DC Analog Reference Manual
for
QSI Quantum® HO Equipped Locomotives

Version 3.1
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Introduction to Quantum Analog Operation

Quantum locomotives are equipped to operate under NMRA[1] Digital Command Control (DCC) or under Analog operation. Although DCC provides considerable operational possibilities, many model railroaders with home layouts prefer standard DC Analog operation to the complexities and cost of a digital system. We have designed the Quantum Sound System to be operated under Analog DC in a simple straightforward manner with most power packs with a reversing switch. DC operation includes many features that are available to DCC such as Horn, Bell, Doppler, Direction Changes, Neutral sound effects, etc. plus a simple method to program your locomotive's behavior such as System Volume control, Load or inertia effects, two types of Throttle Control, Helper types, individual feature sound volumes, etc. You can immediately operate the Quantum Analog features without having to buy additional equipment or spend considerable time learning a complex new operating system. The first time your locomotive moves out, switch the reverse switch to turn on the Horn and back again to turn the Horn off. Other features are as simple to operate. You can become completely familiar with the operation of all basic features in five minutes.

Although the reverse switch can perform all major feature operations and programming, it is not as convenient as using push buttons. We have added a product called Sidekick DC that can be attached to your power pack that adds two simple buttons to perform all of these operations easily and reliably. Sidekick also reduces wear on your reverse switch, which can now be reserved exclusively for its intended purpose – reversing your locomotive's direction.

Quantum under DCC still had much more capability than what Quantum offered under Analog operation. We recognized that Analog would always have limitations unless a simple low cost method was designed to increase and simplify basic train operation. In 2005, we introduced another innovative product called Quantum Engineer™ that can also be added to your standard power pack. Quantum Engineer provides many more basic operations such as progressively applying Air Brakes, releasing brakes, turning on and off lights, turning on and off features like Cooling Fans, smoke units, etc., shutting down or starting up your locomotive, simplified programming, plus some features not available in DCC. Read about both Quantum Engineer and Sidekick in the Appendices. DC Analog operation now rivals DCC in many ways, and is especially suited for smaller home layouts.

Important Information about this Reference Manual

This is a complete reference manual for Analog operation of features included in the Quantum system. Although your Quantum System has the ability to operate under Analog or NMRA Digital Command Control, you do not need to understand or have experience with DCC to operate your Quantum locomotive under Analog control. DCC Operation is covered separately in the *NMRA DCC Reference Manual for QSI Quantum® HO Equipped Locomotives*, Version 3R.

In addition, both the Analog and DCC Reference Manuals apply to all Quantum Locomotives, both new and old [2]. As new locomotives are introduced they may have features not found in older locomotives. Since this reference manual is a complete description of all currently available features for Analog operation, check your individual instruction manual that came with your locomotive to determine which features apply to your locomotive. This document will evolve over time as new information is added with the purpose of making it as current and complete as possible.

This manual is divided into four sections:

- **Basic Analog Operation:** This provides the necessary information to have you up and running all basic features of your locomotive in five minutes using your standard power pack.
- **Advanced Analog Features:** This section describes additional features and operational information including Regulated Throttle Control (RTC), which allows the operator to control his locomotive's throttle like the prototype. This section also includes a description of the new Quantum Engineer controller.
- **Analog Programming:** This section describes in detail how to program the different Quantum behavioral features, which include System Volume, Load (Inertia effects), Helper Types, customizing your locomotive for optimal performance with your individual power pack, individual feature volume control, etc.

1 National Model Railroad Association.

2 The one exception is the Broadway Limited Hudson, which uses a different method for programming in Analog.

- **Appendices:** The Appendices comprise the largest part of this DC Reference Manual and include the following:

    I. Quantum System Sounds

    II. Special Hardware Operations

    III. First Edition BLI Hudson

    IV. Gas Turbine Operation

    V. Power Packs

    VI. Quantum Throttle Control

    VII. Troubleshooting

    VIII. HO DC SideKick

    IX. Quantum Engineer

This manual supersedes all previous versions. Information regarding special operation of earlier locomotives such as the first edition J1e Hudson will be found in the Appendices.

Note: We capitalize proper nouns including QSI on-board features such as Whistle, Bell, etc. When referring to prototype locomotives these nouns will not be capitalized.

Basic Analog Operation

QSI recommends that you get used to operating and having fun with 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 switch. 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 speed [3].
- 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 (or 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.

Whistle/Horn

Blow the authentic locomotive Whistle or Horn (Whistle/Horn[4]) for short or long blasts – you control the duration[5].

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

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

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.

Note: If your locomotive is a diesel or electric type equipped with Ditch Lights, and the locomotive is moving in Forward, these lights 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 stopped [6].

Bell (available on all U.S. or other selected models)[7]

You can turn the Bell on (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 Whistle/Horn hoot instead of the Bell. If you try to do a very short Whistle/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 bell operation stops, just like the prototype.

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3 See Locomotive Inertia Effects on page 9 for further description of this feature. Quantum can be programmed to Standard Throttle Control for more responsive operation.

4 The locomotive will either have a Whistle or it will have a Horn; we refer to this feature as Whistle/Horn; this term does not imply that the locomotive has both a whistle and a horn.

5 Since the prototype diesel and electric locomotive horns use compressed air, we have included in Quantum the sounds of the Air Pump turning on for a short period after the Horn is operated.

6 The hold time for strobing Ditch Lights after the Whistle/Horn button is released can be set in CV 55.110.5 (see Quantum DCC Reference Manual, Version 3).

7 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 switch[8] 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 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[9] and Marker Lights will turn on and Cab Lights[10] will turn off after 10 seconds. If the locomotive has operating Ditch Lights, the front Headlight will be dim, and the Ditch Lights will be off. The Directional Headlight will come on dim or, if your locomotive has a Mars Light, it will be dim and the front Headlight will be off. See a table summary of Directional Lighting Operation described in a section below. If you are operating a diesel, 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. If you are operating a steam locomotive, Air Pumps, Blower Hiss and optional Firebox Lights will turn on and Dynamo will rev.
- Continue[11] to turn up the throttle voltage until the locomotive starts to move in Forward (this voltage is called V-Start[12]). All types of locomotives will start out with labored sounds proportional to the locomotive's Inherent Inertia and Load setting (see QSI Sound of Power™ on page 12) and the locomotive will slowly start to move. The Headlight will switch on bright and the optional Mars Light will begin to pulse. After 10 seconds in Forward, the optional Cab Lights will automatically shut off.

Locomotive Inertia Effects

Your new Quantum equipped locomotives are 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 11). 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.

- As you slow the locomotive down by gradually reducing the throttle to a little below V-start, the locomotive's labored sounds volume decreases, while Squealing Brake sounds occur as the locomotive comes to a slow stop[13].

If you need to turn your throttle up quite high to start your locomotive, V-Start can be adjusted for operation with your particular DC power pack (see Analog Programming starting on page 15). For recommended power packs, see Appendix Va.

If your locomotive has two sets of drivers, you will hear two sets of steam chuff sounds that will go gradually in and out of synchrony.

Directional Lighting Operation

All Quantum locomotives are equipped with Directional Lighting[14] that change state depending on the four directional states of Forward, Neutral from Forward, Reverse and Neutral from Reverse. If the locomotive model also has an optional Mars Light, this hazard light is also part of the directional lighting system. In addition, the Quantum Headlight will dim or shut off and the Mars Light will stop strobing when the locomotive enters Neutral or Reverse, which was common practice for prototype locomotives under Rule 17[15].

8 Some electronic power packs do not have a reverse switch. Instead they may have reverse button or a throttle that moves from forward to reverse. In either case, it is not likely to 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 Appendix Va.
9 Number Board Lights for steam locomotives and some diesels are directly wired to the track power and will be on whenever track power is applied.
10 Your locomotive may not have all light features depending on the model.
11 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 locomotive will immediately go into normal Forward operation.
12 V-Start is set at 8.5 volts. It is important to note where V-Start is located on your throttle control to know where you will enter and leave Neutral (see Neutral on Page 10).
13 Squealing Brakes occur if the locomotive exceeds 40 scale-mph (smph) and then slows down to below 20 smph.
14 Quantum uses constant voltage lighting that is independent of track voltage.
15 Rule 17, followed by prototype railroads, states: The headlight will be displayed to the front of every train by night, but must be dimmed or concealed when a train turns out to meet another and the entire train has stopped clear of main track, or is standing to meet trains at the end of double track or at junctions.

Automatic Lighting Operation in Analog with Mars Light Option

	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
Number Board Lights	On	On	On	On
Cab Lights	Off after 15 seconds	On after 10 seconds	Off after 15 seconds	On after 10 seconds

Automatic Lighting Operation in Analog without Mars Light Option

	Forward	Neutral from Forward	Reverse	Neutral from Reverse
Headlight	On	Dim	Dim	Dim
Reverse Light	Off	Off	On	Off
Number Board Lights	On	On	On	On
Cab Lights	Off after 15 seconds	On after 10 seconds	Off after 15 seconds	On after 10 seconds

Doppler Effect

This effect changes the Whistle/Horn pitch and volume and other locomotive sounds as the locomotive passes.

- While the locomotive is moving toward the observer, flip the direction switch to turn on the Whistle/Horn.
- Wait at least one second while the Whistle/Horn is blowing.
- Flip the direction switch back and forth quickly so the Whistle/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 Whistle/Horn, or continue with long or short Whistle/Horn operations. When you are finished blowing the Whistle/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.

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

Note: Doppler effect can also be activated using the Quantum Engineer™ or SideKick Analog controller[16], which do not require special operation of the Whistle/Horn.

Special Whistle/Horn Ending Sound

- Prototype engineers would often "play" their Whistle/Horns by controlling the flow of compressed air for horns or the amount of steam for whistles. In particular, engineers often had a signature sound associated with how they ended their Whistle/Horn sequences. Some Quantum sound sets have special Whistle/Horn Endings that can be activated using the direction switch to produce a unique sound effect similar to playing the Whistle/Horn.
- Flip the direction switch to blow the Whistle/Horn for at least one second.
- The normal way to end the Whistle/Horn is to flip the direction switch back. To do the special Whistle/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 particular Quantum equipped locomotive may not have special Whistle/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 locomotive to stop[17]. 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 Release when the locomotive stops moving and enters Neutral, and a Long Air Release about three seconds later followed by Air Pumps and other background sounds. In addition to the pumps, the steam Blower Hiss or diesel and electric locomotive Cooling Fans and Vents will come on at random time intervals in Neutral (hereafter this feature is referred to as

16 See description of Quantum Engineer add-on controller on page 13 and in Appendix IX.

17 If Regulated Throttle Control is enabled (see below) it is important to wait until the locomotive stops on its own. The locomotive's electronic inertia 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 go off.

Blower/Fans). After ten seconds the Blower/Fans shut off if they were on when you entered Neutral. Optional Cab Lights come on 10 seconds after entering Neutral.

- After the Air Pumps start, you can also use the direction switch to blow the Whistle/Horn or turn on or off the Bell (if so equipped)[18]

Note: If a 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, Appendix I). The diesel locomotive will return to normal Diesel Motor sounds when the throttle is turned up and the motor starts to rev.

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 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 stop[19].
- 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 Whistle/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 Whistle/Horn will come on) and then turn up the throttle. When the locomotive starts to move in the opposite direction, the Whistle/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 Whistle/Horn will hoot two more times for a total of three hoots[20].

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

Track Polarity Determines Locomotives Direction

Although Quantum uses the direction switch as a remote control signal, we still adhere to the standard in that the locomotive's direction is determined by the applied track polarity when the locomotive starts out. A stopped locomotive will always start out in the same direction as other locomotives on your layout based on the polarity on the track.

If the locomotive was blowing its Whistle/Horn when power was shut down, it will restart from its stopped position in the opposite direction with the Whistle/Horn not blowing. However, if a moving locomotive with Whistle/Horn blowing stutters briefly from a power interrupt, it will not change direction and the Whistle/Horn will continue to blow. This will prevent a moving locomotive with Whistle/Horn blowing from abruptly changing direction because of momentary power loss from a faulty turnout or dirty track.

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 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 voltage 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 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 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 reduces the available power to the motor control circuit and forces the speed to decrease faster than RTC would normally allow.

18 In Neutral, the mechanical bell 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.

19 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. As the locomotive slows, you may need to reduce the throttle a little more to remain below V-Start.

20 Standard prototype railroad signaling is two hoots before starting in forward and three hoots before starting in reverse.

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's speed 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 the 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.

Note: RTC will have different performance with different power packs. In particular, if your power pack operates at voltages in excess of 12 volts[21], you will want to reprogram V-Max (see next section) to a higher value. Also see Appendix VI, *Achieving Optimal Performance from your Power Pack when Operating Under RTC*.

Train Load

You can set your locomotive to have any of 16 different Load levels, which represent added inertia from rolling stock (see Analog Programming 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 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 throttle[22]; 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.

Note: The amount of time to achieve full speed under Load will also depend on the V-Max setting. See Appendix VI, *Achieving Optimal Performance from your Power Pack when Operating Under RTC* for additional information.

Sound of Power™

The locomotive will produce Sound-of-Power labored sound effects if you have selected any of the Load settings from level 1 to 15. Under acceleration, the locomotive 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 locomotive sounds are less labored until it achieves its final speed where it will again produce labored 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 Whistle/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 below and in the next section on Analog Programming.

Helper Type	Horn	Bell	Headlight	Reverse Light
Normal	Enabled	Enabled	Enabled	Enabled
Lead	Enabled	Enabled	Enabled	Disabled
Mid	Disabled	Disabled	Disabled	Disabled
End	Disabled	Disabled	Disabled	Enabled
Pusher	Disabled	Disabled	Disabled	Enabled

Normal and Reversed Direction

Quantum also allows you to reverse the directional sense of your locomotive. This 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 when the locomotive is moving in Reverse and the Headlight is disabled. This is ideal for providing a Reverse Light for the consist. However, if this locomotive is facing backwards at the end of a consist, the Reverse Light faces forward and will be lit when the consist is moving Forward and there will be no Reverse Light for the consist. The "Direction" program feature will ensure that this End Helper's backward facing Headlight will come on only when the consist is backing up and the forward facing Reverse Light will not light at

21 Most MRC Power Packs have a maximum voltage anywhere from 16 to 20 volts, which is way above the recommended NMRA standard of 12 volts.

22 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, Appendix VII).

all. When making up a train with different Helper types, it is recommended that you also change its directional sense if the Helper is intended to be operated backwards within the consist. See "Option 4 Direction", Analog Programming, next section.

Using Magnetic Wand to Shut Down and Start Up Analog Locomotives[23]

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 will not respond to changes in track voltage or Analog horn or bell signals or programming commands.

To shut off a locomotive:

- Enter Neutral and turn on the Bell.
- Place the Magnetic Wand over the reed switch area. After an air release, the Bell will shut off followed by the diesel motor shutting down and all lights will go 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 an air release followed by vents opening, the motor starting up followed by the air pumps and lights turning on. The locomotive is now selected and will respond to track voltage and all bell and horn signals.

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 the air release 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 shut 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, shut it down with the Magnetic Wand. When all locomotives are in place, select each locomotive 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, you first deselect all locomotives one at time and then select each one in turn as you disconnect and pull away from the consist.

Additional Analog Operation Features Available with the Quantum Engineer™ Controller

Your Quantum locomotive may be equipped with our new QSI QARC™ (Quantum Analog Remote Control) Technology, which uses special remote control signals to operate different Quantum features without the need for complicated and expensive digital systems like DCC. Add the simple QARC controller, called Quantum Engineer, to your existing Analog power pack as shown below. With Quantum Engineer, you can operate features that are otherwise available only in DCC plus features that are not yet available in DCC.

The QARC System makes Analog operation more fun and more prototypical than DCC by eliminating the need to configure function keys or to learn complicated DCC protocol and command structures or to spend valuable time reading technical documents on DCC operation. Every button on QARC controllers does exactly what it says.

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. It takes less than five minutes to add Quantum Engineer to your existing power pack.

23 Not available on all locomotives.

With a simple press of different control buttons, QARC technology will allow you to:

1. Turn on or off lights including Headlight, Reverse light, optional Cab Lights and Number Board Lights. In addition, you can turn on or off optional Hazard Lights (Mars or Ditch-lights) plus toggling them to be on steady or pulsing.
2. Shut down and start up locomotives. Complete shut down takes the locomotive off line where it will not respond to either throttle or commands. Two types of Shut Down and Start Up scenarios are available; a short version where the start up and shut down effects take very little time or extended scenarios which include locomotive preparation effects.
3. Operate prototype-like Air Brakes. The Apply Brakes button results in the locomotive sounds reducing to idle while you hear the hiss of the air pressure progressively decreasing causing the locomotive to slow. You control the amount of air pressure and amount of braking effect. The Release Brakes button causes the locomotive sounds to return to normal as the locomotive speed gradually increases back to its original setting.
4. Turn on Dynamic Brakes. Press the Dynamic Brake button and hear the diesel motor reduce to notch 1 while the sounds of the powerful dynamic brakes and cooling fans turn on. Double press the Dynamic Brake button to turn Dynamic Brakes off while the locomotive sounds return to their original power level.
5. Change System Volume while train is operating. The locomotive volume can, of course, be set with manual volume control or through programming. The Quantum Engineer allows you to change volume up or down at the touch of button whenever the locomotive is operating.
6. Mute locomotive sounds while train is operating. Press the Mute button to gradually reduce the volume to a lower level or increase it gradually back to normal. This feature is valuable to lower the sound to allow answering the phone or to have a conversation but also as a way to easily lower the sound of locomotives in the background area of the layout or increase the sound volume as the locomotive moves to the front of the layout.
7. Disconnect the Motors: The Disconnect button turns the motor drive off allowing you to operate the throttle without the locomotive moving. You can rev the diesel motor or vent steam through the throttle on steam locomotives. You can even apply Dynamic Brakes to allow the locomotive to operate under labored conditions – a common practice on prototype diesels to test the motor/generator output.
8. Put the locomotive in Standby: The Standby State allows the locomotive to remain at rest in a low idle condition ideal for unmanned powered locomotives waiting on sidings. In Standby, locomotives will not respond to throttle or most other command buttons. This allows you to operate other locomotives on the same power grid without the standby locomotives responding. Standby locomotives come back to life by pressing the Start Up button.
9. Quickly change between STC and RTC throttle control: There are separate buttons for STC (Standard Throttle Control) and RTC (Regulated Throttle Control). When you want to operate your locomotive in a prototypical manner, use the RTC button and when you want a responsive locomotive, press the STC control. In addition, when in Neutral, use the Load button to turn on or off the load value you have selected in Load programming. This button also acts as a "very heavy Load" when the locomotive is moving. This causes the locomotive's speed to change very slowly when moving around the layout, up and down grades, etc. and allows you to use the throttle to produce exaggerated Sound of Power™ effects when working hard or low labored sounds when coasting to a stop or going down grade.
10. Hear Status Reports: In Neutral, pressing the Status button verbally reports the throttle type (RTC, STC), the amount of Load, whether the Load is on or off, and the Disconnect, Standby or Shut Down condition. While moving, the Status button reports the speed of the locomotive in smph (scale miles per hour).
11. Do programming quickly and easily: Enter programming by holding Mute/Prog button down while you turn power on. Move through the different Program Options (POP's) by using the Next button to advance or the Prev to go back to previous POP's. Use the up or down buttons to make changes at any POP.
12. Operate many other features: Buttons are available to operate Doppler, to blow a Whistle/Horn sequence of two longs, one short and another long for Grade Crossing warnings, to sound Brake or Flange squealing, to sound coupler opening or coupler crash sounds.

See the complete instructions for operating the Quantum Engineer in Appendix IX.

Note: QARC Technology and Quantum Engineer are ideal for most layouts where you run one locomotive or one consist at a time in the same powered block area. It is also ideal for many club layouts where isolated blocks are used to control power to individual trains. However, if you intend to operate more than one train on the same powered block area and wish to control them at different speeds, then DCC is a better choice.

Analog Programming

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

Diesel and Electric Locomotive Programming

Program Option #'s (POP's[24])	Option Name	Message[25] when Entering Option	Option Description
1	System Volume[26] (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 momentum 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[27]. 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 lights are disabled.
4	"Direction" (Normal)	"Direction equals X"	Selects if the features associated with the locomotive's direction are "Normal" or "Reversed".
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 Standard Throttle Control (STC) and Regulated Throttle Control (RTC).
11	Programming Reset	"Warning – about to reset"	After next **Quick** or **Slow** Operation, Bell rings followed by a hoot to indicate locomotive returned to factory default.
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 or Electric Motor Volume. (16 levels). Max is 15.
16	Fan Volume	"Volume equals X"	Customizes Diesel and Electric Vents and Cooling Fans Volume (16 levels). Max is 15.
17	Turbo Volume	"Volume equals X"	Customizes Diesel 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 Diesel 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.
33-51	Reserved	"Reserved"	

Where "X" is the current value of the Program Option. Defaults are shown in parenthesis next to the option name.

24 POP is short for "Program Option".

25 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.

26 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.

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

Steam Programming

Program Option #'s (POP's[28])	Option Name	Message[29] when Entering Option	Option Description
1	System Volume[30] (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 momentum 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 Whistle, Bell and all lights disabled[31]. End Helper has Whistle, Bell and all lights disabled except Reverse Light. Pusher has Reverse Light on all the time as train warning light. Whistle, 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 "Reversed".
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 Standard Throttle Control (STC) and Regulated Throttle Control (RTC).
11	Programming Reset	"Warning – about to reset"	After next **Quick** or **Slow** Operation, Bell rings followed by a hoot to indicate locomotive returned to factory default.
12	About	Model number	Each **Quick** or **Slow** Operation provides progressive information about Quantum Model Number, Software Version, and Software Release Date.
13	Whistle Volume	"Volume equals X"	Customizes Whistle Volume (16 levels). Max is 15.
14	Bell Volume	"Volume equals X"	Customizes Bell Volume (16 levels). Max is 15.
15	Chuff Volume	"Volume equals X"	Customizes Steam Exhaust Volume. (16 levels). Max is 15.
16	Blower Volume	"Volume equals X"	Customizes Blower Hiss Volume (16 levels). Max is 15.
17-19	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 Brakes/Flanges Volume	"Volume equals X"	Customizes Squealing Brake/Flanges Volume (16 levels). Max is 15.
31	Reserved	"Reserved"	
32	Coupler Volume	"Volume equals X"	Customizes All Coupler Sound Volumes (16 levels). Max is 15.
33-45	Reserved	"Reserved"	
46	Dynamo Volume	"Volume equals X"	Customizes Steam Electric Generator (Dynamo) Volumes (16 levels). Max is 15.
47	Pop-Off Volume	"Volume equals X"	Customizes Steam Pop-off Volumes (16 levels). Max is 15.
48	Blow Down Volume	"Volume equals X"	Customizes Steam Boil Blow Down Volumes (16 levels). Max is 15.
49	Injector Volume	"Volume equals X"	Customizes Water Injector Volumes (16 levels). Max is 15.

Where "X" is the current value of the Program Option. Defaults are shown in parenthesis next to the option name.

28 POP is short for "Program Option".

29 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.

30 You can set System 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.

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

Entering Programming

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

- Apply power and turn up the throttle to hear the sound system come on.
- Within five seconds of powering up, turn on the Bell with a **Quick** flip-and-back operation.
- Within three seconds of the Bell turning on, turn the Bell off with a second **Quick** flip-and back operation.
- 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 Lights 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 again[32]. 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 switch. 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 volume[33].

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. 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 back on again.

  Note: The highest program option is POP 51. The system will automatically stop at and repeat "five one".

32 If you have a Quantum Engineer, you can move both back and forth through Program Options.
33 Setting any volume in Analog will also apply to DCC and vice-versa.

Feature Programming Options (POP's)

Each of the following subsections provides compete instructions for individual feature programming including instructions on entering Programming. If you are already in programming, you can skip the first bullet in each of the following POP descriptions and proceed to the higher program options as described in the second bullet. You must be familiar with how to enter programming or know how to do a **Slow** or **Quick** operation with the power pack reverse switch.

Do not be concerned about making mistakes. Programming is designed to allow you to recover from incorrect settings. Even if you cannot remember what you have done, you can always reset all features to factory values through one of the programming options or by using the hardware jumper or the Magnetic Wand supplied with some locomotives (described in Appendix II).

System Volume (POP 1)

This option allows the user to increase or decrease the overall sound system volume. This setting affects all sounds at once. Individual sounds can be adjusted separately in other programming options. (See options 13-16 below).

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on as described above. You will hear "Enter Programming" followed by "Option one – System volume".
- Since Quantum automatically starts at the System Volume POP after entering programming, you do not need to advance to higher Program Options.
- Use either a **Quick** or a **Slow** flip-and-back operation of the direction switch to enter this option. You will hear the current sound level announced followed by an ensemble of locomotive sounds at the current volume level.
- Use a **Quick** operation with the direction switch; you will hear the next lower sound level announced followed by an ensemble played at the new volume setting. Continue to use **Quick** operation to decrease the volume level. At the lowest level, some or the entire ensemble of sounds may fade out.
- Use a **Slow** flip-and-back operation of the direction switch to increase the volume to the next level. Once you reach the highest setting, you will hear "one six". If you continue to perform a **Slow** flip-and-back operation at the highest level, the volume level will repeat and you will not change from this setting.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

In total, there are 16 volume levels at 2 db decrements with level 17 (0 db) as the loudest and level 1 (-32db) as the lowest (which is essentially off). The factory setting for System Volume is at level 17 (0 db).

Note: the verbal programming responses (such as "Enter Programming" etc.) have a minimum volume setting to allow programming even when the system volume is turned all the way off.

Note: If you intend to program the volume electronically, you may first want to turn the manual volume up all the way. This will give you the greatest range of volume programming. Or you may wish to limit the maximum volume you can program, to provide the best sound quality. To do this, first program the volume to the highest level and then use the manual adjustment to set it at its highest desirable setting.

Note: If you are setting the system volumes for a consist and want all locomotives to have the same level setting, first use a series of Slow operations until all locomotives respond with "One Six". Then use Quick operations to lower the volume of all locomotives to the desired level.

Load (POP 2)

Load settings affect how quickly your locomotive accelerates or decelerates. It applies to both "Regulated Throttle Control" (RTC) and "Standard Throttle Control" (STC). However, the results are more realistic with RTC. See Appendix VI, *Achieving Optimal Performance from your Power Pack when Operating Under RTC*, for further information.

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on as described above. You will hear "Enter Programming" followed by "Option one – System volume".
- Flip the direction switch to the opposite position and leave it there. Flip the direction switch back when you hear "Option two". You will then hear "Load".
- Use either a **Quick** or a **Slow** flip-and-back operation of the direction switch to enter this option. You will hear "Load equals X" where X is the current value of the Load.
- Use the direction switch in **Slow** operations to increase the Load setting up to a maximum of 15. Use a **Quick** operation of the direction switch to lower the Load setting. Each new setting will be spoken out.

- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leaving it there. Wait as the option numbers count up in order.

Load 0 is the lowest setting. Under STC, Load 0 will result in the locomotive accelerating or decelerating as fast as the internal flywheels will allow. However, Load 0 under RTC will still result in the locomotive accelerating or decelerating with the Intrinsic Inertia associated with the RTC algorithm. Load 15 is the highest setting and will result in the locomotive taking minutes to reach full speed.

Note: The amount of acceleration or deceleration will also depend on the Throttle Mode setting with RTC generally resulting in slower accelerating and decelerating. Under RTC, the value of V-Max also affects the amount of acceleration or deceleration with higher values of V-Max resulting in slower acceleration. For further information, see Appendix VI, *Quantum Throttle Control; Achieving Optimal Performance from your Quantum Locomotive when Operating Under RTC*.

Helper (POP 3)

This option is useful for making up consists. There are four choices for locomotive types: Normal, Lead, Mid, End, and Pusher. Make the front locomotive a Lead locomotive, the next locomotive a Mid helper (or End helper if double heading) and the last locomotive an End helper. Make any mid train helpers Mid Helpers and a pusher at the end of the train, a Pusher Helper. This will allow only the lead locomotive to have Whistle/Horn and Headlights, while other helpers have lights appropriate for their location in the consist or train. The table above on page 12 summarizes the features that are enabled or disabled for each of the Helper types.

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on as described above. You will hear "Enter Programming" followed by "Option one – System volume".
- Flip the direction switch to the opposite position and leave it there. Flip the reverse switch back when you hear "three". You will then hear "Helper".
- Use either a **Quick** or a **Slow** flip-and-back operation of the direction switch to enter this option. You will hear "Helper equals X" where X is the current setting for Helper Type.
- Use the direction switch in **Slow** operations to change the helper type through the settings of Normal-Lead-Mid-End-Pusher-Normal-etc. in a repeating loop. Use a **Quick** operation of the direction switch to change the Helper Type in the opposite order through the settings of Pusher-End-Mid-Lead-Normal-Pusher-etc. in a repeating loop.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leaving it there. Wait as the option numbers count up in order.

Direction (POP 4)

When making up a train with different Helper types, it is recommended that you also change its directional sense if the Helper is intended to be operated backwards within the consist. This maintains consistency of the Directional Lighting operation of individual locomotives that are facing backwards within the consist. The Direction setting does not affect the direction of motion of an individual locomotive. All locomotives in a consist will always start in the same direction, as determined by the track's electrical polarity.

- Enter Programming after powering up your locomotive by turning the Bell on, then off and then on as described above. You will hear "Enter Programming" followed by "Option one – System volume".
- Flip the direction switch to the opposite position and leave it there. Flip the reverse switch back when you hear "four". You will then hear "Direction".
- Use either a **Quick** or a **Slow** flip-and-back operation of the direction switch to enter this option. You will hear "Direction equals X" where X is the current setting for locomotive's direction.
- Use the direction switch in **Slow** operations to change the helper type through the settings of Normal-Reversed-Normal-etc. in a repeating loop. A **Quick** operation of the direction switch has the same effect.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leaving it there. Wait as the option numbers count up in order.

Optimizing the Quantum System for your Power Pack

The next three programming options allow you to set the operation of your Quantum system to perform optimally with your power pack and throttle. The first two, called "V-Start" and "V-Max" allow you to customize your locomotive for optimal behavior with your individual power packs. V-Start determines where on the throttle your locomotive will leave Neutral and start moving. V-Max determines the throttle setting where your locomotive's motor will have full-applied power. The next program option, Throttle Mode, sets your locomotive to respond either to the throttle directly without any motor control effects (STC) or to enable a motor control algorithm (RTC) that provides internal inertia effects that simulate the slow response of prototype locomotives.

Setting V-Start (POP 8)

This will determine the voltage (and throttle position) where your locomotive will leave Neutral and move out.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "eight" 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 to leave Neutral.
- Use a **Slow** or **Quick** operation of the direction switch to activate this option. Hear the message "Set throttle to V-Start"; the track voltage will be announced[34] every three seconds. When you move the throttle, the new track voltage value will be announced a few seconds later.
- Once throttle is set, use a **Slow** or **Quick** operation of the direction switch to start the procedure. The locomotive will move[35] at a slow speed and the Bell will ring continually for about 25 seconds, indicating the correct value is being calculated. If you choose a very low voltage setting, be patient. If the locomotive does not move during the procedure, return to the beginning of this option[36] or start over and chose a slightly higher throttle setting.
- At the end of the process, the locomotive will stop moving and the Whistle/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 or higher POP's by moving the direction switch and waiting for the following Programming Options 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.

V-Max (POP 9)

For throttle settings below V-Max, only a portion of the track voltage is applied to the motor. Above V-Max, the full track voltage is applied to the motor. If RTC is selected, a proper setting of V-Max will ensure that RTC is effective during the entire throttle range and that full power is applied to the motor at maximum throttle. For a complete description of how V-Max affects RTC and motor power, see Appendix VI, *Achieving Optimal Performance from your Power Pack when Operating Under RTC*.

Setting V-Max is similar to setting V-Start.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "nine" by moving the direction switch back. You will hear "V-Max".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "V-Max equals X" where "X" is the track voltage value currently set to leave Neutral.

34 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.

35 For earlier Quantum locomotives, the locomotive will only move at the very end of the V-Start calibration process.

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

- Use a **Slow** or **Quick** operation of the direction switch to activate this option. Hear the message "Set throttle to V-Max"; the track voltage will be announced[37] every three seconds. When you move the throttle, the new track voltage value will be announced a few seconds later. We suggest you set V-Max to about 80% of full throttle voltage.
- Once the throttle is set, use a **Slow** or **Quick** operation of the direction switch to start the procedure. The Bell will ring continually for a short time indicating the correct value is being calculated.
- At the end of the process, the Whistle/Horn will hoot, signifying the end of the operation and you will hear the message "V-Max = 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 Throttle Mode or higher POP's by moving the direction switch and waiting for the following Programming Options to be announced.

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

Note: When double heading your Quantum equipped locomotives[38], make sure that both locomotives have similar speed/throttle characteristics by adjusting V-Start and V-Max to prevent them from fighting each other.

Setting Throttle Mode (POP 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".
- 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".
- To leave Programming, turn the throttle off, and then power up for normal locomotive operation.
- Or continue to higher POP's by moving the direction switch and waiting for the following Programming Options to be announced.

37 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.

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

Special Programming Options

The following two programming options allow you to reset your locomotive to factory default values or determine information about your software version.

System Reset (POP 11)

This will reset all Analog options back to the factory default settings. Any changes you have made to Program Options will be lost.

Note: "Reset to Factory Values" will not reset DCC parameters. The exceptions are the volume settings, which are shared between Analog and DCC operation.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "one, one" by moving the direction switch back. You will hear "Programming Reset".
- Use either a **Quick** or a **Slow** flip-and-back operation of the direction switch to enter this option. You will hear "Warning – about to reset".
- At this point you can do a **Quick** or **Slow** operation of the direction switch to reset the system or leave programming or move to higher reset options without making any changes. If you do use a **Quick** or **Slow** operation, the bell will start ringing, indicating the reset operation is in progress.
- Within moments, the bell sound ends and you will hear a single Whistle/Horn blast indicating that all options have been reset to factory default values.

Note: If only a few settings need to be reset, the amount of time between the bell coming on and the final Whistle/Horn blast can be very short.

- To leave Programming, turn the throttle off, and then power up for normal locomotive operation.
- Or continue to Throttle Mode or higher POP's by moving the direction switch and waiting for the following Programming Options to be announced.

About "Quantum" (POP 12)

This POP verbally reports software details about your system.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "one, two" by moving the direction switch back. You will hear "About".
- The first **Slow** or **Quick** operation of the direction switch will enter this option and you will hear the Model number (e.g. "three zero zero" for "300", or "four zero zero" for "400"). This identifies the type of locomotive and the sounds programmed into the software.
- The second **Slow** or **Quick** operation of the direction switch will provide information about the Software version (e.g. "five point zero is version 5.0).
- The third **Slow** or **Quick** operation of the direction switch will produce the build date. This is the date the software was released. You will hear three sets of numbers, each separated by a pause. The first number set is the month, followed by the day of the month, followed by the year (e.g. "six" pause "one five" pause "two zero zero three" means June 15, 2003). Further **Slow** or **Quick** operations will have no affect.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Feature Sound Volume

The Quantum System allows independent volume settings of many of the important sound features including Whistle/Horn, Bell, Chuff, Diesel Motor, steam Blower Hiss and diesel Cooling Fans. Most of these sounds are factory set at an intermediate volume levels (often 11) and can be increased or decreased to give you the best balance of sounds for your particular needs.

Note: Depending on the sound feature and the system volume level, you may not be able to hear sound at some of the lowest settings. However, the system is still going through these volume levels as you use **Slow** and **Quick** operations. Continual **Slow** operations will result in the maximum volume setting and you will hear "One, Five" (meaning "fifteen"). If additional **Slow** operations are performed, the volume level will remain at this maximum setting. Continual operations of **Quick** operations will result in the minimum volume setting with an announcement of "Zero". If additional **Quick** operations are performed, the volume level will remain at this minimum setting with an announcement of "Zero" each time.

Note: If you are setting individual feature volumes for an entire consist and want all locomotives to have the same level setting, first use a series of **Slow** operations until all locomotives respond with "One, Five". This sets all locomotives to the same maximum sound volume. Then use **Quick** operations to lower the volume of all locomotives to the desired level.

Whistle/Horn Volume (POP 13)

This sets the volume of the Whistle/Horn independent of other sounds.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "one, three" by moving the direction switch back. You will hear "Whistle Volume" or "Horn Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed immediately by a Whistle or Horn blast at this volume.
- Use the direction switch in **Slow** or **Quick** operations to move through the Whistle/Horn volume choices in the same way you selected System Volume. There are 15 levels of Whistle/Horn volume in 2 db increments[39]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Bell Volume (POP 14)

This sets the volume of the bell independent of other sounds.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "one, four" by moving the direction switch back. You will hear "Bell Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual Bell sound at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Bell volume choices in the same way you selected System Volume. There are 15 levels of Bell volume in 2 db increments[40]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

39 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
40 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

Steam Chuff/Diesel Motor/Electric Traction Motor Volume (POP 15)

This sets the Steam Exhaust (Chuff) or Diesel Motor or Electric Traction Motor volume independent of other sounds.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "one, five" by moving the direction switch back. You will hear "Chuff Volume" or "Motor Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual Chuffing or Diesel Motor or Electric Traction Motor sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Chuff or Motor volume choices in the same way you selected System Volume. There are 15 levels of Chuff or Motor volume in 2 db increments[41]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.

  Note: Each change in Diesel Motor volume will produce a motor start up effect followed by continuous motor sounds.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Steam Blower Hiss/ Diesel and Electric Cooling Fans Volume (POP 16)

This sets the Steam Blower Hiss or Diesel or Electric locomotive Vents and Cooling Fans volume independent of other sounds. Blower Hiss and Cooling Fans sounds occur automatically in Quantum equipped locomotives. However, these sounds can be turned on and off using Quantum Engineer Analog controller.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "one, six" by moving the direction switch back. You will hear "Blower Volume" or "Fan Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual Hiss or Fan and Vent sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Hiss/Fans volume choices in the same way you selected System Volume. There are 15 levels of Blower/Fans volume in 2 db increments[42]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.

  Note: Each change in diesel or electric locomotive Fan volume will result in the sounds of the vents opening followed by continuous fan sounds.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Turbo Volume (POP 17) (Diesel Only)

This sets Diesel Turbo volume independent of other sounds.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "one, seven" by moving the direction switch back. You will hear "Turbo Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual Turbo whine at its current volume setting.

41 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
42 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

- Use the direction switch in **Slow** or **Quick** operations to move through the Turbo volume choices in the same way you selected System Volume. There are 15 levels of Turbo volume in 2 db increments[43]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Air Brakes Volume (POP 20)

This sets Air Brake air release volume independent of other sounds. Air Brakes sounds are used with Quantum Engineer and provide audio feedback to the operator that brake pressure is being reduced and the braking effect is increasing.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "two, zero" by moving the direction switch back. You will hear "Air Brakes Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual hiss of the Air Brakes pressure release at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Air Brakes volume choices in the same way you selected System Volume. There are 15 levels of Air Brakes volume in 2 db increments[44]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Air Pump Volume (POP 26)

This sets the Steam, Diesel or Electric locomotive Air Pump volume independent of other sounds.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "two, six" by moving the direction switch back. You will hear "Pump Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continual sounds of Air Pump operation at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Air Pump volume choices in the same way you selected System Volume. There are 15 levels of Air Pump volume in 2 db increments[45]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Long Air Let-off Volume (POP 27)

This sets the long Air Let-off volume independent of other sounds. Since this sound provides audio feedback for entering Neutral, the volume should not be set so low it cannot be heard over other sounds on a non-moving locomotive.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "two, seven" by moving the direction switch back. You will hear "Air Let-off Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a single operation of the long Air Let-off sound at its current volume setting.

43 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
44 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
45 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

- Use the direction switch in **Slow** or **Quick** operations to move through the long Air Let-off volume choices in the same way you selected System Volume. There are 15 levels of long Air Let-off volume in 2 db increments[46]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume. You will hear a single operation of the long Air Let-off sound each time the volume level is changed.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Short Air Let-off Volume (POP 28)

This sets the short Air Let-off volume independent of other sounds. Since this sound provides audio feedback for entering the initial Neutral period where you can change locomotive direction without blowing the Whistle/Horn, the volume should not be set so low it cannot be heard over other sounds on a non-moving locomotive. Short Air-Let-off may also be used as feedback for the operation of other features.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "two, eight" by moving the direction switch back. You will hear "Short Air Let-off Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a single operation of the Short Air Let-off sound at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Short Air Let-off volume choices in the same way you selected System Volume. There are 15 levels of Short Air Let-off volume in 2 db increments[47]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume. You will hear a single operation of the Short Air Let-off sound each time the volume level is changed.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Squealing Brake/Flange Volume (POP 30)

This sets the Squealing Brake or Flange volume independent of other sounds. Brake sounds are heard when Quantum locomotives come to a stop. These sounds can also be produced by the Quantum Engineer Analog Controller to produce braking sounds or continual squealing to simulate flange squeal sounds or extended braking effects.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "three, zero" by moving the direction switch back. You will hear "Flange Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a single operation of the Squealing Flange sound at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Squealing Brake/Flange volume choices in the same way you selected System Volume. There are 15 levels of Squealing Flange volume in 2 db increments[48]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume. You will hear a single operation of the Squealing Flange sound each time the volume level is changed.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

46 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
47 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
48 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

Dynamic Brakes Volume (POP 31) (Diesel or Electric only)

This sets the diesel or electric Dynamic Brakes volume independent of other sounds. Operation of Dynamic Brakes is only available in Analog using the Quantum Engineer Controller. This setting is not available for steam locomotives; prototype steam locomotives do not have dynamic brakes.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "three, one" by moving the direction switch back. You will hear "Dynamic Brakes Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a continuous operation of the Dynamic Brakes Fan sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Dynamic Brakes volume choices in the same way you selected System Volume. There are 15 levels of Dynamic Brakes volume in 2 db increments[49]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Coupler Volume (POP 32)

This sets the Coupler Arming, Coupler Firing and Coupler Crash sound volume independent of other sounds. Operation of Coupler sounds is only available in Analog using the Quantum Engineer Controller.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "three, two" by moving the direction switch back. You will hear "Coupler Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a single set of three Coupler sounds, Arm, Fire, and Crash at its current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Coupler volume choices in the same way you selected System Volume. There are 15 levels of Coupler volume in 2 db increments[50]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume. You will hear a single set of three Coupler sounds, Arm, Fire, and Crash, each time the volume level is changed.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Dynamo Volume (POP 46) (Steam only)

This sets the steam Dynamo whine volume independent of other sounds. Rev up operation of Dynamo occurs automatically when power is first applied to the track or when turning on Headlights or Rear Lights or performing a Start Up on a locomotive in Shut Down using the Quantum Engineer Controller. After the Dynamo is started, the Dynamo whine will continue as long at the lights are on.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "four, six" by moving the direction switch back. You will hear "Dynamo Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by a start up and continuous Dynamo whine sounds at its current volume setting.

49 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
50 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

- Use the direction switch in **Slow** or **Quick** operations to move through the Dynamo volume choices in the same way you selected System Volume. There are 15 levels of Dynamo volume in 2 db increments[51]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Pop-Off Volume (POP 47) (Steam only)

This sets the steam Pop Off hiss volume independent of other sounds. Operation of the Safeties or Pop-Off's occurs automatically and randomly when a steam locomotive is in Neutral.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "four, seven" by moving the direction switch back. You will hear "Pop-Off Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by continuous Pop-Off hiss sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Pop-Off volume choices in the same way you selected System Volume. There are 15 levels of Pop-Off volume in 2 db increments[52]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.

  Note: You may want to set the volume of Pop-Off quite loud. Pop-Off sounds are incredibly loud on prototype steam locomotives.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Blow Down Volume (POP 48) (Steam only)

This sets the steam Blow Down volume independent of other sounds. Operation of Blow Down occurs automatically and randomly when a steam locomotive is in Neutral.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "four, eight" by moving the direction switch back. You will hear "Blow Down Volume".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by Blow Down sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Blow Down volume choices in the same way you selected System Volume. There are 15 levels of Blow Down volume in 2 db increments[53]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

Injector Volume (POP 49) (Steam only)

This sets the steam water Injector volume independent of other sounds. Operation of the water Injector occurs automatically and randomly when a steam locomotive is in Neutral.

- 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 hear the announcement "Option 1, 2, 3 ... etc.". Stop when you hear "four, nine" by moving the direction switch back. You will hear "Injector Volume".

51 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
52 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.
53 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

- Use a **Slow** or **Quick** operation of the direction switch to enter this option. You will hear "Volume equals X" where X is the current level setting, followed by Injector sounds at their current volume setting.
- Use the direction switch in **Slow** or **Quick** operations to move through the Injector volume choices in the same way you selected System Volume. There are 15 levels of Injector volume in 2 db increments[54]. A **Slow** operation will increase the volume while a **Quick** operation will decrease the volume.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to higher programming options by flipping the direction switch to the opposite position and leave it there. Wait as the option numbers count up in order.

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54 The range of volume settings will depend on the manual and system volume setting. However, incremental volume level changes will remain at 2 db.

Appendix I: Quantum System Sounds [55]

Sounds Available Under Standard Analog, Analog QARC Technology and DCC Operation

1.0 Steam Sounds

1.1 Automatic Sounds

Steam Chuff: The familiar steam chuff comes from steam exhausted from the steam chest through the smoke stack, which creates a powerful draft to feed the fire. QSI Quantum Chuffing produces four distinct chuff sounds per drive wheel revolution, a rhythm recognized by all steam fans. Our software allows the Chuffs to partly overlap to create a more realistic effect; one Chuff sounds does not need to completely terminate before the next one begins.

Articulated Chuff: The Quantum System has two sets of steam Chuff sounds that will gradually go in and out of synchrony as the locomotive moves around the layout. Most prototypical articulated or duplex locomotives had less weight over the front engine, which resulted in more slippage, causing the two engines to run at slightly different speeds.

Blower or Steam Locomotive Hiss: On a moving locomotive, the steam from the steam chest venting through the smokestack also draws air through the firebox, keeping the fire healthy. When the locomotive is sitting still, blowers are often turned on to vent steam through the smokestack and maintain the draft as well as keep smoke out of the locomotive cab. The Blower Hiss sound on Quantum steam locomotives is a continual steam hiss heard in Neutral. ***Take Control [56] only with QARC Analog or DCC.***

Air Pumps: When a locomotive is sitting still, the pumps come on at a steady beat to replace the air lost from the brake air release and from pneumatically operated appliances. Air pumps come on whenever air is used. After a Long Air Let-off in Neutral, usually signifying the operation of the power reverse, you will hear the pumps start up at maximum rate to replace the air lost from the reservoir. Once the pressure is up, the pumps only turn on occasionally to maintain pressure. Large steam locomotives may have more than one pump operating independently.

Air Release: Compressed air is used on locomotives for the braking system and for operating various appliances like the reversing mechanisms common on large steam locomotives. When a large steam locomotive comes to a stop, you will hear a Long Air Let-off release as the power reverse is moved to the center neutral position.

Brake Squeal: Brake squeal on prototype locomotives is usually more noticeable when the wheels are just about to stop turning. Listen for brake squeal sounds as the Quantum locomotive slows to a stop. ***Take Control only with QARC Analog or DCC.***

Steam Pop-off: If there is too much steam pressure in the boiler, special pop-off valves or "safeties" on top of the locomotive release the excess steam in a fury of hissing steam that often will blow for 30' or more above the locomotive. This happens most often when the locomotive is sitting still, since the fire continues to build up steam that is not used. The Quantum Pop-off sound comes on for random lengths, at random times in Neutral.

Steam Water Injector: The water used to make steam is replaced by high-pressure water injectors that are designed to overcome the elevated pressure in the boiler. Water Injectors produce the sound of rushing water and steam hiss, and end with a distinctive valve shut off. This sound comes on for random lengths of time and occurs randomly when the locomotive is in Neutral.

Steam Boiler Blow Down: As water evaporates to produce steam, minerals and other residues settle to the bottom of the boiler. The fireman opens a valve to vent this material through a large pipe under the side of the cab onto the ground. Quantum's Blow Down sound occurs completely at random for undetermined lengths of time when the locomotive is in Neutral.

1.2 Controllable Sounds

Whistle: The Quantum System uses authentic locomotive sounds whenever possible. All Quantum Whistles are engineered by QSI sound experts to give you the most authentic effects The Whistle has a distinctive start up followed by a steady whistle sound as long as the whistle button is pressed, followed by an ending sound effect immediately after the whistle signal stops. Use the whistle signal to produce any combination of long or short blasts. Quantum Sound also includes a distinctive short Hoot for very brief Whistle blasts. This allows the operator to easily produce a series of short Hoots before starting out or for other signaling.

Bell: The bells on steam locomotives may be either hand pulled or pneumatic depending on the size or type of locomotive. Pull bells have a distinctive ding-dong sound as the bell moves towards and then away from the observer. With pull bells, you can sometimes hear the squeak of the bushings as the bell swings to and fro. Mechanical bells use a pneumatic clapper and produced a very regular striking pattern. During turn-on in Neutral, you will hear the pneumatic clapper gain greater throw with each stroke until it finally strikes the Bell. Most bells on steam

55 Not all features are included on every locomotive. Consult your Model Specifications sheet for a list of features and sounds for your model.

56 "Take control" allows the operator to take over the control of automatic features such as directional lights, fans, smoke, etc. during normal operation by operating their remote control keys. Take Control is available under DC with locomotives that have QARC technology using the add-on Quantum Engineer controller or under DCC using standard NMRA function keys operations.

locomotives are loud because they are mounted high up on the locomotive. In addition, some bells made during World War II were manufactured from steel rather than brass. You can tell the more harsh sound of the steel bell from the more melodic sound of brass bells. Quantum uses a variety of different bell sounds from hand pulled, pneumatic, to steel and brass bell types.

Doppler Run-by: Instantly recognizable, the locomotive 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 change the pitch exactly when and where you want.

The QSI patented Doppler Run-by responds to 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 whistle is no longer being blown, the locomotive's volume and sound pitch subtly return back to normal. ***Independently controllable under Analog or DCC.***

Flanges or Extended Brake Squeal: When a train enters a curve, the flanges on the wheels tend to ride up on the inside of the rail and squeal. Recreate this squealing effect by pressing and releasing the Brake Sound Function Key button quickly and repeatedly as necessary. Or for slow stops, use the same function key to produce long protracted squealing brake sounds. ***Independently controllable only with QARC Analog or DCC.***

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 locomotive model as braking is continually increased. The longer the air is released, the quicker the 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. ***Controllable only with QARC Analog or DCC.***

Dynamic Brakes: Steam locomotives do not have Dynamic Brakes. When steam locomotives are operated today, they are often coupled to a diesel to provide dynamic brakes on down grades. If a Quantum steam locomotive is coupled to a Quantum diesel, and Dynamic Brakes are activated, the diesel Dynamic Brake effect will start up and the steam locomotive labored Chuffing will reduce at the same time. Since prototype dynamic brakes are relatively ineffective a low speeds, the Quantum Dynamic Brakes will shut off automatically below 8 smph and steam locomotive Chuff will return to normal. ***Controllable only with QARC Analog or DCC.***

Coupler Sounds: There are three coupler sounds in Quantum depending on the type of operation. When coupling up to rolling stock, hear the sound of the locomotive crashing into and pushing a string of cars. When uncoupling, hear the sound of the lift bar and coupler pin after backing up over a magnet to open the couplers. Hear the knuckle opening and the air brake lines parting when moving from the uncoupled cars. ***Controllable only with QARC Analog or DCC.***

Locomotive Shut Down (Extended): 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. A long Air Let-off will first occur followed by the steam Dynamo revving down and the Directional lights shutting off. The Air Pumps will turn off, followed by the sounds of Pop Off [57] operating for about ten seconds and finally the Blower Hiss will shut off. ***Controllable only with QARC Analog or DCC.***

Locomotive Start Up (Extended): Turn the throttle up slowly until you hear the Quantum System™ come on with a Long Air Let-off sound, Air Pumps, Blower hiss and the Dynamo revving as the Headlight comes up to its "dim" setting. Optional Number Board Lights and Firebox Lights will turn on and Cab Lights[58] will turn on after 10 seconds. If your locomotive has a Mars light, it will be dim and the front headlight will be off. . ***Controllable only with QARC Analog or DCC.***

57 Some steam locomotives may not produce a Pop-Off effect during shut down.
58 Your steam locomotive may not have all lights described here, depending on the model.

2.0 Diesel Sounds

2.1 Automatic Sounds

Diesel Motor Rev: Quantum allows Diesel Motors to be operated with all eight notches corresponding to the throttle notches used on the prototype. As the DC throttle is turned up, the Diesel Motor RPM will increase in fixed increments until the maximum RPM occurs at notch 8. All eight notches are evenly distributed between 0 and the maximum speed step.

Diesel Turbo: QSI diesels have a turbo effect – a very distinctive high frequency whine. Turbo appliances are used to improve the locomotives horsepower by pumping air into the intake manifold under pressure. The power to activate the turbo motor comes from the locomotive exhaust pressure. QSI turbo sounds are separate from the Diesel Motor sound, which allows the turbo effect to lag the motor when the Diesel Motor is revving down or revving up, just like the prototype.

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 in through louvers on the sides of the locomotive, which is then blown across large radiators. When cooling fans start, you will also hear the sounds of louvers opening. When cooling fans shut down, you will hear the louvers close. ***Take control only with QARC Analog or DCC.***

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 or any other 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.

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

Brake Squeal: You can hear the brake squeal on prototype locomotives when the locomotive is moving slowly which can become particularly loud when the wheels are just about to stop turning. Listen at slow speeds for constant Brake Squeal sound and the final distinctive squealing sounds as the diesel slows to a stop. ***Take control under QARC Analog or DCC.***

Quick Locomotive Start Up and Shut Down: All diesel locomotives have a quick start up and shut down effect when a locomotive is selected in DCC or power is applied in DC. Extended turn-on effects are also available in DC with QARC technology and in DCC (see Controllable Sounds below).

2.2 Controllable Sounds

Air Horns: The Quantum system uses authentic locomotive sounds whenever possible. The Quantum Horn has been recorded from a variety of diesel locomotives. The number of chimes and the horn manufacturer determines how air horns sound. Quantum Horns include single chime horns found on early F units, as well as multi-chime horns more common on modern diesels. In addition, all diesels include a special short horn blast. If you blow the Horn briefly, you will produce a realistic short Horn sound or "Hoot".

Bells: Diesel and electric locomotives, as well as larger steam locomotives, usually have pneumatically operated mechanical bells. Diesel bells can be as distinctive as steam bells. They are characterized by their tone, clapper rep rate and their location in the locomotive. In addition, it often takes time to get the clapper up to speed on the prototype or to shut down. When the Quantum Bell is turned on in Neutral, you will hear the wheezy sound of the pneumatic clapper starting up before the Bell starts to ring and you will hear the Bell fade out with soft rings along with the Short Air Let-off sound associated with turning this appliance off.

Doppler Run-by: Prototype locomotive 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 change the pitch exactly when and where you want. Doppler shift is based on the scale 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, locomotive sounds return to normal. ***Independently controllable under Analog or DCC.***

Flanges or Extended Brake Squeal: When a train enters a curve, the flanges on the wheels tend to ride up on the inside of the rail and squeal. Recreate this squealing effect by pressing and releasing the Brake Sound remote control button quickly and repeatedly as necessary. Or for slow stops, use the same remote key to produce long protracted squealing brake sounds. ***Independently controllable only with QARC Analog or DCC.***

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 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. ***Controllable only with QARC Analog or DCC.***

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 on diesel locomotives 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 the traction motors is dissipated as heat by the resistor grid. These resistor arrays get quite hot and require cooling. When Dynamic Brakes are turned on in the Quantum equipped diesel locomotive, the Diesel Motor sound drops to notch 1 and the Dynamic Brake Cooling Fan sounds come on. Since prototype dynamic brakes are relatively ineffective a low speeds, the Dynamic Brakes will shut off automatically below 8 smph. ***Controllable only with QARC Analog or DCC.***

Coupler Sounds: There are three types of coupler sounds in Quantum depending on the type of operation. When coupling up to rolling stock, hear the sound of a locomotive crashing into and pushing a string of cars. When uncoupling, hear the sound of the lift bar and coupler pin after backing up over a magnet to open the couplers. Hear the knuckle opening and the air brake lines parting when moving from the uncoupled cars. ***Controllable only with QARC Analog or DCC.***

Low Idle: Low Idle is used on prototype diesel 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.

Diesel Locomotive Shut Down (Extended): A Long Air Let-off will occur first followed by the Directional Lighting shutting off. The Air Pumps will turn off, as will the Number Board Lights, followed by the sounds of the Cooling Fans shutting off, the louvers closing, the Diesel Motors shutting down and finally, the engineer's door opening and shutting. ***Controllable only with QARC Analog or DCC.***

Diesel Locomotive Start Up (Extended): The engineers door will open and close, then the Number Board Lights will turn on, followed by vents opening, the two Diesel Motors starting up one at a time (if two motor diesel), the Air Pumps starting up, and the locomotive entering normal operation. ***Controllable only with QARC Analog or DCC.***

3.0 Electric Locomotive Sounds

3.1 Automatic Sounds

Traction Motor Whine: Although both diesels and electric locomotives have traction motors, electric locomotives do not have loud diesel motors drowning out the sounds of the traction motors. You will hear the traction motors when the electric locomotive starts out, especially if the Cooling Fan volume is turned down to a lower value. Like the prototype, the Quantum traction motor whine pitch increases and decreases with the speed of the locomotive. It is not affected by track voltage, only the speed.

Cooling Fans: The electric traction motors get quite hot from the enormous current supplied to their circuits. All electric locomotives have powerful cooling fans that can create so much draft the access panel doors cannot be opened when the fans are operating at full power. It is not surprising that these fans can easily be heard in idling and operating locomotives. You will also hear the sounds of louvers opening before the fans start. When Cooling Fans shut down, you will hear the louvers close. ***Take control only with QARC Analog or DCC.***

Air Pumps: When a locomotive is sitting still, the air pumps come on in a steady beat to replace the air lost from the brake air release or any other air operated appliances. Once the pressure is up, the pumps only turn on occasionally to maintain the pressure. Air pumps are electrically operated and are quite noticeable if the fans are turned down or off. In Forward, you will hear the Air Pumps come on soon after the Horn is operated to maintain the air pressure

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

Brakes Squeal: You can hear the brake squeal on prototype locomotives when the locomotive is moving slowly and can become particularly loud when the wheels are just about to stop turning. Listen at slow speeds for constant Brake Squeal sound and the final distinctive squealing sounds as the electric locomotive slows to a stop. ***Take control under QARC Analog or DCC.***

3.2 Controllable Sounds

Horn: The Quantum system uses authentic locomotive sounds whenever possible. The Quantum electric locomotive Horn has been recorded from a prototype single chime GG-1 at a passenger station. All Quantum Horns and Whistles are engineered by our 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: Diesels and electric locomotives, as well as larger steam locomotives, usually have pneumatically operated mechanical bells. The Quantum electric locomotive bell was recorded from the prototype. When the Bell is shut off, you will hear the Bell fade out along with the Short Air Let-off sound associated with turning this appliance off.

Doppler Run-by: The locomotive 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 change the pitch exactly when and where you want. Doppler shift is based on the scale 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, locomotive sounds return to normal. ***Independently controllable under Analog or DCC.***

Flanges or Extended Brake Squeal: When a train enters a curve, the flanges on the wheels tend to ride up on the inside of the rail and squeal. Recreate this squealing effect by pressing and releasing the Brake Sound remote control button quickly and repeatedly as necessary. Or for slow stops, use the same button to produce long protracted squealing brake sounds. ***Independently controllable only with QARC Analog or DCC.***

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 electric locomotive model as braking is continually increased. The longer the air is released, the quicker the 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. ***Controllable only with QARC Analog or DCC.***

Dynamic Brakes: Electric locomotives do not have dynamic brake sounds such as the roar of the cooling fans. However, the Dynamic Brake function has been included to make the Quantum electric locomotive consistent with other Quantum equipped locomotives in a consist. If Dynamic Brakes are activated, the Traction Motor Sound-of-Power will reduce to the lowest setting since It would be inconsistent for an electric locomotive to be working at full Sound-of-Power while Dynamic Brakes are being applied to other locomotives within the same consist. When Dynamic Brakes are shut off, the traction motor sounds will return to normal Sound of Power. Since prototype dynamic brakes are relatively ineffective a low speeds, Quantum Dynamic Brakes will shut off automatically below 8 smph. ***Controllable only with QARC Analog or DCC.***

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 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. ***Controllable only with QARC Analog or DCC.***

Electric Locomotive Shut Down (Extended): A Long Air Let-off will occur first followed by the Directional Lighting shutting off. The Air Pumps will turn off, Cab Lights will turn off, followed by the sounds of the louvers being closed and the engineer's door being opened and shut. ***Controllable only with QARC Analog or DCC.***

Electric Locomotive Start Up (Extended): The engineer's door will open and close, then the Cab Lights will turn on, followed by the Air Pumps, Directional Lights, vents opening and then the locomotive will enter normal operation. ***Controllable only with QARC Analog or DCC.***

4.0 Gas Turbine Sounds

4.1 Automatic Sounds

Diesel Motor Rev: The diesel used in the prototype was a Cummings 250 horsepower motor. Under Diesel control in RTC or SC throttle mode, the Gas Turbine top speed is limited to 25 smph. Quantum allows the Diesel Motor to be operated over eight notches corresponding to the throttle notches used on most prototype diesels. As the throttle is turned up, the Diesel Motor RPM will increase in fixed increments until the maximum RPM occurs at notch 8. All eight notches are evenly distributed between 0 and the maximum speed step.

Turbine Whoosh: The Gas Turbine produced an almost deafening roar that seemed to drown out all but the horn. It was sometimes referred to as "The Big Blow" since its dominant sound was that of furiously rushing exhaust gas. We have modeled this effect by synthesizing this sound in the Quantum system until it sounded exactly like the prototype turbine. We have coupled this effect to our Sound of Power™ concept to provide labored Turbine Whoosh when the locomotive is under heavy load.

Turbine Whine: Some witnesses to the prototype Gas Turbine maintain there is no Turbine Whine, such as the sound that a jet airplane would make. However, other witnesses say that there was a discernable whine as the turbine was revving up that could still be barely heard at idle. We have included a separate whine sound in the Quantum System, which can easily be heard during the transition from Diesel to Turbine sounds, and which is almost buried in the Turbine Whoosh sound when the turbine is "on the line".

Cooling Fans: The diesel motor, turbine and generator enclosed in the Gas Turbine 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. When cooling fans start, you will also hear the sounds of louvers opening. When cooling fans shut down, you will hear the louvers close. ***Take control only with DCC.***

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 or any other air operated appliances. Once the pressure is up, the pumps only turn on occasionally to maintain the pressure. Air Pumps are operated directly from the diesel Motor or from two electric motors when the turbine is "on the line". Air Pumps are quite noticeable when turned on in a non-moving locomotive in Diesel Mode.

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

Brakes Squeal: You can hear the brake squeal on prototype locomotives when the locomotive is moving slowly and can become particularly loud when the wheels are just about to stop turning. Listen at slow speeds for constant brake squeal sound and the final distinctive squealing sounds as the Gas Turbine slows to a stop.

Quick Diesel motor Start Up: All diesel locomotives have a quick start up and shut down effect when power is first applied in DC or when the locomotive is selected in DCC. Extended turn-on effects are also available in DC with QARC technology and in DCC (see Controllable Sounds below).

4.2 Controllable Sounds

Air Horn: The Quantum Horn used for the Gas Turbine is a single chime horn usually found on early F units. Some commercial videotapes of the Gas Turbine have dubbed a multi-chime horn in for sound effects and do not represent the actual locomotive horn. In addition, the Quantum Gas Turbine Horn includes a special short Horn blast. If you blow the Horn briefly, you will produce a realistic short Horn sound or "Hoot".

Bell: The Gas Turbine used a pneumatically operated mechanical bell. When the Quantum Bell is turned on in Neutral, you will hear the wheezy sound of the pneumatic clapper starting up before the Bell starts to ring and you will hear the Bell fade out with soft rings along with the Short Air Let-off sound associated with turning this appliance off.

Transition from Diesel to Turbine and Ignition: Starting the Gas Turbine was a complex procedure, which required considerable time for the Turbine to be at full power. We have shortened the amount of time to start the Turbine in the model but preserved much of the important procedures necessary to bring the Turbine "on the line". This includes first ramping up the diesel one notch to start the Turbine rotating to the point where it would fire. The firing of the Gas Turbine model sounds a bit like lighting a large industrial gas furnace. At this point the Turbine starts revving up with its distinctive Whine coupled with a low level Whoosh. The diesel is then revved up further followed by the Turbine Whine and Whoosh increasing up to the point where the diesel disconnects and returns to idle. Shortly after this, the Turbine is ramped up to full power where the Whoosh or roar now dominates the Turbine Whine.

Transition from Turbine to Diesel: Turning off the prototype Gas Turbine was almost as complex as turning it on. In the model the diesel is first ramped up to engage the Turbine at full RPM. The Turbine throttle is reduced to zero. The Diesel Motor is maintained at full power to allow the Turbine to cool over about 40 seconds; during this period, the Turbine Whoosh is first reduced to off while the Turbine Whine is gradually reduced to zero. After the Turbine is completely shut down, the Diesel Motor returns to idle.

Doppler Run-by: The locomotive 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 change the pitch exactly when and where you want. Doppler shift is based on the scale speed of

the model, 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, locomotive sounds return to normal.

Flanges or Extended Brake Squeal: When a train enters a curve, the flanges on the wheels tend to ride up on the inside of the rail and squeal. Recreate this squealing effect by pressing and releasing the Brake Sound DCC remote control button quickly and repeatedly as necessary. Or for slow stops, use the same button to produce long protracted squealing brake sounds. ***DCC only.***

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 by the resistor grid. These resistor arrays get quite hot and require cooling. When Dynamic Brakes are turned on under diesel operation, the Diesel Motor sound drops to notch 1 and the Dynamic Brake Cooling Fan sounds come on. Under Turbine operation, the Turbine sound will drop to its lowest Sound of Power setting but since the Turbine Whoosh stays relatively constant and loud, it may be difficult to hear the Dynamic Brake sounds. Since prototype dynamic brakes are relatively ineffective a low speeds, the Dynamic Brakes will shut off automatically below 8 smph. ***DCC only.***

Coupler Sounds: 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 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 only.***

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.

Diesel Locomotive Shut Down (Extended): A Long Air Let-off will occur first followed by the Directional Lighting shutting off. The air pumps will turn off, as will as Directional Lighting, followed by the sounds of the Cooling Fans shutting off, the louvers closing, the Diesel Motor shutting down and finally, the engineer's door opening and shutting. ***DCC only.***

Diesel Locomotive Start Up (Extended): The engineers door will open and close, followed by vents opening, the Diesel Motor starting up, the Air Pumps starting up, and the locomotive entering normal operation. ***DCC only.***

Appendix II: Special Hardware Operations

Using the Quantum Hardware Reset and Volume Controls:

Quantum software can be programmed by the operator to reset the system to factory defaults. As a safety precaution, Quantum also has a backup hardware method to do a system reset. Either method can be used to reset the locomotive to original factory settings. In case your Quantum Sound and Train Control System misbehaves and simply turning the power off for five seconds does not return it to normal operation, you can reset your locomotive using POP 11 (See Analog Programming, Page 15) or you can use the hardware Reset Jumper found on earlier Quantum Systems or the Magnetic Wand to activate a reed switch included on more modern Quantum Systems.

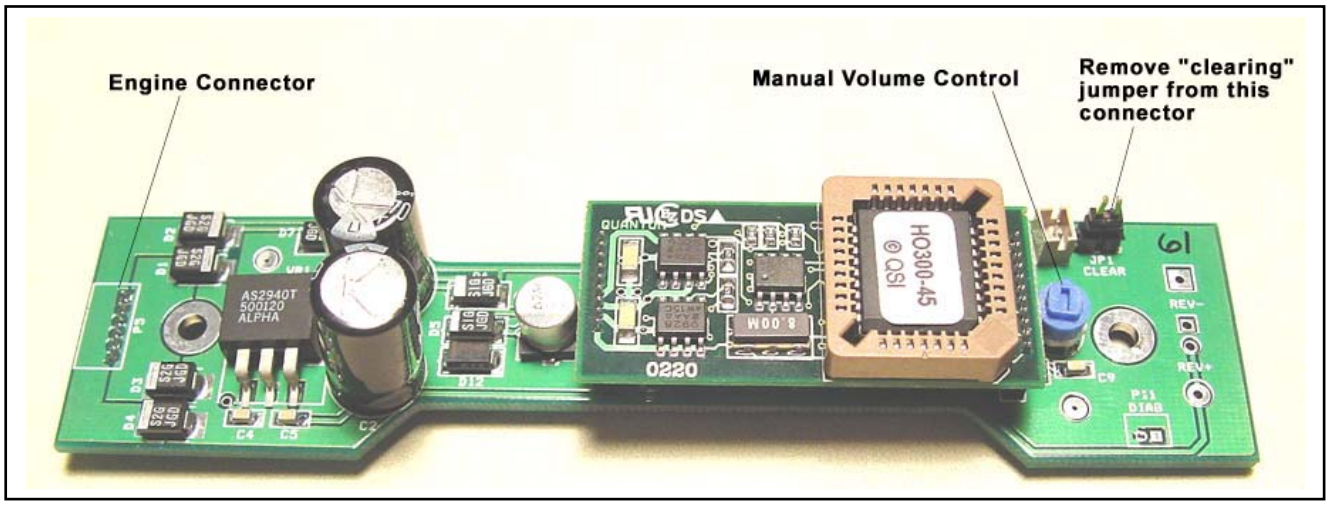
Quantum system volume can also be adjusted using software programming (POP 1) or by a hardware volume adjustment or with the Quantum Engineer add-on Power Pack controller. Earlier Quantum systems used a potentiometer volume control and later models use a Magnetic Wand.

Reset Jumper Models

Both early Quantum steam and diesel locomotives used jumper and volume potentiometer to control reset and sound volume. The diagram below shows a Quantum circuit board used in some steam locomotive tenders. The jumper and volume potentiometer are located on the bottom board as shown.

To Reset the Locomotive

- Turn off the main track power.
- For steam locomotives, remove the tender body or water filler hatch to reveal the circuit board. Many plastic tenders do not use mounting screws; the plastic tender cabs press fit to the chassis. Large plastic tenders and die cast tenders will have retaining screws under the chassis. Most diesels will have a removable access panel over the Quantum circuit board on the roof. The location of the access panel will be shown in the *Steam or Diesel Model Specification* sheet that was included with your locomotive instructions.
- To reset the Quantum system to its default values, locate the black "clearing" jumper (see below) and remove by pulling it up.
- Reapply main track power, the horn will hoot three times and/or bell will sound after a few seconds.
- Turn main track power off and reinstall jumper, and tender cab or access panel. The locomotive has now been returned to original factory settings including all Analog and DCC settings.



Note: Do not try to perform the jumper reset-operation on the DCC Program Track under Service Mode power. Always perform this operation under full power.

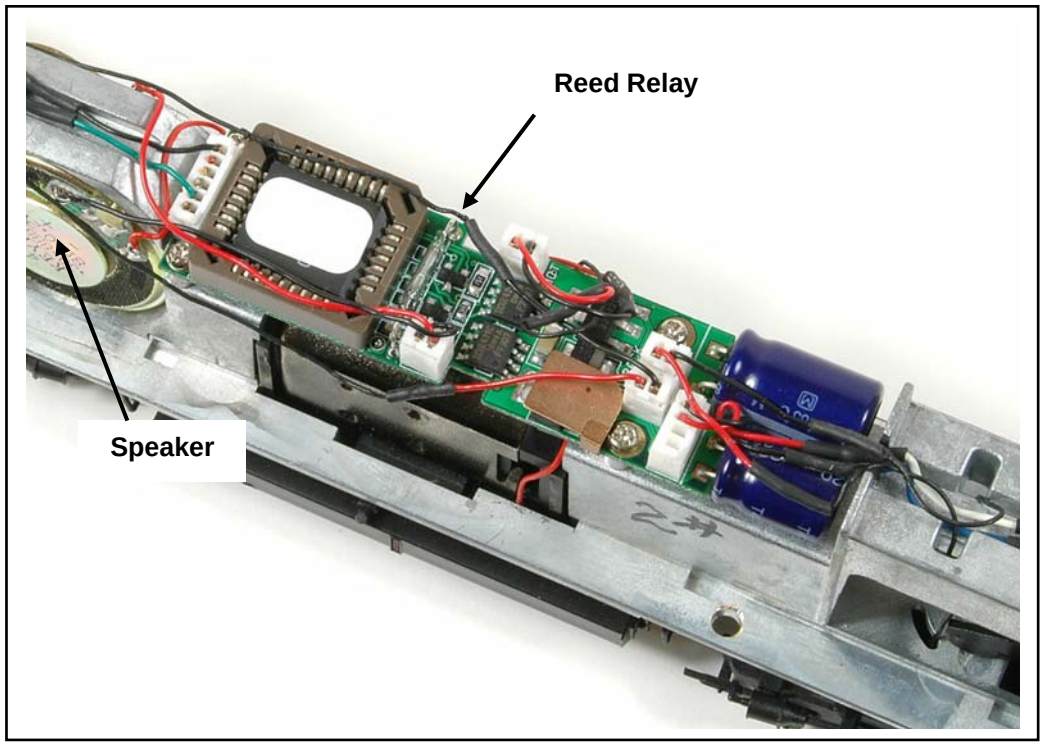
To Adjust the Volume Using the Potentiometer

- Locate the manual volume control under the access panel on the roof of your diesel locomotive or under the water hatch on steam locomotive tenders as shown in the *Diesel or Steam Model Specification* sheet that was included with your instructions.
- Turn on main track power. You may want to turn on and leave on some of the significant sound effects such as Whistle/Horn and Bell.
- Use a small screwdriver to turn the volume clockwise to increase volume or turn it counterclockwise to decrease the volume.
- Replace the access panel or water hatch cover.

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

Magnetic Wand Models

Modern Quantum steam and diesel models use a glass enclosed reed relay to reset the Quantum System or adjust the volume. The reed relay will close its contacts when the Magnetic Wand supplied with your locomotive is placed in close proximity. The advantage of this method of adjusting your locomotive's volume or resetting it to factory defaults is that you do not need a removable panel to gain access to the controls. Also 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.



Quantum small diesel board with a reed relay mounted in a narrow-body diesel

To Reset the Locomotive

- Locate the reed relay area as shown in the *Diesel or Steam Model Specifications* sheet that was included with your model.
- Turn off the track power.
- Place the Magnetic Wand over the reed switch area on the roof of the diesel locomotive or steam tender perpendicular to the track and re-apply track power and leave the wand there until you hear the word "reset" or three hoots. Remove the Magnetic Wand; your locomotive is now reset.

The locomotive has been returned to original factory defaults including all DCC and Analog values.

Note: Do not try to perform this reset operation on the DCC Program Track under Service Mode power. Always perform this operation under full power.

To Adjust the Volume Using the Magnetic Wand

- Locate the reed relay area on the locomotive's roof as shown in the *Diesel or Steam Model Specifications* sheet that was included with your model.
- Power up locomotive and leave in Neutral.

Place the enclosed Magnetic Wand over this reed switch area on the roof of the diesel locomotive or tender 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.

High Voltage Circuit Breaker (Analog and DCC)

Your locomotive is designed to operate on normal HO track voltage supplied by most HO power packs. If track voltage exceeds 21.5 volts peak[59], the motor drive circuit will automatically shut down and the locomotive will coast to a stop, while the Quantum System alerts you to the problem through a continuous series of hoots. This built in safety feature protects the Quantum System and motor from excessive voltage.[60]

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

59 Later Quantum equipped models may not have this limitation on operating voltage due to design and component improvements. Consult your Operation Manual that came with your locomotive model.

60 The high voltage circuit breaker will sometimes activate if the Load (POP 2) programming 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.

Appendix III: First Edition BLI Hudson

Quantum Operation of BLI NYC J1e Hudson Locomotive

The fist addition BLI Hudson with Quantum System used a different method to advance through program options and had a different listing of program options. The following describes entering programming and moving through the different POP's (Program Options) using a standard HO power pack throttle. Normal operation of the Bell, Horn, direction changes, Doppler, etc. are consistent with current Quantum equipped locomotives although the first edition Hudson will not have all the features or improvements that are in the most recent releases of the Quantum System.

Programming your Hudson Locomotive

Program Option #'s (POP's[61])	Option Name	Message[62] when Entering Option	Option Description
1	System Volume[63] (17, Max)	Hear the system volume at its current setting	Quantum will play an ensemble of whistle, chuff and bell at each setting. Sets System volume (17 levels) where level 16 is maximum volume and level 0 is off.
2	Whistle Bell Off (8, -16 db)	Hear "Off" or the sound of a Bell right and whistle blast.	A **Slow** operation of the direction switch will toggle between "off" to disable the Horn and Bell operation and "a single bell ring followed by a whistle blast" to indicate that the whistle and bell have been enabled. Disabling Horn and Bell operation allows the Hudson to be operated in helper service in consists.[64]
3	Whistle Volume (8, -16 db)	Hear a Whistle blast at current volume level.	Each **Slow** operation of the direction switch will cause the volume of the Whistle to decrease one level. Each **Quick** operation of the direction switch will cause the volume of the Whistle to increase one level. The Whistle will blast once at each volume level setting.
4	Bell Volume (8, -16 db)	Hear Bell Ringing at current volume level.	Each **Slow** operation of the direction switch will cause the volume of the Bell to decrease one level. Each **Quick** operation of the direction switch will cause the volume of the Bell to increase one level. During volume adjustments, the Bell will ring continuously.
5	Chuff Volume (8, -16 db)	Hear Chuff sound at current volume level.	Each **Slow** operation of the direction switch will cause the volume of the Chuff to decrease one level. Each **Quick** operation of the direction switch will cause the volume of the Chuff to increase one level. During volume adjustments, the Chuff will sound continuously at a constant rate.
6	V-Start (8.5v)	Hear single Bell ring.	A **Quick** or **Slow** Operation will start the bell ringing while the new value of V-Start is being calculated. The locomotive will move slightly when final value is calculated and whistle will sound once.
7	V-Max (12 v)	Hear single Bell ring.	A **Quick** or **Slow** Operation will set the new value for V-Max depending on where the throttle is set and whistle will sound once.
8	Programming Reset	Hear a single Whistle Blast.	Then whistle blast indicates that Quantum has been reset to factory default values.
9	About*	Software Model Name "Three zero zero"	The first **Quick** or **Slow** Operation will generate the version number (e.g. "one point two). The second **Quick** or **Slow** operation will generate the software release date as month first, followed by day of month followed by year (e.g. "zero nine" pause "two four" pause "zero two" or 09/24/02 for September 24, 2002.

* There is no verbal response; just silence.

61 POP is short for "Program Option".

62 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.

63 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.

64 If you disable the Whistle and Bell, you will not be able to hear the Bell sound when you want to enter programming at a later time. However, if you go through the procedure of three Quick flip-and-back operations of the reverse switch, Quantum will enter programming as usual.

Entering Programming

There is a simple sequence to enter programming using the direction switch.

- After you apply power and turn up the throttle to hear the sound system come on, do three **Quick** operations in succession. In other words, right after you apply power, turn on the Bell with a **Quick** flip-and-back, then turn the Bell off with a second **Quick** flip-and back, and then turn the Bell back on again with a third **Quick** flip-and-back. You have done this correctly if you have moved the direction switch three times in one direction and three times in the other direction. 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 should be on. After a short period, the Bell and all locomotive sounds will shut off automatically. You will hear the phrase "***Enter Programming***" followed by silence. You can now start to navigate through the Programming Options.

  Note: The reason for the unusual procedure for entering programming is to prevent it from accidentally happening during normal operation.

Navigating through the Programming Options

The Hudson Locomotive has nine different programming options.

- Each option is selected by turning the throttle up until you hear a long air release, then back down until you hear a short air let-off, but no further. If you turn the throttle down too far, you may lose power and sound and will have to start over and re-enter programming. The voltage where you hear the long air release is called V-High and the voltage where you hear the short air release is called V-Low.
- Each programming option will be announced with a verbal response.
- Once you select a programming option, you make the changes by using the direction switch. If you do not use the direction switch, you will not make any changes to the current settings and can move on to other options or leave programming.
- Once you reach POP 9, further attempts to advance to the next option, will repeat POP 9. To move to lower POP's you will need to leave programming and start over.
- If you get lost in adjusting the different Programming Options or do not like your settings and wish to return to the factory settings, you can do so using Programming Option #8 (see below).

Leaving Programming

- You can exit Programming anytime you want by turning the power off and back on again.

Entering an Option and Selecting a Setting:

- After hearing the announcement of the option, use the direction switch to enter programming for that option and make changes. *You can use either a **Slow** or **Quick** operation of the direction switch to enter the option.*
- When you first enter the option, you will hear the current setting.

  Note: You may do **Slow** operations of flip-and-back with the direction switch to select the next setting, or in certain options, a **Quick** operation of the direction switch will select the previous setting. This will become clear with the following examples.

  Note: You can leave an option by advancing to the next option or by returning to regular operation. Use an up and down motion of the throttle to advance or turn the power off to leave programming entirely.

Example: Setting System Volume

System Volume (option 1): This option allows the user to increase or decrease the overall sound system volume. This setting affects all sounds at once. Individual sounds can be adjusted separately in other programming options (see options 3, 4 and 5 below).

- Enter the programming mode.
- Move the throttle up to V-High to hear a short air release and then back down to V-Low to hear a long air release. You will hear a verbal announcement, "One - System volume".
- Use either a **Slow** or **Quick** flip-and-back operation of the direction switch to enter this option. You will hear an ensemble of locomotive sounds at the current volume level. The next time you do a **Slow** operation with the direction switch, you will hear the ensemble play again at the next lower volume setting. If you do not hear any sounds at all or some of the sounds disappear after reducing the volume

a number of times, do not be alarmed; you can simply continue doing **Slow** operations until the volume is restored to its loudest setting and then continue to reduce the volume from that point. There are a total of 17 volume levels.

- After entering this option, use a **Quick** flip-and-back operation of the direction switch to increase the volume to the next level. If you suddenly loose the sounds as you are increasing the volume with **Quick** Operations, do not be alarmed; the volume will increase until it reaches maximum and then will reduce to minimum. You can then continue to do **Quick** operations from that point to increase the volume.
- Continue with either **Slow** or **Quick** operation to move down and up in volume until it is at the level you want.
- To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation.
- Or continue to the next programming option by turning the throttle up to a high value (V-High) to hear a short air release and then back down to V-Low to hear a long air release.

Note: You can move up or down in volume using both **Quick** and **Slow** operations. Or you can stay with either **Slow** or **Quick** operations exclusively and cycle through all possible volumes in an endless loop. In total, there are 17 volume levels at 2 db decrements with level 1 (0 db) as the loudest and level 17 (-32db) as the lowest (which is essentially off). The default factory setting for System Volume is at maximum volume (Level 1, 0 db).

Appendix IVa: Gas Turbine Prototype Design and Operation

Introduction

The Veranda Gas Turbines were powerful locomotives, developing 4,500 horsepower with 138,000 lbs of tractive effort at start up. As a point of comparison, the N & W J 4-8-4 steam locomotive provided 80,000 lbs and the largest steam locomotive, the UP Big Boy, provided 135,000 lbs of tractive effort. The popular GP series diesels were rated at 2000 hp with a maximum of 65,000 lbs of tractive effort. The gigantic UP DD40AX Centennials comes close with 134,000 lbs of tractive effort. Later large two-unit turbines developed over 8,500 horsepower but the Veranda retained its distinction of having the largest internal combustion engine in a single power unit.

The Verandas were designed for freight operation with a top speed of 65 mph.

The advantage of all gas turbines for Union Pacific was their ability to operate on inexpensive heavy oil called "Bunker C" that was readily available on long UP desert lines. The chief disadvantages of gas turbines were their lower efficiency than diesels particularly at low speeds and their tendency towards corrosion. The Bunker C caused both fouling and corrosion of the turbine blades over time and the heavy oil was difficult to handle. Turbines carried their own steam boilers to preheat the Bunker C to 240 degrees to be suitable for combustion in the turbines. These problems combined with the increasing price of Bunker C and competition from new more efficient and powerful diesels, caused the demise of the Gas Turbines. However, the UP Verandas were a success story. They performed well for the UP from 1952 to when they were retired in the early sixties. The more advanced two unit turbines served the UP up to December of 1969 when the last gas turbine was retired.

The following provides a description of the prototype Union Pacific Veranda Gas Turbine.

Design and Description

The Veranda Gas Turbine used two different methods to power the locomotive; a 4500 horsepower gas turbine and a 250 horsepower diesel motor.

Diesel Motor

This was a Cummings diesel motor that powered three different machines.

1. **Diesel Generator:** The diesel generator, in turn, had three different functions:
    a) Provide electrical power to change batteries and power for d-c auxiliaries when turbine power was shut down.
    b) To motor one of the main traction generators to crank turbine for starting.
    c) To power two of the eight traction motors for low power locomotive movement in the yard (hostling). During hostling, there was no battery charging or air compressor operation.

2. **Diesel Alternator:** This was belt driven from the diesel motor to provide three-phase a-c auxiliary power to run the radiator-fan motors, starting fuel-pump motor, and water booster-pump motor until turbine is up to idling speed.

3. **Air Compressor:** This was also belt driven from the diesel motor to pump up main reservoir air pressure until the two motor driven air compressors take over during battery charging. This is primarily intended for use during hostling and turbine cranking.

The diesel motor was not used to provide additional power during normal operation or when staring the locomotive from a dead stop.

Gas Turbine

This was the main power plant rated at 4,500 horsepower. It is an oil burning, axial flow gas turbine. It delivers power through a single reduction gearbox to drive four traction generators, an auxiliary generator and a turbine alternator.

The traction generators are excited by four amplidyne exciters and furnish power to eight traction motors. Power is controlled in 20 steps by the main handle of the master controller. There are four independent power circuits, each consisting of a traction generator and two traction motors. The following connections are obtained during locomotive operation:

1. Series-connected traction motors, full field.
2. Series-connected traction motors, shunted fields.
3. Parallel-connected traction motors, full field.
4. Parallel-connected traction motors, shunt fields.

Transitions are automatically controlled as a function of locomotive speeds.

While the field current was determined as a function of speed, the series parallel connection of the motors was determined by selection handle. The choices of the selection handle were OFF at the left followed by motor position, M1, motoring position M2, and BRAKE to the right.

The turbine alternator is a three-phase, six–pole machine driven by the turbine and supplies power to the a-c auxiliary system.

The auxiliary generator driven by the turbine furnishes power for d-c auxiliaries and battery charging when turbine is running and "on the line".

Operation

The Turbine Control Switch, TC, has four positions and along with the Turbine Control Switch Light, controls and monitors diesel-motor and turbine operations.

Starting the Diesel Motor (TC1)

1. Move TC switch to position 1 and all necessary switches and breakers must be closed.
2. Close battery switch BVS.
3. Close breaker TB1 – Turbine generator, Diesel Start.
4. Close breaker TB3 – Coolant pump.
5. Close breaker TB12 – Diesel alternate field (this breaker should normally be left closed). The following sequence will happen:

    - Coolant water pressure switch picks up.
    - Battery charge timing relay, **T-BC**, picks up.
    - Fuel pressure relay, **FPR** picks up.
    - **MF TEMP** lamp lights.
    - **LUB PRS** lamp lights.
    - Sequence relay, **T-SQ**, picks up.
    - Fuel dump solenoid valve**, FDSV,** is energized.

Momentarily depress the engine-start button, ES.

a) The diesel crank timing relay, T-DC, picks up and remains closed for 20 seconds. Engine cranks for 20 seconds and fires within this period.
b) Ten seconds later battery charging power is supplied from diesel generator.
c) After battery charging commences, the motor driven train air compressors run to supply main reservoir air. Also the diesel alternator is excited to furnish ac auxiliary power to necessary ac auxiliaries only. At this time, lights can be turned on.

Note: The turbine's diesel did not have an air start. It was also started from the batteries.

The diesel motor can now be used to do hostling of the locomotive. Because of the notoriously inefficient operation of the gas turbine power plant at idle and low speeds, hostling was usually done using the diesel motor. To move the locomotive using the diesel motor:

1) Close propulsion control breaker, TB4.
2) Move reverse handle to FORWARD or REVERSE.
3) Move Selector Handle to M1 position.

    Note: When operating the diesel, the selector handle connects motors in series, M1, or in parallel, M2. Maximum diesel RPM in M2 is 843 rpm.

4) Advance throttle to 1st and then to 2nd notches.
5) To increase speed above 10 mph, move throttle handle to IDLE, then move Selector Handle to motoring position, M2, and again advance throttle handle to notches 1 and then to 2.

Note: The UP operation manuals do not seem to indicate the top speed in M2. Using the speed ratios for an F7 between series and parallel connections gives a speed ratio of 2.79 independent of gear ratios. I would guess the same holds true for the Turbine diesel. This would give a top speed of about 28 mph.

Note: In the Mighty Turbine video and on independent recordings, there is a high pitch whine when the motor is idling. Since it does not seem likely that the diesel locomotive would have a turbo and the turbine is not running, this is likely the sound of the gearbox.

Turbine Cranking (TC2)

When Turbine Control Switch, TCS, indicating lamp (green) on engineer's instrument panel lights, TC Switch can be advanced to Position 2, at which time the following occurs in the sequence listed below which takes about 3-5 minutes.

- TCS lamp goes out.
- Battery charging and motor driven air compressors nullified.
- Diesel generator is coupled to traction generator G4 to crank turbine (with diesel motor operating at idling speed).
- When turbine reaches 10-15 percent of speed (about 700 rpm), a limited amount of diesel fuel is admitted to turbine.
- Ignition is turned on.
- Atomizing air is fed to turbine.
- Turbine fires.
- Generator main field is weakened.
- Diesel motor governor is advanced to top speed.
- Turbine accelerates toward top speed.
- Generator G4 uncouples from diesel generator and turbine operates at IDLE speed.
- Diesel motor returns to IDLE speed and diesel generator reconnected for battery charging and air compressor operation.
- Turbine alternator furnishes power to traction motor blower motors, amplidyne drive motors, main lube pump motor.

Fuel Transfer (TC3)

When TCS green indicator lamp again goes on after the above 3-5 minute sequence finishes, TC switch can be moved to position 3. The following then occurs over about one minute

- Turbine auxiliary generator (dc) takes over battery charging function and supplies control power. Air compressors come on line.
- Fuel transfer mechanism operates progressively to transfer fuel from diesel oil to "Bunker C" within 40 seconds.

Turbine "ON THE LINE"

When TCS green indicator lamp relights after the 1-minute sequence above, TC Switch can be moved to position 4.

- Diesel motor shuts down.
- Turbine alternator takes over to supply auxiliary ac power to all ac motors.
- Turbine is "on the line" and locomotive is ready for operation.

Setting Turbine Speeds

Under normal conditions, turbine speed is adjusted for idle speed of 5,175 rpm using rheostat R# while having the turbine running in TC4., TH, IDLE, RH OFF and SR OFF. To adjust top speed, install reverse handle, throttle up to notch 13 slowly and adjust rheostat, R14A. Top speed is 6900 plus or minus 70 rpm.

Moving the Locomotive Under Gas Turbine Power

- Move reverse handle to FORWARD or REVERSE, depending on direction desired.
- Move selector handle to MOTORING position **M1** or **M2** position as required.

Note: The Selector Handle sets the turbine at idle in motor position, M1, or full turbine operation, M2.

- Make sure handbrake is released
- Advance throttle handle as quickly as possible to the position that starts locomotive. Observe limitations of loadmeter and do not permit notching guide pointer to make prolonged indications in the RED band. Reduce throttle position if necessary.
- Operate locomotive according to loadmeter and notching guide limitations.

Stopping the Locomotive

- Move throttle handle to IDLE and apply air brakes.
- If leaving engineers position, move selector and reverse handles to OFF.

Dynamic Brakes

- When Selector Handle is moved to Brake, the turbine goes to idle and dynamic brakes are applied. Resistor grid cooling fans come on automatically.

Reversing the Locomotive

- Bring locomotive to a full stop.
- Move reverse handle to opposite direction.
- Release brakes.
- Continue operation according to *Moving the Locomotive Under Gas Turbine Power* described above.

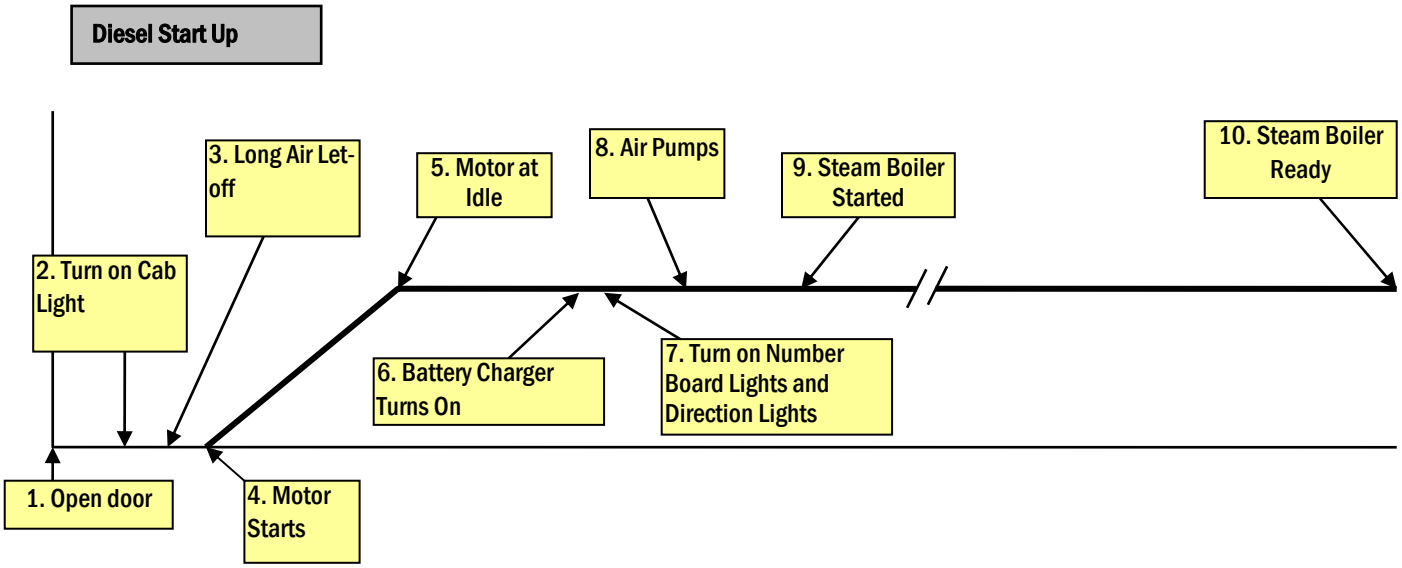
Shutting Down the Locomotive

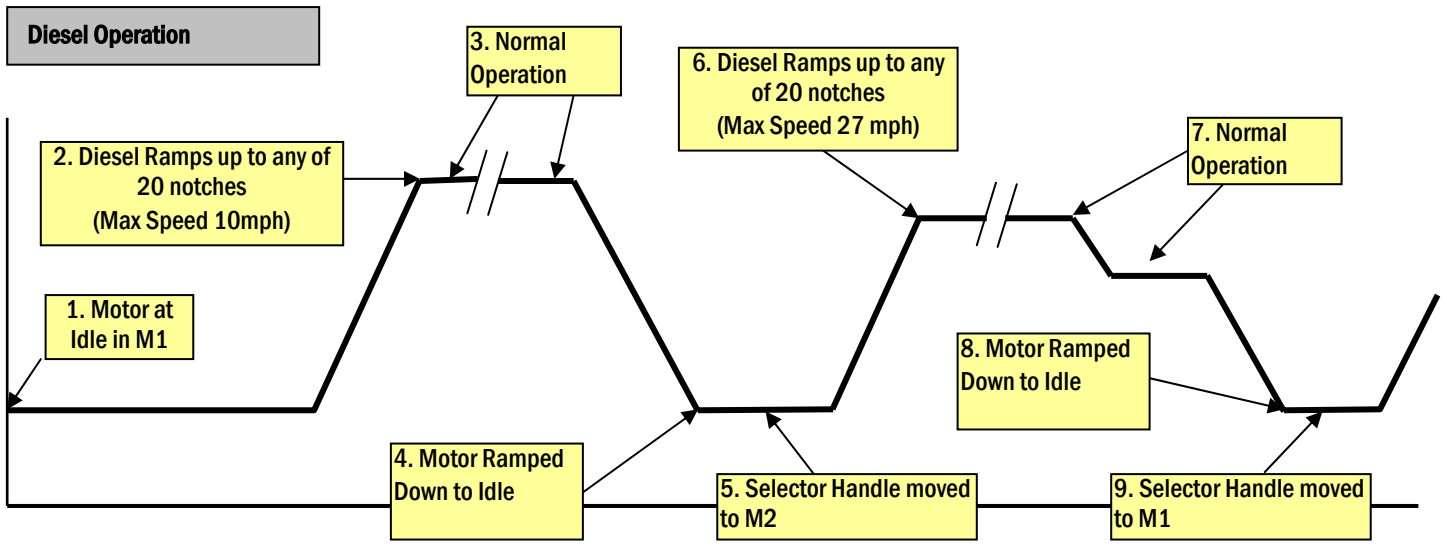
- Turn turbine control switch, **TC**, to position 1. Diesel motor automatically starts and gas turbine shuts down in approximately 4½ minutes.

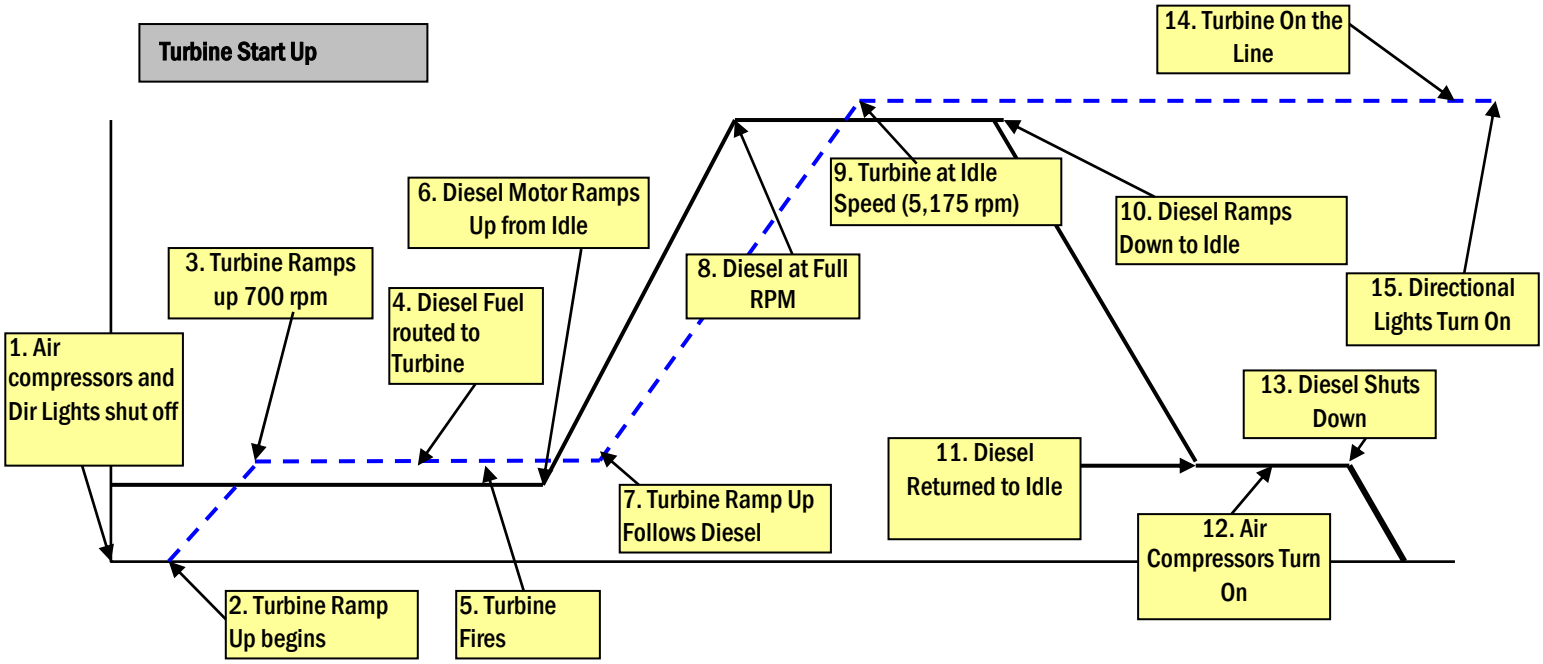
  Note: When fuel was cut to the turbine, without power, it probably took only about thirty seconds to completely stop. However, the diesel was allowed to operate to run the turbine with just air moving through the blades. I understand this was done to prevent heat damage to the blades. Assume that the diesel motor continued at full speed for about forty minutes followed by the diesel shutting down to idle, followed by the turbine winding down to off.

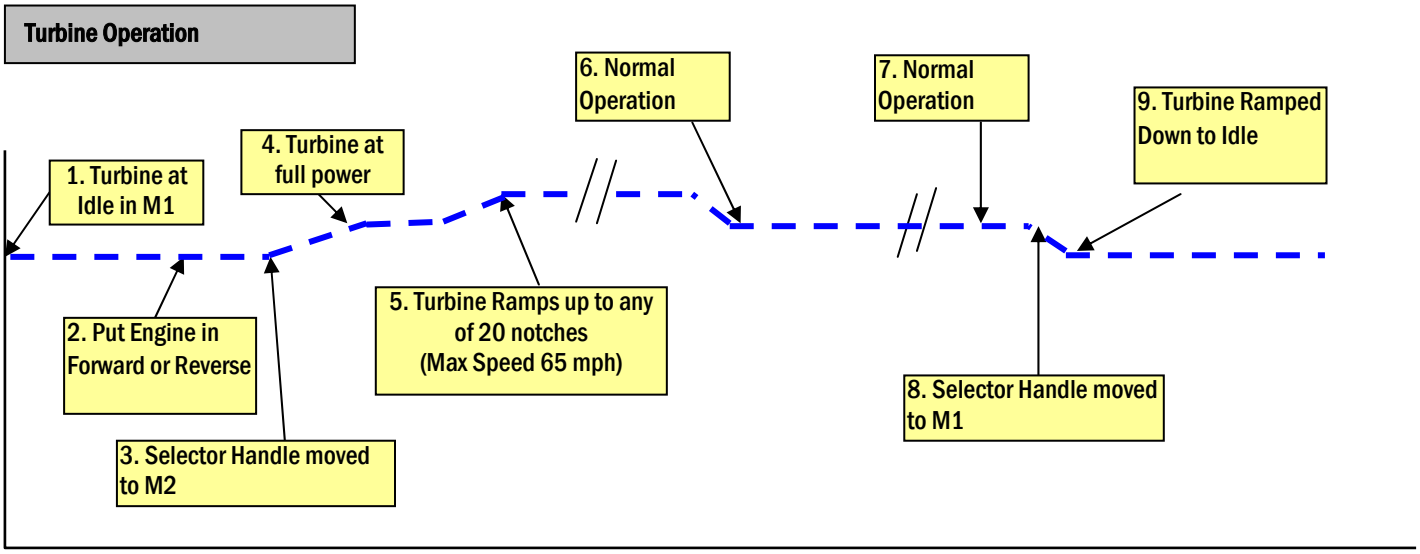
Leaving the Locomotive

- Set handbrake and close windows and doors.
- Move throttle handle to OFF.
- Move selector handle to OFF.
- Move reverse handle to OFF and remove handle.

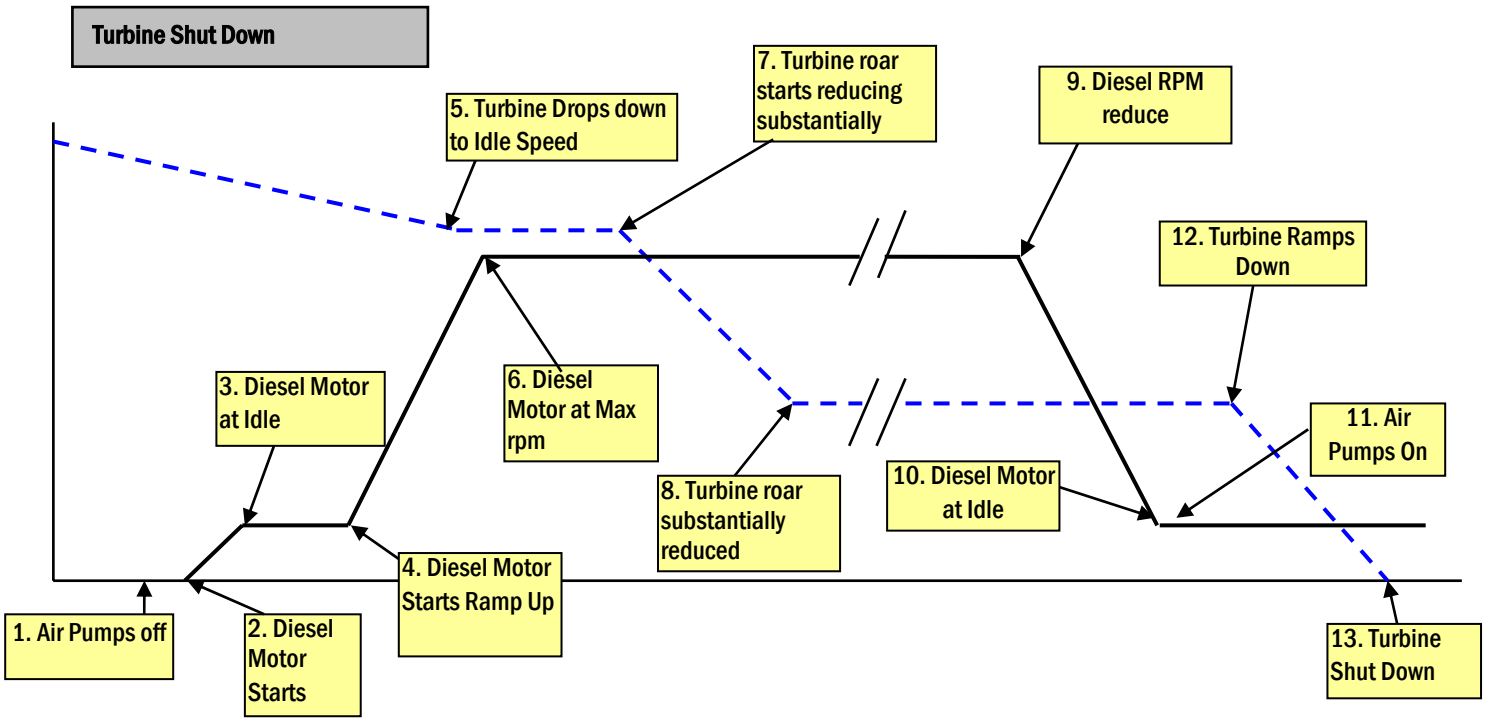

Diesel Start Up
1. Open door
2. Turn on Cab Light
3. Long Air Let-off
4. Motor Starts
5. Motor at Idle
6. Battery Charger Turns On
7. Turn on Number Board Lights and Direction Lights
8. Air Pumps
9. Steam Boiler Started
10. Steam Boiler Ready

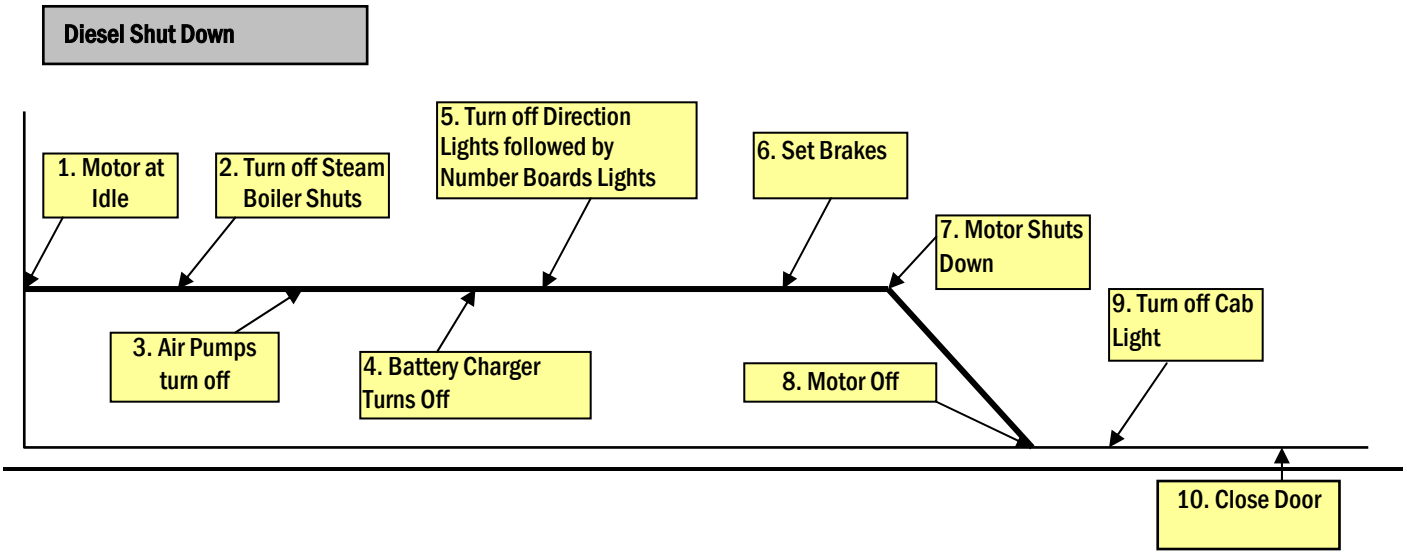

Diesel Operation
1. Motor at Idle in M1
2. Diesel Ramps up to any of 20 notches (Max Speed 10mph)
3. Normal Operation
4. Motor Ramped Down to Idle
5. Selector Handle moved to M2
6. Diesel Ramps up to any of 20 notches (Max Speed 27 mph)
7. Normal Operation
8. Motor Ramped Down to Idle
9. Selector Handle moved to M1


Turbine Start Up
14. Turbine On the Line
9. Turbine at Idle Speed (5,175 rpm)
10. Diesel Ramps Down to Idle
6. Diesel Motor Ramps Up from Idle
3. Turbine Ramps up 700 rpm
8. Diesel at Full RPM
4. Diesel Fuel routed to Turbine
15. Directional Lights Turn On
1. Air compressors and Dir Lights shut off
13. Diesel Shuts Down
11. Diesel Returned to Idle
7. Turbine Ramp Up Follows Diesel
12. Air Compressors Turn On
2. Turbine Ramp Up begins
5. Turbine Fires


Turbine Operation
6. Normal Operation
7. Normal Operation
9. Turbine Ramped Down to Idle
4. Turbine at full power
1. Turbine at Idle in M1
5. Turbine Ramps up to any of 20 notches (Max Speed 65 mph)
2. Put Engine in Forward or Reverse
8. Selector Handle moved to M1
3. Selector Handle moved to M2

Turbine and Diesel Shut Down





Appendix IVb: Quantum Gas Turbine Basic Analog Operation

Introduction

The Lionel Gas Turbine model has two modes of operation, Diesel and Turbine Mode. Because the prototype Gas Turbine required considerable time to bring the turbine on-the-line or to shut it down, the operation of the transitions between Diesel and Turbine Mode for the Quantum equipped model is compressed in time. In the case of shutting down the turbine, the twenty-minute sequence is reduced to a little less than a minute. In addition, there are some conflicting reports about the turbine sound itself. Some witnesses report that the Big Blow only had the deafening whoosh sound and no turbine whine at all. In some of the tapes we heard, there appeared to be a slight turbine whine, especially at idle. Some maintained that there was a whine sound distinctly heard as the turbine was revved up before ignition. We have left it to the operator to decide how the Gas Turbine should sound. We have included both a Whoosh sound and Turbine Whine on separate sound channels, which can have their volumes adjusted independently. We have set the defaults of the Turbine Whine to be easily heard during the Start Up and Shut Down sequence. However, on the main, the Whoosh clearly dominates especially during Sound-of-Power™ periods.

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 Gas Turbine in less than five minutes.

Running the Locomotive

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

- Turn the throttle up slowly until you hear the Quantum System™ come on with the Number Board Lights turning on followed by a Long Air Let-off. The factory default is to have the locomotive start up in Diesel Mode. You will see the Mars light come on steady and will hear Diesel Start Up sounds.
- Continue to turn up the throttle voltage until the locomotive starts to move in Forward. The Directional Headlight will come on and optional Mars Light will start strobing. As you turn up the throttle the diesel will rev through all eight notches and the locomotive will power up to full speed operation.[65]
- As you slow the locomotive down by gradually reducing the throttle, Squealing Brake sounds occur as the locomotive comes to a stop.

Reversing the Locomotive

This simple operation is exactly the same as with standard DC powered 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 locomotive's Reverse Lights on both the locomotive and fuel tender will turn on and the Headlight will turn off. The Mars Light will continue strobing.

Horn

Blow the authentic Turbine 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 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

You can turn on the Bell 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**

65 Because of the limited power of the Cummings diesel, top speed for a prototype in Diesel mode was less than 25 mph. Quantum operation under Regulated Throttle Control (RTC) will also limit the top speed to 25 smph (see Regulated Throttle Control on Page 54)

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.

Switching between Turbine Mode and Diesel Mode

In Analog, QSI uses a coded horn signal to switch between Turbine and Diesel Mode.

Transitioning from Diesel to Turbine Mode:

- In Forward, reduce the throttle until the locomotive stops but do not completely shut off the track power. At this point, the headlight will shut off and the Mars light will stop strobing and switch to steady-on and you will hear a Short Air Let-off. About three seconds later, you will hear a Long Air Let-off and the Air Pumps will start.
- Do four **Slow** flip-and-back operations of the direction switch to blow the horn four times in quick secession. This will start the transition into Turbine Mode. The steady Mars Light will turn off and you will hear the Diesel Motor rev up followed by the Turbine igniting and the Turbine revving up to full power. The entire procedure takes about 48 seconds. The Mars Light will switch back to steady-on at the end of the procedure. You are now in Turbine Mode and can proceed to operate your locomotive with the throttle.

Transitioning from Turbine to Diesel Mode:

- Reduce the throttle until the locomotive stops but do not completely shut off the track power. At this point, the Headlight will shut off and the Mars light will stop strobing and switch to steady-on and you will hear a Short Air Let-off. About three seconds later, you will hear a Long Air Let-off and the Air Pumps will start, although they will be dominated by the Turbine sounds.
- Do four **Slow** flip-and-back operations of the direction switch to blow the Horn four times in quick secession. This will start the transition into Diesel Mode. The steady Mars Light will turn off and you will hear the Diesel Motor start and rev up to full RPM followed by the Turbine Whoosh and Whine decreasing to off. The Diesel Motor will then decrease to idle. The entire procedure takes about 55 seconds. The Mars Light will switch back to steady-on at the end of the procedure. You are now in Diesel Mode and can proceed to operate your locomotive with the throttle.

Note: Once the locomotive is in Turbine Mode or Diesel Mode, it will stay in that mode through direction changes and power downs.

Appendix IVc: Quantum Gas Turbine Advanced Analog Features Operation

Advanced Analog Features for the Gas Turbine

Although many of the functions for the Gas Turbine are the same as diesels as already described in this reference manual, we have included all operating instructions in this appendix to make it easier to learn how to operate the Gas Turbine and its special features.

Starting the Locomotive

Most HO DC power packs with a standard reversing switch[66] 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 Gas Turbine 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.

- Turn the throttle up slowly. The Number Board Lights will turn on first[67]. As the voltage is increased further, you will hear the Quantum System™ come on with a Long Air Let-off sound. The Mars Light will turn on steady and the Headlight will be off (See a table summary of Directional Lighting Operation on page 55). If you are in Diesel Mode, you will hear the motor in the diesel locomotive start up followed immediately by the Air Pumps.
- Continue[68] to turn up the throttle voltage until the locomotive starts to move in Forward (this voltage is called V-Start[69]). The Headlight will switch on bright and the optional Mars Light will begin to strobe.
- As you slow the locomotive down by gradually reducing the throttle to a little below V-start, the locomotive speed decreases, while Squealing Brake sounds occur as the locomotive comes to a slow stop[70].

Note: If you need to turn your throttle up quite high to start your Gas Turbine locomotive, V-Start can be adjusted for operation with your particular DC power pack (see Analog Programming on pages 59-61). See Appendix V for recommended power packs.

Doppler Effect

This sound effect feature 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.

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

Neutral

In Neutral, the Gas Turbine 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 locomotive to stop** [71]. The Headlight or Mars Light switches to a steady-dim. The Reverse Light will remain on if entering Neutral From Reverse (NFR).

66 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 Appendix V.

67 Number Board Lights for the Gas Turbine are directly wired to the track power and will be on whenever track power is applied.

68 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 locomotive will immediately go into normal Forward operation.

69 V-Start is set at 8.5 volts. It is important to note where V-Start is located on your throttle control to know where you will enter and leave Neutral (see Neutral on Page 53-54).

70 Squealing Brakes occur if the locomotive exceeds 40 scale-mph (smph) and then slows down to below 20 smph.

71 If Regulated Throttle Control is enabled (see below) it is important to wait until the locomotive stops on its own. The locomotive's electronic inertia 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 go off.

- 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.
- If the Gas Turbine locomotive is in Diesel Mode and 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 37). The Gas Turbine locomotive will return to normal Diesel Motor sounds when the throttle is turned up.

  Note: If it is in Turbine Mode, there is no special Low Idle sound in Neutral.
- After the Air Pumps start, you can also use the direction switch to blow the Horn or turn on or off the Bell[72].

  Note: If you are in Turbine Mode, you will be able to hear the long Air Let-off but you may not be able to hear the Air Pumps over the sound of the Turbine.

Note: 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 on page 59).

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 stop[73].
- 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:

- Turn the power all the way off, change the direction switch and turn the power back on, or,
- 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.

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 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 voltage[74] 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 and finally coast to a stop.

STC and RTC are selected in Inertial Load setting under Analog Programming (see next section). The default for the Gas Turbine is STC.

72 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.

73 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.

74 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

Note: RTC will have different performance with different power packs. In particular, if your power pack operates at voltages in excess of 12 volts[75], you will want to reprogram V-Max (see Analog Programming) to a higher value. Also see Appendix VI, *Quantum Throttle Control*.

Note: The Gas Turbine in Diesel Mode under RTC will initially start and operate as a standard diesel locomotive except that the top speed is limited to 25 smph or less to model the limited speed of the prototype locomotive when operated with the small 250 hp Cummings diesel. You will need to change to Turbine Mode to achieve full power, just like the prototype.

Note: Always make sure all locomotives in a consist are set to the same Throttle Mode and have the same Inertia or Load Values[76]. If the Gas Turbine is operating under RTC in a consist, make sure that it is in Turbine Mode, since Diesel Mode has a limited top speed of 25 smph and will fight with other locomotives in a consist at higher speeds.

Train Load

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

For an Inertia setting of 0, your locomotive will accelerate or stop as quickly as the internal flywheels will allow. For any Inertia setting from 1-15, your Gas Turbine will automatically be under RTC and will take longer to change speed. At level 1, it will take approximately 15 seconds or more to achieve full speed at max throttle; at level 15, it will take over 3 ½ minutes to achieve full speed. In addition, at higher Inertia settings, your locomotive will decelerate more slowly as you decrease your throttle.

Train Inertia setting also affects the labored sounds of your locomotive (See Sound-of-Power (SOP) on page 58).

Directional Lighting Operation

All Quantum locomotives are equipped with Directional Lighting[77] that changes state depending on the four directional states of "Forward", "Neutral from Forward", "Reverse" and "Neutral from Reverse". The Gas Turbine also has a Mars Light, which is part of the directional lighting system. In addition, the Quantum Headlight will shut off and the Mars Light will stop strobing and switch to steady-on when the locomotive enters Neutral or Reverse, which was common practice for prototype locomotives under Rule 17 [78].

	Forward	Neutral from Forward	Reverse	Neutral from Reverse
Headlight	On	Off	Off	Off
Reverse Light	Off	Off	On	On
Mars Light	Strobing	Dim	Strobing	Dim

Note: Number Board lights are on whenever track power is applied and are not under the control of the Quantum System.

Note: Both the tender Reverse Light and locomotive Reverse Light will operate whenever the Gas Turbine is in Reverse or Neutral from Reverse. These lamps are wired together when tender is plugged in and are not under individual Quantum control.

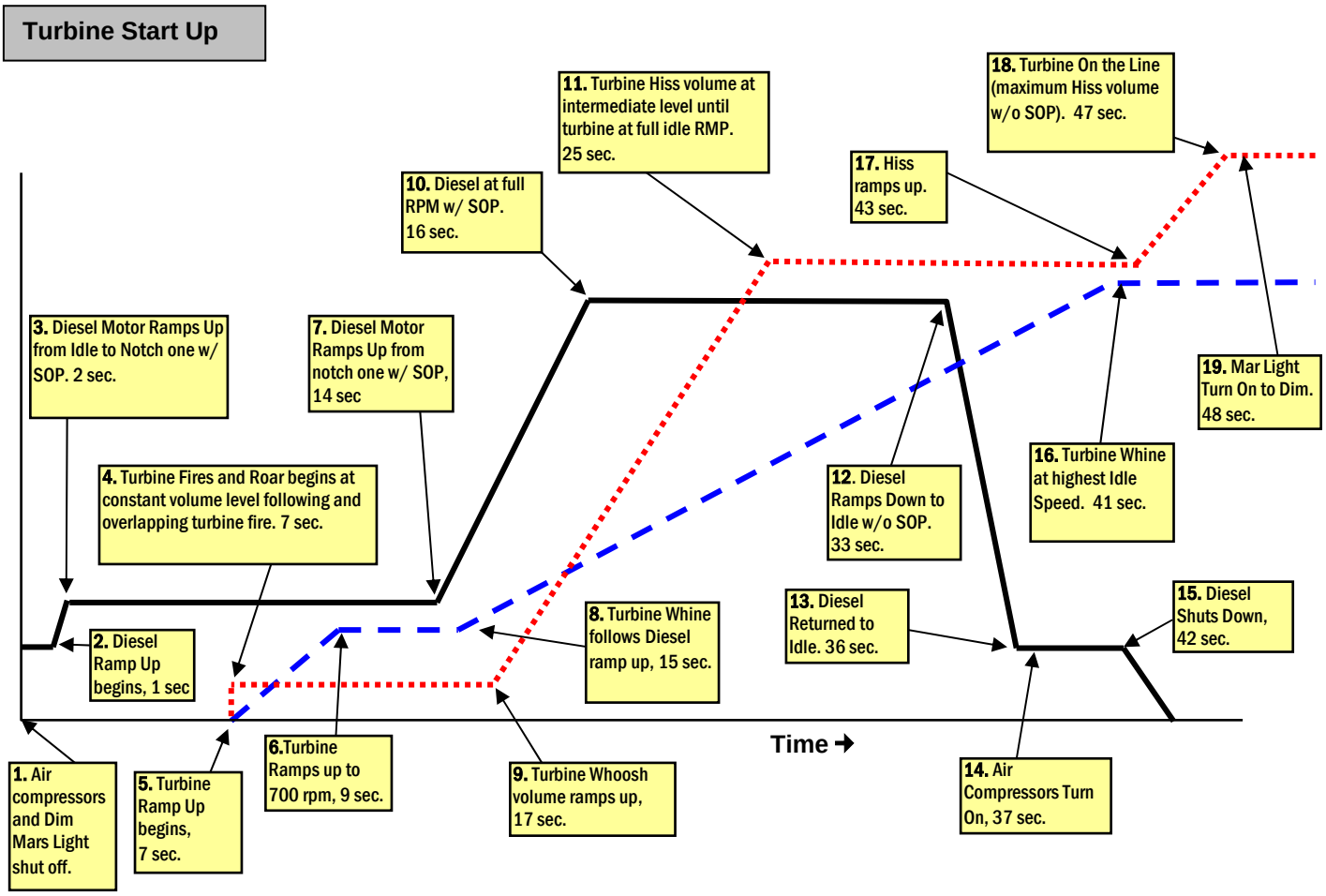
75 Most MRCTM Power Packs have a maximum voltage anywhere from 16 to 20 volts, which is above the recommended NMRA standard of 12 volts.
76 Recent Quantum locomotives use the term "Load" rather than Inertia or Momentum, which better describes the effect.
77 Quantum uses constant voltage lighting that is independent of track voltage.
78 Rule 17, followed by prototype railroads, states: The headlight will be displayed to the front of every train by night, but must be dimmed or concealed when a train turns out to meet another and the entire train has stopped clear of main track, or is standing to meet trains at the end of double track or at junctions.

Changing between Diesel and Gas Turbine Mode

Diesel Mode to Turbine Mode: The Gas Turbine locomotive comes from the factory in Diesel Mode. Because of the limited power from the diesel engine in the prototype, the model will be limited to 25 smph in Diesel Mode under RTC[79]. To achieve full power from your model for mainline operation, you will need to change to Turbine Mode. To change from Diesel Mode to Turbine Mode:

- Use a flip-and-back operation of the reverse switch four times to produce four short horn hoots in Neutral.

The locomotive will go through a complex Turbine Start Up scenario as depicted in the graph below. At the start of the transition to Turbine Mode, the Mars Light will change from Dim to Off. When the transition scenario is completed, the Mars light will change from Off to steady-on.



There are three operations shown:

The solid black lines show the volume and RPM operation of the Diesel Motor.

The dotted blue line with large dashes shows the volume and RPM of the Turbine Whine.

The dotted red line with small dashes shows the volume of the Turbine Whoosh.

The yellow boxes indicate major events in the transition to Turbine Mode. The timing shown in each box indicates the number of seconds since the transition command was sent to start Turbine Mode.

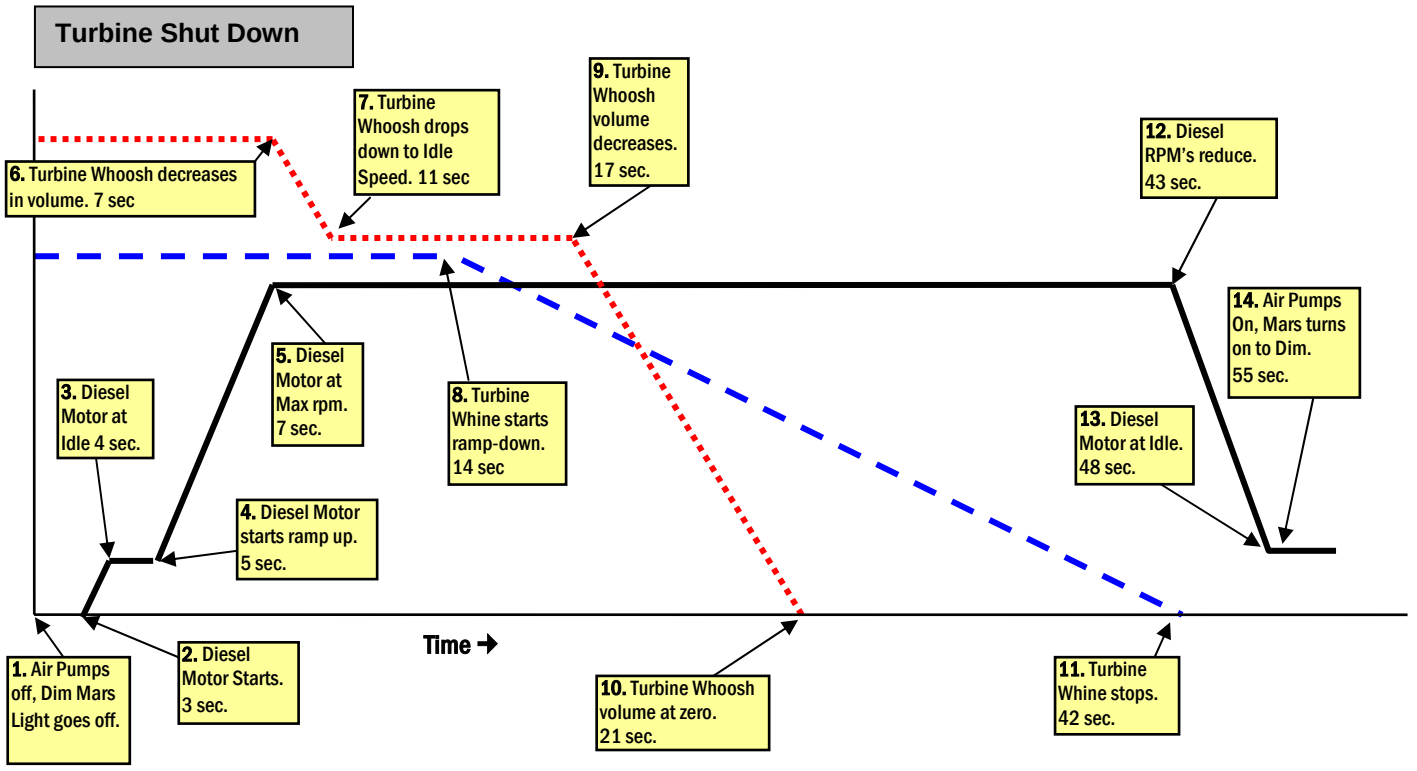
Note: Turbine fire is a distinctive sound that sounds like a giant gas furnace being ignited.

79 RTC is automatically enabled if you have any inertia setting greater than 0.

Turbine Mode to Diesel Mode: The prototype Gas Turbine locomotive was quite inefficient for yard operation at slow speeds. Once the locomotive entered the yard, the turbine was shut down and the locomotive was moved about using the small auxiliary 250 hp Cummings diesel. Under RTC, the model will be limited to 25 smph in Diesel Mode. To change from Turbine Mode to Diesel Mode:

- Use a flip-and-back operation of the reverse switch four times to produce four short horn hoots in Neutral.

The locomotive will go through a complex Turbine Shut Down scenario as depicted in the graph below. The prototype diesel was used to power the turbine blades and slow it down slowly to prevent heat damage. At the start of the transition to Diesel Mode, the Mars Light will change from Steady to Off. When the transition scenario is completed, the Mars light will change from Off to steady-on.



Notes: The following is a list of operational issues when changing between Diesel and Turbine Mode:

- After the Turbine Whoosh starts reducing, the Diesel Motor will continue at maximum RPM for 36 seconds to model the Turbine cool down process.
- Cooling Fans and vent opening sounds only occur in Diesel Mode.
- Mars Light, Air Pumps, Cooling Fans and other Neutral Sounds will be suspended during transition from Turbine Mode to Diesel Mode or from Diesel Mode to Turbine Mode, like the prototype.
- If the locomotive is in Turbine Mode or Diesel Mode when power is shut off, the locomotive will power up in the same Mode when power is reapplied.
- If locomotive is at any point in transition from Turbine to Diesel Mode, it will power up in full Diesel Mode when power is reapplied with standard rapid diesel start up sounds.
- If locomotive is in Turbine Mode or in transition from Diesel to Turbine Mode when power is shut off, Turbine sounds will sequence through rapid turn-on operation instead of artificially and abruptly producing full Turbine sounds when power is reapplied.
- If the locomotive is in any point in the transition from Diesel Mode to Turbine Mode, and the throttle is turned up to leave Neutral, the locomotive will terminate Diesel/Turbine transition and rapidly enter full Turbine operation in Turbine Mode.

- If the locomotive is at any point in the transition from Turbine Mode to Diesel Mode, and the throttle is turned up to leave Neutral, the locomotive will terminate Turbine/Diesel transition and rapidly enter Diesel Mode.
- A power cycle or a Software Reset (such as POP 11, see page 59) in Analog or DCC will not change from Diesel Mode to Turbine Mode or from Turbine Mode to Diesel Mode. A Hardware Reset using the jumper will always return the locomotive to Diesel Mode.
- It is disallowed to move back and forth between Turbine and Diesel Mode when the locomotive is in transition between either Mode. The transition process must be completed before another transition can be initiated.
- Transition from Diesel to Turbine Mode or transition from Turbine to Diesel Mode will only happen in Neutral. The coded horn (four short horn hoots) will not have any affect on changing modes in Forward or Reverse.

Sound of Power™

The locomotive will produce Sound-of-Power labored sound effects under RTC if you have selected any of the Load settings from level 1 to 15. Under acceleration, in either Diesel or Turbine Mode, the locomotive 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 locomotive sounds are less labored until it achieves its final speed where it will again produce labored sounds appropriate to its throttle setting.

Turbine Whine and Whoosh will change with the throttle only slightly over the entire throttle range during normal operation in Forward or Reverse since the turbine was often run near full RMP at all times. Although the change in Turbine sound is not as dramatic as change in diesel RPM's or volume, it is nevertheless quite noticeable.

Helpers

Prototype Helpers are locomotives that are used to provide extra power and/or braking for a heavily loaded train. These locomotives can be part of the head-end consist or as mid-train helpers or as pushers at the end of the train. Prototype helper locomotives behave differently than the train's lead locomotive. Their whistle/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 below and in the next section on Analog Programming.

Helper Type	Horn	Bell	Headlight	Reverse Light	Mars Light
Normal	Enabled	Enabled	Enabled	Enabled	Enabled
Lead	Enabled	Enabled	Enabled	Disabled	Enabled
Mid	Disabled	Disabled	Disabled	Disabled	Disabled
End	Disabled	Disabled	Disabled	Enabled	Disabled

Appendix IVd: Quantum Gas Turbine Analog Programming

The Gas Turbine Locomotive can be Programmed Using a Standard Power Pack.

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

Program Option #'s (POP's[80])	Option Name (Default Value)	Message[81] when Entering Option	Option Description
1	System Volume[82] (16, Max)	"Volume equals X"	Sets System volume (17 levels) where level 16 is maximum volume and level 0 is off.
2	Inertia (0, No Load, STC)	"Inertia equals X"	Selects the starting and stopping Load. For Level 0 (no Load), Standard Throttle Control (STC) is automatically selected. For Loads from 1-15, Regulated Throttle Control (RTC) is automatically selected. For levels 1-15, Load is increased with acceleration increasing from 15 seconds to 210 seconds.
3	Helper (Normal)	"Helper equals" "Normal", "Lead", "Mid" "End"	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[83]. End Helper has Horn, Bell and all lights disabled except Reverse Light.
4-7	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	Reserved	"Reserved"	
11	Programming Reset	"Warning – about to reset"	After next **Quick** or **Slow** Operation, Bell rings followed by a hoot to indicate the locomotive is returned to factory default condition.
12	About	"500; 4.4; 02/16/04"	Each **Quick** or **Slow** Operation provides progressive information about Quantum Model Number, Software Version, and Software Release Date.
13	Horn Volume (11)	"Volume equals X"	Customizes Horn Volume (16 levels). Max is 15.
14	Bell Volume (13)	"Volume equals X"	Customizes Bell Volume (16 levels). Max is 15.
15	Motor Volume (7)	"Volume equals X"	Customizes Diesel Motor Volume. (16 levels). Max is 15.
16	Fan Volume (8)	"Volume equals X"	Customizes Vents and Cooling Fans Volume (16 levels). Max is 15.
17	Reserved	"Reserved"	
18	Whoosh Volume (12)	"Volume equals X"	Customizes Turbine Whoosh Volume (16 levels). Max is 15.
19	Whine Volume (8)	"Volume equals X"	Customizes Turbine Whine Volume (16 levels). Max is 15.
1			After POP 19, the next advances will return to POP 1.

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.

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

80 **POP** is short for "**P**rogram **Op**tion".

81 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.

82 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.

83 Some lights, such as Number Board Lights, on the Gas Turbine that are not controlled by the Quantum System will remain on.

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 again or continue up through POP 19 where the Programming Options will start again at POP 1.

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 switch[84]. 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 volume[85].

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 enter this option and 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 System 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 Inertia and Throttle Mode (Program Option # 2)

This will determine whether your locomotive uses Regulated Throttle Control (RTC) or Standard Throttle Control (STC) and will set the Inertia (Load or Momentum) value.

- 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... etc.". Stop when you hear "two" by moving the direction switch back. You will hear "Inertia".
- Use a **Slow** or **Quick** operation of the direction switch to enter this option. If the throttle mode is at its default value (STC), you will hear "Inertia equals 0;" otherwise, you will hear "Inertia equals X." where "X" is the current Inertia level setting.
- Use a **Slow** operation of the direction switch to increase the Inertia Setting. At Level 0, there are no inertia effects and the Throttle Mode is set to Standard Throttle Control (STC). At Levels 1-15, the Inertia effects increase and Regulated Throttle Control (RTC) is automatically[86] selected. Use **Quick** operations to reduce the Inertia level.

84 If you have a Quantum Engineer, **Quick** and **Slow** operations are done with specific program buttons.
85 Setting any volume in Analog will also apply to DCC and vice-versa.
86 Later Quantum equipped locomotives have a separate Program Option (POP 10) dedicated to selecting Throttle Mode. Load (Inertia) settings remain at POP 2.

- Once you have selected the Throttle Mode you wish to use, turn the throttle off. When you then power up again, your locomotive will be using the Inertia Value and concurrent Throttle Mode you have just selected.

Note: Set Inertia level to "1" to match the Gas Turbine to current Quantum equipped locomotives that use the factory default settings of RTC and Level 0 Load. This will provide the best operation in consists.

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

This will determine the voltage (and throttle position) where your locomotive will leave Neutral and move out.

- 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 hear the announcement "Option 1, 2, 3 … etc.". Stop when you hear "eight" 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 to leave Neutral.
- Use a **Slow** or **Quick** operation of the direction switch to activate this option. Hear the message "Set throttle to V-Start" and after three seconds the voltage will be announced. If you move the throttle, the new track voltage value is announced.
- Once throttle is set, use a **Slow** or **Quick** operation of the direction switch to start the procedure. The bell will ring continually, indicating the correct value is being calculated. If you chose a very low setting, be patient. If you do not get a setting within a minute, chose a slightly higher throttle value.
- At the end of the process[87], the locomotive will move slightly and stop. 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.

Note: The value of V-Start may decrease from the original voltage reading because the power pack may drop voltage during calibration.

Note: Sometimes it is difficult to see the locomotive move unless you are watching carefully.

- To leave Programming, turn the throttle off, and then power up for normal locomotive operation.

Or continue to V-Max by changing the direction switch and waiting for the next Programming Option to be announced.

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)[88]. Then do a **Quick** or **Slow** operation to start the V-Max setting procedure. Like V-Start, the bell will ring continually 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 locomotives[89], make sure that both locomotives have similar speed/throttle characteristics by adjusting V-Start and V-Max to prevent them from fighting each other.

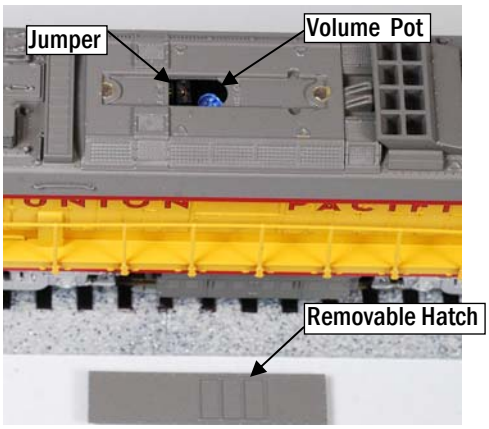
87 Later Quantum equipped locomotives use an improved method to set V-Start.

88 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 verbal Voltmeter.

89 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.

Appendix IVe: Quantum Gas Turbine Special Analog Operation and Troubleshooting

Manual Volume Adjustment (Analog and DCC)



To adjust the volume by hand:

- Locate the removable hatch on the top of your Lionel Gas Turbine locomotive and remove it using your fingernail. It is located in the center of the roof and is held in place magnetically. Manual Volume Control (blue potentiometer) is located towards the front with the Reset Jumper directly behind.
- Use a small screwdriver to turn the potentiometer clockwise to increase volume or turn it counterclockwise to decrease the volume.

Note: Volume can also be adjusted digitally using the programming methods described in the programming sections of this manual. However, if you turn the volume down using the Manual Volume Control, you will not be able to increase the volume using programming above the level set by the potentiometer.

Using the Quantum Reset Jumper to Return Your Locomotive to Factory Default Values (Analog and DCC)

In case your locomotive's sound and control system misbehaves and turning the power off and back on does not return it to normal operation, you can reset your locomotive to original factory values.

- Turn off the power.
- Use small needle nose pliers to pull the jumper up and out.
- Reapply power; after a few seconds you hear three Horn hoots in quick succession.
- Turn power off, reinstall the jumper. The locomotive has now been returned to original factory defaults for all DCC and Analog values.

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 Quantum Engineer Mute key.
- Check to see if your volume potentiometer or digital sound has been turned all the way down.
- You may have shut your locomotive down in DCC using the F9 key, **which will also shut it down in Analog**. Go back to DCC operation and start your locomotive with the F6 key. Once started, you can return to DC or DCC operation.
- If the above methods do not start your locomotive, use the jumper to reset your locomotive to factory default values as described above.

High Voltage Circuit Breaker

Your Gas Turbine 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, while the Quantum system alerts you to the problem through a continuous series of hoots. This built in safety feature protects the Quantum system and motor from excessive voltage.

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

Appendix Va: Power Packs

Power Pack Recommendations

Not all power packs are created equal. HO power packs have been manufactured since the forties with vast differences in characteristics, usually dictated by the limitations of the technology of the time. As more electronics were added to power packs, diversity in design became even greater. Today, there are so many different designs that it is difficult to comment on them all.

A number of Power Packs have been tested for use with the Quantum sound system and we have tabulated the results. Other Power Packs that are not listed may also be suitable. However, some power packs produce excessive open-circuit output voltage in excess of 35 volts, which can damage the Quantum System while others do not produce enough voltage to activate the electronics or produce a reasonable top speed. Make sure you always test the unloaded output from your power pack to be sure it does not exceed 35 volts peak and test that the loaded output is at least 12 volts. Generally, modern electronic type power packs will provide better operation with your Quantum equipped locomotive. Many power packs with a reverse switch are acceptable. However, some are not but can be made so with the addition of the HO DC SideKick controller, or the Quantum Engineer, which can be easily added to any power pack for improved performance. These controllers also prevent excessive wear of the reverse switch by providing highly reliable push buttons for Whistle/Horn, Bell operation and Programming.

Power Pack	Recommended	Comments
MRC Control Master 20	Excellent	This power pack has a *Nudge* mode switch that affects the throttle settings. However, Quantum works well with either the Nudge setting turned on or off without Quantum reprogramming of V-Start. V-Max should be set closer to the maximum output voltage. .
MRC Tech 4 Series	Excellent	Works well without Quantum reprogramming of V-Start. V-Max should be set higher to take advantage of the Tech 4 higher throttle range.
Bridgewerks Magnum Series	Excellent (HO DC SideKick Recommended)	This powerful power pack can put out excessive voltage that can cause the Quantum high voltage circuit breaker to trip. Use the high voltage lock provided with this power pack to prevent the throttle from applying too much voltage. With the high voltage lock on, Quantum operation with Bridgewerks power packs is excellent. No reprogramming of V-Start is required but you may want to set V-Max near your maximum throttle voltage. The direction switch has a center off position, which requires a quicker operation to blow horn or ring bell. HO DC SideKick or Quantum Engineer Controller are recommended.
MRC Tech II	Excellent	We have encountered a number of designs for this power pack, all under the Tech II designation. You may find your V-Start setting varies from one model to the other and may want to reprogram for better throttle range. V-Max should be programmed to a higher value.
MRC Tech 3 Power Command	Excellent	Works well without Quantum reprogramming for V-Start. V-Max should be set at a higher value to take advantage of the increased throttle range.
MRC Train Power 6200	Acceptable	There are two modes for this power pack – one for HO with a lower voltage range and another for O' and G' Scale with a higher voltage range. Your locomotive's top speed may be a little slow at full throttle in Mode II. However, if you use Mode I, your locomotive will run very fast and may actually trip the high voltage circuit breaker at full throttle. If this occurs, refrain from moving the throttle to the very high voltage settings. V-Max should be set at about 85% of the throttle setting where the Quantum high voltage circuit breaker activated.
Troller Autopulse Transamp 1	Acceptable with Reservations	Maximum voltage is lower than desirable; locomotive's top speed may be reduced. Also V-Start will probably need to be set lower to increase useful throttle range as well as lower V-Max to improve top speed.
Throttle Master Model, Throttle Pack and most early MRC power packs with Pulse/Full option switch.	Acceptable with Reservations (HO DC SideKick Controller recommended)	These early Power Packs use a variable series resistor to change the track voltage and have an optional pulse drive switch labeled "Pulse/Full". Operation with these Power Packs are generally acceptable but we strongly recommend that you read section in Appendix Vb on *Older and Unusual Power Packs* before operating your Quantum equipped locomotive. All the MRC Power Packs of this type were in metal copper colored cases.
Marx HO Power Pack	Acceptable with the addition of the HO DC SideKick Controller	Train runs a little slow but it will operate and program the Quantum system. The reversing lever must go through an off position before it will change polarity and cannot be activated fast enough to blow the Whistle/Horn reliably. You will need to add a reversing switch or HO DC

		SideKick or Quantum Engineer Controller between the track and the power pack for Whistle/Horn, Bell and programming operations.
Tech 4 MRC Rail Power 350 with Memory	Acceptable with the addition of the HO DC SideKick Controller	The electronic reversing mechanism on this power pack goes through an off position before it will change polarity and cannot be activated fast enough to blow the Whistle/Horn without the train slowing down and you cannot operate the direction fast enough to operate the Bell. You will need to add an HO DC SideKick controller for Whistle/Horn, Bell and programming operations. You may want to add a reversing switch between the track and the power pack to perform reversing operation without losing Quantum sounds. V-Max needs to be set closer to the maximum throttle voltage. Otherwise it is a fine power pack.
LGB DC Power Packs	Acceptable with the addition of the HO DC SideKick Controller	G'Gauge power packs often have no reverse lever. Instead the throttle is moved from variable positive DC voltage to a center off position to variable negative DC voltage to reverse the locomotive. Adding a reverse switch or a HO DC SideKick controller will allow operating the Whistle/Horn and Bell separate from the reverse function.
MRC Throttle Pack, Dual Control HO Power Pack and other early MRC Power Packs without pulse drive switch.	Unacceptable	These early Power Packs use a variable series resistor to change the track voltage but do not have the optional pulse drive switch labeled "Pulse/Full". Although these Power Packs will not damage your locomotive, we do not recommend them for Quantum operation since the throttle voltage cannot be lowered enough to enter Neutral. Also, peak voltage can be high enough to engage the high voltage circuit breaker. All the MRC Power Packs of this type were in metal copper colored cases. If you do use these power packs, we strongly recommend that you read Appendix Vb before operating your Quantum equipped locomotive.
Lionel Type 0100 DC Multi Volt Power Pack	Unacceptable	There is barely enough voltage to operate a Quantum locomotive. Also, the reversing lever must go through an off position before it will change polarity and cannot be activated fast enough to blow the Whistle/Horn. .
Gilbert HO Pike Master	Unacceptable Do not use	These Power Packs can produce excessively high voltage that may damage your locomotive. Do not use this or similar model Power Packs that were normally provided with inexpensive HO sets without first testing for open circuit voltage that must be below 35 volts peak.
Tyco Model No 899 C Hobby Transformer	Unacceptable Do not use	These smaller Power Packs can produce excessively high voltage that may damage your locomotive. Do not use this or similar model Power Packs that were normally provided with inexpensive HO sets, without first testing for open circuit voltage that must be below 35 volts peak.

Circuit Breaker Operation

Some power packs deliver so much track voltage that it could damage high efficiency electronics or HO motors. In the interest of safety and preventing damage to your motor, a circuit breaker has been installed on your locomotive that shuts off the motor drive whenever the peak track voltage exceeds 22 volts. If your locomotive stops at high throttle positions, turn down the throttle to reengage the motor. This automatically resets the circuit breaker. If you engage the high voltage circuit breaker, refrain from using the higher throttle positions in the future. Some power packs have dual mode operation allowing higher operating voltages for G'Gauge and O'Scale locomotives. If your locomotive shuts down at the higher settings, use the mode that is more appropriate for HO and N'Gauge trains or avoid using the very high throttle settings.

Note: Recent Quantum equipped locomotives may not have the high voltage circuit breaker due to a redesign of the Quantum system with more advanced components.

Appendix Vb: Older or Unusual Power Packs

Programming your Quantum Locomotive with Older Power Packs Equipped with a Pulse Drive Switch

Older non-electronic power packs often use a variable high power series resistor to change the track voltage, which usually requires a load on the track to operate properly. Since Quantum locomotives take less power as they slow down, your older Power Packs may not allow the locomotive to operate under pulse drive and the direction switch may not produce the correct whistle/horn or bell operations. We suggest you add a DC SideKick Controller and a fixed load to the variable DC output on your power pack. We have found that a 500-ohm, 1 watt resistor will improve performance.

Note: that this resistor can become hot so place it where it will not be touched by hand and away from flammable material.

If your power pack has a pulse drive switch, set the position to full power for all your normal locomotive operations. Pulse drive has no advantage for operating your Quantum locomotive since it usually produces low voltage along with the pulse operation and will not provide enough voltage to leave Neutral. While in full power, check to see that your locomotive will slow down enough to enter Neutral. If not, you will need to enter programming to reset the throttle position using V-Start to allow the locomotive to slow down to a full stop.

Programming

Programming should not be a problem. If you cannot turn the throttle down low enough to stop the locomotive, you can still enter programming even if the locomotive is moving. The locomotive will stop moving once programming is entered.

Entering Neutral

You can also enter Neutral using the pulse mode switch. Although you may not be able to enter Neutral using the Full power mode, you can bring your locomotive to a slow speed. Moving the Pulse/Full switch to Pulse will allow the locomotive to stop in Neutral.

You can also try resetting your V-Start value in the programming mode although this does not always work with every older power pack. To do this:

1. Enter Programming.
2. Go to Option 8 and enter the option.
3. Flip the Pulse/Full switch to Full and move the throttle to the position where you want the locomotive to leave Neutral (about 20% of full throttle). The verbal voltage reading from the locomotive should not be less than five volts.
4. Use the reverse lever to begin the V-Start procedure. The bell will start ringing continually, indicating the process is calculating the correct value of throttle setting.
5. At the end of the process, the Whistle/Horn will hoot, signifying the end of the operation. You will hear "V-Start equals X" where X is the new V-Start voltage setting. If this setting is not greater than 5 volts, you will need to enter the option again and set your throttle higher.
6. To leave programming, interrupt the power by turning the throttle off, and then power up for usual locomotive operation with the Pulse/Full switch in the Full position.

Note: If you are still unable to enter Neutral, you may find that the factory settings are the best choice. Reprogram your locomotive in Pop 11 to factory default values.

High-Voltage Circuit Breaker:

Some of these older Power Packs have excessively high open-circuit output voltage that can trigger the high voltage circuit breaker in your locomotive[90]. The high voltage will not damage your locomotive but can prevent it from moving. Normally, the motors in typical non-sound equipped HO locomotives will load this type of power pack and draw down the voltage. However, Quantum equipped locomotives provide a very low electrical load when the motors are lightly powered (i.e. starting out with high inertia or Load settings), which may allow the Power Pack to produce a high enough voltage at full throttle to trigger the circuit breaker. Try turning the throttle up only half way at first to allow the motors to start moving before increasing to full output. Once the motors are engaged, the voltage will usually be kept low enough value to prevent the circuit breaker from activating over the full throttle range.

90 New Quantum Systems may not have this high-voltage limitation or the circuit breaker operation.

Appendix VI: Quantum Throttle Control

Achieving Optimal Performance from your Quantum Locomotives when Operating Under RTC.

RTC allows you to operate your locomotive under normal throttle control and at the same time provide operation as though the locomotive has huge inertia. For instance, under RTC, Quantum Inertial Control™ will allow you to run your locomotives very slowly without concern that it will abruptly stop from minor impediments such as misaligned track joints, tight curves, rough turnouts, etc. or variations in track voltage. RTC Inertial Control will resist changes in speed once it is moving and will resist starting up quickly if it is at rest.

However, unlike some motor control systems, RTC is not speed control; it is throttle control. RTC does not maintain speed at some constant value independent of changing conditions. For instance, if your Quantum equipped locomotive with enabled RTC encounters a grade, it will eventually slow down. You will need to provide more throttle, just like the prototype, to accelerate it back to speed. What is different is how it responds to grades or other conditions that would normally stop your train. A standard model train locomotive without RTC Inertial Control would very quickly slow down or stop when encountering a grade unless you rapidly increase the throttle by the right amount at the right time. Under RTC, the locomotive would still stop or slow down by the same amount but would do so slowly and realistically based on the RTC built-in Inertial Control.

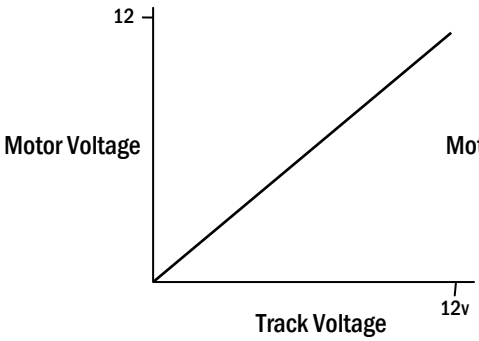


Figure 1

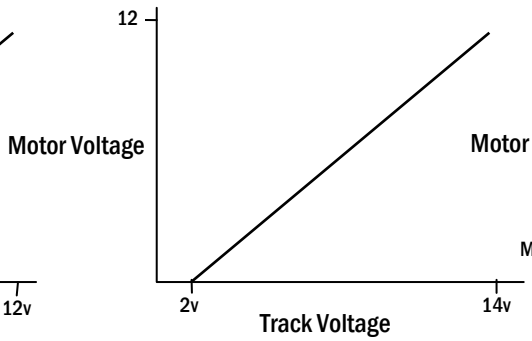


Figure 2

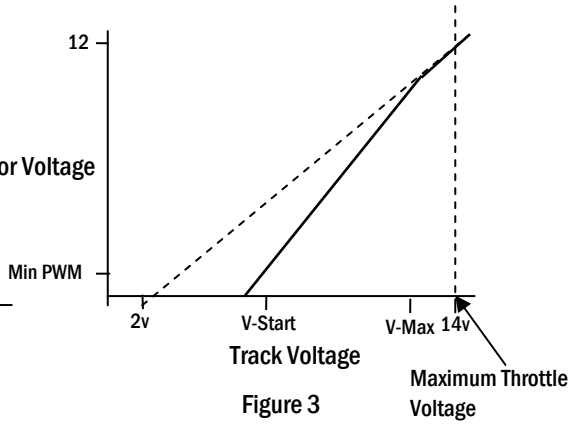


Figure 3

In order to take full advantage of RTC, it will be helpful to understand how electronic motor control operates. Figure 1 shows the voltage delivered to the motor as a function of the applied track voltage for a standard HO locomotive without electronic motor control. Since the motor is wired directly to the track pickups, the track voltage is applied directly to the motor and the direction of the motor's rotation depends on the track polarity. Figure 2 shows the effect of adding a very simple electronic motor reverse unit without any motor power control circuitry The electronics use up some of the voltage for its own operation resulting in a decrease in motor voltage of about 2 volts; under 2 volts, no voltage is delivered to the motor and at 14 volts, only 12 volts is delivered to the motor.

Figure 3 shows the effect of adding motor control electronics. In this figure, the dotted line is the same as the line in Figure 2; it represents the available voltage that could be delivered to the motor. However, the electronic control is designed so that only a portion of the available power is actually used. Having this reserve power (or reserve voltage) is very useful when making adjustments to the motor voltage to maintain momentum when the locomotive encounters an obstacle such as a misaligned track joint. When such an obstacle starts to slow the train, more power is delivered instantly by the electronics to ensure the momentum does not change quickly. This is particularly important at low throttle where the model train can be easily stopped by slight variations in track conditions. At higher throttle, where the natural inertia of the locomotive's flywheel will keep the locomotive moving, it is much less important.

The Quantum system has a higher starting voltage, V-Start, to provide this necessary reserve power for the motor control. V-Start is the track voltage where the locomotive will just start to move. Since every locomotive requires some minimum power (represented as Min PWM) to overcome the locomotive's drive train friction, V-Start is a bit higher than the throttle value where voltage is first applied to the motor. During programming of V-Start, the internal electronics will continually apply greater amounts of motor power until the locomotive moves. This setting is then stored in the Quantum system and will then affect the slope of the line and where this line goes to zero.

Since reserve power is not as important at higher voltages, a second parameter called "V-Max" determines where full power is applied to the motor with no reserve voltage. Above V-Max, the motor voltage follows the same line as Figure 2.

Setting V-Start and V-Max determines how your locomotive will behave under RTC. Quantum's default setting for V-Start is 8.5 volts, which allows about 3 to 5 volts of reserve power for most locomotives and power packs. If V-Start is set at a lower value to allow the locomotive to start at a lower throttle voltage, the reserve motor power is lowered as well and slow speed performance may be reduced. However, if your locomotive is a "smooth runner" and your layout has few obstacles that can affect momentum, you can lower the V-Start voltage without compromising performance. Setting V-Start to a higher voltage than is necessary has no negative affect except it lowers your throttle range.

Both Standard Throttle Control (STC) and Regulated Throttle Control (RTC) follow the same curves determined by V-Start and V-Max. There are, however, differences in behavior. At a zero Load setting, the locomotive under RTC will achieve the final motor voltage over time according to the internal Inertial Control algorithm while a locomotive under STC will achieve the final motor voltage immediately. If these two identical locomotives are placed on the same power track section, the locomotive programmed to operate under STC will race up to its final speed as quickly as the internal mechanical flywheels will allow, while the locomotive programmed to operate under RTC will accelerate much more slowly. After both locomotives finally reach "steady state" operation, both locomotives will be seen to have the same average speed.

The second difference has to do with how power is delivered to the motor. At a steady throttle setting, the average voltage to the motors will be the same for both locomotives, but the actual voltage variations to the RTC motor will be dithering around trying to maintain the locomotives Inertial Control while the voltage to the STC locomotive will remain relatively constant. The effects on operation are quite noticeable at slow speeds. Since the RTC locomotive is constantly adjusting motor power; it will move much more steadily at slow speeds while the STC locomotive will stop and start and may need a push now and then to keep it going.

V-Max Settings

Note in Figure 3 that V-Max is shown set slightly lower than the full throttle setting, which is the recommended setting for most locomotives. If V-Max is set above the maximum throttle voltage, then the locomotive will not receive full power at full throttle. If V-Max is set precisely at the maximum throttle voltage, the locomotive may still not receive full power since the voltage output from most power packs will decrease under load. When the locomotive is running at full speed with a full trainload, the track voltage may be lower than expected by a couple of volts. We recommend that you either measure your maximum track voltage under load or, as general rule, that you set V-Max to about 85% of your full "unloaded" throttle voltage[91].

It is also a good idea not to set V-Max too low since the Quantum Inertial Control is not operational above V-Max. In addition, the voltage curve will have a change in slope at V-Max (see Figure 3), which may be undesirable.

Double Heading

Another advantage of RTC is evident when operating different types of locomotives in a consist. Since the RTC algorithm is a throttle control concept, locomotives operating together under RTC will attempt to share power equally. This is not true for some locomotives in the market that use true electronic Speed Control (SC) This type of control tries to maintain locomotives at a constant speed regardless of changes in loading, grades or track voltage. Under true Speed Control, when a locomotive is set to operate at say, 35 smph, it will try to maintain this exact speed up and down grades, through tight curves or even if you attempt to slow the locomotive down by restraining it with your hand. It will draw whatever power it can, within the limits of the control system and the power pack, to maintain the locomotive's 35 smph operation.

True electronic Speed Control has a fundamental problem. When two or more locomotives with true electronic Speed Control are coupled together in a consist, the consist operation becomes inherently unstable. Imagine two locomotives both responding to a speed command or track voltage setting to go 35 smph. If both locomotives were identical, they would travel together at the same speed with no problems. But because of variations in electronic component values, gear ratios, age, etc., both the internal speed references and the on-board speed measurements will be slightly different. For instance, let's say the front locomotive has a slightly lower internal speed measurement than the trailing locomotive for a given track voltage setting. When the two locomotives are traveling at 35 smph, the front locomotive will sense that it is going too slow and will apply more power to the motor to speed up the consist to achieve its reference value. The trailing locomotive on the other hand is happy at 35 smph and will react to the increased pull exerted by the lead locomotive by decreasing the motor power to slow down. The lead locomotive will feel the drag from the trailing locomotive and apply more power to maintain what it believes to be the correct speed value. The trailing locomotive, in turn will decrease the motor power even more. The result will be that the lead locomotive will apply full power to the motor while the trailing locomotive will be shut down completely. This instability will occur even if the speed reference or internal speed measurements of the two locomotives is off by an infinitesimal amount (i.e. it is unstable). It is only the finite gain in the motor control circuits that will prevent this from occurring to such an extreme. However, no matter what the loop gain, there is this inherent instability.

Another way to see this problem is to take a locomotive under true speed control at a fixed throttle setting (which will give a fixed speed) and try to pull or push it with your hand at a speed different than what it wants to go. It feels rock solid and resists any attempt to make it go faster or slower. Now imagine another locomotive on the track that wants to travel faster then the first locomotive. If these locomotives are coupled together it will be the "irresistible force" trying to move the "immovable object".

91 Also, be aware that the throttle voltage on many power packs may not be a linear function of the throttle knob's position. We have observed power packs where the last 15 or 20% of the throttle's setting will not produce any further increase in track voltage.

If you try this same hand experiment with a Quantum locomotive under RTC, you will find that the locomotive will at first resist your attempts to slow it down or speed it up, but if you maintain your effort the locomotive will indeed start to slow down or speed up over time. You can completely restrain a locomotive under RTC to where the wheels are forced to not move and when you release the locomotive, it will slowly speed up to its original speed. Even though the locomotive resists changes in motion, it will eventually modify its motion depending of changes in loading, just like the prototype.

If an RTC locomotive is going 40 smph and couples to another RTC locomotive that is going 30 smph, the two locomotives will reach a compromise speed of about 35 smph. RTC allows mismatched locomotives to operate in a consist by internally adjusting their speed to share power equally. If the locomotives are too mismatched, the RTC algorithms may not be able to completely adjust their speeds, which is the same problem that prototype locomotives would have. However, RTC locomotives in a consist would never have the inherent instability where one locomotive would be supplying all the power while the other was completely shut down.

Adjusting mismatched locomotives using V-Start and V-Max.

Locomotives that are mismatched in gear ratio and speed can be better matched for operation by setting V-Max differently for the two locomotives. Figure 4 shows the motor voltage curve in black for a slow locomotive and in red for the fast locomotive. V-Max 1, for the slow locomotive is set lower to ensure that at high throttle settings, this locomotive's motor is receiving full power to go as fast as it can. The fast locomotive's V-Max is set higher to provide a slower increase in motor voltage as a function of throttle to match the slower locomotive's performance. The vertical dotted line represents the track voltage at the maximum throttle setting. If both V-Max's are set to voltage values below this maximum throttle voltage, then at full throttle, both locomotives will receive equal voltage and there will be no advantage in having different V-Max settings. This is evident from Figure 4 where both the red curve and the black curve meet at V-Max 2 after which both curves then follow the same line as a function of increasing throttle voltage.

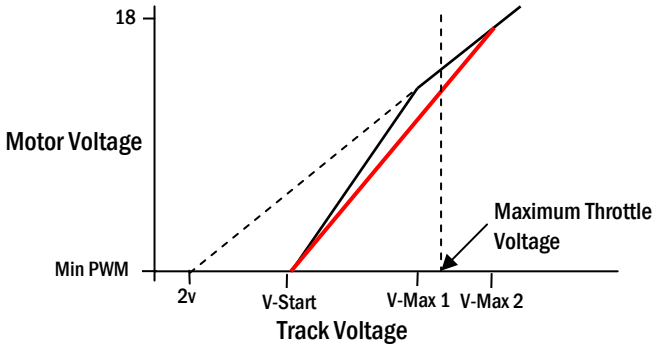


Figure 4

The best way to adjust two dissimilar locomotives to better match their speed performance curves is as follows:

- Set both locomotives to have the same V-Start since both locomotives should start to move at the same throttle setting.
- Set V-Max for the slower locomotive just below your maximum throttle voltage. This will ensure that the slow locomotive will have maximum power and maximum speed at maximum throttle.
- Set V-Max for the faster locomotive above your maximum throttle voltage. To do this, you will have to set V-Max with a different power pack or DC power supply that has a higher output voltage. You can set V-Max to a maximum of 22.2 volts.
- Test the locomotives together but not coupled on the same powered track to see that they start up at the same throttle setting and travel at approximately at the same speed at higher throttle settings. If your fast locomotive is still too fast, set V-Max to an even higher value.

Keep in mind that you do not have to have both locomotives perform exactly the same since the RTC algorithm will attempt to compensate for the difference in performance. Adjusting the performance of each locomotive with V-Max and V-Start to reduce gross differences will help ensure that they are within the limits of the RTC algorithm to equalize their speeds and power.

Load Effects

The acceleration and deceleration of your locomotive can be changed under Programming Option 2 (POP 2). We use the term "Load" or "Inertia" rather than momentum since strictly speaking, we are not changing momentum, which has to do with a quality of motion that changes with speed.

Load settings apply to both STC and RTC but since RTC already has an Inherent inertia, the same Load setting will produce a slower acceleration for RTC than STC. For instance, at a Load setting of "0", the RTC locomotive will accelerate to full speed in about 30 seconds[92], while an STC locomotive will accelerate to top speed in a couple of seconds. Each increase in Load will decrease the acceleration of your model.

In addition, the behavior under rapid increases in throttle voltage will be different under RTC and STC. If the locomotive is initially at rest, rapidly increasing the throttle will produce smooth acceleration for either throttle mode and any non-zero Load setting. However, if the locomotive has achieved its final speed at some intermediate throttle setting, and the throttle is suddenly turned up all the way, a locomotive under STC will rapidly increase speed and thereafter accelerate based on its Load setting. The rapid increase in speed is due to the fact that available power was suddenly increased and there was no Inertia Control to maintain the locomotive's momentum. Under RTC, the same operation would not produce a sudden increase in speed; instead the locomotive would slowly increase to its new speed based on the higher throttle setting and the Load setting.

Figure 5 shows a series of "speed versus time" curves for different track voltages. The track voltage settings are shown next to each curve on the right and ranges from 10 volts for the first curve to 15 volts for the top curve. These measurements were made on an Atlas B23-7 GE locomotive model under RTC. For all measurements, the locomotive was initially at rest in Neutral with the track voltage set to 7.5 volts. The Load in POP 2 was set to the intermediate value of Level 10. Timing started as soon as the throttle was rapidly moved to the specified track voltage value.

Note that acceleration increases at higher throttle settings but that it takes longer to reach full speeds at the higher throttle settings. This is what you would expect and is similar to how your car responds to its throttle. If you press your car throttle down more, you expect to accelerate faster but you would also expect that it will take longer to reach its full speed.

These curves are shown for a V-Max of 13.7 volts.

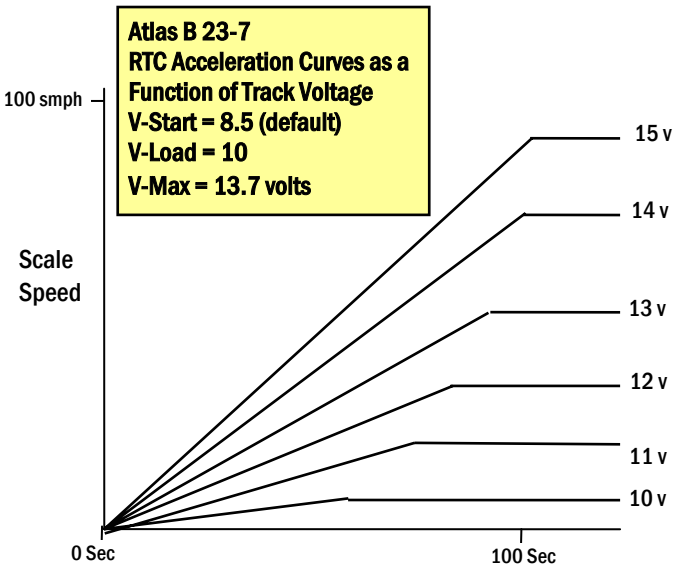


Figure 5

The values of V-Start and V-Max also affect how locomotives accelerate. Figure 6 below shows the time to reach full speed as a function of V-Max for the same locomotive. As before the locomotive was at rest in Neutral when the throttle was turned up rapidly to 19 volts and timing begun. For low values of V-Max, the acceleration is much more rapid than for high values of V-Max. The reason is that the Quantum acceleration routine will reach 100% motor power sooner with a lower V-Max. We recommend that V-Max be set near the maximum throttle voltage to take full advantage of RTC operation over the entire throttle range and to provide the greatest possible range in acceleration from the Load settings.

Figure 7 shows acceleration times as a function of Load for two different values of V-Max. These measurements were made on the same B23-7 GE Atlas model. Again the locomotive was at rest in Neutral when the throttle was turned up rapidly to 19 volts and timing begun. For the maximum Load of 15, at a V-Max of 18 volts, the total time to accelerate to full speed was 1000 seconds (16 minutes 40 seconds) while at the factory default V-Max of 12 volts; it took 390 seconds (6 minutes 30 seconds). Both are respectable times but the larger acceleration times are within the range of acceleration of large prototype trains.

Figure 7 also shows that the acceleration time is approximately linear with Load up to about Level 9 where it increases rapidly for Levels 10 through 15. As a rule, the acceleration time increases about 10-12% per Load Level up to level 9. The higher load levels are increased more rapidly and are intended for those layouts that have sufficient room for true prototype operation. Load level 15 has twice the acceleration time of level 14.

92 This is at the factory default settings for V-Max of 12.0 volts and V-Start of 8.5 volts and with a rapidly applied increase of track voltage to 18 volts.

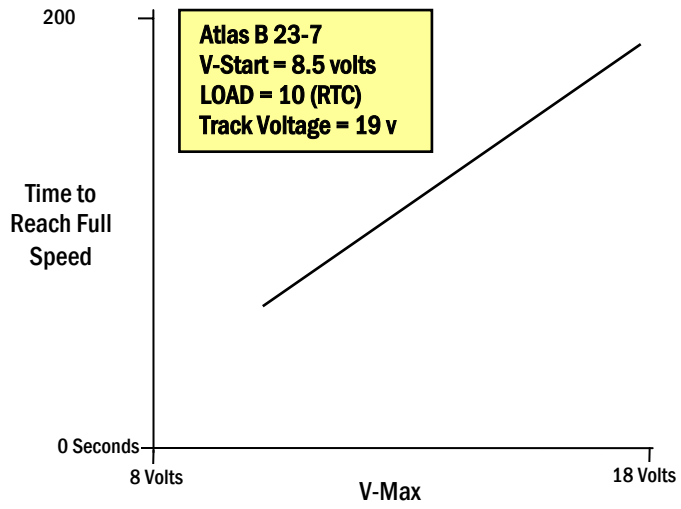


Figure 6

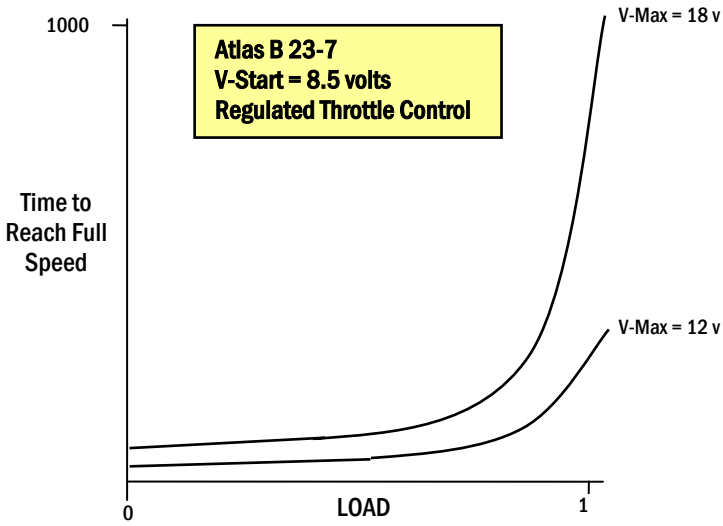


Figure 7

Heavy Load Command using QARC Technology

QARC technology does provide a way for us to have much more functionality under Analog control. It was tempting to use one of the many commands available with Quantum Engineer to place a locomotive under Cruise Control. Everyone who owns a modern car is familiar with cruise control. This feature allows you to set your car motor control to maintain the automobile at its present speed and allow you to take your foot off the throttle. If you set your car to 55 mph, it will continue at that speed over hill and dale, applying more power where necessary and backing off on the gas when going down hill. This same principle seems like a natural function to add to model trains as well. However, Cruise Control is a form of Speed Control and it is subject to the problems and instabilities described at the beginning of this section when operating locomotives in consists. We opted for a different approach using our RTC algorithm. When a consist is moving, the Load button on the Quantum Engineer will set the Load level to a value we call "Heavy Load". This Load level is so high that it would take the consist over 20 minutes to accelerate to full speed. However, because different locomotives in the consist can still adjust their speed, albeit slowly, to changes in external loading, the locomotives will continue to try and share power. However, the very long acceleration and deceleration times under Heaving Load allows the consist to maintain smooth operation over typical layouts grades with little variation in speed. The "Heavy Load" feature also allows the operator to either increase diesel motor rev and labored Sound-of-Power by increasing the throttle or decrease rev and lower the labored Sound-of-Power by decreasing the throttle without the consist changing speed appreciably. This provides a way for a train to sound like it is working hard while climbing a grade and coast down a grade with little laboring, all under the control of the user's throttle and with little change in apparent speed.

Braking with Throttle and using QARC Technology

You can reduce the speed of your locomotive faster than the RTC and Loading would allow by bringing the throttle down fast. This actually robs power from the RTC routine and forces the locomotive to slow down. However, when the speed of the locomotive reduces far enough to be within the RTC limits, the locomotive will proceed to decelerate at the Load setting in POP 2. This can be a little confusing to the operator since the locomotive appeared to be responding directly to the throttle for its initial slow down and is now slowly decelerating for the rest of the deceleration period. The tendency of the operator may be to turn the throttle down more to force the locomotive to stop. This usually results in the entire Quantum system shutting off because there is insufficient voltage to keep the electronics alive. If the track voltage is lowered to below V-Start, further reductions will have little effect. If you want your locomotive to stop more quickly, you either need to program a lower Load in POP 2 or you need to use the braking key on the Quantum Engineer (see Quantum Engineer Operating Instructions, Appendix IX).

Horn and Whistle Operation under STC and RTC

Blowing the Horn or Whistle requires extra power from your DC power pack. Because some power packs have considerable internal resistance, the locomotive may slow down or stop completely if running at low speeds under STC. However RTC is quite immune to rapid changes in track voltage and will maintain its speed while the Horn or Whistle is operated. If the Horn or Whistle is operated continually for a long period of time, the locomotive will gradually slow down under RTC.

Appendix VII: Troubleshooting

Common Problems and Suggested Solutions.

Locomotive coasts to a stop at full throttle setting and just emits a series of Hoots.	The Quantum High Voltage Circuit breaker has been tripped from too much voltage applied to the track. Turn the throttle down a little to re-engage the motors. Refrain from using these higher throttle settings when starting out.
Bell will not toggle on and off.	Make sure you are not flipping the direction switch back and forth too quickly or too slowly. A little practice with your timing will give you a feel for how this operation works. It also helps to use your other hand to steady the power pack to keep it from slipping during the Quick flip-and-back operation.
Locomotive does not make any sounds but responds to throttle.	Make sure the system volume is not turned off either through programming, volume potentiometer or Magnetic Wand. Check to see that the individual volumes have not been turned off. You may have shut your locomotive down in DCC using the F9 key, which will also shut it down in Analog. If your locomotive has Magnetic Wand technology, use the wand to start your locomotive or go back to DCC operation and start your locomotive with the F6 key. Once started, you can return to DC or DCC operation. Your locomotive may be in an unusual mode of operation. Use the reset jumper or Magnetic Wand to reset your locomotive as described in this manual. If you do not hear verbal responses in programming, your speaker may be disconnected or wires may be disconnected from the speaker terminals.
When blowing the Whistle/Horn, the locomotive stutters slightly before the Whistle/Horn goes on.	You are moving the direction switch too slowly through its center position, which can momentarily turn off track power.
When I blow the Whistle/Horn, the locomotive slows down or if it is moving slowly, it may stop altogether and then start again when I stop blowing the Whistle/Horn.	When the Whistle/Horn is operated, additional power is required, particularly if the volume is turned up high. The extra current can cause voltage drops along the track or in the locomotive pickups or from the resistance in some of the less expensive power packs. Operating the locomotive under RTC will usually prevent any locomotive slow down from operating the Whistle/Horn.
I want to change directions in Neutral but flipping the direction switch makes the Whistle/Horn come on.	You need to change the direction switch before the second Long Air Let-off and the Air Pumps come on in Neutral. If you wait too long and the Whistle/Horn comes on when you flip the direction switch, simple turn up the throttle: the locomotive will start in the opposite direction and the Whistle/Horn will stop and blow twice more if going in Reverse or once more if going in Forward. .
I cannot get the Whistle/Horn to blow or the Bell to toggle in Neutral using the direction switch.	After entering Neutral, wait for the second air release and the start of the Air Pumps before trying to use the direction switch to operate the Whistle/Horn or Bell.
When I turn down the throttle below V-Start on a moving locomotive, it slows down at first but then will not enter Neutral.	If you have a high Load setting, the locomotive will at first slow down quickly when you reduce the throttle but will then decelerate slowly according to the Load value which may take many minutes. Also, some power packs have a lot of series resistance. Even though you turn the throttle down below V-Start, the voltage may creep back up as the locomotive slows down which will require that the throttle be

	turned down even more.
The locomotive will not enter Neutral.	If the locomotive comes to a complete stop and the track voltage is below V-Start, it will enter Neutral. If you cannot get your locomotive to stop with power still applied, you may need to set a new "V-Start". If you cannot use your current power pack to do this, use another power pack from the recommended list and set "V-Start" until it does work with your power pack.
The locomotive will not produce the Doppler shift effect.	This might be a timing problem. Always blow the Whistle/Horn for at least 1 second before interrupting the Whistle/Horn signal with a **Quick** flip-and-back operation of the direction switch. If you flip it too slowly, the Whistle/Horn will actually shut off and turn back on again. Also, Doppler is speed dependent and does not operate below 15 smph.
Sounds come on but I cannot get my locomotive to move when I increase the throttle.	Your Power Pack may not have sufficient maximum throttle voltage. If it measures below about 11 volts with a voltmeter, it may not have enough power to operate your locomotive and load. We recommend power packs with a maximum throttle output of 14 volts to 17 volts. On the other hand, some power packs have too much open circuit (unloaded) voltage when turned on even at the lowest throttle position. This will activate the High Voltage Circuit Breaker on the locomotive and prevent the motors from engaging. Try turning the throttle up very slowly when leaving Neutral to allow the motors to engage at the lowest possible track voltage. Often times, when the motors do engage, they will load the power pack enough to prevent the circuit breaker from engaging even at the highest setting.
When using 12 volts filtered DC on the track, my top speed is too slow at full throttle.	Quantum is designed to operate with the most popular power packs that usually have a maximum voltage of 16 volts. Set V-max to about 10 volts for your 12-volt power pack for much higher top speed.
When I set a high Load value and turn up my throttle all the way to start out, the locomotive does not move and emits a series of short hoots. However, without Load, it operates fine at high throttle.	When operating without a Load (Load = 0), the locomotive requires full current as the throttle is turned up which lowers the output voltage because of internal resistance in most power packs. However, when Load is set high, and the throttle turned up all the way, there is at first very little current demand from the locomotive and the power pack produces maximum voltage, which cause the circuit breaker to engage. When operating with high Load, turn up the throttle part way until the locomotive gets moving before turning it up to full.
When running a consist with all locomotives under RTC, the locomotives fight each other.	If this causes a problem, use Standard Throttle Control (STC).

Appendix VIII: HO DC SideKick

The Quantum Two-Button Activator for DC: Installation and Operation Instruction

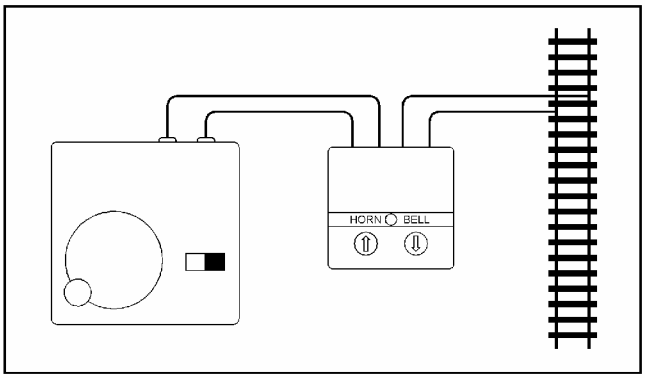
The HO DC SideKick is designed to work with any DC Analog power pack to make operating and programming your Quantum® Systems more convenient. HO DC SideKick simplifies horn and bell operation by using two buttons to perform functions that are usually done with the direction switch, making programming the Quantum system easy and saving wear and tear on your power pack's direction switch.[93]

Installation

- Wire the HO DC SideKick to your power pack's variable DC output and to the track as shown in the diagram below.
- Remove the backing from the loop side (fussy side) of the Velcro tape and press it to the bottom of the HO DC SideKick, under the button area. Remove backing from the hook side of the Velcro tape and attach it to your power pack or to a convenient place in your control area.

The unit will be in **Run Mode** as soon as power is applied. In **Run Mode** the Bell and Horn buttons will operate normally, and the red LED will shine steadily. Your unit is ready to operate.

Wiring the HO DC SideKick Unit to the Power Pack



93 It is an ideal addition to some of the new HO power packs that use an electronically activated direction switch, which operates too slowly to send Quantum bell or program commands.

Operation

Horn Button (Red)
Press the Horn button for any length of time to produce long or short horn blasts. Tapping once briefly will produce a short hoot and tapping repeatedly will cause a series of short horn hoots. This is ideal for reproducing prototype horn signals: for example, use two hoots for starting a locomotive in Forward or three hoots for starting the locomotive in Reverse.

Bell Button (Blue)
Press the Bell Button to toggle the bell on or off. It does not make any difference how long you hold the Bell button down; it will only toggle the bell once.

Note: Tapping the horn and bell will be remembered by the HO DC SideKick for up to eleven operations. You can use this memory feature to hoot the horn and toggle the bell on and off in succession according to the sequence you have entered.

Combination Horn and Bell Button Operation

Doppler Effect

- Blow the Horn with the Horn button and interrupt the horn signal briefly by releasing and re-pressing the Horn button,
- OR operate the Doppler effect by continuing to hold the Horn button down and tap the Bell button once while the Horn button is still pressed [94].

The Power Pack Direction Switch

Use the direction switch to change the direction of your locomotive as described in the Quantum Operation manual supplied with your locomotive.

Quantum Programming

To enter Programming Mode:

- Hold either the Bell or Horn button down while you turn on track power to trigger the HO DC SideKick to enter **Programming Mode**[95].
- The Red LED on the HO DC SideKick and the directional lights on the locomotive will blink to indicate that you are in **Programming Mode** and you will hear "Enter Programming. Option 1 – System Volume".

Selecting the Program Option

- Hold the Horn button down until the Quantum System starts counting through the Program Option numbers one by one. It will count from Option 1 up through the last option available for your locomotive[96].
- When you reach the number for the Program Option you want, release the Horn Button. The Quantum System will announce the Option Name. For example, if you stopped at option number 14, you would hear "Bell Volume".
- If you missed your option number or want to move on to other options, either: 1) press and hold the Horn button or 2) turn off the power and re-enter programming as described above.

Note: If you press the Horn button when you first apply power, and continue pressing the Horn button, the HO DC SideKick will automatically enter programming and count up through the Program Options. Release the Horn button when you reach the desired Program Option.

Note: Pressing the Bell button will not decrease the program option level you are at, it will enter the option. You can only scroll forward with the Horn button to select program options.

94 There is no effect designated for holding the bell down and tapping the horn button. This procedure will simply toggle the bell feature.
95 You can enter programming by tapping the bell button three times in rapid succession after you apply power, just as described in your Quantum Operating manual. However, the HO DC SideKick horn timing is different in Programming than in Run Mode. You will need to hold the horn button down until you hear the soft hiss from the Quantum system as described in order to increase the level setting.
96 On some early Quantum Systems, the locomotive will return or loop back to the beginning option and start over as you continue to hold the Horn Button down.

Use Horn or Bell Button to Enter and Change the Programming Option

After you stop at the Program Option you want, tapping the Horn or Bell button will enter the option. You will hear the **current value** for that programming option spoken out from the Quantum system in the locomotive. **The next time you press either button, you will be making changes to the value for that option.**

Pressing and releasing the Horn button will **increase** the level of the option's value each time it is tapped. If it is quickly tapped repeatedly, the HO DC SideKick will remember the number of times it was pressed and you will hear the Quantum system progress to the next option level for each of the stored button pressings.

Hold down the Horn button to leave the current program option and start advancing through the next programming options.

Pressing and releasing the Bell button will **decrease** the level of the option's value each time it is tapped. If it is quickly tapped repeatedly, the HO DC SideKick will remember the number of times it was pressed and you will hear the Quantum system count down to the next option level for each of the stored button pressings.

Hold down the Horn button to leave the current program option and start advancing through the programming options.

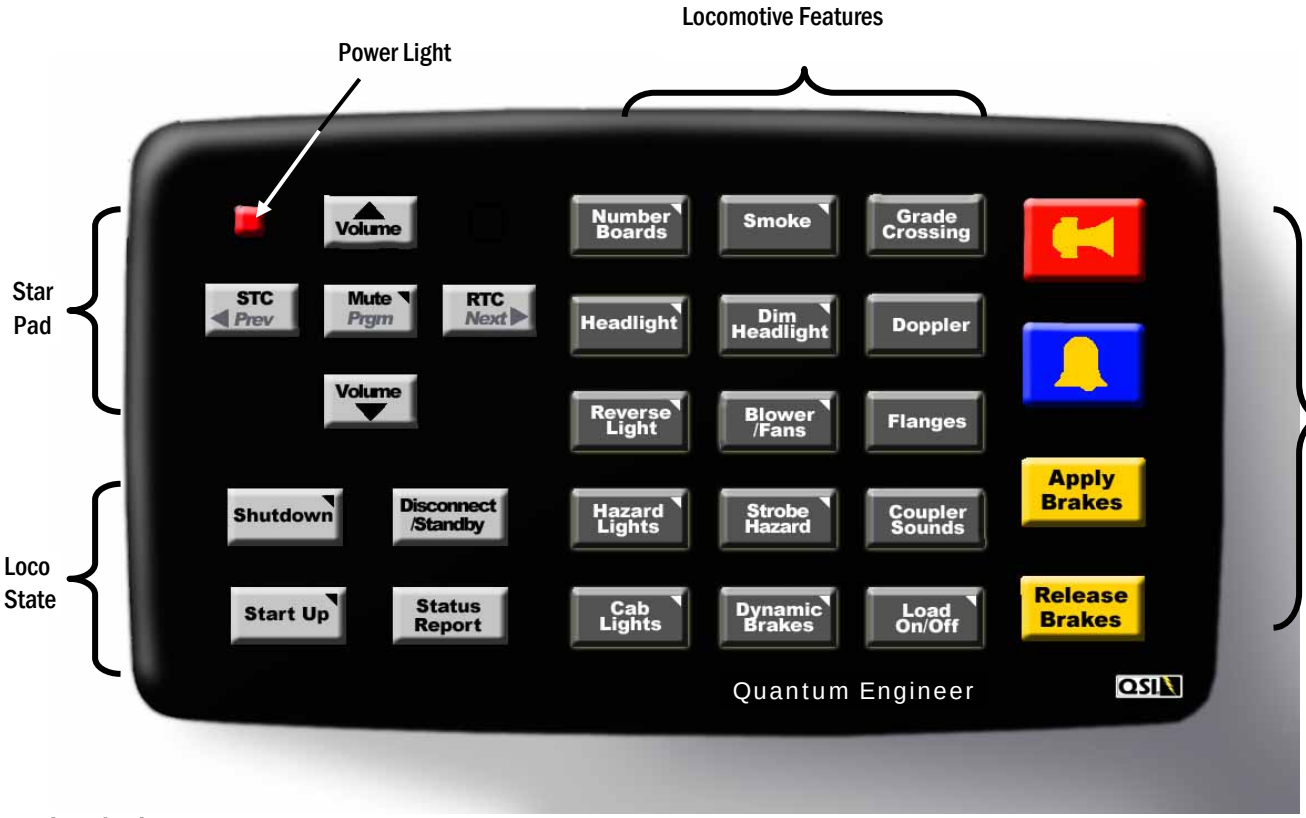
Leaving Programming

- To leave programming, simply turn the power off and back on. The DC SideKick's LED and the Quantum locomotive's directional lighting will stop blinking and both will begin to shine steadily.
- You are now in Run Mode and ready to Operate.

Appendix IX: Quantum Engineer

Quantum Engineer™ Operating Instructions

Quantum Engineer Controllers are designed to easily and quickly operate locomotives that have QARC (Quantum Analog Remote Control) technology. Except for simple horn and bell operations, the Quantum Engineer Control is not suitable for older Quantum locomotives that do not have QARC technology (see your locomotive Operation Manual).



Introduction

The Quantum Engineer buttons are organized by function to make operation simple. The buttons on the right are the **Primary Control Keys** for locomotive operation and include horn, bell and brakes.

The set of fifteen gray keys to the left of the Primary Control Keys, are the **Locomotive Feature Keys**, and provide operation of different locomotive settings such as lights and fans, as well as controlling different effects like Doppler and Flange sounds.

The cluster of five keys in a star pattern in the upper left corner are used for two different types of control. During operation, the vertical arrow keys control sound volume, and the left/right arrow keys select the throttle mode. During programming, the arrow keys select the different program options and allow you to change the settings. This group of five keys is called the **Star Pad Keys**.

The keys in the lower left are used to control the locomotive states of Start Up, Shut Down, Disconnect and Standby as well as locomotive Status reporting. This group is called the **Locomotive State Keys**.

Note: Some keys have a small triangle in the upper right corner. These keys turn the indicated feature on or off using a special technique: pressing these keys once will turn the feature on while pressing it twice in quick succession[97] will turn the feature off. This allows you to know whether you have turned a feature on or off without having to see or hear the locomotive. *The only exceptions are the Start Up and Shut Down keys where a double press produces an extended Start Up or extended Shut Down sound effect.*

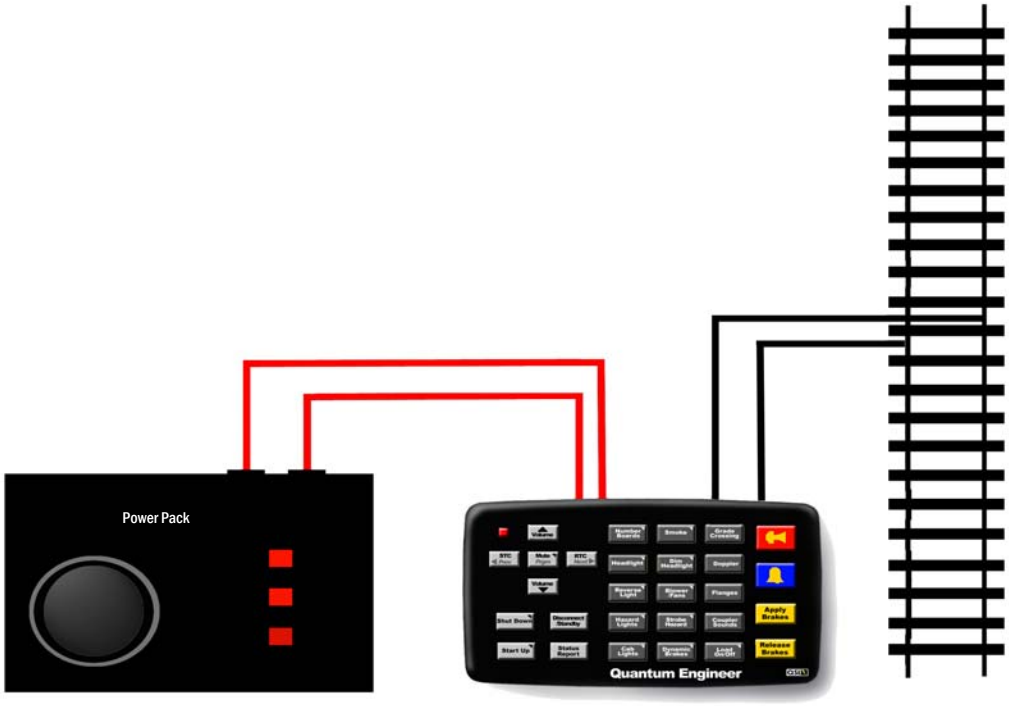
97 Like double clicking a mouse key on a PC.

Installation

Wire the Quantum Engineer to your power pack's variable DC output and to the track as shown in the diagram below. The red wires connect to the power pack's variable DC output (throttle) and the black wires connect to the track.

- Remove the backing from the loop side (fuzzy side) of the Velcro tape and press it to the bottom of the Quantum Engineer. Remove backing from the hook side of the Velcro tape and attach it to your power pack or to a convenient place in your control area.

The unit will be in **Run Mode** [98] as soon as power is applied. In **Run Mode** the Bell and Horn buttons will operate normally, and the red LED will shine steadily. Your unit is ready to operate.



98 Quantum Engineer has two modes, Run and Programming..

Operation in Run Mode

If Quantum Engineer has been installed correctly, the red Power Light will glow steadily when the throttle is turned up.

The following is a list and explanation of the features for the four different key groups.

Primary Operation Keys

Pressing the **Horn** key will produce Horn or Whistle blasts as long as the button is pressed. If you press and release it quickly, you will get a short "hoot" sound.

Note: Some Quantum locomotives (See your locomotive's Operation Manual) have special Horn Endings that can be triggered by releasing the **Horn** key and then quickly pressing and releasing[99] or tapping the **Horn** key before the horn sound quits. Or, this special effect can be performed by releasing the **Horn** key and quickly pressing the **Bell** key.

Pressing and releasing the **Bell** key will toggle the locomotive's Bell effect on or off.

Apply Brakes and

Release Brakes You can apply brake effects with the **Apply Brake** button in STC (Standard Throttle Control)[100] or RTC (Regulated Throttle Control) although RTC provides more realistic control[101].

- Without reducing the track voltage, press and hold the **Apply Brakes** key. Hear air being released from the brake lines continually. The longer the air is released the greater the braking action. Diesel motor sounds will automatically reduce to idle and steam chuffing will reduce to its lowest Sound of Power® setting.
- Let go of the **Apply Brakes** key to stop the air release. The train will continue to slow at the last braking value.

Note: If you initially press the **Apply Brakes** key only briefly, you will hear no air release sound and the locomotive will coast to a stop at its Intrinsic Inertia[102] and Load setting without any braking applied.

- If you want to apply more braking, press and hold the **Apply Brakes** key to release more air. When you reach the desired amount of braking, let go of the **Apply Brakes** key to stop the air release.
- Press the **Release Brakes** key to release the brakes to return the locomotive to coasting.
- Press the **Release Brakes** key a second time and hear the Diesel Motor or steam Chuff return to its pre-braking throttle setting. The locomotive will accelerate back to its original speed at a rate proportional to its Intrinsic Inertia and Load setting.

Note: Apply Brakes will have no affect in STC unless the locomotive has an active Load value (see Load On/Off below).

Note: If the locomotive is in Neutral when the **Apply Brakes** key is pressed, a Long Air Let-off sound simulates setting the brakes. However, no braking effect is activated [103].

Note: If you leave the throttle at a high setting and apply brakes, the locomotive will come to a much smoother stop than simply lowering the throttle to stop the locomotive.

Note: When a locomotive is stopped with brakes, it will not enter Neutral until the throttle is reduced below V-Start.

Note: We recommend using the brakes to stop a consist rather than the throttle. After the consist has stopped, lowering the throttle below V-Start will ensure that all locomotives enter Neutral at the same time, making it more likely that the consist can be reversed reliably.

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99 Do not confuse this with a Doppler action, which is triggered by quickly releasing and pressing the horn key during horn operation.

100 A Load value greater than "0" must be programmed in Program Option 2 and the Load must be activated using the Load On/Off key in order for the Apply Brakes key to have any affect in STC. RTC does not require a Load value for the braking features to operate.

101 See description of RTC and STC in the Quantum Operation Manual supplied with your locomotive or refer to Appendix VI in this Analog Reference Manual.

102 RTC has Intrinsic Inertia; STC does not. Load value is set in POP 2.

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

Load On/Off Once you enter the Load value into Programming Option #2 (POP 2) and return to Run Mode, you can toggle this Load value on or off in Neutral with the **Load On/Off** key. When Load is off, the locomotive will accelerate or decelerate at its Intrinsic Inertia value.

Operation while in Neutral

- Press the **Load On/Off** button once in Neutral to turn on the Load. You will hear a Long Air Let-off.
- Double press the **Load On/Off** button in Neutral to turn off the Load. You will hear a coupler clink.

Note: Locomotive labored sounds (Sound-of-Power™) are increased when Load is on and the locomotive is accelerating.

Operation while Moving

With **RTC**[104] selected and the locomotive moving in Forward or Reverse, pressing the **Load On/Off** button will apply or remove a very "Heavy Load" to the locomotive. This represents a train that would take over ten minutes to accelerate to full speed or to coast to a complete stop. You can apply a Heavy Load as soon as you start moving or wait until you are up to speed.

- Press the **Load On/Off** button once in Forward or Reverse to turn on Heavy Load. Hear a single Horn or Whistle hoot.
- Double press the **Load On/Off** button in Forward or Reverse to turn off Heavy Load. Hear a double Horn or Whistle hoot.

Note: Heavy Load does not require you to program any Load values in POP 2.

Note: If you apply Air Brakes while in Heavy Load, the locomotive will return to operation using the programmed Load setting in POP 2.

Note: Be aware that once Heavy Load is turned on, the throttle will have little effect in changing the speed of the train. If you turn the throttle up, you will hear very intense Sound of Power effects or if you turn the throttle down, you will hear very subdued Sound of Power[105]. You can use this feature to create heavy labored sounds while climbing a grade or reduced labored sounds while descending a grade with very little change in the speed of the train.

Dynamic Brakes Many prototype diesel locomotives have dynamic brakes that cause the train to slow down by using the traction motors in generator mode. This helps dissipate 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.

- While the locomotive is operating at a steady speed, press the **Dynamic Brakes** key once to turn on the Dynamic Brakes. Hear the Diesel Motor reduce to notch 1 followed by the sound of the powerful diesel Cooling Fan starting up.
- Double press the **Dynamic Brakes** key to turn off the Dynamic Brakes. Hear the Dynamic Brake Cooling Fan shut off while the Diesel Motor returns to its original notch and Sound-of-Power setting.

Note: If the **Dynamic Brakes** key is pressed for a steam locomotive, the Chuffing will reduce to a low level and return to its previous setting when Dynamic Brakes are shut off. This makes steam locomotive behavior similar[106] to diesels in a consist.

Note: In contrast to Air Brakes (F7), Dynamic Brakes do not increase the deceleration rate specified by the Load setting in POP 2. *The Dynamic Brakes are only a sound effect and have no actual braking action*[107].

Note: The Dynamic Brake function automatically turns off when entering or leaving Neutral, or when the speed of the locomotive drops below 7 smph[108]. The Dynamic Brakes cannot be turned on in Forward or Reverse unless the locomotive is traveling over 8 smph. Dynamic Brakes will not turn on if the locomotive is accelerating.

Note: Dynamic Brakes can be turned on in Neutral if the locomotive is in Disconnect (see below under **Locomotive State Keys**).

Grade Crossing Prototype railroads use horn or whistle codes of long and short blasts for communication or warning signals. One of the most common is the code of two longs, a short and a long horn signal to warn of approaching a grade crossing. Although the Quantum operator can perform these signals with the **Horn** button, we have made it even more convenient.

- Press the **Grade Crossing** key once to trigger the two longs, short and long whistle or horn grade crossing warning signal.
- If you press the **Horn** key during the Grade Crossing scenario, you will terminate this feature and take control of the Horn.

104 Load On/Off has no effect under STC in Forward or Reverse.
105 If you turn the throttle down too far, the train will slow quickly as the available power to the track falls below the level that is necessary for RTC to operate.
106 It would be unrealistic for a steam locomotive to be working at full Sound-of-Power while Dynamic Brakes are being applied to other locomotives within the same consist.
107 Prototype dynamic brakes are commonly used on down grades with the intention of maintaining a constant speed rather than stopping the train.
108 Dynamic Brakes on prototype diesel locomotives are seldom used at low speeds where they are less effective.

Note: Grade Crossing feature does not operate in Neutral.

Doppler You can trigger the Doppler effect by quickly interrupting the horn signal in the same way it is described in the Analog section of your Quantum Operation Manuals. Or you can use the **Doppler** Key dedicated to the Doppler effect.

- Start the Horn or Whistle by pressing the **Horn** key[109] and hear the normal Horn or Whistle.
- While still pressing the **Horn** key, press and release the **Doppler** key to hear the Doppler shift. A few seconds after the **Horn** key is finally released the locomotive sounds return to normal [110].

Flanges Quantum provides automatic Squealing Brakes[111] sounds 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 wheel Flanges on curved track.

- Pressing the **Flanges** key when the locomotive is moving at any speed will manually activate Squealing sounds, and repeated pressings while the Squealing sounds are occurring will continue the sounds uninterrupted.
- **Note:** Flanges are a sound effect only and will not slow the locomotive.

Coupler Sounds There are two ways to use the Coupler Sounds key.

- As your locomotive is about to couple up to a string of cars, press the **Coupler Sounds** key to trigger the Coupler Crash sound. Use the **Coupler Sounds** key again as the locomotive moves out to trigger the same sound as the slack is taken up in the cars[112].
- Coupler Sounds have a different effect in Neutral. While stopped in Neutral in uncoupling position over an uncoupling magnet, press the **Coupler Sounds** key once to produce the sound of the lift bar and coupling pin being raised. This also Arms the uncoupling sound effect. Press the **Coupler Sounds** key again while pulling away or in Neutral to trigger the sound of the coupler knuckle opening and air-lines parting.

Smoke Your locomotive may be equipped with an automatic Smoke Unit, which may control the smoke differently in each of the directional states.

- Press the **Smoke** key once to turn on the automatic Smoke Unit.
- Double press the **Smoke** key to turn off the automatic Smoke Unit. The Smoke Unit will be off in all directional states.
- **Note:** The Smoke Unit in your locomotive may be wired directly to the power pick-ups in which case it will not be controlled by QARC technology and pressing the Smoke button on the Quantum Engineer will have no effect.

109 If you do not turn on either Horn or Bell, the Doppler shift will still occur with the locomotive sounds, but will be less dramatic.
110 If the bell was on, it will shut off prior to all sounds returning to normal.
111 Squealing Brakes come on automatically when the speed is reduced from high-speed travel (over 40 smph) to less than 20 smph.
112 The locomotive must actually be moving in order for this effect to occur.

Automatic Features with "Take Control" Operation

Many of the features that can be turned on or off by Quantum Engineer already have Automatic Control. The Quantum System allows the operator to "Take Control" of certain automatic features by using their associated control keys. Once you "Take Control", the features will no longer have Automatic Control and you will control their operation and state with their key commands. Automatic and Take Control operations are described in the table below.

Quantum "Take Control" Operation

	Automatic Operation			Take Control	
	Forward	**Reverse**	**Neutral**	**Key**	**Operation**
Steam Blower Hiss	Off after 10 seconds	Off after 10 seconds	On after 10 seconds	Blower/Fans	Turns the Blower hiss sounds on or off.
Diesel Vents & Cooling Fans	Non-operating	Non-operating	On and off at random times	Blower/Fans	Turns the Cooling Fans on or off.
Number Board Lights	On	On	On	Number Boards	Turns the Number Board Lights on or off.
Headlight	On	Dim	Dim	Headlight and Dim Headlight	Headlight key turns Headlight on or off. Dim Headlight key will dim or brighten a Headlight that is turned on.
Reverse Light	Off	On	Off	Reverse Light	Turns the Reverse Light on or off.
Hazard Lights	Strobing	Dim	Dim	Hazard Lights and Strobe Hazard	Hazard Light key turns the Hazard Lights on or off. Strobe Hazard key selects Hazard light to strobe or become steady-on.
Cab Lights	Off after 15 seconds	Off after 15 seconds	On after 10 seconds	Cab Lights	Turns the Cab Lights on or off.

Automatic operation is restored if the power is shut down and reapplied or if the **Start Up** key is pressed in Neutral (see the description of Start Up on page 83).

Note: If your locomotive has an optional Hazard Light, the Headlight may not be dimmable.

- The following are all Take Control features that can be operated by the different Quantum Engineer keys.

Number Board Lights This key turns the Number Board lights on or off on specially equipped diesels.

- Press the **Number Boards** key once to turn on and take control of the Number Board Lights.
- Double press the **Number Boards** key to turn off and take control of the Number Board Lights.

Headlight

- Press the **Headlight** key once to turn on and take control of the Headlight. The Headlight will be on in all directional states.
- Double press the **Headlight** key to turn off and take control of the Headlight. The Headlight will be off in all directional states.

Dim Headlight

- Press the **Dim Headlight** key once to dim the Headlight and Take Control of the Directional Headlight brightness.
- Double press the **Dim Headlight** key to brighten the headlight and take control of the Headlight.
- **Note:** If the Headlight has been turned off with the **Headlight** key, the **Dim Headlight** key will not have a noticeable effect. However, if the Headlight is turned on at a later time, it will come on with the dim setting set by the **Dim Headlight** key.

Reverse Light

- Press the **Reverse Light** key once to turn on the Reverse Light and Take Control of the Reverse Light. The **Reverse Light** will be on in all directional states.
- Double press the **Reverse Light** key to turn off and take control of the Reverse Light. The Reverse Light will be off in all directional states.

Hazard Lights Hazard Lights can be a Mars Light, Over-Head Blinking Lights, or Ditch Lights.

- Press the **Hazard Lights** key once to turn on and take control of the Hazard Lights. The Hazard Light will be on in all directional states.
- Double press the **Hazard Lights** key to turn off and take control of the Hazard Lights. The Hazard Lights will be off in all directional states.
- **Note:** Mars Light and Ditch Lights are part of the automatic lighting system. Overhead Blinking Lights are on in all directional states.

Strobe Hazard Hazard Lights can either be steadily-on or be strobed. The Mars Light strobe gives the effect of a moving beam of light, the Over-Head Light strobe is a steady repetitive blinking, and Ditch Light strobe blinks back and forth between the right and left lights.

- Press the **Strobe Hazard** key once to turn on the strobe effect and take control of the Hazard Lights.
- Double press the **Strobe Hazard** key to turn off the strobe effect and take control of the Hazard Lights.
- **Note:** If Hazard Lights have been turned off with the **Hazard Lights** key, the **Strobe Hazard** key will not have a noticeable effect. However, if the Hazard Lights are turned on at a later time, they will come on at the strobe setting set by the **Strobe Hazard** key.

Cab Lights This key turns the Cab Lights on or off on specially equipped locomotives.

- Press the **Cab Lights** key once to turn on and take control of the Cab Lights.
- Double press the **Cab Lights** key to turn off and take control of the Cab Lights.

Blower/Fans This key turns the steam Blower or diesel Cooling Fans on or off.

- Press the **Blower/Fans** key once to turn on and take control of Blower or Cooling Fans operation.
- Double press the **Blower/Fans** key to turn off and take control of Blower or Cooling Fans operation.

Locomotive State Keys

Disconnect/Standby Disconnect will disable the locomotive's electric motor drive circuit to allow the throttle to be changed without the locomotive moving. In Disconnect, the operator can increase the throttle on a stationary locomotive to rev the Diesel Motor or vent steam in a steam locomotive.

Standby places the locomotive in a special idle state with subdued sounds where it will not respond to throttle or most of the feature keys[113]. Standby is ideal for leaving your locomotives running on a siding while you operate other locomotives.

- Press the **Disconnect/Standby** key once in Neutral to enter Disconnect.
- To leave Disconnect:
    - Press the **Start Up** key to regain normal operation.
    - Or press the **Disconnect/Standby** key again to enter Standby.
    - Or press the **Shut Down** key to enter Total Shut Down.
- To leave Standby:
    - Press the **Start Up** key to enter normal operation.
    - Or press the **Shut Down** key to enter Total Shut Down.

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

Note: If power is turned off during either the Disconnect or Standby procedures, the locomotive will remember the last command and will power up in the same stage.

113 The four exceptions are the F6 Start Up key, the Mute Key, the Shut Down key and the Status Key.

Note: If Start Up is initiated during any of the above procedures, the locomotive will immediately return to normal operation.

Note: Neither the **Horn** nor the **Bell** key will operate in Standby or Shut Down. Analog Programming is disabled in Disconnect and Standby.

Shut Down Shut Down allows the operator to take the locomotive "off line" (turn off sounds, lights, ignore throttle settings and feature commands[114]) independent of the operating session; that is, the locomotive will still be "off line" when power is reapplied for the next operating session.

- Press the **Shut Down** key once to produce a Rapid Shut Down. Rapid Shut Down will shut the locomotive off in a few seconds.
- Double press the **Shut Down** key to produce an Extended Shut Down scenario. Extended Shut Down will shut the locomotive down over thirty seconds with progressive sound and light effects. The Extended Shut Down for diesels and steam locomotives is as follows:

Diesel Extended Shut Down: After double pressing the **Shut Down** key, hear a Long Air Let-off, followed by Directional Lighting turning off (if on). In a few seconds, the Air Pumps shut off, followed by the Number Boards and the sounds of the Cooling Fans shutting off, the louvers closing, the Diesel Motor shutting down and finally, the Cab Lights shutting off. After a short time, you will hear the engineer's door open and then shut.

Steam Extended Shut Down: After double pressing the **Shut Down** key, you will hear a Long Air Let-off, followed by Directional lighting turning off (if on). In a few seconds, the Air Pumps will turn off, followed by the sounds of Pop Off operating for about ten seconds followed by a hiss sound that gradually trails off to silence.

- To leave the Shut Down state, press the **Start Up** key.

Note: If power is turned off during a Shut Down procedure, the locomotive will be in Shut Down when power is reapplied.

Note: If the **Start Up** key is pressed during a Shut Down procedure, Shut Down is aborted and the locomotive returns to normal operation.

Note: Except for a few extra sound effects for Extended Shut Down, the shutting down of lighting and sound effects still occur during Rapid Shut Down but happen more quickly.

Note: You cannot shut down a locomotive while it is moving. There is no response if you press the **Shut Down** key in Forward or Reverse.

Note: Any locomotive on the powered track while you press the **Shut Down** key will go into Shut Down

Start Up If your locomotive is in Disconnect, Standby or Shut Down, you can return your locomotive to normal operation by pressing the **Start Up** 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.

- **Start Up from Disconnect:** Press the **Start Up** key in Disconnect and the locomotive will produce a Long Air Let-off then enter normal operation.
- **Start Up from Standby:** If you double press the **Start Up** key in Standby, the locomotive will produce a Long Air Let-off, the Directional Lighting will turn on and then the locomotive will enter normal operation.
- **Start Up from Shut Down:**
  - Press the **Start Up** key once to produce Rapid Start Up.
  - Double press the **Start Up** key to produce an Extended Start Up scenario. The Extended Start Up for diesels and steam locomotives is as follows:

Diesel Extended Start Up: If you double press the **Start Up** key, the diesel locomotive will produce a Long Air Let-off. After a few seconds, you will hear the engineer's door opening and closing, followed by the vents opening, the Diesel Motor starting up, the Air Pumps starting up, and the locomotive entering normal operation.

Steam Extended Start Up: If you double press the **Start Up** key in Shut Down, the steam locomotive will produce a Long Air Let-off, the Dynamo will rev up and the Directional Lighting will turn on, followed by the Air Pumps starting up, the steam Blower turning on and then the locomotive will enter normal operation.

Note: If your locomotive has been Deselected and Shut Down using a Magnetic Wand, it must first be selected by pressing the **Start Up** key for 3 seconds followed by again pressing the **Start Up** key to start the locomotive.

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

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114 In Total Shut Down, the locomotive will not respond to throttle or commands. The two exceptions are the Start Up Key and the Status Key. If your locomotive is equipped with the Magnetic Wand option, this can be used to perform a Total Shut Down (see your Quantum Operating Manual).

Status Report Quantum provides verbal information about the locomotive's current operating state when the locomotive is stopped or the locomotive's current speed in scale miles per hour when the locomotive is moving.

- Press the **Status** key when the locomotive is stopped in Neutral. If the locomotive is in Disconnect /Standby /Shut Down it will say so. Otherwise the locomotive's Helper type (if not Normal) will be announced, followed by Load level, followed by Load on/off status (if Load not equal to zero), followed by type of Throttle Mode (Regulated or Standard).
- Press the **Status** key while the locomotive is moving. The locomotive will verbally report its speed in scale miles per hour.

Note: When Status Report is activated, the locomotive's sounds will reduce to one half their current volume settings during the verbal report and then return to normal volume when the report has ended.

Star Pad Keys During Normal Operation

Volume ▲ and

Volume ▼ Locomotive System Volume can be changed[115] anytime the locomotive is operating (except in Shut Down).

- Press the **Volume** ▲ key to increase the System Volume level.
- Press the **Volume** ▼ key to decrease the System Volume level.

Each time either **Volume** key is pressed and released, the volume changes by 2 db. Or press and hold either **Volume** key to automatically step up or down through the volume levels one by one; release the key when the desired volume is reached.

Note: System Volume cannot be changed while a locomotive is in Shut Down.

Mute The Quantum System allows you to reduce the System Volume to a lower level or increase it back to its original setting using the **Mute** key. This is useful when you need to lower the sound to engage in a conversation or to answer the phone. 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 **Mute** key once to gradually reduce the volume to the Mute level.
- Double press the **Mute** key to gradually restore the locomotive sounds to its normal level.

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

STC and

RTC Use these keys in Neutral to select Throttle Mode. Quantum has two types of throttle control as described in the Quantum Operation Manual that came with the locomotive. Regulated Throttle Control (RTC) has motor control capability that allows the locomotive to behave as though it has massive inertia. Locomotives under Standard Throttle Control (STC) respond quickly to changes in throttle or loading. The default is RTC.

- Press the **STC** key to select Standard Throttle Control. Hear the locomotive respond with "Standard".
- Press the **RTC** key to select Regulated Throttle Control. Hear the locomotive respond with "Regulated".

Regulated Throttle is preferred under normal operation. However, STC is preferred when putting locomotives away or when uncoupling.

115 If your locomotive is equipped with Magnetic Wand option, the System Volume can also be increased or decreased, using the wand, in any state. See your Quantum Operation Manual.

Programming with Star Pad Keys

The Quantum Engineer Controller makes Analog programming of your Quantum locomotive with QARC technology very simple. All programming is done using the Star Pad keys. When a key's programming function is different from its normal function, the programming function is indicated in gray italics.

Entering Program Mode

Prgm Press and hold the ***Prgm*** key prior to turning up the throttle to where the locomotive sounds come on. Continue to hold the ***Prgm*** button until you hear "Enter Programming". The locomotive will then respond with "Option One – System Volume".

Note: You cannot use the ***Prgm*** key to enter programming on earlier Quantum locomotives that do not have QARC technology.

Note: Once you have entered Programming, the ***Prgm*** key has no effect.

Note: When in Programming Mode, the red power light on the Quantum Engineer blinks on and off continuously[116].

Note: When in Programming Mode, the locomotive's Directional Lighting alternately blinks between the Headlight and the Reverse Light.

Scrolling through the Program Options

Next and

Prev Use the ***Next*** and ***Prev*** keys on the Star Pad to move easily through the Program Options (POP's). The Program Option numbers and names are listed in a table in your Quantum Locomotive Operation Manual under Analog Programming.

- Press the ***Next*** key once to move to the next POP. The locomotive will announce the next POP number and name. Or press and hold the ***Next*** key to automatically step up through the POP's one by one and then release the key when the desired POP is reached. The locomotive will verbally count up through each POP number while the key is pressed and then will announce the POP name when the ***Next*** key is released.
- Press the ***Prev*** key once to move to the previous POP. The locomotive will announce the previous POP number and name. Or press and hold the ***Prev*** key to automatically step backwards through the POP's one by one and then release the key when the desired POP number is reached. The locomotive will verbally count down through each POP number while the key is pressed and then will announce the POP name when the ***Prev*** key is released.

Entering a Program Option and Making Changes

Volume ▲ and

Volume ▼ The **Up Volume** and **Down Volume** level keys can be used to enter and change POP values.

- Press either the **Volume ▲** or **Volume ▼** key once to enter the POP. Entering a POP does not make any changes. The locomotive will announce the current setting for that option. 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 volume[117].
- After the announcement of the current value, press the **Volume ▲** or the **Volume ▼** key to increase or decrease the option setting by one level. Or press and hold the **Volume ▲** or **Volume ▼** key to automatically step up or down through the level settings one by one and then release the key when the desired level is reached.

Note: Most of the POP's are for features that have different level settings. For instance, many POP's are used to increase or decrease volume levels of the different sound effects while POP 2 is used to increase or decrease the Load setting.

For volume settings, the **Volume ▲** will increase the volume level and the **Volume ▼** will decrease the volume level. Volume will change by 2 db for each level change. These two buttons also increase or decrease the Load level in POP 2. For POP's with level settings, you will hear the level value spoken out.

116 If programming has been entered correctly, the locomotive directional lights should also be blinking.
117 Setting any volume in Analog will also apply to DCC and vice-versa.

For other POP's, the **Volume ▲** and **Volume ▼** keys scroll through the possible settings.

Some POP's simply go through some ordered procedure such as V-Start, V-Max, Reset, and About. These POP's do not distinguish between the **Volume ▲** and **Volume ▼** keys. These POP's will advance through their procedures one step at a time when either the **Volume ▲** or **Volume ▼** key is pressed.

Note: Press the ***Next*** or the ***Prev*** keys any time to move to the next or previous POP. Or press and hold the ***Next*** or the ***Prev*** keys to automatically step through the POP's.

Leaving Programming

- Exit Program Mode anytime you want by turning the power off and back on again.

Note: You can leave Programming anytime you want, regardless of which part of Programming you are in. If you have made a change, that change will be retained when you exit.

Trouble Shooting Quantum Engineer

My loco does not respond to any or some Quantum Engineer keys.	Your locomotive may not have Quantum Analog Remote Control (QARC) technology. Or you may have shut your locomotive down with the **Shut Down** key or Magnetic Wand. If so, press the **Start Up** key for three seconds. Or you may have forgotten that a double press turns off some features and a single press turns them on. Or some features may not be included in your model.
I can turn on a feature with a single press but cannot turn it off with a double press. The feature stays in the on state.	You are probably doing the double press too slowly. Double-pressing is similar to double-clinking a computer mouse key. It is very rapid. If you are pressing the key and waiting too long before pressing it again, you are simply sending the "on" command twice.
My locomotive is completely dead. No sounds, not even an air release when power is first applied.	Try resetting the loco with its jumper or magnetic wand (see your Quantum Operation Manual). Or, if your locomotive was being operated in DCC and power was suddenly removed while moving, the loco may still be waiting for a DCC signal. Place the locomotive on DCC track, activate, stop loco and turn off power. Or you may have pickup problems in your loco or an area of dead track.
My loco makes sounds but will not respond to the throttle.	You may have applied brakes to stop your locomotive. Either reduce the throttle below V-Start or press the Release Brake key two times. Or your locomotive is in Disconnect or Standby. Press the **Start Up** key.
I cannot get my locomotives to program.	Older Quantum locomotives cannot be programmed using the Quantum Engineer Program keys. Or you may not be holding the ***Prgm*** key down before turning on the power, Or you may not be holding it down long enough after turning on the power.
Pressing the **Apply Brake** key does not seem to have much affect at high speeds.	Set V-Max to a higher value (about 85% of full throttle voltage). Or you are in STC and no Load is turned on.
Sometimes in Neutral, **Horn** or **Bell** keys have no affect.	When entering Neutral, you must wait for the long air release before the Horn and Bell buttons will operate.
My Quantum Engineer will not send commands when keys are pressed. I do not hear any clicking sounds like I normally do.	Turn power off and back on again to reset the Quantum Engineer to normal operation.
When I press the Apply Brake key, the locomotive will not slow down for a long time and then when it does, it stops suddenly.	If you press the Apply Brake once briefly, the locomotive will enter coasting and slowly decelerate to a stop. However, if you have set V-Max too low, it will take some time before the RTC algorithm applies an internal motor voltage below V-Max. The effect is to "hang" the locomotive at a constant high speed for some time before it starts to slow down. Some operators will apply more and more braking to slow the locomotive when it is in this state, which causes the locomotive to slow rapidly when the internal voltage drops below V-Max. To minimize this problem, set V-Max close to your maximum throttle position.
After I apply Air Brakes and the locomotive is stopped, changing the direction switch blows the Whistle/Horn instead of changing direction.	After stopping with the Air Brakes, you must turn the throttle down until you hear a Short Air Let-off to enter Neutral and then change direction with the direction switch. If you leave the throttle turned up above V-Start, you are not in Neutral.

Quantum Engineer Features

Quantum Engineer will operate the following features in locomotives equipped with Quantum Analog Remote Control (QARC) technology:

Horn	Grade Crossing Horn Signal
Bell	Smoke On/Off
Apply Air Brakes	Headlight On/Off & Dim
Release Air Brakes	Reverse Light On/Off
Loco Shut Down	Number Board Lights On/Off
Loco Start Up	Hazard Lights On/Off & Strobe
Standby Idle	Cab Lights On/Off
Flange Squeal	Blower or Fans On/Off
Squealing Brakes	Dynamic Brakes On/Off
Doppler Shift	Motor Disconnect
Coupler Lift Bar and Pin	Mute
Coupler Opening Sounds	Verbal Speedometer Readout
Coupler Crash	Locomotive Status Report
Load On/Off	Easy Quantum Programming
Heavy Load On/Off	Prev & Next Program Stepping
System Volume Control in Run Mode	
Regulated (RTC) & Standard Throttle (STC) Selection	

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