



Diesel Locomotive Operation Manual

**for QSI Quantum 1 System™ Analog & DCC Sound
Decoder Equipped Locomotives w/ Magnetic Wand**



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Version 3.1**

Basic Analog Operation

QSI recommends that you get used to operating and having fun with your new sound-equipped locomotive before exploring its more advanced features or programming options. Read through this section and be up and running with your new Quantum equipped locomotive in less than five minutes.

Running the Locomotive

Use an HO power pack with a standard direction switch¹. Set the switch to run your locomotive Forward.

- Turn the throttle up slowly until you hear the Quantum System™ come on. You will hear Start Up sounds and lights will turn on.
- Continue to turn up the throttle voltage until the locomotive starts to move in Forward. The Directional Headlight and optional Ditch Lights will come on or optional Mars Light will start pulsing. The locomotive will start out slowly due to special Quantum Inertial Control™ that resists rapid increases or decreases in speed².
- As the locomotive slows down by gradually reducing the throttle, Squealing Brake sounds occur as it comes to a stop.

Reversing the Locomotive

This simple operation is exactly the same as with standard locomotives.

- Bring the locomotive to a stop and turn the power all the way off.
- Flip the direction switch and reapply power to go in the opposite direction.

The Reverse Light (rear Headlight) turns on. If so equipped, the Ditch Lights will turn off or the (front) Mars Light will stop pulsing and switch to dim. The front Headlight will switch to off or switch to dim if the dim headlight feature is available.

Horn

Blow the authentic diesel locomotive Horn for short or long blasts – you control the duration.

- While the locomotive is **moving**, flip the direction switch to turn on the Horn.
- Flip the direction switch back to shut off the Horn.

The locomotive will not change direction when you blow the Horn.

Note: If your locomotive is equipped with Ditch Lights, they will automatically strobe from one light to the other when the Horn is being blown and will continue for five seconds after the horn signal has stopped³.

Note: If you use a reversing-throttle that changes continuously from forward-to-off-to-reverse or if you flip the direction switch too slowly from one position to the other, you can momentarily lose track power as the switch is being moved through its center position.

Bell (available on all U.S. and other selected models)⁴

You can turn on the Bell (if so equipped) and leave it on while you operate other functions on the locomotive.

- Turn the Bell **on** with a **Quick** flip-and-back operation of the direction switch.
- Turn the Bell **off** with a second **Quick** flip-and-back operation of the direction switch.

The Bell will stay on until you do another **Quick** flip-and-back operation of the direction switch to turn it off or if you interrupt the track power. If you do a **Slow** flip-and-back operation, you will get a short Horn hoot instead of the Bell. If you try to do a very short Horn blast using a **Quick** operation, you will activate the Bell instead. If you have trouble doing the **Quick** flip-and-back operation, try holding the power pack in place with your other hand to keep the unit from slipping.

Note: When you toggle the Bell off, it will continue ringing briefly with less volume as the pneumatic clapper slows down, just like the prototype.

1 If your power pack has a reversing-throttle that changes from forward to off to reverse in a continuous manner, we recommend that you install a reversing slide-switch between power pack and track. Suitable double-pole double-throw reversing switches are available at most model railroad hobby shops or electronic supply stores.

2 See Locomotive *Inertia Effects* on page 3 for further description of this feature. Re-programming your locomotive to use Standard Throttle Control (STC) will disable inertial effects that occur with Regulated Throttle Control (RTC). See pages 8 to 9.

3 The hold time for strobing Ditch Lights after the horn button is released can be set using CV 55.110.5 (see DCC Programming on pages 15-17). The setting of this CV applies to both Analog and DCC operation.

4 If the prototype locomotive does not have a bell, your model will not have the Bell feature. However, all Quantum locomotives have a "Bell State" used for a number of Quantum operations. The Bell State is turned on and off with a Quick Flip and Back operation of the reverse switch as described. You will hear a single bell ding when you enter the Bell State and a double ding when you leave the Bell State.

Advanced Analog Features

Starting the Locomotive

Most HO DC power packs with a standard reversing switch⁵ are suitable for Analog operation. Generally, modern electronic type power packs will provide better performance.

When operated with a standard DC power pack, your Quantum equipped Diesel locomotive behaves quite differently from other locomotives you may have operated. Unlike standard HO locomotives that start at very low track voltages, Quantum equipped locomotives require a minimum amount of voltage to operate the electronics. Also, the response to the throttle is realistically much slower, just like a prototype locomotive.

- Turn the throttle up slowly until you hear the Quantum System™ come on with a Long Air Let-off sound. The Number Board Lights and Marker Lights will turn on and Cab Lights⁶ will turn on after 10 seconds. If the locomotive has operating Ditch Lights, the front Headlight will be dim, and the Ditch Lights will be off. If your diesel locomotive has a Mars Light, it will be dim and the front Headlight will be off. See a table summary of Directional Lighting Operation in the DCC section of this manual. You will hear the motor in the diesel locomotive start up followed by the Air Pumps. If the diesel has two motors, you will hear both motors start one after the other.
- Continue⁷ to turn up the throttle voltage until the locomotive starts to move in Forward (this voltage is called V-Start⁸). The Diesel Motor(s) sounds will rev up with labored sounds proportional to the locomotives acceleration and Load setting (see QSI Sound of Power™ on page 5) and the locomotive will slowly start to move. The Headlight will switch on bright and the optional Ditch Lights will turn on or the optional Mars Light will begin to pulse. After 10 seconds in Forward, the Cab Lights (if so equipped) will automatically shut off.

Locomotive Inertia Effects

Your new locomotive is pre-programmed at the factory to use Regulated Throttle Control (RTC) in Analog (DC powered) operation. RTC makes your locomotive operate as though it has the mass and inertia of a prototype locomotive. As a result, your locomotive will resist starting up too quickly if at rest and will resist changes in speed once moving (see *Standard Throttle Control™ (STC™)* and *Regulated Throttle Control™ (RTC™)* on page 4). It takes a little practice to learn to move the throttle slowly and wait until the locomotive responds. If you prefer that your locomotive respond almost immediately to throttle movements on your DC power pack, it may be reprogrammed to use Standard Throttle Control (STC). Under STC there is no Inertial Control. Example 1 at the bottom of page 8 in the Owners Manual explains how to program your locomotive to use STC.

- As you slow the locomotive down by gradually reducing the throttle to a little below V-start, the Diesel Motor(s) rev and labored sounds volume decreases, while Squealing Brake sounds occur as the diesel locomotive comes to a slow stop⁹.

Note: If you need to turn your throttle up quite high to start your diesel locomotive, V-Start can be adjusted for operation with your particular DC power pack (see Analog Programming on pages 7-9). For recommended power packs, consult the *Quantum Analog Reference Manual* (Version 3) available at <http://www.qsindustires.com/>

Doppler Effect

This sound effect changes the pitch and volume of the Horn, Bell and other diesel sounds as the locomotive passes by.

- While the locomotive is moving toward the observer, flip the direction switch to turn on the Horn.
- Wait at least one second while the Horn is blowing.
- Just before the locomotive passes in front of the observer, flip the direction switch back and forth quickly so the Horn does not shut off. You will hear the Doppler Effect as the locomotive passes by.
- Either flip the direction switch back to shut off the Horn, or continue with long or short Horn operations. When you are finished blowing the Horn, the locomotive sounds will automatically return to normal after a few seconds. If the Bell was on, it will shut off just before the sounds return to normal.

5 Some electronic power packs do not have a reverse switch. Instead they have a reverse button, which does not cause a rapid change in track polarity to the track and is not suitable for Quantum operation. See the list of suitable power packs in the *Quantum Analog Reference Manual* (Version 3) at <http://www.qsindustires.com/>

6 Your diesel locomotive may not have all lights described here, depending on the model.

7 It is not necessary to wait for the locomotive Start Up to finish before entering Forward. If you turn up the throttle, the Start Up sounds terminate and the diesel locomotive will immediately go into normal Forward operation.

8 V-Start is set by default at 8.5 volts. It is important to note where V-Start is located on your conventional DC throttle control knob to know where you will enter and leave Neutral (see *Neutral* on Page 4).

9 Squealing Brakes occur if the locomotive exceeds 40 scale-miles per hour (64.4 scale kilometers/hour) and then slows down to below 20 smph (32 skph).

Note: The faster the locomotive is moving, the greater the Doppler shift. Below 15 smph, there is no Doppler shift.

Special Horn Ending Sound

Prototype engineers would often “play” their horns by controlling the flow of compressed air. In particular, engineers often had a signature sound associated with how they ended their horn sequences. Some Quantum System sound sets have special Horn Endings that can be activated using the direction switch to produce a unique sound effect similar to that of a prototype engineer’s “playing” the Horn.

- Flip the direction switch to blow the Horn for at least one second.
- The normal way to end the Horn is to flip the direction switch back. To do the special Horn Ending, add an immediate **Quick** flip-and-back operation.

Note: If you wait too long to do the **Quick** Flip-and-Back operation, the Bell might turn on instead.

Note: Your Quantum equipped locomotive may not have Special Horn Ending Sounds included.

Neutral

In Neutral, the locomotive will continue to make prototypical sounds appropriate to its resting state.

- Enter Neutral by **turning the throttle down below V-Start but not off and wait for the locomotive to stop**¹⁰. The Headlight or (if so equipped) the Mars Light switches to a steady dim or (if so equipped) the Ditch Lights will turn off and Reverse Light will turn off if entering Neutral From Reverse (NFR).
- You will hear a Short Air Let-off when the locomotive stops moving and enters Neutral, and a Long Air Let-off about three seconds later followed by Air Pumps and other background sounds. In addition to the pumps, diesel motor Cooling Fans and Vents will come on at random time intervals in Neutral. After ten seconds the diesel motor Cooling Fans shut off if they were on when you entered Neutral. Cab Lights (if so equipped) come on 10 seconds after entering Neutral.
- If the diesel locomotive is left in Neutral From Reverse, a special Low Idle state marked by subdued throbbing motor sounds will automatically come on after 30 seconds (see description of Low Idle in the section on Quantum System Sounds on page 18). The diesel locomotive will return to normal Diesel Motor sounds when the throttle is turned up.
- After the Air Pumps start, you can also use the direction switch to blow the Horn or turn on or off the Bell (if so equipped)¹¹.

If you cannot enter Neutral, or have difficulties with any of the operations, you may need to program your locomotive for optimal use with your particular DC power pack (see Analog Programming in next section).

Changing the Locomotive’s Direction without Turning off the Sound

You can use the power pack’s direction switch while the locomotive is in Neutral to change the locomotive’s direction.

- Put the locomotive in Neutral by bringing the throttle down below V-start and wait for the locomotive to stop¹².
- Flip the direction switch after you hear the Short Air Let-off but before you hear the Long Air Let-off and the Air Pump sounds turn on. During this short time (3 seconds) the Horn will not blow when you flip the direction switch.
- Turn up the throttle anytime thereafter to operate the locomotive in the opposite direction.

If you have waited until the Air Pumps start in Neutral and now wish to change direction, you can either:

1. Turn the power all the way off, change the direction switch and turn the power back on, or,
2. Flip the direction switch (the Horn will come on) and then turn up the throttle. When the locomotive starts to move in the opposite direction, the Horn will stop automatically and then hoot one more time if the direction is Forward for a total of two hoots. Or if the direction is Reverse, the Horn will hoot two more times for a total of three hoots¹³.

Note: To prevent the first Horn hoot from being too long, do not delay in turning up the throttle after you have flipped the direction switch.

Standard Throttle Control™ (STC™) and Regulated Throttle Control™ (RTC™)

Quantum locomotives have two types of Analog throttle control available, Standard and Regulated. Both Standard Throttle Control (STC) and Regulated Throttle Control (RTC) will apply more power to the motor as a function of increasing track voltage beginning at the V-Start setting. RTC includes an Inertial Control feature that prevents the locomotive from reacting quickly to changes in voltage or minor

10 If Regulated Throttle Control is enabled (see below) it is important to wait until the locomotive stops on its own. The locomotive’s electronic Inertial Control will keep it moving even though you have reduced the throttle far enough below V-Start to stop the locomotive. In your attempt to stop the locomotive, do not try to reduce the throttle so far that all sounds turn off.

11 In Neutral, the mechanical Bell feature has a distinctive turn-on effect as the pneumatic clapper gains full motion to strike the bell. The Bell may also have a shut-down effect where each strike becomes less loud as the clapper slows its motion.

12 On some power packs that have high internal resistance, the track voltage may rise slightly as the locomotive slows down and requires less power to operate. With these power packs, as the locomotive slows, you may need to reduce the throttle a little more to remain below V-Start.

13 Standard US prototype railroad signaling is two hoots before starting in forward and three hoots before starting in reverse. Other countries have different signaling. Check your Diesel Model Specification sheet for horn sequences used on your model.

impediments to motion such as misaligned track joints, tight curves, rough turn-outs, etc. A locomotive under STC may come to an unrealistic halt from a raised track joint or a drop in voltage¹⁴ while the same locomotive under RTC, with its Inertial Control, will continue at the same speed. RTC operates your locomotive as though it has the mass and inertia of a prototype locomotive; your locomotive will resist changes in speed once it is moving and will resist starting up quickly if at rest. You will be able to operate your locomotive at very slow prototypical speeds without having to adjust your throttle voltage continually to maintain speed.

While small obstacles will not affect the locomotives speed under RTC, a continual force will slow your train down, just like the prototype. For instance, if your diesel locomotive encounters an upward grade under RTC, it will eventually slow down. Providing more throttle will slowly accelerate it back to speed. The same locomotive under STC would quickly slow down or stop if it encountered an upward grade.

The type of throttle control also affects how your locomotive decelerates. Under STC, your locomotive will respond quickly to a reduction in track voltage. Under RTC, your locomotive will decelerate slowly as you bring the throttle down. If you bring the throttle down below V-Start, the locomotive will slowly come to a stop. You can, however, force a locomotive to slow down rapidly under RTC by bringing the throttle down quickly; this action reduces the power available to the motor inertial control circuit and forces the speed to decrease faster than RTC would normally allow. Once the locomotive slows down and regains normal RTC operation, it will continue to decelerate slowly according to its built-in inertia and Load setting. For instance, if your locomotive was running at top speed and you quickly reduced the track voltage to just below V-Start (where the locomotive would normally be stopped) the locomotive would at first slow down rapidly as you reduced the available power to the motor. After this initial rapid slow down, the locomotive would decelerate at a rate determined by RTC Inertial Control and Load setting and finally coast to a stop.

STC and RTC are selected under Analog Programming (see next section). The default is RTC.

Train Load

You can set your diesel locomotive to have any of 16 different Load levels, which represent added inertia from rolling stock (see Analog Programming, Option 2, in next section). The higher the Load setting, the greater the inertia effect during acceleration and deceleration. As you increase track voltage, the motor is provided an increasing portion of that voltage which, depending on the Load setting, will gradually accelerate the locomotive realistically until it reaches full speed. Level 0 is the default, which is no Load.

Under STC, the level 0 Load setting will allow your locomotive to accelerate or stop as quickly as the internal flywheels will allow. Under RTC, level 0 will add no additional Load to the Intrinsic Inertia already provided by RTC. For any Load setting from 1-15, your diesel locomotive will take longer to change speed under either STC or RTC. At level 1, it will take approximately 15 seconds more to achieve full speed at max throttle¹⁵; at level 15, it will take over 3 ½ minutes to achieve full speed. In addition, at higher Load settings, your locomotive will decelerate more slowly as you decrease your throttle.

Sound of Power™

Your diesel locomotive will produce Sound-of-Power labored Diesel Motor sound effects under RTC or under STC as long as you have selected any of the Load settings from level 1 to 15. Under acceleration, the Diesel Motor sounds will be more labored until the locomotive has achieved its final speed where it will then produce standard sounds appropriate to its throttle setting. Under deceleration, the Diesel Motor sounds are less labored until it achieves its final speed where it will again produce standard Diesel Motor sounds appropriate to its throttle setting.

Helpers

Prototype Helpers are locomotives that are used to provide extra power and/or braking for a heavily loaded train. These Helper locomotives can be part of the head-end consist or as mid-train helpers or as pushers at the end of the train. Helper locomotives behave differently than the train's lead locomotive. Their horns and bells are usually not operated, and their lighting options are different or not used at all.

When you make up your train using more than one locomotive, the Quantum System allows you to easily program how each locomotive will behave by selecting between a Lead locomotive, Mid Helper, End Helper, or Pusher. Each type of Helper locomotive has different lighting and sound characteristics, as described in the table in the next section on Analog Programming, Option 3, page 7.

Normal and Reversed Direction

Quantum also allows you to reverse the directional sense of your locomotive. This capacity is normally not an issue with DC two-rail trains since all locomotives will go in the same direction whether they are facing forwards or backwards. However, certain features like Directional Lighting or diesel Low Idle do depend on the directional sense. For instance, if you program your locomotive to be an End-Helper for your consist, its Reverse Light (rear Headlight) operates only when the locomotive is moving in Reverse and the front Headlight is disabled. This arrangement is ideal for providing a Reverse Light for the consist. However, if this diesel locomotive is facing backwards at the end of a

¹⁴ For instance, blowing the Horn takes power and can reduce track voltage substantially and quickly. Under STC at low speeds, blowing the Horn can stop your locomotive. Under RTC blowing the Horn will not cause your locomotive to stop or slow abruptly

¹⁵ Some unloaded power packs produce excessive voltage at max throttle and will activate the Quantum high-voltage circuit breaker. When this happens, your locomotive will stop and emit a series of hoots until the power is reduced to a lower voltage (see Troubleshooting, page 20).

consist, the Reverse Light (rear Headlight) faces forward and will be lit when the consist is moving Forward; there will be no Reverse Light for the consist. The "Direction" program feature will ensure that this End Helper's backward-facing front Headlight will come on only when the consist is backing up and the forward facing rear Headlight will not light at all. When making up a train with different Helper types, it is recommended that you also change the directional sense of any Helper that is intended to be operated backwards within the consist. See "Option 4 Direction", Analog Programming, next section.

Additional Analog Operation Features Available with the Quantum Engineer™ Controller

Your Quantum diesel locomotive is equipped with QSI's QARC™ (Quantum Analog Remote Control) Technology. QARC Technology uses special remote control signals to operate various Quantum System features without the need for complicated and expensive digital systems. With QARC technology, you can operate features that are otherwise available only in Digital Command Control (DCC) plus some new features that are not yet available in DCC. QARC will allow you to: 1) turn on or off individual lights, 2) shut down and start up locomotives, 3) make up consists easily, 4) simplify Analog programming, 5) set System Volume or Mute while train is operating, 6) trigger Coupler Crash sounds, 7) operate prototype-like Air Brakes, 8) turn on Dynamic Brakes, 9) activate Status Report or Verbal Speedometer Readout, and operate many other features. The QARC System makes Analog operation more fun and more prototypical than DCC by eliminating the need to configure function keys. Every button on the QARC controller does exactly what it is labeled to do. The only major difference between QARC and DCC is that, with QARC, you are not able to independently operate multiple trains on the same powered track section at different speeds at the same time.

The QARC controller, called Quantum Engineer, can be added to your existing Analog DC power pack in less than five minutes. Wiring is simple: two wires go the variable DC output from the power pack and two wires go to the track. All features on the power pack remain the same including throttle and reverse switch control. See our web site at <http://www.qsindustires.com/> for further information.



Analog Programming

The Diesel Locomotive can be Programmed Using a Standard Power Pack.

All advanced operations are easily programmed using your standard HO power pack. After entering programming (described below), the various features are selected and operated by using the direction switch¹⁶.

Program Option #'s (POP's ¹⁷)	Option Name (Default Value)	Message ¹⁸ when Entering Option	Option Description
1	System Volume ¹⁹ (16, Max)	"Volume equals X"	Sets System volume (17 levels) where level 16 is maximum volume and level 0 is off.
2	Load (0, No Load)	"Load equals X"	Selects the starting and stopping inertia for both Regulated Throttle Control (RTC) and Standard Throttle Control (STC). Level 0 (no load), Level 1-15, increasing Load with acceleration to full speed from 15 seconds to 210 seconds in RTC and from 3 seconds to 45 seconds in STC.
3	Helper (Normal)	"Helper equals" "Normal", "Lead", "Mid" "End" "Pusher"	Selects Normal, Lead, Mid, End, or Pusher Helper in consists. Normal Locomotive has all sounds and lights enabled. Lead locomotive has all sounds enabled and Reverse Light disabled. Mid Helper has Horn, Bell and all lights disabled ²⁰ . End Helper has Horn, Bell and all lights disabled except Reverse Light. Pusher has Reverse Light on all the time as train warning light. Horn, Bell and all other lights are disabled.
4	"Direction" (Normal)	"Direction equals X"	Selects if the features associated with the locomotive's direction are "Normal" or "Reverse".
5-7	Reserved	"Reserved"	
8	V-Start (8.5v)	"V-Start equals X"	Sets track voltage where locomotive will leave Neutral. (See Example below)
9	V-Max (12v)	"V-Max equals X"	Sets track voltage where full power is applied to motor.
10	Throttle Mode (RTC)	"Throttle Mode equals X"	Selects between Regulated Throttle Control (RTC) and Standard Throttle Control (STC).
11	Programming Reset	"Warning - about to reset"	After next Quick or Slow Operation, Bell rings ²¹ followed by a hoot to indicate the locomotive is returned to factory default condition.
12	About	Model number	Each Quick or Slow Operation provides progressive information about Quantum Model Number, Software Version, and Software Release Date.
13	Horn Volume	"Volume equals X"	Customizes Horn Volume (16 levels). Max is 15.
14	Bell Volume	"Volume equals X"	Customizes Bell Volume (16 levels). Max is 15.
15	Motor Volume	"Volume equals X"	Customizes Diesel Motor Volume. (16 levels). Max is 15.
16	Vents and Cooling Fan Volume	"Volume equals X"	Customizes Vents and Cooling Fans Volume (16 levels). Max is 15.
17	Turbo Volume	"Volume equals X"	Customizes Turbo Volume (16 levels). Max is 15.
18-19	Reserved	"Reserved"	
20	Air Brakes Volume	"Volume equals X"	Customizes Air Brake Air Release Volume (16 levels). Max is 15.
21-25	Reserved	"Reserved"	
26	Pump Volume	"Volume equals X"	Customizes Air Pump Volume (16 levels). Max is 15.
27	Air Let-off Volume	"Volume equals X"	Customizes Long Air Let-off Volume (16 levels). Max is 15.
28	Short Air Let-off Volume	"Volume equals X"	Customizes Short Air Let-off Volume (16 levels). Max is 15.
29	Reserved	"Reserved"	
30	Squealing Brake/Flange Volume	"Volume equals X"	Customizes Squealing Brake/Flange Volume (16 levels). Max is 15.
31	Dynamic Brakes Volume	"Volume equals X"	Customizes Dynamic Brake Cooling Fan Volume (16 levels). Max is 15.
32	Coupler Volume	"Volume equals X"	Customizes All Coupler Sound Volumes (16 levels). Max is 15.
33	Reserved	"Reserved"	

¹⁶ Programming is even simpler using a Quantum Engineer Controller (see previous section on page 6).

¹⁷ POP is short for "Program Option".

¹⁸ The verbal programming responses (such as "Enter Programming" etc.) have a minimum volume setting to provide programming information even when the system volume is turned all the way off.

¹⁹ You can set volume with the Manual Volume Control or with Programming or both. The Manual Volume Control will determine the range of volume control under Programming; that is, if you turn the Manual Volume Control down to say, 50%, you will not be able to increase the volume above the 50% value using Programming.

²⁰ Some lights that are not controlled by the Quantum System may remain on.

²¹ Bell will not be heard on models without bell feature.

Where "X" is the current value of the Program Option. Defaults are shown in parenthesis along with the option name; defaults for volume levels are listed on the Diesel Model Specification sheet included with your locomotive. .

Entering Programming

Use this simple sequence to enter Programming using the direction switch.

1. Apply power and turn up the throttle to hear the sound system come on.
2. Within five seconds of powering up, turn on the Bell²² with a **Quick** flip-and-back operation.
3. Within three seconds of the Bell turning on, turn off the bell²³ with a second **Quick** flip-and back operation.
4. Within three seconds, turn the Bell back on again with a third **Quick** flip-and-back operation.

If you delay too long after power has been first applied, the opportunity to enter Programming will time out and you will need to start again by shutting off and reapplying track power.

Once you perform the three bell operations after applying power, the Bell will shut off automatically and you will hear "Enter Programming" and the Headlight and Reverse Light will flash alternately off and on.

Scrolling through the Program Options

- After entering Programming, you will hear an announcement of the first Program Option, "Option 1 - System Volume".
- To access other Program Options, simply flip the direction switch to the opposite position and leave it there. Listen as each option number is announced in order.
- When you hear the Option Number you want, flip the direction switch back and leave it there. After you stop at an option you will hear the option number and name announced. When you are scrolling through and stopping at Program Options, **you are not making any changes**. To make changes you must actually **enter** the Program Option.

Note: If you accidentally go to a higher option number other than the one you wanted, simply turn the power off, re-enter Programming and start again²⁴. Once you reach the last Program Option, it will continue to announce the last option number.

Entering a Program Option and Making Changes

After the verbal announcement of a Program Option, you can enter that option by performing a **Slow** or **Quick** flip-and-back operation of the direction switch²⁵. Upon entering a Program Option, you will hear the current setting for that option. For unused Program Options, you will hear "Reserved". For any volume option, you will hear "Volume equals X" (where "X" is its current volume level setting). After a moment, you will hear the sound playing at its current volume²⁶.

Note: It is easy to distinguish between doing a **Quick** and **Slow** operation. When you flip the direction switch to do a **Slow** operation, wait until you hear a low level "hiss" sound from the locomotive and then immediately flip the direction switch back. To do a **Quick** operation, make sure you flip the direction switch back **before** you hear the "hiss" sound.

Note: Entering a Program Option does not change the settings for that option; it only provides information about its current value. After entering the Program Option, additional **Slow** or **Quick** flip-and-back operations will program new settings as described in the above table. For all level adjustments, a **Quick** operation will decrease one level, while a **Slow** operation will increase one level.

Note: Since "System Volume" is the first Program Option, you can use **Quick** or **Slow** operations immediately after entering Programming to change the System Volume.

Moving on to Other Program Options or Leaving Programming

- Flip the direction switch at anytime to the opposite position, and leave it there. The Quantum will first return to and announce the current Program Option and then automatically advance to on to higher options.
- Exit Programming anytime you want by turning the power off and then back on again.

Example 1: Setting Throttle Mode (Program Option # 10)

This will determine whether your locomotive uses Regulated Throttle Control (RTC) or Standard Throttle Control (STC).

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on as described above.
- After the "Enter Programming" followed by "Option One - System Volume" announcement of the first Program Option, flip the direction switch and leave it there. You will hear the announcement "Option 1, 2, 3 ... etc." Stop when you hear "one-zero" by moving the direction switch back. You will hear "Throttle Mode".

22 If your locomotive does not have the Bell features, you will only hear a single bell ding to indicate you have entered the Bell State.

23 If your locomotive does not have the Bell feature, you will hear a double ding to indicate you have left the Bell State.

24 If you have a Quantum Engineer, you can move both back and forth through Program Options.

25 If you have a Quantum Engineer, Quick and Slow operations are done with specific program buttons.

26 Setting any volume in Analog will also apply to DCC and vice-versa.

- Use a **Slow** or **Quick** operation of the direction switch to enter this option. If the throttle mode is at its default value (RTC), you will hear “Mode equals Regulated;” otherwise, you will hear “Mode equals Standard.”
- Use a **Slow** or **Quick** operation of the direction switch to change the Throttle Mode. Repeated **Slow** or **Quick** operations will cause the throttle mode to alternate between its two possible values “Regulated” or “Standard”.
- Once you have selected the Throttle Mode you wish to use, turn the throttle off. When you power up again, your locomotive will be using the Throttle Mode that you have just selected.

Example 2: Setting V-Start (Program Option # 8)

This option will determine the voltage (and throttle position) at which the locomotive will leave Neutral and start moving.

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on - as described above.
- After the “Enter Programming” announcement followed by “Option One - System Volume” announcement for the first Program Option, flip the direction switch and leave it there. You will hear the announcement “Option 1, 2, 3 ... etc.”. Stop when you hear the number “8” by moving the direction switch back. You will hear “V-Start”.
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear “V-Start equals X” where “X” is the track voltage value currently set for leaving Neutral.
- Use a **Slow** or **Quick** operation of the direction switch to activate this option. Hear the message “Set throttle to V-Start.” After three seconds, the voltage will be announced²⁷. If you move the throttle, the new track voltage value is announced a few seconds later.
- Once throttle is set, use a **Slow** or **Quick** operation of the direction switch to start the V-Start voltage setting procedure. The locomotive will move²⁸ at a slow speed and the Bell will ring continually for about 25 seconds²⁹, indicating the correct value is being calculated. If you chose a very low voltage setting, be patient. If the locomotive does not move during this procedure, return to the beginning of this option or start over³⁰ and then chose a slightly higher throttle setting.
- At the end of the process, the locomotive will stop moving and the Horn will hoot, signifying the end of the operation, and you will hear the message “V-Start = X” where “X” is the new setting.
- To leave Programming, turn the throttle off, and then power up for normal locomotive operation.
- Or continue to V-Max by moving the direction switch and waiting for the next Programming Option to be announced.

Note: The final value of V-Start may decrease from the original voltage reading because resistance in the power pack or pickups will drop the voltage slightly during the calibration procedure.

Example 3: Setting V-Max (Program Option # 9)

V-Max is set in the same manner as V-Start except after entering this Program Option, you will hear “Set throttle to V-Max” which is the throttle position where you want the full track voltage to be applied to the motor (usually about 80% of full throttle)³¹. Then do a **Quick** or **Slow** operation to start the V-Max setting procedure. Like V-Start, the bell will ring continually³² until the voltage is set followed by a Horn hoot to indicate the procedure is finished. Setting V-Max is much quicker than V-Start.

Note: During the V-Max setting, the locomotive will not move as it does under V-Start.

Note: When double heading your Quantum equipped locomotives³³, make sure that both locomotives have similar speed/throttle characteristics by adjusting V-Start and V-Max to prevent them from fighting each other.

For more information, download the *Quantum Analog Reference Manual (Version 3)* from <http://www.qsindustires.com/>

²⁷ Quantum systems have a built-in voltmeter that measures the track voltage and announces its value verbally. Depending on the power pack, this voltage may be slightly different than values measured by an external meter. However, since the Quantum voltmeter uses its own values for throttle levels, it is the correct value for the system.

²⁸ For earlier Quantum Locomotives, the locomotive will only move at the very end of the V-Start calculation.

²⁹ If the locomotive model does not have a bell feature, you will hear only a single ding indicator at the start of the process.

³⁰ See section above: *Moving on to Other Program Options or Leaving Programming*.

³¹ V-Max should not be set too low when using RTC. For most MRC™ power packs, the best choice for V-Max is about 1.5 volts below the highest throttle setting as determined by the Quantum built-in Voltmeter.

³² If the locomotive model does not have a bell feature, you will hear only a single ding indicator at the start of the process.

³³ Do not double-head Quantum equipped locomotives with standard locomotives and then operate the Horn or Bell while locomotives are moving. The standard locomotive will reverse direction and fight with the Quantum equipped locomotive.

DCC Operation

These steps will allow you to start operating your Quantum equipped diesel locomotive immediately using any DCC system that is compatible with the applicable NMRA DCC specifications.

1. Select locomotive number 3.
2. Set your DCC controller to 128 (preferable) or 28 (acceptable) speed step range.
3. Start your locomotive immediately by pressing the F6 DCC function key³⁴ to hear the locomotive Start Up sounds. The Directional Lighting System (Front Headlight, Reverse Light (Rear Headlight), and Mars Light³⁵) will be off. Use the FL or FO key to turn on the Directional Lighting. The Cab Lights (if so equipped) and Number Board Lights will be on. The Cab Lights will shut off automatically after ten seconds.

When you reduce the throttle to zero, the locomotive will automatically enter Neutral when the locomotive stops. You will hear a Short Air Let-off when the locomotive stops moving and a Long Air Let-off about one second later - followed by Air Pumps and other background sounds³⁶. The Directional Front Headlight will go dim. If the locomotive is equipped with Quantum Ditch Lights, they will turn off in Neutral. Similarly, if your model diesel locomotive has a Quantum Mars Light, it will stop pulsing and go dim and the Front Headlight will turn off in Neutral. If your locomotive has QSI multicolored Marker Lights, they will go to red.

The direction of your locomotive will change when you press the direction key on your DCC throttle.

Function Keys

The following table lists features that have been pre-assigned to your DCC function keys. Operation of these keys can be different in the Neutral state (locomotive stopped) and the Motive states (locomotive moving in Forward or Reverse). After you have selected your locomotive, simply press any of the function keys listed below to produce the described effects.

Function Key*	Forward and Reverse	Neutral
F0 or FL or Headlight	Directional Lighting on or off	Directional Lighting on or off
F1	Bell on or off	Bell on or off
F2	Horn or hom with Doppler Effect (see below)	Horn
F3	Coupler Crash/Coupler Fire	Coupler Arm or Coupler Fire
F4	Cooling Fans on or off	Cooling Fans on or off
F5	Dynamic Brake function on or off	Dynamic Brake function on or off ("Disconnect" only)
F6	Initiate Doppler Effect	Start Up
F7	Squealing Brake/Flanges and Air Brakes	Brake Set - Long Air Let-off
F8	Audio Mute on or off	Audio Mute on or off
F9	Short Air Let-off	Shut Down
F10	Locomotive's Verbal Speed Readout in SMPH.	Locomotive's Verbal Status Readout
F11	Number Board Lights on or off	Number Board Lights on or off
F12	Cab Lights on or off (if so equipped)	Cab Lights on or off (if so equipped)

* Quantum supports the new NMRA 0-12 function key standard; the old 0-8 standard is not supported.

If you have a DCC command station that supports only the older 0 to 8 function key standard, you will have no way to initiate Shut Down in Neutral with these pre-assigned feature to function key mappings. There is an interim solution to this problem; Swap the features assigned to the F7 and F9 outputs in Neutral by doing the following:

1. Set CV49 to 9, set CV50 to 1, and set CV53 to 145. Now F7 in Neutral controls Shut Down.
2. Set CV49 to 11, set CV50 to 1, and set CV53 to 9. Now F9 in Neutral controls Long Air Let-off.

Directional Lighting Operation (FO or FL or Headlight)

The FL (or FO, or Headlight) key toggles the Automatic Directional Headlight/Reverse Light/Ditch Lights/Mars Light System³⁷ on or off.

The defaults for Headlight/Reverse Light (Reverse Headlight) and optional Ditch Lights and Mars Directional Lights are off; default for Marker Lights is on. When toggled on, the Directional Lights³⁸ come on according to the table below.

³⁴ It does not need to be F6; any function or speed command for a locomotive that is not in Shut Down will activate the locomotive.

³⁵ Not all locomotive models have the Ditch Light or Mars Light feature.

³⁶ Neutral sounds also include Cooling Fans with Vents opening and closing that turn on and off randomly.

³⁷ Explicit lighting control features for Headlight, Reverse Light and optional Ditch Lights, Mars Light or Marker Lights can be assigned to DCC function outputs. (See QSI DCC Reference Manual, version 3)

Directional Lighting Operation in DCC and Analog including Optional Ditch Lights, Mars Light and Marker Lights.

	Forward	Neutral from Forward	Reverse	Neutral from Reverse
Headlight	On	Off	Off	Off
Reverse Light	Off	Off	On	Off
Mars Light	Strobing	Dim	Dim	Dim
Ditch Lights	On or Strobing	Off	Off	Off
Front Marker Lights	White	White	White	White
Rear Marker Lights	White	White	White	White

Note: If your locomotive does not have Mars Light, the Headlight will be dim (instead of "Off") in all states except Forward where it will be bright.

Coupler and Coupler Crash Sounds (F3)

There are two ways to use the F3 key.

- As your locomotive is about to couple up to a string of cars, press the F3 key to trigger the crashing sound of locomotive coupling. Use the F3 key again as the locomotive moves out to trigger the same sound as the slack is taken up in the cars.
- Use the F3 key in Neutral to produce uncoupling sounds as you disconnect cars over uncoupler magnets. Press the F3 key once to produce the sound of the lift bar and coupling pin being raised. This first press also arms the uncoupling sound effect. Press the F3 key again while moving or in Neutral to trigger the sound of the coupler knuckle opening and air-lines parting.

Sound-of-Power™

Your diesel locomotive will produce labored Diesel Motor sounds under acceleration and lighter Diesel Motor sounds under deceleration, but only if CV 3, or CV 23 and CV 4, or CV 24 have been set to non-zero positive values. The level of labored sounds is proportional to the values for these four CV's, and how much the throttle is increased or decreased.

Diesel Motor RPM: Quantum has all eight diesel-motor throttle "notches" found on prototype locomotives. As you increase the throttle, you will hear the RPM's increase for every increase in ten speed steps (at 128 speed step setting). Idle is considered Notch 1 and occurs for speed step 0. Notch 2 ranges from 1 to 10, Notch 3 from 11 to 20, Notch 4 from 21 to 30, etc. If your controller has an option to increment or decrement your throttle set setting by ten speed steps, it is very easy and predicable to set your notch value.

Horn and Bell Buttons (F2, F1)

Some DCC controllers have separate horn and bell buttons along with function keys assigned to horn and bell operation. The bell is usually assigned to F1 and the horn is usually assigned to F2. The F2 key behaves differently than using the horn button.

- Pressing the F2 key and releasing it will cause the horn command to come on and stay on, until you press F2 again³⁹.
- Pressing the horn button will send the horn command only as long as you are holding the button down.

Pressing the F1 key and releasing it will cause the Bell to come on and stay on, until you press F1 again⁴⁰. There is no difference in operation between the bell button and its corresponding function key.

Note: If your locomotive is equipped with Ditch Lights, they will automatically strobe from one light to the other when the Horn is being blown and will continue for five seconds after the horn signal has stopped⁴¹.

Doppler Operation (F6)

With DCC, you can trigger the Doppler Effect by quickly interrupting the horn signal in the same way as described under Analog Operation. Or, you can use the function key (F6) assigned to the Doppler Effect.

- Start the Horn and/or Bell by pressing and releasing their function keys⁴².
- Press F6 to hear the Doppler shift. A few seconds after the horn button is turned off with the F2 key the diesel locomotive sounds return to normal⁴³.

³⁸ The Quantum System uses constant voltage lighting that is independent of track voltage.

³⁹ Since the prototype horn uses compressed air, you will hear the Air Pump sounds turn on after the Horn is operated.

⁴⁰ If the prototype locomotive does not have a bell, your model will not have the Bell feature. However, all Quantum locomotives have a "Bell State" used for a number of Quantum operations. The Bell State is turned on and off with the F1 key. You will hear a single bell ding when you enter the Bell State and a double ding when you leave the Bell State.

⁴¹ The hold time for strobing Ditch Lights after the horn button is released can be set in CV 55.110.5 (see DCC Programming on pages 15-16).

⁴² If you do not turn on either Horn or Bell, the Doppler shift will still occur but will be less dramatic.

⁴³ If the Bell was on, it will shut off prior to sounds returning to normal. If you do not have the Bell feature, but the Bell State is on, it will turn off prior to locomotive sounds returning to normal.

Squealing Brake and Flange Sounds (F7)

- Quantum provides automatic brake squeal as a locomotive slows to a stop. The operator can also control squealing sounds for continuous and variable brake sounds for protracted stops or to simulate the sounds of squealing wheel flanges on curved track.
- Squealing Brakes come on automatically when the speed is reduced from high-speed travel (over 40 smph) to less than 20 smph.
- Pressing the F7 key when the locomotive is moving at any speed will manually activate Squealing Brake sounds, and repeated pressings while the Squealing Brake sounds are occurring will continue the sounds uninterrupted.

Note: If you slow the locomotive too quickly, the brake sounds will terminate abruptly when the locomotive stops and enters Neutral.

Note: If you lower your throttle to speed step 0 on a moving locomotive, the F7 key will apply Air Brakes to slow the locomotive. See next section.

Air Brakes (F7)

If you have selected any non-zero deceleration inertia or momentum value in CV 4 and/or CV 24, the F7 key can be used to apply Air Brakes to stop the locomotive more quickly than it would normally stop from the inertia settings⁴⁴. To use Air Brakes:

- Turn the throttle down to speed step 0 on a moving locomotive; this enables the F7 key to act as a brake.
- Press the F7 key. Hear a brief brake squeal sound and air being released from the brake lines continually. The longer the air is released the greater the braking action.
- Press the F7 key again to stop the air release. The train will continue to slow at the last braking value.
- If you want to apply more braking, press the F7 key again to release more air. When you reach the desired amount of braking, press F7 again to stop the air release.

Note: If you continue to release air (for over 24 seconds total), all the pressure will be released and brakes will be on full; you will hear no further air release sounds.

- Turn up the throttle to any value above 0 to release the brakes; this action resets the locomotive's deceleration to a value determined by the sum of CV 4 and CV 24.
- If the locomotive is in Neutral when the F7 key is pressed, the Long Air Let-off sound simulates setting the brakes. However, no braking effect is activated⁴⁵.

Note: If the throttle is set to any speed step except 0, Air Brakes are not enabled; instead the F7 key will now manually activate Squealing Brake/Flange sounds but will not affect the locomotive's deceleration.

Automatic Features with "Take Control" Operation

The Quantum System allows the operator to take control of certain automatic features by using their associated function key or keys. Once you "Take Control", the features will no longer have automatic operation; you will control their operation and their state with function key commands. Automatic and Take Control operations are described in the table below.

Diesel Locomotive "Take Control" Operation

	Automatic Operation			Take Control	
	Forward	Reverse	Neutral	Function Key	Operation
Vents & Cooling Fans	Non-operating	Non-operating	On and off at random times	F4	Toggles Vents/Cooling Fans operation on or off.
Number Board Lights	On	On	On	F11	Toggles Number Board Lights on or off
Cab Lights	Off after 15 seconds	Off after 15 seconds	On after 10 seconds	F12	Toggles Cab Lights on or off.

Example: Take control of Automatic Cooling Fans

- Take Control of Automatic Cooling Fans with the F4 key to stop Automatic Control and select whether the Cooling Fans are on or off. Regardless of the state of the automatic Cooling Fans (on or off), if you press the F4 key, the Cooling Fans will be set to on if the F4 key is "1" and off if the F4 key is "0" and Automatic Control will be disabled. Thereafter, the fans will respond only to the state of the F4 function. Automatic Control will be restored if the power is shut down and reapplied or if the F6 Start Up key is double pressed in Neutral (see the description of Start Up on page 13-14).

Three Stages of Diesel Locomotive Shut Down: 1. Disconnect, 2. Standby, 3. Total Shut Down (F9)

Locomotive Shut Down has three distinct stages that you can control. Each stage is entered by double pressing the F9 key⁴⁶.

⁴⁴ CV4 and CV24 determine the deceleration rate. Applying the brakes increases the deceleration rate temporarily.

⁴⁵ If the brakes are set in Neutral, turning up the throttle automatically releases the brakes.

⁴⁶ Double pressing ensures that Shut Down stages are not entered or exited accidentally. Double pressing is defined as two F9 commands sent within two seconds. Note that the F9 key may have to be pressed three times, due to the DCC command station and locomotive having different initial states for F9.

Stage One: Disconnect

- Double press the F9 key in Neutral to enter Disconnect. You will hear a Long Air Let-off.
- To leave Disconnect, either double press the F6 Start Up key, as described in the Start Up section or double press the F9 key again to reach the next stage of Shut Down: Standby.

If you double press the F9 key in Neutral, the motor drive will be disconnected. Once you hear the Long Air Let-off, the DCC throttle can be moved up and down without the diesel locomotive moving. As the throttle is moved up or down, you will hear the Diesel Motor rev up and down in proportion to the throttle setting.

Note: You can also turn on the Dynamic Brakes (see description of Dynamic Brakes below) to create Sound-of-Power as the throttle is moved up and down. Engineers on prototype diesels use dynamic brakes to load the motor-generator to test its output efficiency while the locomotive remains stationary.

Stage Two: Standby

- Double press the F9 key while in Disconnect to enter Standby. You will hear a Long Air Let-off followed by a special “Low Idle” sound. The Directional Lighting and optional Ditch Lights or Mars Light will shut down. The motor will remain disconnected, while the Air Pumps, automatic Cooling Fan operation, Number Board Lights and Cab Lights will continue to operate. In Standby, the locomotive will not respond to throttle or function keys⁴⁷. The three exceptions are the F6 Start Up Key, the F8 Mute Key (described below) and the F10 Status Key (described below).
- To leave Standby, either double press the F6 Start Up Key, as described in the Start Up section, or double press the F9 key again to reach the final stage of Shut Down: Total Shut Down.

Note: Standby is ideal for leaving your locomotive running on a siding. Besides hearing the Low Idle diesel motor sounds, the locomotive will not respond to accidentally changing the throttle setting or pressing the function keys.

Stage Three: Total Shut Down

- Double press the F9 in Standby to enter Total Shut Down. You will hear a Long Air Let-off.
- To leave Total Shut Down, double press the F6 key.

The Air Pumps will turn off, followed by the Number Boards (if so equipped) and the sounds of the Cooling Fans shutting off, the louvers closing, the Diesel Motor shutting down and finally, the Cab Lights (if so equipped) turning off. A few seconds later you will hear the engineer’s door open and then shut. In Total Shut Down, the locomotive will not respond to throttle or function keys. The two exceptions are the F6 Start Up Key (described below) and the F10 Status Key (described below).

Note: Total Shut Down allows the operator to take the locomotive “off line” (turn off sounds, lights, ignore throttle settings and function commands) independent of the operating session; that is, the locomotive will still be “off line” when power is reapplied for the next operating session, irrespective of whether this next session is Analog (conventional DC) or DCC.

Note: If power is turned off at any stage of Shut Down (Disconnect, Standby or Total Shut Down) or during a Shut Down procedure, the locomotive will remember the last Shut Down stage it was at during power down, and the locomotive will power up in the same stage. If Start Up is initiated during any of the above Shut Down procedures, Shut Down is aborted, and locomotive will return to normal operation.

Dynamic Brakes (F5)

The prototype diesel locomotive usually has dynamic brakes that cause the train to slow down by using the traction motors in generator (rather than motor) mode. This method of braking dissipates the energy of a moving train by converting it to electrical power, which is then applied to a large air-cooled resistor load in the locomotive.

- Pressing the F5 key in Forward or Reverse will set the locomotive’s Diesel Motor sound to idle at the lowest Sound of Power setting and turn on the powerful Dynamic Brake Cooling Fans.
- Pressing the F5 key in Neutral will have no Dynamic Brake effect unless the locomotive is in Disconnect (see above).

Dynamic Brakes automatically turn off when entering or leaving Neutral, when locomotive speed drops below 7 smph⁴⁸, or when the throttle is turned up. Dynamic Brakes cannot be turned on in Forward or Reverse unless the locomotive speed is over 8 smph.

Note: In contrast to Air Brakes (F7), Dynamic Brakes do not increase the deceleration rate specified by CV 4 and CV 24.

Start Up (F6)

If your Quantum equipped diesel locomotive is in any stage of Shut Down, you can return it to normal operation by double pressing⁴⁹ the F6 key. Start Up will be different for each stage of Shut Down, but all will start up with a Long Air Let-off and will enter normal operation.

⁴⁷ Pressing a function key will only produce a Short Air Let-off.

⁴⁸ Dynamic Brakes on prototype locomotives are less effective and are seldom used at low speeds.

⁴⁹ Double pressing ensures that Start Up is not entered accidentally. Double pressing is defined as two F6 commands sent within two seconds. Note that the F6 key may have to be pressed three times, due to the DCC command station and locomotive having different initial states for F6.

Start Up from Disconnect: If you double press the F6 key in Disconnect, the diesel locomotive will produce a Long Air Let-off, Dynamic Brakes will shut off (if on) and the locomotive will enter normal operation.

Start Up from Standby: If you double press the F6 key in Standby, the diesel locomotive will produce a Long Air Let-off, Directional Lighting will turn on (if previously on), the Diesel Motor sound will change from the special Low Idle to regular Idle, and the locomotive will enter normal operation.

Start Up from Total Shut Down: If you double press the F6 key in Total Shut Down, the diesel locomotive will produce a Long Air Let-off, you will hear the engineer's door opening and closing, and see Cab Lights come on (if so equipped), Number Boards come on (if so equipped), and Directional Lighting turn on (if previously on). These actions are followed by the sounds of vents opening, the Diesel Motor starting up, the Air Pumps starting up, and the locomotive entering normal operation.

Note: During the Start Up procedure, none of the DCC function keys are active. If the throttle is turned up from zero during any of the above Start Up procedures, the Start Up procedure will abort and the locomotive will enter normal operation.

Note: Whenever a Start Up command is sent, regardless of whether the locomotive is in Shut Down or operating normally (in Neutral), the Quantum System will automatically restore all Automatic Control.

Mute (F8)

The Quantum System allows you to reduce the System Volume to a lower level or increase it back to its original setting using the F8 function key. This capability is useful when you need to reduce the sound to engage in a conversation or to answer the phone. If you have many trains operating at once, you can reduce the volume on all those that are running in the background of the layout and increase the volume of the closest locomotive. The Mute feature changes the sound gradually over a second or two, which allows the sound to increase or decrease realistically as the locomotive approaches or recedes from the observer.

- Press the F8 key in Neutral or Forward/Reverse to gradually decrease or increase the locomotive's volume.

Note: Mute state is not maintained if power is turned off and then turned back on; the locomotive will return to full volume setting.

Note: Mute is shut off if the Status F10 key is pressed to allow clear audio reporting (see Status below).

Note: Mute Volume can be programmed in CV 51.1.

Status (F10)

The Quantum System provides verbal information about the locomotive's current operating state when the locomotive is in Neutral or the locomotive's current speed in scale miles per hour when the locomotive is moving.

- Press the F10 key in Neutral; the locomotive will verbally report its currently enabled long or short DCC address followed by its consist ID (if it has one), followed by its Shut Down state, if any (Disconnect, Standby or Shut Down).
- Press the F10 key in Forward or Reverse; the locomotive will verbally report the locomotive's speed in scale miles per hour.

Note: When Status Report (or Verbal Speedometer Readout) is activated, mute is shut off and the locomotive's sounds will reduce to one half their current volume settings during the verbal report. Locomotive sounds return to normal non-muted volume when the report has ended.

Note: In a consist, all locomotives will simultaneously report their status when the F10 key is pressed unless disabled in CV 22.

Function Key Operation in Neutral

Some function keys used in Forward and Reverse will have different effects when used in Neutral:

- The F7 key produces Squealing Brake Sounds or applies brakes for a moving locomotive but produces a Long Air Let-off in Neutral.
- Pressing F6 results in Doppler shift for a moving locomotive but activates Start Up in Neutral.
- Pressing F9 produces a Short Air Let-off in a moving locomotive but activates Shut Down in Neutral.

Note: The Horn, Bell, Doppler Shift, Squealing Brake and Neutral sounds are described in detail on page 18-19, in the *Quantum System Sounds* section of this manual.

DCC Programming

Most DCC command stations currently available will program Quantum equipped locomotives in Service Mode⁵⁰ on a programming track or Operations (Ops) Mode on the main track. In Service Mode, your locomotive (if queried) will report back CV values to your command station. In Ops Mode, reports are verbal using the locomotive sound system.

Changing the System Volume Electronically in CV 51.0

You can change the volume either manually (as described in the *Special Operation and Troubleshooting* section) or electronically using QSI CV 51.0 in DCC⁵¹. To change volume in Service or Ops Mode, do the following:

- Set CV 49 to 0.⁵²
- Enter the System Volume in CV 51. The System Volume can be set to any value between 0 (no sound) and 127 (100%). The default System Volume is 127.

Note: When you change the System Volume in Ops Mode, you will immediately notice the change in volume.

Changing the Mute Volume Electronically in CV 51.1

To change the Mute Volume in Service or Ops Mode, do the following:

- Set CV 49 to 1.
- Enter the Mute Volume in CV 51. The System Volume can be set to any value between 0 (no sound) and 63 (100%). The default Mute Volume is 0.

Note: When you change the Mute Volume in Ops Mode, and the locomotive is muted, you will immediately notice the change in Mute Volume.

Note: The Mute Volume level will be the smaller of the Mute Volume setting or one-half the current System Volume. In other words, the Mute Volume will never be more than one half of the System Volume.

Enable/Disable Horn Triggered Doppler Shift (CV 51.2)

- Set CV 49 to 2.
- Set CV 51 to 0 to disable Horn Triggered Doppler; set to 1 to enable Horn Triggered Doppler.

Changing Individual Sound Volumes (CV 52.X⁵³)

To change the volume of individual sounds listed in the table below do the following⁵⁴:

- Set CV 49 to the Primary Index for the individual sound from the table below.
- Enter Volume level in CV 52 as follows: “0” = No sound, “1 – 15” sets volume from the lowest level at “1” to the highest at “15”, with volume levels at 2db increments.

Primary Index entered into CV 49	Individual Sound
0	Horn
8	Bell
10	Diesel Motor
14	Turbo
16	Air Pump
19	Vents and Cooling Fans
21	Long Air Let-off
22	Short Air Let-off
24	Squealing Brakes/Flanges
28	Dynamic Brakes
34	Coupler Sounds
37	Air Brake Sounds

See your *Diesel Model Specifications* sheet for Individual Sound Volume default settings.

⁵⁰ If your DCC command station will not program in Service Mode, check with the command station manufacturer; some companies will give you a free upgrade. Also, see Special Operation and Troubleshooting on page 20.

⁵¹ System Volume changes in DCC also apply to Analog and vice-versa.

⁵² In Ops Mode, you will hear the value spoken out when changing the value of a CV.

⁵³ 'X' refers to the value in column 1 of the table, the Primary Index number that will be entered into CV 49.

⁵⁴ Setting any Individual Sound Volumes in DCC will also apply to Analog and vice-versa.

Setting the Ditch Light Strobe Hold Time (CV 55.110.5)

After the Horn stops blowing, Ditch Lights will continue to strobe for the hold time set in CV 55.110.5.

- Set CV 49 to 110.
- Set CV 50 to 5.
- Set CV 55 to the number of seconds you want the Ditch Light Strobe to continue after the horn command is stopped⁵⁵. Range is from 0 to 31 seconds. Default is 5 seconds.

Reset all ⁵⁶ CV's to Factory Default Values (CV 56.128.255)

Note: This does not affect Analog settings, except for volumes.

- Set CV 49 to 128.
- Set CV 50 to 255.
- Set CV 56 to 113 ⁵⁷. In Ops mode, you will hear 3 hoots when reset is completed.

Special Procedure for Short or Extended Address Programming (CV 56.129)

If you cannot program your Short or Extended ID number in Service Mode and your DCC command station prevents you from setting either of these addresses in Ops Mode (using CV 1, or CV 17 and CV 18) use the following alternative procedures to program your locomotive's ID's.

Alternate Procedure for Entering Short (Primary) Address in CV 56.129.1 in Ops Mode

- Set CV 49 to 129.
- Set CV 50 to 1.
- Set CV 56 to your Short Address (1 or 2 digits). Hear the address spoken back.
- If necessary, set CV 29, bit 5 to '0' (or set CV 29 to 6 which is factory default) to enable your new Primary Address.

Procedure for Entering Long (Extended) Address in CV 56.129.17 in Ops Mode.

- Determine the value of CV 17 and CV 18 for your Extended Address from the ID Table in your *Diesel Model Specification Sheet* or follow instructions in CV 17 and CV 18 in the *Quantum DCC Reference Manual (Version 3)* to calculate a different ID number.
- Set CV 49 to 129.
- Set CV 50 to 17.
- Set CV 56 to the value of CV 17 from the table. There will be no verbal response.
- Set CV 50 to 18.
- Set CV 56 to the value of CV 18 from the table. Hear the new full Extended Address spoken out.
- Set CV 29, bit 5 to '1' (or set CV 29 to 38 ⁵⁸) to allow operation with your new Extended Address.

Disable/Enable Verbal Announcements (CV 62)

In Ops Mode, the Quantum System will automatically speak out the value of the CV that you enter.

- To disable set CV 62 to 0⁵⁹; to enable set CV 62 to 1⁶⁰. Default is "Enabled".

CV Inquiry with Verbal Feedback in Ops Mode (CV 64)⁶¹

To inquire about the current value of any CV through Verbal Feedback in Ops Mode:

- Set CV 64 to the CV you wish to query. Hear the verbal message "CV 'X' equals 'Y'", where 'X' is the CV number and 'Y' is the value.

Note: If the CV has a Primary Index such as QSI CV nn.pp (where nn is the CV number and pp is the Primary Index), set CV 49 to pp before you set CV 64 to nn. For example, if you want to inquire about the Diesel Motor Volume, which is CV 52.10, set CV 49 to 10 and set CV 64 to 52. You will hear, "CV five two

⁵⁵ Setting the Ditch Strobe Hold time will apply to both DCC and Analog operation.

⁵⁶ Consult the Quantum DCC Reference Manual (Version 3) to learn how to reset different groups of CV's.

⁵⁷ "113" is QSI's Manufacturer's ID Number assigned by the NMRA.

⁵⁸ Entering "38" leaves the other configuration settings in CV 29 at factory default, but changes the ID to Extended Address type.

⁵⁹ You will not hear "CV 62 equals 0".

⁶⁰ You will hear "CV 62 equals 1".

⁶¹ This option is not affected by CV 62 (Disable/Enable Verbal Announcements).

point one zero equals 'Y' (where 'Y' is the current volume setting). If the CV has both a Primary and Secondary Index, such as CV nn.pp.ss where ss is the Secondary Index, set CV 50 to ss in addition to setting CV 49 to pp before you set CV 64 to nn. .

Note: If you enter either '17' or '18' in CV 64, you will hear the full one to four digit Extended Address ID number spoken out.

Common NMRA Configuration Values (CV 29)

Each bit in CV 29 controls some basic operational setting for DCC decoders, including Extended Addressing, Speed Table Enable, Power Source Conversion, Lighting Operation, Locomotive Direction, and others. Quantum default for CV 29 is 6.

The following table provides some of the more common values for CV 29 for the features indicated.

Extended Addressing	Speed Tables	Power Conversion	28/128 Speed Steps	Reversed Direction	Decimal Value	Binary Value	Hex Value
			X		2	00000010	2
		X	X		6	00000110	6
	X		X		18	00010010	12
	X	X	X		22	00010110	16
X			X		34	00100010	22
X		X	X		38	00100110	26
X	X		X		50	00110010	32
X	X	X	X		54	00110110	36
			X	X	3	00000011	3
		X	X	X	7	00000111	7
	X		X	X	19	00010011	13
	X	X	X	X	23	00010111	17
X			X	X	35	00100011	23
X		X	X	X	39	00100111	27
X	X		X	X	51	00110011	33
X	X	X	X	X	55	00110111	37

For more information, download the *Quantum DCC Reference Manual (Version 3)* from <http://www.qsindustires.com/>.

Quantum System Sounds⁶²

Diesel Motor Rev: The Quantum System allows Diesel Motors to be operated with all eight notches corresponding to the throttle notches used on the prototype. As the throttle is turned up, the Diesel Motor RPM will increase in fixed increments until the maximum RPM occurs at notch 8.

Diesel Turbo: Turbo appliances are used to improve the horsepower on modern diesel motors by forcing air into the intake manifold under pressure. The power to operate the turbo comes from the diesel motor's exhaust pressure, which causes the turbo's high-pitched whine to lag the revving of the motor. Quantum systems use a separate sound for the Turbo to allow it to lag behind revving the motor up and to "hang" for a few seconds when the motor is revved down.

Low Idle: Low Idle is used on prototype locomotives to maintain a warm and ready locomotive with a minimum of fuel consumption. The special Low Idle sound has a lower base throb and is less harsh than the normal idle.

Cooling Fans: The enormous diesel motors and generators enclosed in the diesel cab need ventilation to stay cool. All diesel locomotives have powerful cooling fans on the roof to draw outside air through louvers on the sides of the locomotive, which is then blown across large radiators. You will also hear the sounds of louvers opening before the fans start. When Cooling Fans shut down, you will hear the louvers close.

Air Pumps: When a locomotive is sitting still, the pumps come on in a steady beat to replace the air lost from the brake air release and from air-operated appliances. Once the pressure is up, the pumps only turn on occasionally to maintain the pressure. Diesel Air Pumps are operated directly from the motor and are quite noticeable when turned on in a non-moving locomotive. In Forward, you will hear the Air Pumps come on soon after the Horn is operated to maintain the air pressure.

Appliance Air Release: Compressed air is used on locomotives for operating various appliances. You will hear either a Short Air Let-off or Long Air Let-off at various times.

Air Brakes: When prototype train brakes are applied, air is released from the brake lines to reduce the pressure. The more the pressure is reduced, the greater the braking. You will hear a continual air release sound from the diesel locomotive model as braking is continually increased. The longer the air is released, the quicker the diesel locomotive model will slow down. Once all the pressure is released, the locomotive will continue at maximum braking, which can still require a long stopping distance depending on your Load settings. *DCC and QARC⁶³ Only.*

Brake Squeal: You can hear the brakes squeal on prototype locomotives when it is moving slowly. This sound can become quite loud when the wheels are just about to stop turning. Listen for automatic Squealing Brake sounds at slow speeds and the final distinctive squealing sounds as the Quantum equipped diesel locomotive slows to a stop.

Dynamic Brakes: Electric motors can act as motors or generators depending on whether they are using power or generating power. When used as generators, the traction motors are disconnected from taking power from the locomotive's prime mover, and instead are connected to large resistor grids in the roof. By increasing the resistive load on the traction motors, the traction motors become harder to turn and act as brakes for the locomotive. The electric power generated by turning the traction motors is dissipated as heat in the resistor grid. These resistor arrays get quite hot and require cooling. When Dynamic Brakes are turned on in a Quantum equipped diesel locomotive, the Diesel Motor sound drops to notch 1 and the Dynamic Brake Cooling Fan sounds come on. Since dynamic brakes are relatively ineffective at low speeds, the Dynamic Brake sounds on the model will shut off automatically below 8 smph. *DCC and QARC Only.*

Horn: The Quantum System uses authentic locomotive sounds, whenever possible. All Quantum Horns are engineered by QSI sound experts to give you the most authentic effects. If you blow the Horn briefly, you will produce a realistic short Horn sound or "hoot".

Bell: North American Diesels and Electric locomotives, as well as larger steam locomotives, usually have pneumatically operated mechanical bells. Small steam locomotives often have hand-pulled bells. During turn-on in Neutral, you will hear the pneumatic clapper gain greater throw with each stroke until it finally strikes the Bell. During shut down in Neutral, you will hear a Short Air Let-off followed by the Bell sound fade out.

Doppler Run-by: The locomotives sounds get louder as the train approaches, then immediately drop to a much lower pitch and lower volume as the train passes by. With a little practice, you can activate the Doppler Effect exactly when and where you want. Doppler pitch change is based on the speed of the locomotive, so the sounds change more dramatically when the locomotive is running faster. After the Doppler shift has occurred and the Horn is no longer being blown, the Bell shuts off automatically and locomotive sounds return to normal.

Coupler: To give you the most authentic coupler sounds, QSI has identified three distinct types of coupler activity. The first is when the coupler is Armed where you will hear the clanking sound of the coupler lift bar and coupler pin raising. The next is Firing the coupler, where

⁶² Not all features are included on every diesel. Consult your *Diesel Model Specifications* sheet for a list of features and sounds that apply to your particular locomotive model.

⁶³ QARC™ or Quantum Analog Remote Control™ uses special signals under Analog control to operate different Quantum features. With QARC, you can operate features that are currently available only in DCC in addition to features that are not yet available in DCC.

you hear the opening of the coupler with the hiss of the air-lines parting. The third sound occurs when the locomotive couples up to its load of cars, and you hear the Coupler Crash as all of the cars bunch together from the impact. ***DCC and QARC only.***

Flanges: When a train enters a curve, the flanges on the wheels ride up on the inside of the rail and usually squeal. Recreate this squealing effect by pressing and releasing the Squealing Brake/Flanges DCC function key or QARC Analog button quickly and repeatedly as necessary. ***DCC and QARC only.***

Special Operation and Troubleshooting

For a full description, see the Troubleshooting section in the Quantum DCC Reference Manual (Version 3) at <http://www.qsindustires.com/>.

With some DCC command stations, using the horn button to activate the Horn, and, while this button is held down, activating the F6 Doppler Key, will cause the Horn to shut off instead of causing a Doppler Effect.

We have experienced intermittent and independent horn signal interruption with some DCC command stations, causing unexpected Doppler shifts. If this happens frequently, you may want to disable the Horn Triggered Doppler (CV 51.2).

Reed Switch Operation with Magnetic Wand (Analog and DCC)

- Your Quantum equipped locomotive includes a special reed switch located directly under the plastic diesel roof; this switch can be activated by the Magnetic Wand (enclosed) without having to disassemble the locomotive. The reed switch can be used to change the volume of your sound system or to reset the Quantum System to factory defaults or to turn on or shut off your locomotive in Analog.

Manual Volume Adjustment (Analog and DCC)

- Locate the reed switch area on the locomotive's roof as shown in the *Diesel Model Specifications* sheet that is included with your model.
- Power up the locomotive and leave in Neutral. Make sure that the Bell is not on⁶⁴.
- Place the enclosed Magnetic Wand over the reed switch area on the roof of the locomotive⁶⁵ (perpendicular to the track) and wait as you hear the volume increase or decrease in incremental amounts as the Horn hoots about every second. Move the wand away and again place it over the reed area to change the direction (louder or softer) of the volume. Remove the wand when you reach the desired volume level.

Note: Volume can also be adjusted digitally using the programming methods described in the Analog and DCC programming sections of this manual.

Resetting your Locomotive to Factory Default Values with Magnetic Wand (Analog and DCC)

In case your locomotive's sound and control system is not operating correctly and if turning the power off for 15 seconds does not return it to normal operation, you should reset your locomotive to original factory values.

- Locate the reed switch area as shown in the *Diesel Model Specifications* sheet that came with the locomotive.
- Turn off the power.
- Place the Magnetic Wand over the reed switch area and apply power and leave the wand there until you hear the word "reset". Your locomotive is now reset to original factory defaults including all DCC and Analog values.

Turn Your Locomotive Off or On, using the Magnetic Wand (Analog Only)

Your locomotive can be selected (turned on) or deselected (turned off) using the Magnetic Wand. When the locomotive is deselected, it will remain unmoving and silent with lights off and it will not respond to changes in track voltage or Analog horn or bell signals or programming commands.

To turn off a locomotive:

- Enter Neutral and turn on the Bell⁶⁶.
- Place the Magnetic Wand over the reed switch area. After a Long Air Let-off, the Bell (if so equipped) will shut off followed by the Diesel Motor shutting down and all lights will turn off.

To turn on a locomotive:

- Make sure track power is applied. Place the Magnetic Wand over the reed switch area on the locomotive. The lights will briefly flash along with a Long Air Let-off. This is followed by the sounds of vents opening, the motor starting up, air pump sounds and lights turning on. The locomotive is now selected and will respond to track voltage and all bell and horn signals.

⁶⁴ If your locomotive does not have a bell feature, make sure the "Bell State" is off by using the bell button or Quick Flip-and-Back operation of the reverse switch. If you hear one ding the Bell State is on; if you hear two dings, the "Bell State" is off.

⁶⁵ The wand does not need to touch the body. It can be held a reasonable distance from the roof area to prevent possibly marring the painted surface.

⁶⁶ If your locomotive does not have a bell feature, make sure the "Bell State" is off by using the bell button or Quick Flip-and-Back operation of the reverse switch. If you hear one ding the Bell State is on; if you hear two dings, the "Bell State" is off.

Note: You can turn off a locomotive in a consist even though it has been programmed as a Helper type with disabled Bell and Horn sound. Simply send the bell signal command. Even though the Bell will not be heard, the Magnetic Wand will shut the locomotive down. You will still hear a Long Air Let-off indicating that the shut down command was received.

Using the Magnetic Wand makes it easy to turn locomotives off or on in Analog without the need for blocks. You can place locomotives on sidings and turn them off without having to switch power off in that track section. You can make up consists by bringing up each locomotive one at a time. After you couple each locomotive to the consist, turn it off with the Magnetic Wand. When all locomotives are in place, select each one in turn with the Magnetic Wand until all locomotives are running. You can now operate the consist as a single unit. When you break up the consist, first deselect all locomotives one at a time and then select each one in turn as you uncouple and pull away from the consist.

High Voltage Circuit Breaker (Analog and DCC)

Your Quantum equipped locomotive is designed to operate on normal HO track voltage supplied by most HO power packs. If track voltage exceeds 21.5 volts peak, the motor drive circuit will automatically shut down, and the locomotive will coast to a stop. The Quantum System will alert you to the problem through a continuous series of Horn hoots. This built in safety feature protects Quantum electronics and the electric motor from excessive voltage⁶⁷.

- To restart your locomotive, reduce the track voltage until the hooting stops and the motors re-engage.

Program Track Operation (DCC)

This locomotive conforms to NMRA standards for program track operation. However, the Quantum System requires more current to operate than standard DCC decoders and may not respond to the limited program track power from some DCC command stations. If you are unable to program in Service Mode on your program track, all CV's in your locomotive can be programmed in Ops Mode. You can also purchase from Tony's Train Exchange⁶⁸, a simple, inexpensive power booster (PowerPak™ by DCC Specialties) that will allow you to program on the program track with any DCC command station.

Reasons why Your Locomotive is Silent or will not Start (Analog and DCC)

In case your locomotive remains silent after power up and turning the power off for 15 seconds does not return it to normal operation, try the following suggestions to bring your locomotive back to normal sound operation.

- Make sure the locomotive has not been Muted with the F8 key.
- Check to see if your Manual Volume Control (using Magnetic Wand) or digital volume control has been turned all the way down.
- You may have shut your locomotive down in DCC using the F9 key, **which remains in effect in Analog** or you turned off your locomotive using the Magnetic Wand in Analog. Go back to DCC operation and start your locomotive with the F6 key⁶⁹. Once started, you can return to either DC or DCC operation. Or use the Magnetic Wand in Analog, which selects and starts the locomotive if it is shut down or deselected.
- **NOTE:** The Magnetic Wand will not start your locomotive in DCC. You must use the F6 key. It will take a couple of seconds after you double press the F6 key before you will hear the pump sounds start.
- If the above methods do not start your locomotive, use the Magnetic Wand to reset your locomotive to factory default values as described above.

⁶⁷ The high-voltage circuit breaker will sometimes activate if the Load (inertia or momentum) feature is used. Most power packs have substantial series resistance, which lowers the track voltage when the locomotive is drawing power. However, with a Load setting, the locomotive does not require much power when it first starts moving. If the throttle is turned up all the way before the locomotive gains speed, the track voltage will be unusually high and can trigger the high-voltage circuit breaker.

⁶⁸ Tony's Train Exchange; 1-800-978-3472; <http://www.tonystrains.com/>.

⁶⁹ It may take a couple of tries to get it started.

Sounds & Features Common to Analog & DCC	Analog Features*	DCC Features*
<p>Horn or hoot Bell with shut down and turn on Effects (if so equipped) Diesel Motor Diesel Turbo (if so equipped) Automatic Cooling Fans Doppler Shift Brake or Flange Squeal Neutral Sounds Long Air Release Short Air Release Air Pumps Sound of Power™ Neutral State (Idle) Directional Lighting Bright/Dim Headlight Reverse Light (optional) Ditch Lights (optional) Mars Light (optional) Number Board Lights (optional) Cab Lights (optional)</p> <p>Manual Volume Control with Magnetic Wand Reset to Factory Default with Magnetic Wand</p>	<p>System Volume Programming Individual Sound Volume Control Regulated Throttle Control and locomotive Load Inertia. Helper Type: (Normal) Normal loco, Lead Loco, Mid Helper, End Helper. Pusher. Direction: (Normal) Normal/Reversed DC Power Pack Programming V-Max (12v) V-Start (8.5v)</p> <p>Select or Deselect locomotive with Magnetic Wand</p> <p>QSI QARC™ Operation** (with QSI QARC Controllers™) Air Brakes Flanges Dynamic Brakes Locomotive ID's. Consist ID's. Coupler Sounds Diesel Extended Shut Down Extended Start Up Explicit Lighting Control Controllable Flange Squeal Load on/off toggle Fan on/off toggle Verbal Status Reports Grade Crossing Horn Signal Audio Mute System Volume Control and Additional Features</p>	<p>F0 or FL light control F1-F12 Function Keys 14/28/126 speed steps (28) Coupler Sounds Air Brakes Dynamic Brakes Programming Modes Supported: Address Mode, Register Mode, Service Mode, Direct Mode, Ops Mode Long Form & Ops Mode Short Form NMRA™ CV's supported: 1 Primary Address 2 V-Start 5 V-High 8 QSI MFG's ID Number (113) 3-4,7,17-25,29,33-46,66-95 QSI CV's supported: 49 Primary Index 50 Secondary Index 51 Sound Control 51.0 System Volume 51.1 Mute Volume 51.2 Doppler (Enabled) 52 Individual Sound Volume Control 53 Function Output Mapping 56 QSI Configuration 56.128.n Reset 56.253 Version Build Information 62 Auto CV Verbal Feedback (enabled) 64 CV Inquiry Verbal Readout</p>

*Settings in parentheses indicate factory default. For factory defaults not listed here, see the Diesel Model Specification Sheet included with your locomotive.

**QARC⁷⁰ Technology allows commands to be sent to locomotives under Analog control to operate different Quantum features. With QARC technology, you can operate features that are otherwise available only in DCC plus features that are not yet available in DCC. QARC controllers are inexpensive accessories that employ the QARC system. They can be added to your existing power pack to operate additional features on your Quantum⁷⁴ equipped locomotive.

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**QSI Industries, Inc.
Beaverton, OR**

70 Quantum Analog Remote Control (QARC) Technology
71 Not all Quantum equipped locomotives contain QARC Technology.