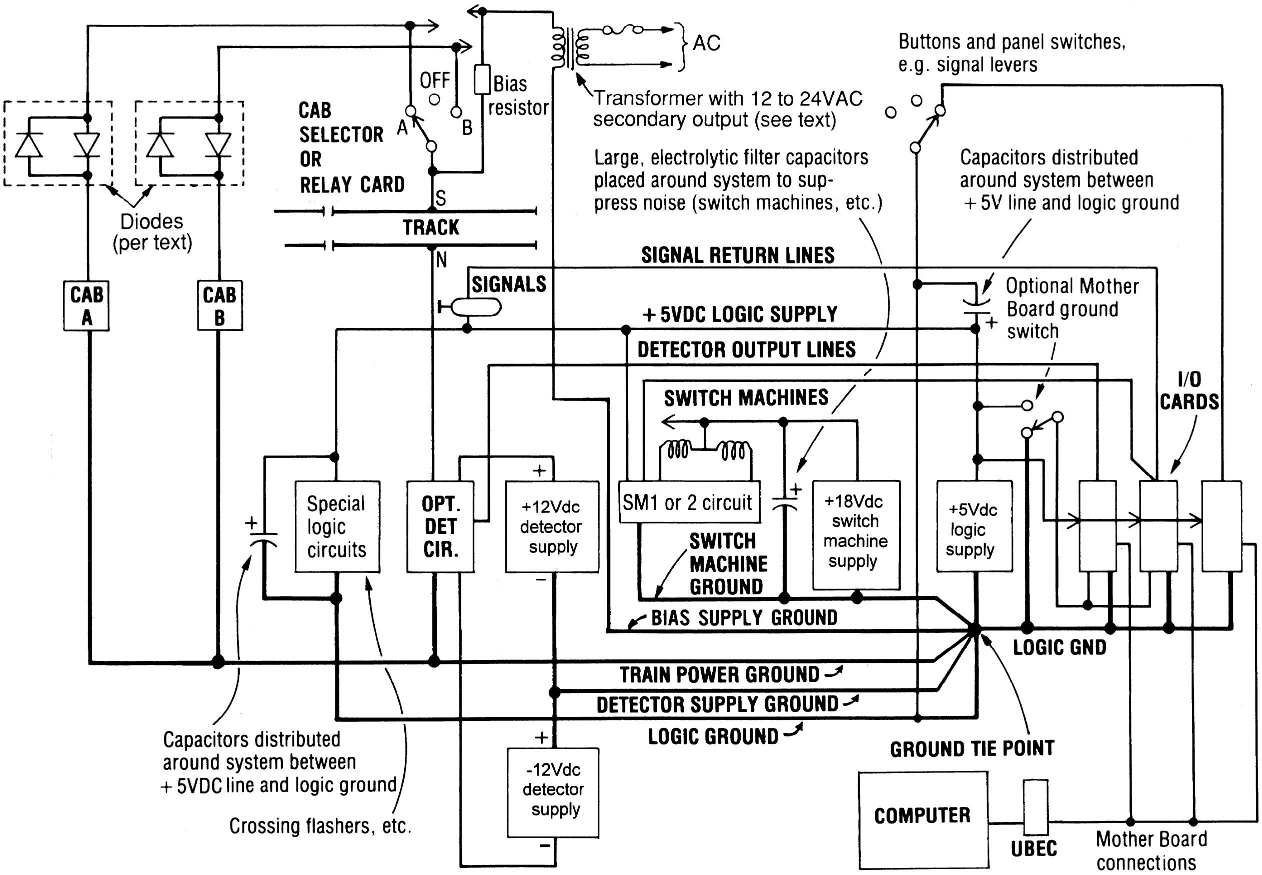


Fig. 3-12. Good ground wiring.

Then, by running separate ground feeds, electrically connected at one point, for the separate functions around your layout, you minimize the impact of current surges in the track and switch machine feeds impacting the very sensitive signal logic ground feeds.

For example, you want to avoid tapping any of the ground lines for signal logic level circuitry, including any of the C/MRI logic level grounds, into the ground used to feed twin-coil switch machines. Throwing the heavier duty versions of such switch machines can easily create a current spike of say 4A which when passed through 100 feet of AWG 16 ground wire (.4Ω per 100ft) can result in a voltage differential of 1.6V which can easily cause unwanted changes in signal logic.

To further minimize such ground line voltage variations, frequently referred to as “ground bounce” from affecting signal logic, extra capacitors can be distributed around your layout, as indicated in Fig. 3-12, between the 5Vdc logic power line and the logic ground line. These “despiking capacitors” are already built into all of the C/MRI circuit boards and play a key role in making the system immune to electrical noise. Further discussion of ***Good Ground Wiring*** is presented in Chapter 9.

USING ODs WITH DCC

Using the DCCOD is far superior in its application to DCC railroads when compared to using any of the diode-type detectors, including the OD. Therefore, I really wish that I could convince every user that is switching over from DC and using the ODs, to sell the ODs and use the proceeds to obtain DCCODs. I have talked to many C/MRI users who followed this advice and they too now recommend this approach. Therefore, I will cover this recommended approach in more detail shortly.

On the other hand, many C/MRI users have retained their ODs when converting to DCC and have found the results to be very satisfactory. This is especially the case if the switch to DCC is for a smaller application that uses a single DCC booster. Multiple DCC booster applications retaining the ODs do result in added system complexities, i.e. unless the brand of booster happens to include, or is able to be modified, to include an optoisolated control bus connection. Most DCC boosters do not provide for this capability.

The next chapter details the DCCOD. Then in Chapter 5, ***Using the C/MRI with Digital Command Control***, I go into detail showing the application of both the OD and the DCCOD to DCC layouts. Exploring the application of both detector types, and observing the pros and cons of each approach should help in making the decision whether to keep the ODs with DCC or to start anew using the DCCODs.

If you have no interest in DCC, and thus no interest in the DCCOD, please feel free to skip ahead to Chapter 7 covering ***Prototypical Turnout Control***. Otherwise, before we move forward, let’s just take a moment to close out this chapter by taking a look at selling existing ODs to pick up DCCODs

SELLING ODs TO PURCHASE DCCODs

Although many may feel that DCC has taken over the whole railroading community, if you really analyze the situation, there is still a very strong base of strictly DC users. For example, even with an obviously strong shift to DCC, JLC Enterprises continues to fill orders for the OD, albeit at this stage the DCCOD probably outsells the OD by a 4 to 1 margin. Consequently, there remains a good market for second-hand fully-functional ODs. By using Ebay and/or contacts obtained through the C/MRI User’s Group, many users converting from DC to DCC have very successfully sold their ODs and put the proceeds toward purchasing new DCCODs.

Baseline pricing for ODs has a very wide range and depends on if they are purchased as kits, for an estimated price of $10 or as completely assembled and tested, estimated at $17 (based upon SLIQ Electronics data as of January 2016). For the Do-It Yourselfers purchasing the OD board from JLC at quantity discount and the electronic parts from each of the recommended suppliers, again at substantial quantity discount, the estimated cost can be as low as $8 to $9 but more typically at $11 to $12 for low quantities. Averaging all these prices together, it would appear that a reasonable, rather quick to sell, price for a used, assembled and tested OD would be about $10 to $12 each. Basically this sells the detectors at an “averaged” cost level for the board plus parts but with nothing charged for the assembly time.

Applying that amount toward a Do-It Yourselfer’s version of the DCCOD basically covers the cost of the boards, pulse-transformer and electronic parts, assuming all were purchased at quantity discount. In summary, Do-It Yourselfers who purchase boards directly from JLC with a discount and similarly purchase parts from the recommended sources, again at a discount, can basically just about break even when exchanging ODs for DCCODs, that is if you disregard your assembly and test time.

Because of the true superiority of the DCCOD over the OD when applied to DCC railroads, I really recommend that the above approach be given serious consideration by anyone having ODs now planning on switching to DCC. At this point however, let us just move ahead and take a look at the DCCOD.