GENERAL SIGNALING
& AUTOMATION INFORMATION

In order to do any type of signalling or automation on a model railroad it is necessary to have some understanding of how and why signals function on the real railroads. The why of railroad signals is a vast area, well beyond the scope of this discussion. How railroad signals operate is of more concern as we attempt to create an accurate model.

The initial problem in any signal system is to know the location of all trains. To know the location of a train requires an ability to detect the presence of a train as it moves along the track. The railroads accomplish this detection by means of track circuits utilizing batteries and insulated rail joints. The train completes the battery circuit by electrically bridging across the rails thereby activating a relay. The relay contacts then become the input to the system stating that this section of track is occupied. What the system does with this information is wholly dependent upon the operating rules of the railroad and how these rules are to be displayed by the signals themselves. As an oversimplification we can state that the signals located at either end of the involved track section should be RED when the track is occupied so that an approaching train should not enter the track section.

There are several ways to provide detection on model railroad track. If a third rail (center, outside or as overhead wire) is being used for propulsion power the solution is very simple. If both of the running rails (propulsion ground) are electrically isolated from each other, then any metal wheel and axle set can complete a low voltage circuit across the rails to activate a relay just as is done by the battery circuits on the real railroads. The relay then becomes the initial input for the signal system. In a two rail system both rails are needed to provide for propulsion power and detection becomes a more complex matter. One method of detection is to monitor propulsion power to the track and assume that if current is flowing in a given area of track there must be something occupying that track section. Detecting current flow can be done in several ways, however there are some shortcomings. Power must be on and detection only happens if something draws current. A piece of rolling stock with plastic wheels would not be detected. Generally this is not a major problem as in most cases the track block can be longer than a train and a lighted car or some other current draw can be on the rear of a train allowing for detection of the entire train. Detection can also be done magnetically using reed switches which respond to magnets in rolling stock or locomotives. Again, the difficulty is that only equipment with magnets can be detected. As with current flow, if the signal block is longer than a train and all locomotives and rear of train cars are magnet equipped, the problem is minimized. Another method of detection would be optical utilizing light sensing devices that respond either to removal of or a reduction in intensity of light. This type of detection is independent of track power but for best results should not be influenced by variations of existing (ambient) light levels. The OPTO-DT manufactured by DALLEE ELECTRONICS is an optical device which uses an infra-red line of sight beam for detection. When the beam is interrupted a relay is activated.

Most model railroad signal systems seem to be based on detecting current flow, primarily in series with track power. Examples of this are the original NMRA circuits, twin-t per Lynn Westcott or the various schemes that measure the voltage drop across diodes. There are two flaws in all of the series arrangements. First, power for propulsion is being used by the detection circuit and is therefore not available to run trains. This loss of propulsion power to the detection circuits may not be of significant amounts to be of concern. Secondly, however the detection circuit itself must be able to withstand the current levels resulting from a short circuit on the track. In larger gauges or in situations where double heading of steam locomotives or multiple unit diesels are involved the current levels could be high.

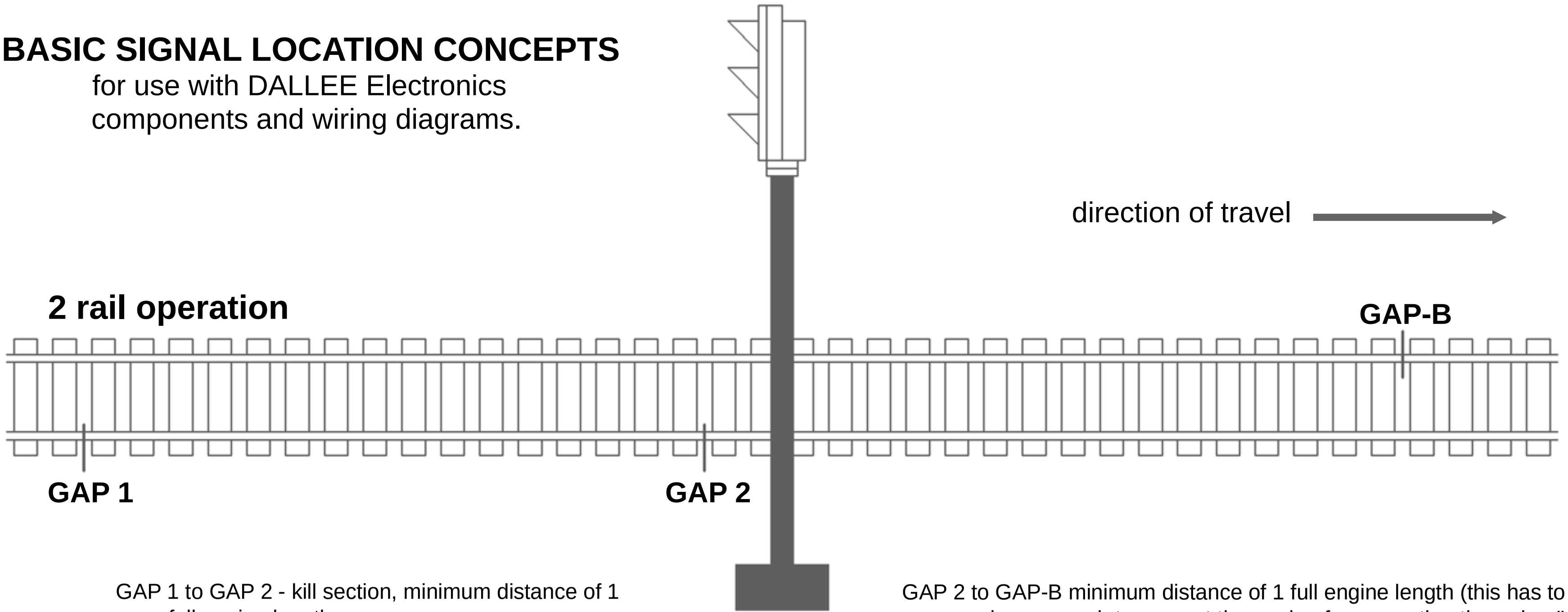
The TRAK-DT family of detection devices manufactured by DALLEE ELECTRONICS are designed to sense the flow of current but unlike the various series devices the TRAK-DT is electrically isolated from track power. It will function as if it is in series with track power but is completely unaffected by a short circuit other than to sense that current is being drawn. This electrical isolation is accomplished by having one wire to the track section physically pass through a hole in the detection coil of the TRAK-DT. When current is flowing in this wire the electronic circuitry will activate the relay of the TRAK-DT which then becomes the input information for all signal applications.

Numbers of TRAK-DT devices together with the available variations of the basic TRAK-DT can be combined with other input information such as turnout positions to develop complex signal systems and / or automation functions.

Using dual color LED's is shown at the end of the Wiring Guide.

BASIC SIGNAL LOCATION CONCEPTS

for use with DALLEE Electronics components and wiring diagrams.



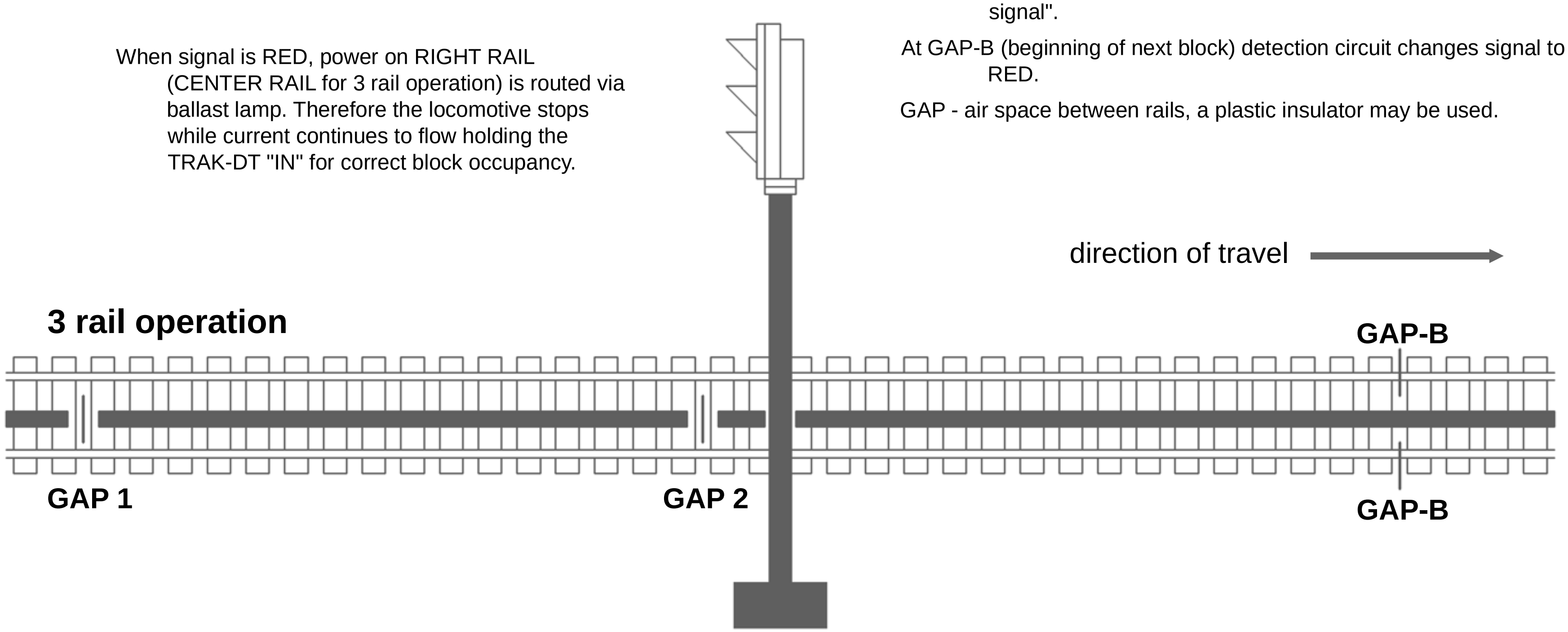
GAP 1 to GAP 2 - kill section, minimum distance of 1 full engine length.

When signal is RED, power on RIGHT RAIL (CENTER RAIL for 3 rail operation) is routed via ballast lamp. Therefore the locomotive stops while current continues to flow holding the TRAK-DT "IN" for correct block occupancy.

GAP 2 to GAP-B minimum distance of 1 full engine length (this has to be long enough to prevent the engine from coasting through a "stop signal".

At GAP-B (beginning of next block) detection circuit changes signal to RED.

GAP - air space between rails, a plastic insulator may be used.



TWO ASPECT SIGNALS & AUTOMATION

In a two speed signal system there are only two aspects to deal with. If the block ahead is occupied, the signal is RED and the train should stop. With the block ahead clear, the signal is GREEN and the train can proceed. It is possible to do both signals and automation with the relay contacts available on the DALLEE ELECTRONICS TRAK-DT (Item 365).

Each signal block must have a TRAK-DT for detection and at least one rail electrically insulated for the full length of the block. The wire that feeds electrical power to the insulated rail is passed through the detection coil of the TRAK-DT. When a train (locomotive, lighted car or anything that draws electrical current) is getting its power from the insulated rail the TRAK-DT will activate its (double pole double throw) relay contacts. Each block will also need an insulated rail section where power can be disconnected so that a train can be stopped if the signal is RED. As a convenience it is a simple matter to provide detection on the left rail and power selection on the right rail.

The beginning point of detection in a signal block should be at least one locomotive length past the actual signal location and the stopping area for automation should begin a full locomotive length prior to the signal. The actual dimension of a locomotive length will depend on operating practice. Key dimensions are the length of your longest steam locomotive and tender combination and/or the length of multiple unit diesel sets.

In operation, as a train goes past the signal and is detected, the signal turns RED and the stopping area of track prior to the signal should have no power so that an approaching train will stop. It is not possible to merely shut off the power to this track section as we must maintain continuous current flow so the TRAK-DT devices will function properly. Track power is connected to the normally closed terminal of one contact set and to the running area of the block. The common terminal connects to the stopping section of rail. A ballast lamp is connected between the open and closed terminals of this contact set so that when the relay is activated the lamp is in series with the stopping section. If a KEEP-A-LIVE (Item 588) device is installed on the throttle, then a capacitor (0.1 mfd or larger non-polarized) can be used instead of the ballast lamp.

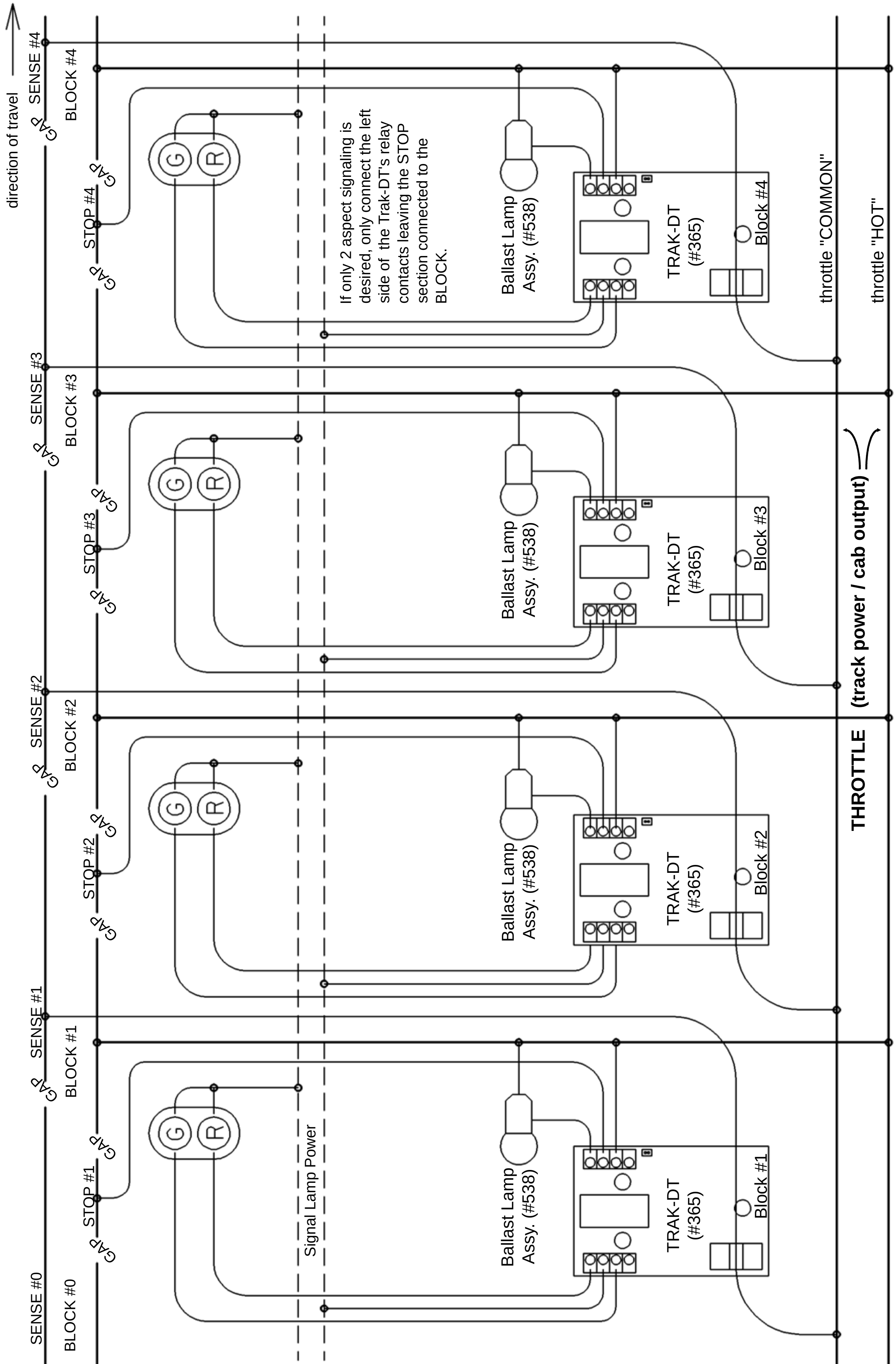
Power for the signals comes in to the common terminal of the other contact set of the relay. The normally open terminal is connected to the RED indicator and the normally closed terminal is connected to the GREEN indicator. When the train is detected the relay on the TRAK-DT is activated. One contact set switches signal power to the RED indication and the other contact set connects the ballast lamp in series with track power going to the stop section of rail. The ballast lamp will shunt power so that a locomotive in stop section will not run but current flow is maintained. With KEEP-A-LIVE devices installed, the capacitor will block the DC track power from reaching the stop section so a locomotive will not run. The KEEP-A-LIVE signal will pass through the capacitor to the stop section providing the maintenance of current flow. When the block is cleared the relay on the TRAK-DT relaxes switching signal power to the GREEN indicator and full track power back to the stop section of rail.

While the above discussion has been based on two rail DC applications the two speed automation is also possible with AC or with three rail layouts running either AC or DC. All sequence reversing (E-UNITS) devices on the locomotives must be locked or disconnected so the locomotive will run only in one direction. In a three rail system it is necessary to gap both of the outside "ground" rails. Again the rail gaps should be located one engine length beyond the signal location. Power selection is then made on the center rail with its gaps cut prior to the signal location. DC should be wired with the "plus" on the center rail and "minus" to the two outside rails. AC should always be wired so that transformer "hot" is on the center rail and base post "ground" connects to the two outside rails.

The one exception to the choice of detecting on the "ground" rails is if LIONEL track switches are employed on the automated loop. These switches use the "ground" rails to provide non-derailing features and for the light bulbs. If LIONEL switches are in use then detection should be done on the center rail and power selection done on the "ground" rails. In this circumstance the power for the switch lamps must come from the fixed voltage plugs so that the lamps are isolated from the center rail.

The following pages cover basic operation with just signals to that of full automation. Complexity grows when opting for east / west operations along with multiple locomotives used in one train. For multiple locomotives, it is necessary for the lead locomotive to enter the stop section for the signal. Then the rest of the locomotives must also have their power removed, hece the necessity for the second detector. This detector basically makes the stop block grow to a longer block covering all of the locomotives in the consist.

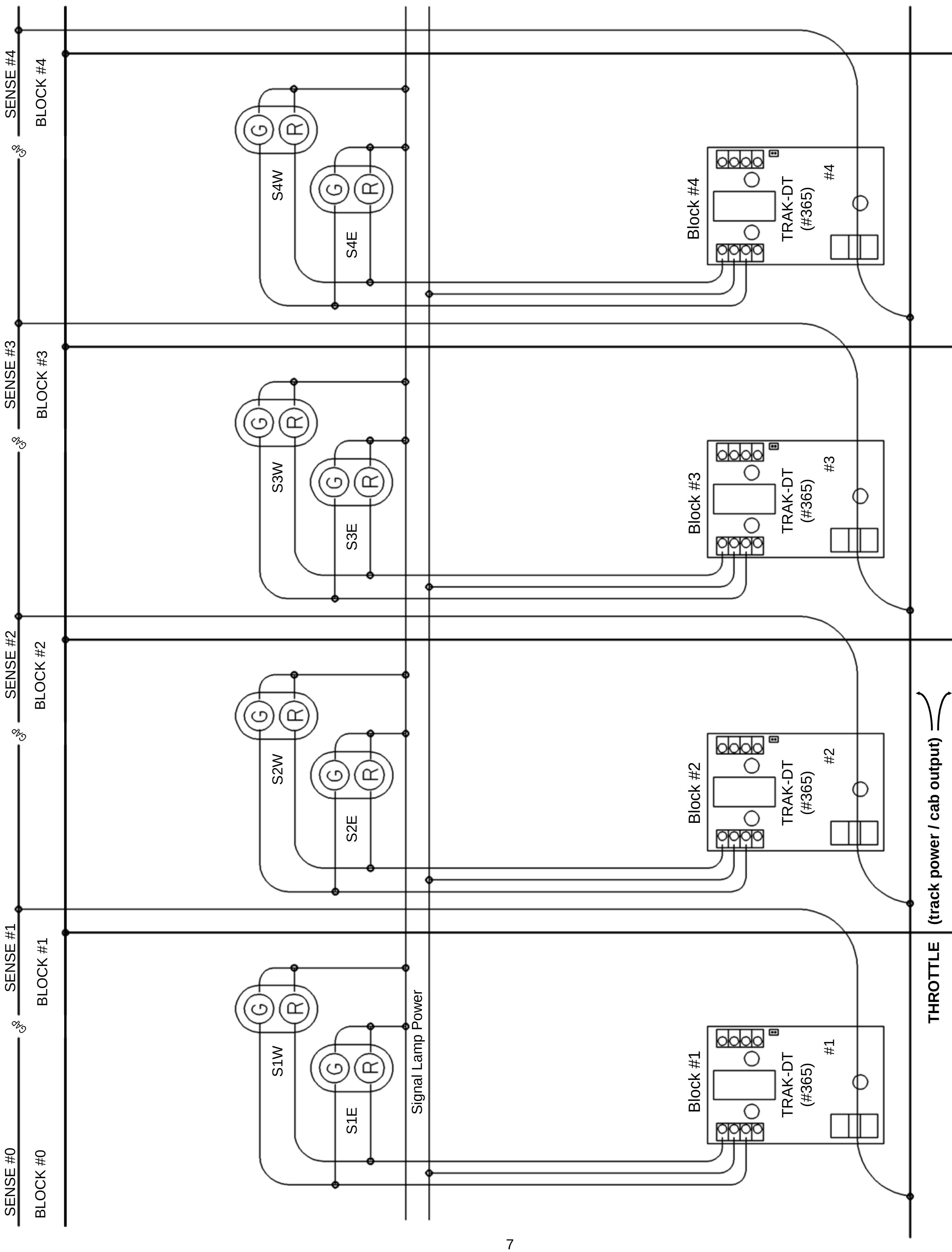
TWO ASPECT SIGNALS with stop block for automation



GAP - air space between rails, a plastic insulator may be used.

All TRAK-DT's need to be connected to the 12VPS "+" and "—" accordingly for proper operating power.

TWO ASPECT SIGNALS for East / West automation

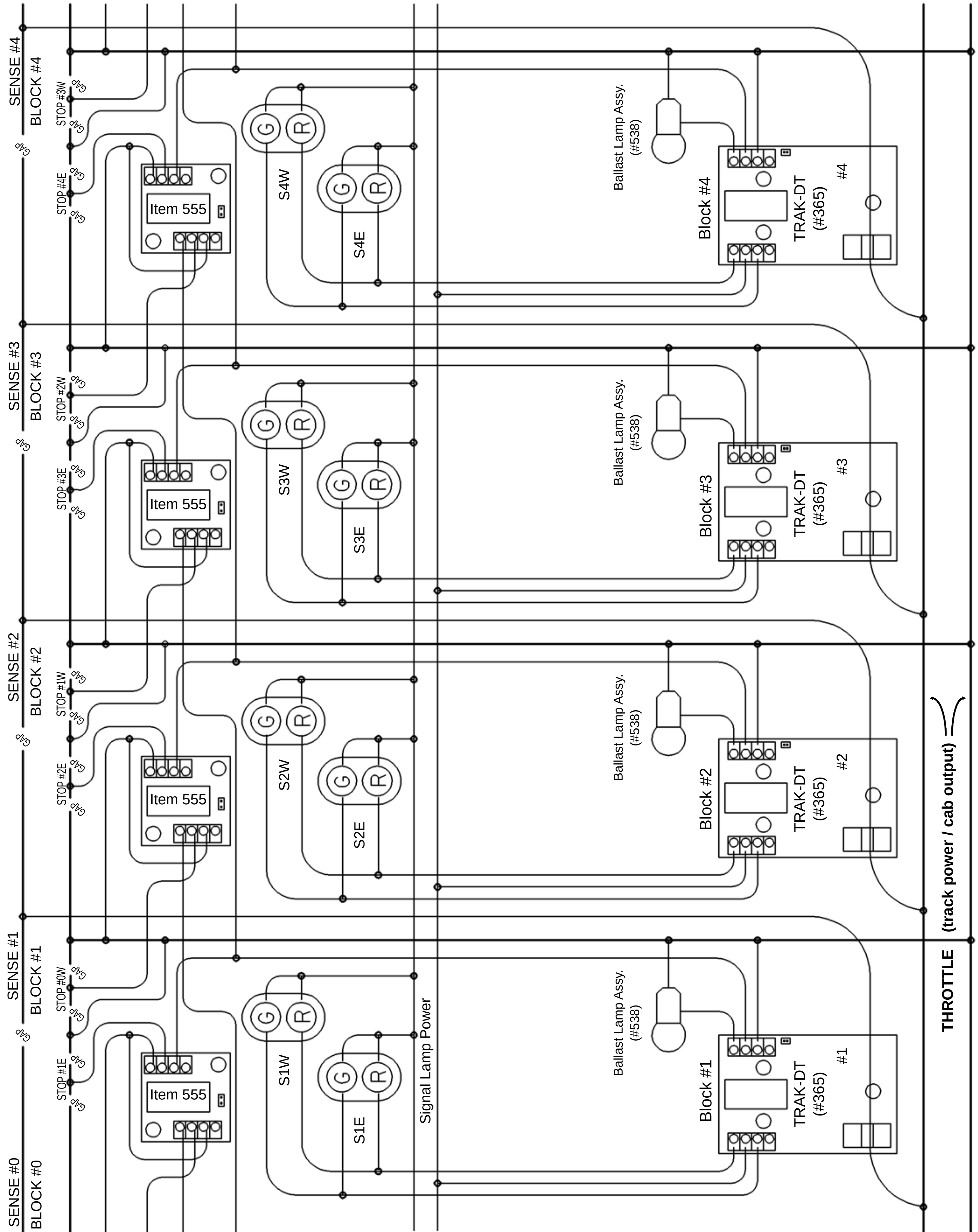


GAP - air space between rails, a plastic insulator may be used.

All TRAK-DT's need to be connected to the 12VPS "+" and "-" accordingly for proper operating power.

TWO ASPECT SIGNALS with stop block for East / West automation

One engine per train

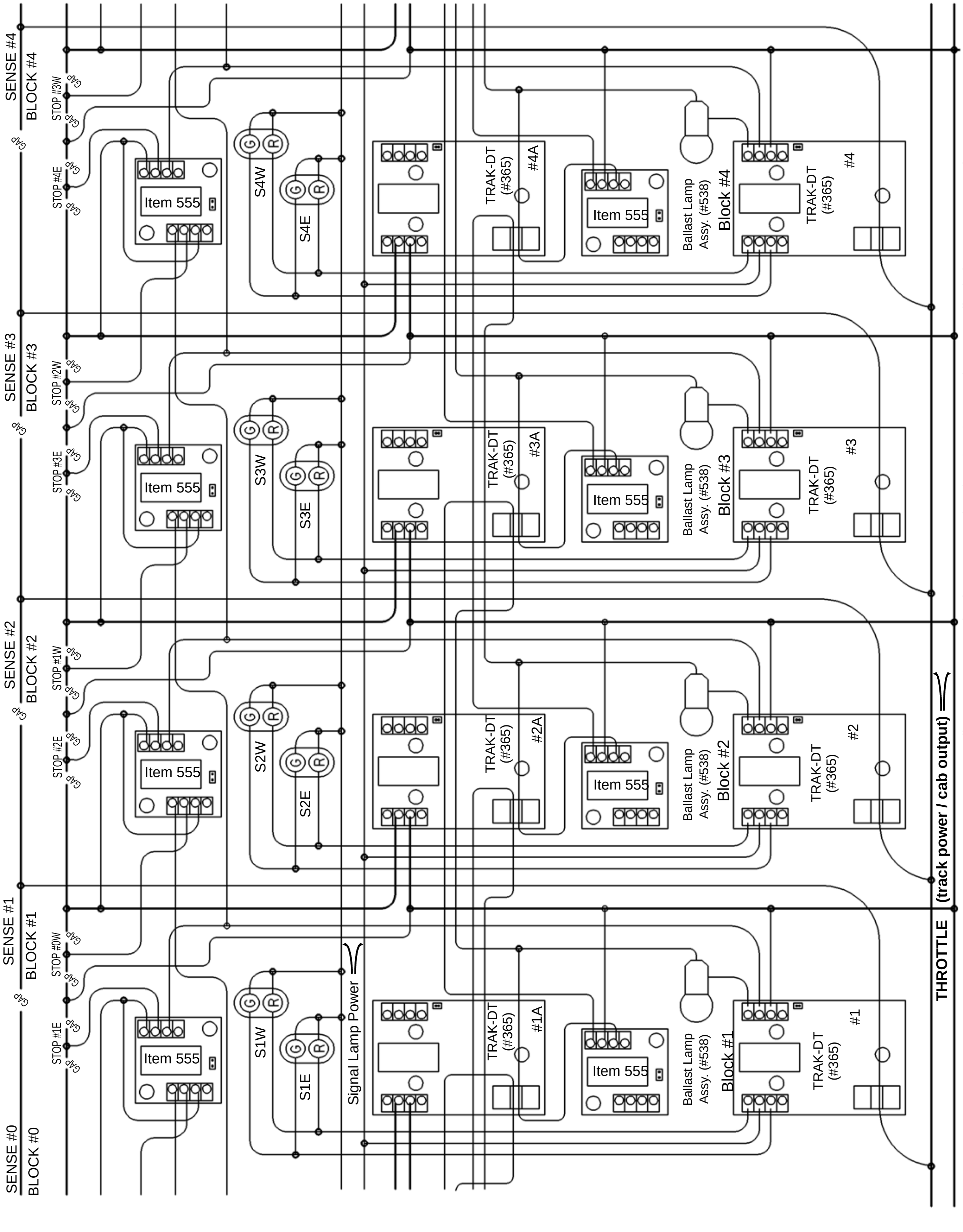


GAP - air space between rails, a plastic insulator may be used.

All TRAK-DT's need to be connected to the 12VPS "+" and "-" accordingly for proper operating power.
Relay BD (#555) shown above "RC" must be connected to TRAK-DT below

TWO ASPECT SIGNALS with stop block for East / West automation.

Multiple engines per train.



All TRAK-DT's need to be connected to the 12VPS "+" and "-" accordingly for proper operating power.
Each Relay BD (#555) shown above a TRAK-DT must be connected from "RC" to TRAK-DT exp. below.

GAP - air space between rails, a plastic insulator may be used.

THREE ASPECT SIGNALS & AUTOMATION

Stated in simple terms, THREE ASPECT SIGNALS say that if the block ahead is occupied the signal is RED and you must stop. If there is one clear block ahead, the signal is YELLOW allowing a reduced speed. Normally this YELLOW or restricted aspect includes the order---prepare to stop at the next signal (it is probably RED if there is only one clear block ahead). With two or more clear blocks ahead the signal is GREEN allowing normal speed.

A single signal head displaying all three aspects provides a simple method of speed limiting. By combining several aspects, usually through the use of multiple heads, information other than speed can be displayed. This is frequently done at junctions (interlocks) where the HOME SIGNAL is indicating both speed and routing. How extensive the variations of these multiple aspects are is dependent upon the operating rules of each individual railroad.

THREE ASPECT SIGNALS are easily modeled using DALLEE ELECTRONICS TRAK-DT devices. Each signal block must have a TRAK-DT for detection and at least one rail electrically insulated for the full length of the block. The wire that feeds electrical power to the insulated rail is passed through the detection coil of the TRAK-DT. When a train (locomotive, lighted car or anything that draws electrical current) is getting its power from the insulated rail the TRAK-DT will activate its (double pole double throw) relay contacts. These two sets of contacts are then used to illuminate the appropriates signal aspect. When the relay is activated one contact set is used to illuminate the RED aspect. This same contact set can, at the same time, be used to illuminate occupancy indicators on a control or display panel if the indicators are the same type of lamp or LED as the signals. If the relay is not activated (block clear) the signal can be either YELLOW or GREEN depending upon the situation at the next ahead block. The second contact set of the relay of the next ahead TRAK-DT is used to illuminate the YELLOW or GREEN aspect as appropriate.

Circuitry for the signal aspects is interconnected between the contact sets of the relays. Signal illumination power inputs at the common terminal of the first contact set. The RED aspect is connected to the normally open terminal of this set. When the relay activates, signal power goes to the RED indicator. With the relay relaxed, signal power is switched to the normally closed terminal of this contact set which is connected to the common terminal of the second contact set of the next ahead TRAK-DT relay. If the next ahead relay is activated (one clear block) signal power goes to the normally open terminal of the second contact set and therefore to the YELLOW indicator. If the next ahead relay is relaxed (two or more clear blocks) signal power switches to the normally closed terminal of the second contact set and thus to the GREEN indicator. If signals are desired in both directions on a single track, this can be accomplished with only one TRAK-DT per block, however two additional sets of relay contacts are required. Two sets of contacts operate the signals in one direction and two sets of contacts operate the other direction.DALLEE ELECTRONICS product Item 555 RELAY BOARD is a double pole double throw relay mounted on a circuit board with a jumper connector allowing it to be operated with the TRAK-DT. This converts each TRAK-DT into a four pole double throw relay to accommodate both signal directions.

Full automation with THREE ASPECT SIGNALS can also be accomplished with DALLEE ELECTRONICS TRAK-DT devices if ballast lamps or KEEP-A-LIVE devices, two throttles and additional relay contacts are used. THREE ASPECT SIGNALS requires two contact sets of the TRAK-DT and matching automation also requires two contact sets. The RELAY BOARD provides the correct number of contact sets to accomplish both the signal and speed requirements. The ballast lamps or KEEP-A-LIVE will maintain continuous current flow when a train is stopped for a RED signal. One throttle is used for approach speed (YELLOW signal) and the second throttle provides normal running speed (GREEN signal). The extra relay contacts connect either throttle, KEEP-A-LIVE or the ballast lamp to the track as required.

In order to provide more realistic operation there are several suggestions to be given consideration. First, since there can be several trains connected to each throttle at any given time it is suggested that the throttles be of voltage regulated design so that as the load is changed by more or less trains, the output voltage, and therefore speed, remains constant. A second consideration involves the placement of the insulating rail gaps which define signal sections and the stop area for the RED signal aspect. Past experience suggests that the beginning point of detection in a signal block should be at least one locomotive length past the actual signal location and the stopping area for automation should begin a full locomotive length prior to the signal. The actual dimension of a locomotive length will depend on operating practice. Key dimensions are the length of your longest steam locomotive and tender combination and / or the length of multiple unit diesel sets.

It is possible to automate two trains following each other on one track loop, with three aspect signaling, using only five signal blocks but it is suggested that a minimum of six blocks be employed and that each block be as long as the longest train. Additional trains should have two additional blocks each for appearance although an absolute minimum could be one block per train plus four blocks for running. The current carrying capacity of the throttles is probably the major limiting factor in this automation.

If detection is done on one rail and power selection is done on the other rail the whole process becomes rather simple. Suppose that we are going to detect on the left rail. This rail is then "gapped" one locomotive length beyond each signal all the way around the track loop resulting in a section of this rail for each block. Power to this rail originates at the minus (ground) terminals of each throttle which are commoned and then routed through the sense coil of each TRAK-DT to the individual rails. The plus (hot) terminal of the approach throttle is connected to the normally open terminal of the second contact set of the relay of each TRAK-DT and the plus (hot) of the normal running throttle connects to the normally closed terminal of this contact set. The common terminal of the second contact set is connected to the normally closed terminal of the first contact set of the prior TRAK-DT and to the right rail of the track between signals. The common terminal of the first contact set connects to the stopping section which is a "gapped" right rail one locomotive length prior to each signal. A ballast lamp is connected between the open and closed terminals of this contact set so that when the relay is activated the lamp is in series with the stopping section. If KEEP-A-LIVE devices are installed on both throttles, then a capacitor (nonpolarized preferred) replaces the ballast lamp.

In operation, as a train goes past a signal and is detected, the signal should turn RED and the stopping area of track prior to the signal should have no power. Also, since the preceding signal has been changed to YELLOW all track between the signals should be connected to the approach speed throttle. The common terminal of the first contact set of each TRAK-DT is connected to the stop section of rail. When the relay is activated, power comes through the normally closed terminal, from the next ahead TRAK-DT, via a ballast lamp to the normally open terminal, thence via the common terminal to the rail. The ballast lamp will shunt the power so that a locomotive in the stop section will not run but current flow is maintained. With KEEP-A-LIVE devices installed, the capacitor will block the DC track power from reaching the stop section so a locomotive will not run. The KEEP-A-LIVE signal will pass through the capacitor to the stop section providing the maintenance of current flow. The second contact set connects approach power to the prior TRAK-DT and to the track between the signals. With the relay relaxed, power goes directly from the normally closed terminal to the common terminal and to the stop rail. This power can be either normal or approach as determined by the condition of the next ahead TRAK-DT. The second contact set now supplies normal running power to the prior TRAK-DT and to the track between signals.

Station stops can also be included in this automation as long as the stop section is located wholly within one signal block and the stop does not interrupt current flow to the TRAK-DT devices. Station stops are done with a TRAK-DTT and associated ballast lamp. When the TRAK-DTT senses current flow its relay switches track power off at the stop location and simultaneously switches power to illuminate a ballast lamp to maintain continuous current flow in both the TRAK-DTT and the TRAK-DT for this signal block. Visually, operation is much more realistic if the trains are slowed to approach speed prior to a stop and are also connected to the approach speed throttle when starting out after a stop.

On the NEBRASKA CENTRAL, an HO layout in Omaha, NE, built by DUNHAM STUDIOS, three speed automation involving 16 signal blocks was employed. In those cases where station stops were provided the stops were set at or near the center of a signal block. The TRAK-DT for the block ahead of the stop block was wired so that only the approach speed throttle could feed power to the stop block. Regardless of the condition of this next ahead block, every train had to use approach speed coming into the station stop and when departing the station. Full running speed could not happen until the first signal past the station provided this signal was GREEN.

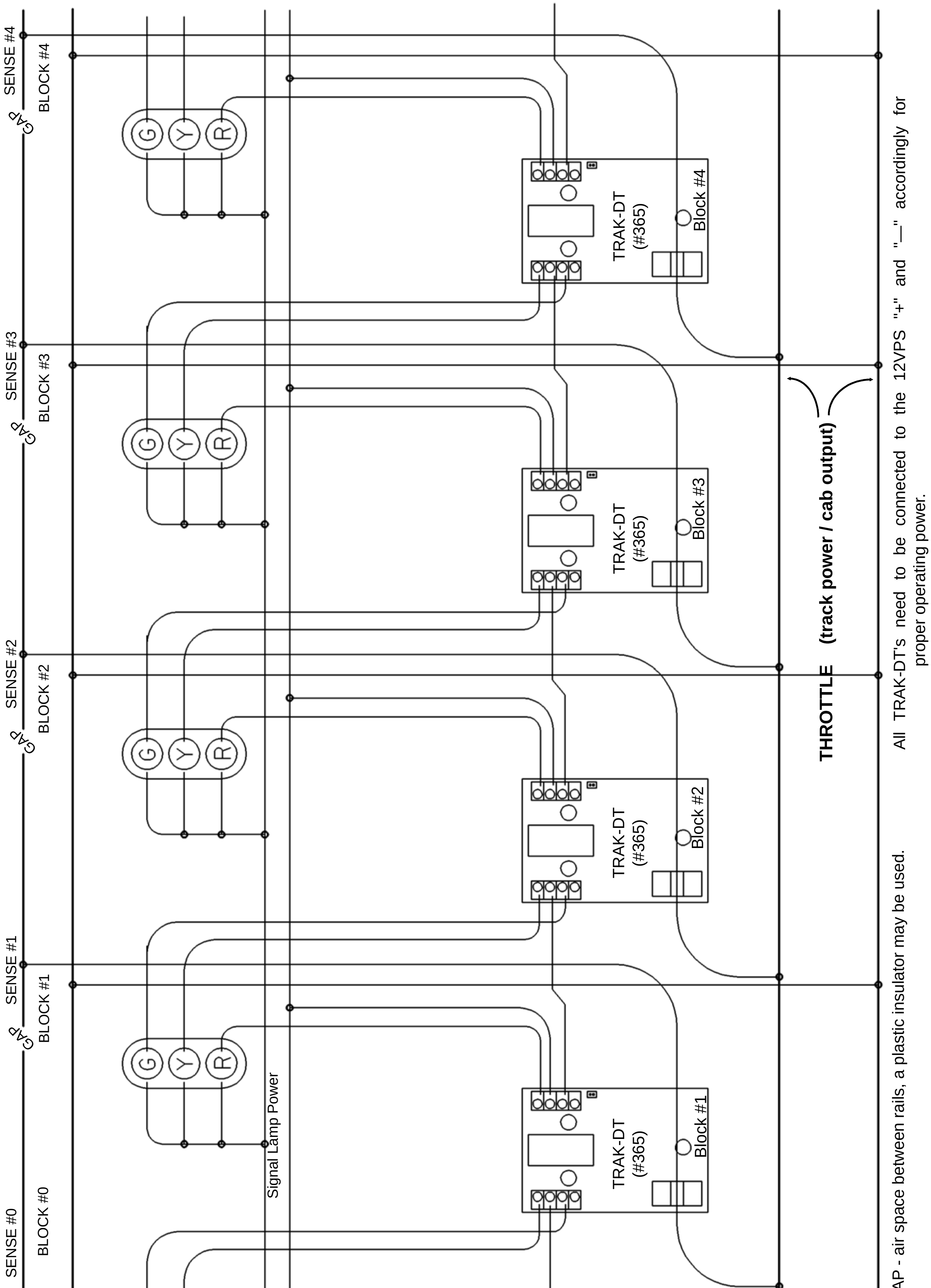
Another example of an actual installation involves a station stop on the passenger perimeter track of the CITIBANK STATION display built by DUNHAM STUDIOS. A TRAK-DTT provided the station stop and an additional TRAK-DTT was employed as a timer to hold speeds at the approach level during the stop sequence. A TRAK-DTL was also used to set up a sequential arrangement whereby every other train stopped at the station.

There are unlimited possibilities as to how these variations can be handled using different combinations of DALLEE ELECTRONICS TRAK-DT and related devices.

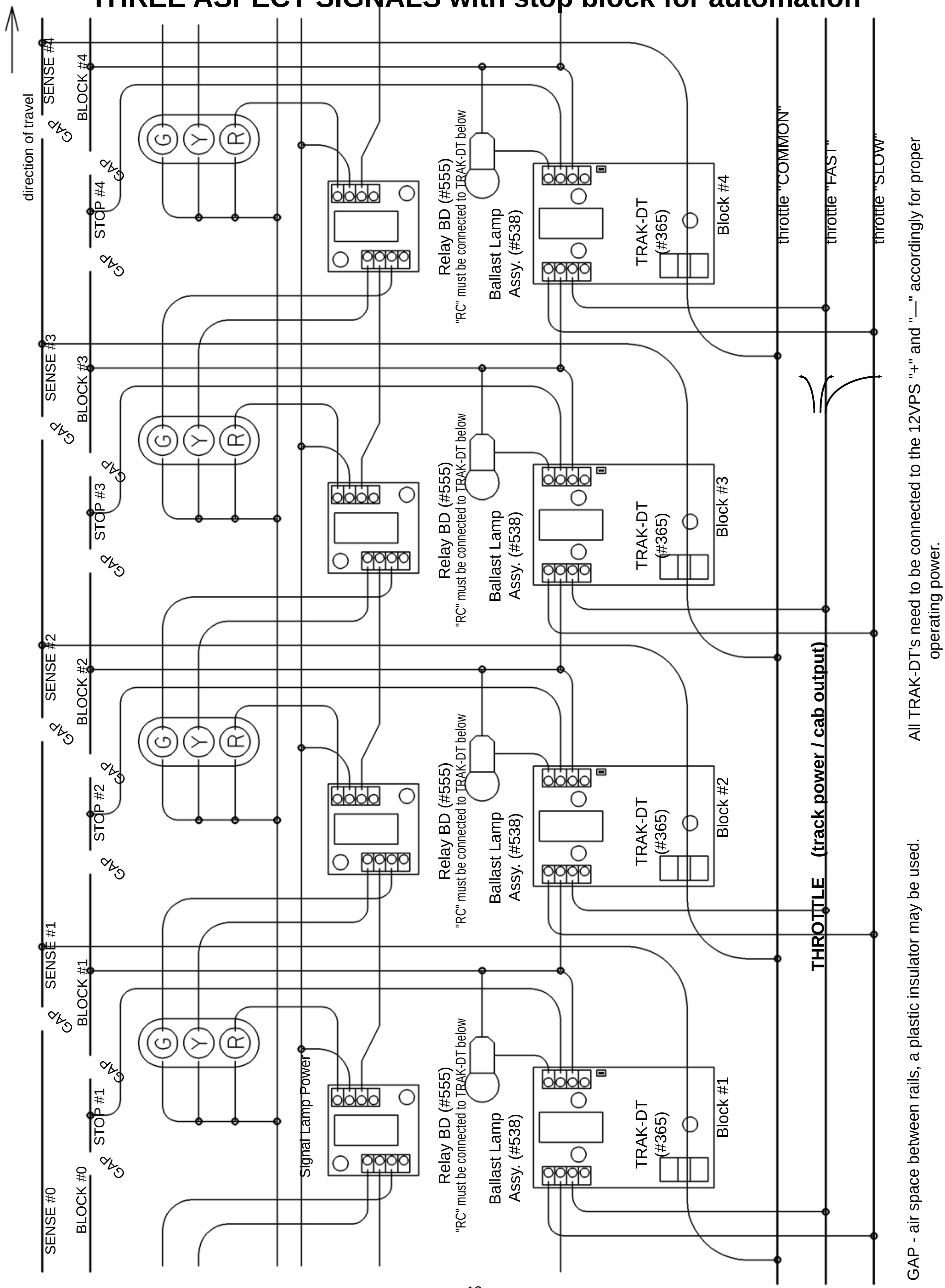
AC operator : While the above discussion has been based on two rail DC applications the three speed automation is also possible with AC or with three rail layouts running either AC or DC. All sequence reversing (E-UNITS) devices on the locomotives, for best operation, must be locked or disconnected so the locomotive will run only in one direction. As an alternative to locking the reversing units, you could elect to use a seperate low voltage tap. One lead of the low voltage would be connected to the N/O contact on each TRAK-DT instead of the ballast lamp. The other lead (common) would be connected to the "throttle COMMON". This way a low "holding" voltage will be applied to the STOP section (this has to be low enough that the train does not run / coast through a RED signal). In a three rail system it is necessary to gap both of the outside "ground" rails. Again the rail gaps should be located one engine length beyond the signal location. Power selection is then made on the center rail with its gaps cut prior to the signal location. DC should be wired with the "plus" on the center rail and "minus" to the two outside rails. AC should always be wired so that transformer "hot" is on the center rail and base post "ground" connects to the two outside rails. The one exception to the choice of detecting on the "ground" rails is if LIONEL track switches are employed on the automated loop. These switches use the "ground" rails to provide non-derailing features and for the light bulbs. If LIONEL switches are in use then detection should be done on the center rail and power selection done on the "ground" rails. In this circumstance the power for the switch lamps must come from the fixed voltage plugs so that the lamps are isolated from the center rail.

Targets: When using target type signals, wiring is the same as single signal heads as shown except you need to wire as follows. First, the center lamp is always on (assuming the signal is not approach illuminated). The Green signal is then obtained by wiring the top and bottom lights together and connected as a single green lamp. The Yellow would be the opposite angled lamps and the Red would be the opposite horizontal lamps.

THREE ASPECT SIGNALS



THREE ASPECT SIGNALS with stop block for automation



Making a detected STOP block "GROW"

Sometimes it's necessary to have a block "grow" in size. This is particularly true when doing automation with multiple locomotives that do not have any track power pickups wired between them to create a single pickup. By making the stop block grow (become longer), it makes trains stop at a particular location every time instead of stopping by engine length's which is particularly helpful when operating with multiple units not wired together.

This drawing provides a simple approach to utilizing one TRAK-DT or TRAK-DTT to accomplish this.

Operation is simple as well. When the first locomotive enters the stop block, the detector detects it's presence and then switches the power to the section behind it to be included into the stop block instead of the main track power. This way all of the locomotives are contained in the stop section since it has grown which prevents the trailing locomotives from pushing the lead locomotive.

The upper side (section "A") of the block TRAK-DT is utilized in the same fashion as it would be in all of the Automation / Signaling drawings and is shown that way. The main difference is the added TRAK-DT which also senses when the first locomotive enters the STOP section. This second TRAK-DT does the switching to the newly created block behind the stop block. The extra relay contacts can be used to switch whatever else you would like operated when the engine get to the stop block.

As in all of the other drawings, the 12VPS is shown powering these two TRAK-DT's and the rest of the TRAK-DT's you are using. Don't forget that the total current draw may not exceed the 1/2 ampere rating of the 12VPS. No harm will be done but the 12 volt output will be less than 12 volts since it is overloaded. Sufficient input power is also required to provide the output power from the 12VPS. An ideal power transformer is item 690 or 990.