ProtoThrottle

Realistic Control Stand Throttle

MANUAL

IOWA SCALED ENGINEERING – ELECTRONICS MADE EASY!

www.protothrottle.com

Thank you for purchasing the ProtoThrottle.

Our goal was to design and develop a wireless throttle that provides the diesel modeler with the most realistic experience operating their model locomotives.

The ProtoThrottle mimics a standard EMD control stand including full detent throttle and reverser handles, a spring-loaded horn handle, a push-on/push-off bell button, and fully programmable front and rear headlights with a setting for ditch lights. In addition, the ProtoThrottle comes with a robust faceplate machined from aluminum, including prototype bezels, and anodized to give the look and feel of a real control stand.

The ProtoThrottle comes with our commitment to your satisfaction. We warranty the throttle from manufacturing defects for one year, and if you should have any questions or issues with the ProtoThrottle, please contact us.

Scott Thornton **Michael Petersen** **Nathan Holmes**

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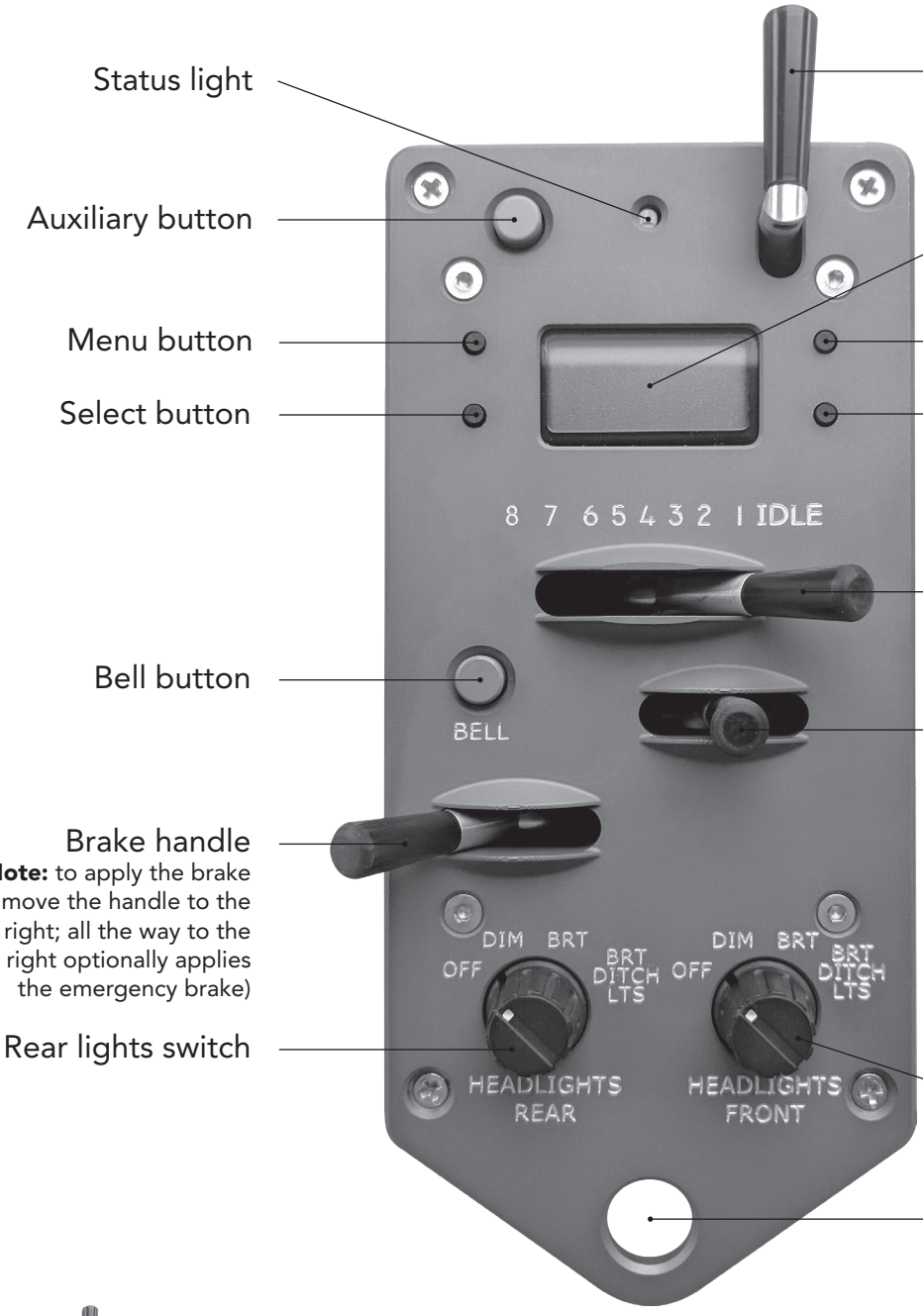
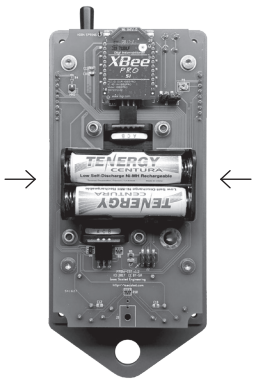
ProtoThrottle Controls & Battery Install



The ProtoThrottle is powered by 2 AA batteries (not included). The batteries can be alkaline or rechargeable NiMH.

To access the battery holder, unscrew the 4 phillips head screws on the corners of the throttle's faceplate; remove the box; **IMPORTANT:** when removing the batteries from the holder, use one hand to hold **both** sides of the holder to prevent it from bending away from the printed circuit board; insert batteries and reattach the box. **Do not over tighten the screws.**



To conserve battery life: make sure the throttle handle is in "idle" position and the reverser handle is in "centered" position when not in use. This will cause the throttle to go to sleep after 5 minutes.

Quick Start Guide

The ProtoThrottle will work with any scale and with sound- or non-sound decoders (though using sound enhances the control stand experience significantly). Any DCC decoder compatible with the NMRA standards will work with the ProtoThrottle because it uses standard DCC commands and functions via your command station.. The ProtoThrottle is not a DCC system and will not replace the system you use.

Check the Iowa Scaled Engineering website for the most current list of supported DCC command stations: **www.iascaled.com**

NOTE: if the ProtoThrottle is in "sleep" mode the LCD screen will be dark, click any of the LCD buttons to wake the throttle.

1

1. Configure your ProtoThrottle receiver using the instructions provided with the receiver.

2. Make sure the base address of the ProtoThrottle matches that of the receiver. (See page 18.)

3. If using multiple ProtoThrottles, set each throttle to a unique ID. (See page 18.)

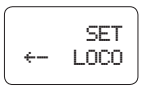
2

Using your DCC system, **set acceleration momentum (CV3) mid-range to moderately high** so that the ProtoThrottle will need to "notch up" to get the train moving.

Set deceleration momentum (CV4) high or maximum. This will allow the train to "coast" when the throttle is in the idle position requiring the use of the brake to slow or stop the train.

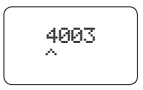
3

Input the locomotive number into the ProtoThrottle:

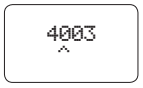


1. Click the Menu button 5 times

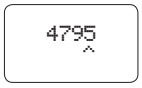
2. Click the Select button once



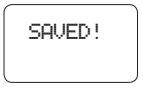
3. Use the Up and Down buttons to change numbers



4. Use the Menu button to move cursor right



5. After number is input, click Select button to save

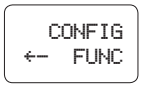


NOTE: see page 10 for how to set a short (primary) address.

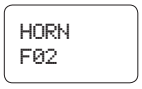
NOTE: the ProtoThrottle function settings are set to standard DCC function numbers by default. If you need to change any function number, the steps are explained below:

4

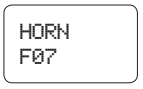
To check or set the horn, bell, and brake function numbers:



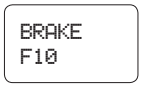
1. Click the Menu button 7 times



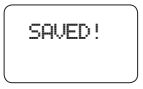
2. Click the Select button once



3. Click the Up or Down button to change the function number



4. Click Menu button to toggle through the other function choices. Repeat step 3 to change additional function numbers.



5. Click the Select button to save all changes

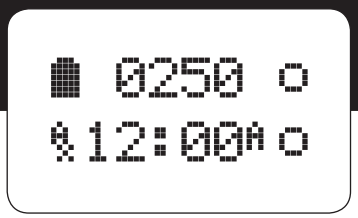
5

Enjoy operating your locomotive!

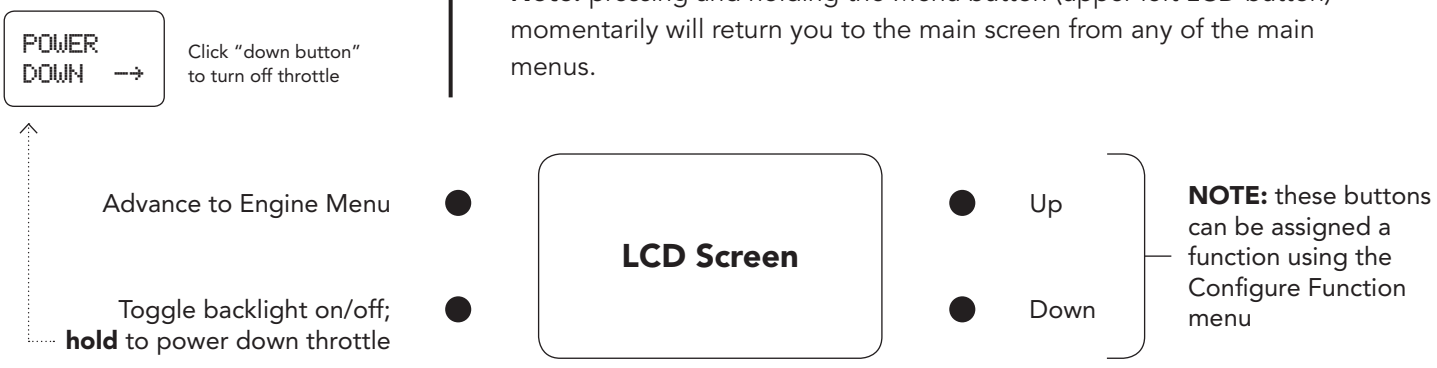
Please read the entire manual to familiarize yourself with all the features of the ProtoThrottle. See our website for more specific instructions on programming lights and our future tonnage feature.

In addition, our website has detailed operational scenarios developed by professional locomotive engineer, Tim Garland. If you are not familiar with prototype operation from a engineer's perspective, Tim's scenarios will give you insight on how to operate more realistically using the ProtoThrottle.

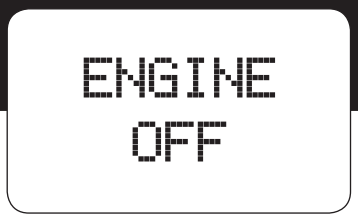
Main Screen



ELEMENT	DESCRIPTION
0250	Locomotive Address. Long (extended) addresses are displayed directly (e.g. 0250 0000 9999). Short (primary) addresses are displayed with an 's' prefix (e.g. s003 s000 s127). In certain situations the locomotive address may be replaced by an alert message: EMRG Emergency stop is active! **Note:** move the brake handle all the way left to deactivate. REV! Reverser was moved with the throttle not in idle
12:00A	The ProtoThrottle acts as a secondary display for Iowa Scaled Engineering's wireless fast clocks www.iascaled.com/store/MRBW-FCM or the fast time provided by the NCE Cab Bus. A 12-hour mode AM indicator P 12-hour mode PM indicator No AM or PM indicator when in 24-hour mode.
	Battery Status: Batteries good Batteries low Replace batteries Display will show LOW BATTERY when the batteries are critically low. Operation will not be possible until the batteries are replaced.
	When "AX" is on screen the auxiliary button is active
	Up/Down Button Status. On the main screen, the Up and Down buttons can be assigned to functions. The on/off status of those assigned functions are displayed on the LCD screen. Function off Function on **Note:** pressing and holding the Menu button (upper left LCD button) momentarily will return you to the main screen from any of the main menus.

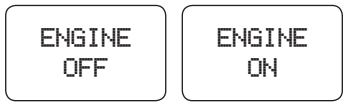


Engine Menu



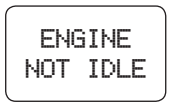
DESCRIPTION

The behavior of the Engine menu depends on the configuration of the ENG ON and ENG STOP settings in the **Configure Function menu**. For DCC decoders that take a single function on/off to turn the prime mover on/off (such as ESU Loksound or TCS WOWSound decoders), configure ENG ON to that function number and set ENG STOP to off (F--). The Engine menu will then change between OFF and ON when pressing the Up and Down buttons.



If a decoder is edge triggered instead (requires a function on/off transition) to turn the prime mover on and off (such as Soundtraxx Tsunami2), set both ENG ON and ENG STOP to the appropriate function numbers.
In this case, the Engine menu will display STARTING and STOPPING between the ON and OFF settings as the assigned functions are sent to the locomotive decoder.

If the throttle is not in idle when attempting to turn off the prime mover, a warning will be displayed and the ENG STOP function will not be sent. Move the throttle back to idle to continue.

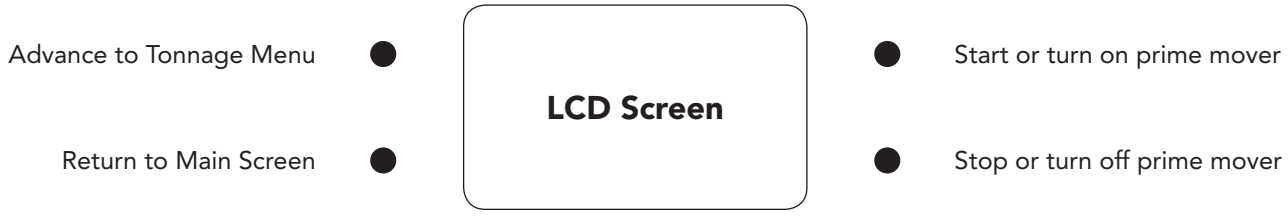


Example #1, F8 for ESU Loksound or F12 for TCS WOWSound:

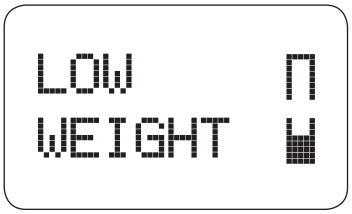
ENG ON = F08 ENG ON = F12
ENG STOP = F-- ENG STOP = F--

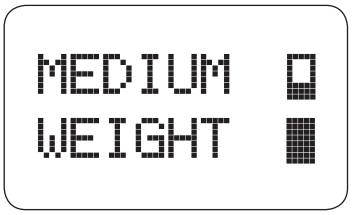
Example #2, F5 (on, RPM+) and F6 (off, RPM-) for Soundtraxx Tsunami 2:

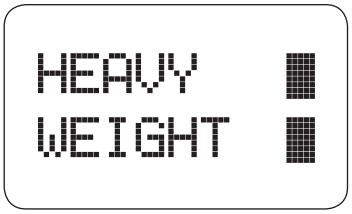
ENG ON = F05
ENG STOP = F06



Tonnage Menu







Note: the tonnage feature is a future release. Watch our website for updates.

Advance to Load Configuration Menu

Return to Main Screen

LCD Screen

Increase tonnage value

Decrease tonnage value

Load / Save Configuration Menus

LOAD CNF: Advance to SAVE CNF
SAVE CNF: Advance to Set Locomotive Menu

Load selected configuration (and return to Main Screen) or Save current configuration (and return to Main Screen)

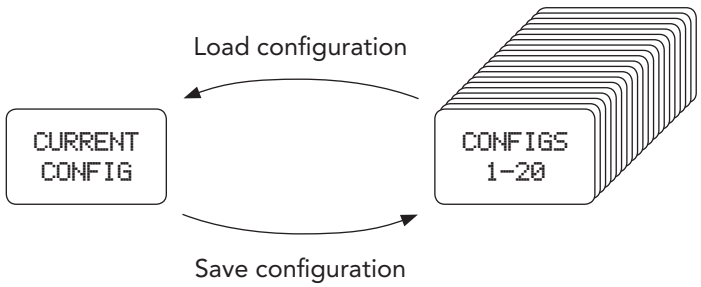
LCD Screen

Increase configuration number

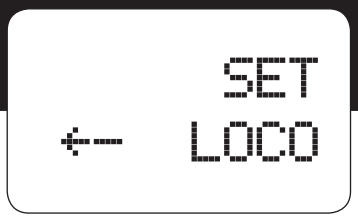
Decrease configuration number

Load / Save Configuration Sub-Menu

ELEMENT	DESCRIPTION
LOAD CNF 01: 0250	01: Configuration Number. Up to 20 distinct configurations (locomotive address, function mappings, throttle notch settings, options) can be stored in the ProtoThrottle and loaded quickly using this menu. 0250 Locomotive Address. This is the locomotive address associated with the selected configuration number.
SAVE CNF 01: 0250	Save Configuration screen saves the **current loaded configuration** (with any changes you've made) into whatever configuration slot is on the screen. In order to copy an established configuration, you must load it into the throttle first before "saving" it to another slot.
CONFIRM LOAD? →	Both the Load Configuration and Save Configuration functions will ask you to confirm before executing by pressing the Down button. To cancel, click the Menu button.
CONFIRM SAVE? →	



Set Locomotive Menu



Advance to Force Function Menu ●

Enter Set Locomotive Sub-Menu ●

LCD Screen

● None

● None

Set Locomotive Sub-Menu

ELEMENT	DESCRIPTION
0250	Locomotive Address.
^	Digit Selector.

Move Digit Selector to the next digit ●

Save locomotive address and return to Set Locomotive Menu ●

LCD Screen

● Increase selected digit.

● Decrease selected digit.

NOTE: To set a short (primary) address, press the decrease button once more when the first digit is zero. You will see an "s" which indicates "short". Move the digit selector to enter the remaining numbers. For example, a single digit address would be entered "s003", a two digit address "s025", etc.

Force Function Menu

Advance to Configure Function Menu ●

Enter Force Function Sub-Menu ●

LCD Screen

● None

● None

NOTE: The Force Function menu allows any of the 29 standard DCC functions to be turned ON or OFF, regardless of any other ProtoThrottle lever or button. These can be used to test functions or control additional features of the decoder such as auxiliary, class, or lesser used lights.

Force Function Sub-Menu

ELEMENT	DESCRIPTION
F00	Function Number. Available range from function 0 to function 28.
---	Function Setting. --- Function can be controlled by a ProtoThrottle button or lever ON Function forced on, regardless of any other button or control OFF Function forced off, regardless of any other button or control

Cycle through Function Numbers ●

Save function settings and return to Force Function Menu ●

LCD Screen

● Cycle through Function Settings

● Cycle through Function Settings

Configure Function Menu

Advance to Notch Configuration Menu

Enter Configure Function Sub-Menu

LCD Screen

Up

Down

Configure Function Sub-Menu

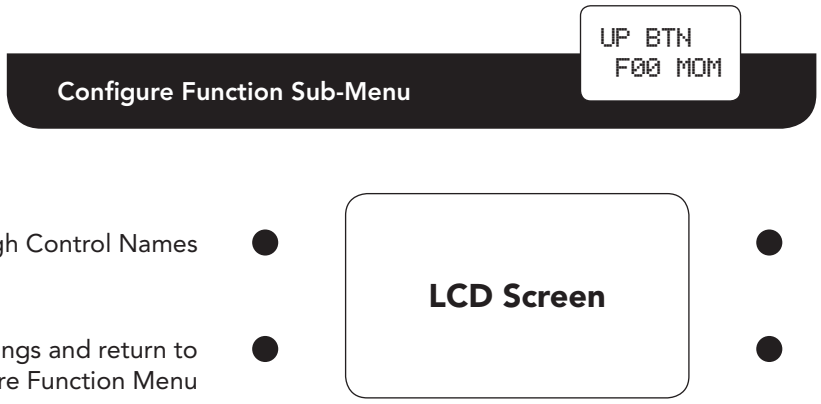
ELEMENT	DESCRIPTION
HORN	Control Name. The name of the ProtoThrottle button or handle to which a function can be assigned. HORN Horn lever BELL Bell button BRAKE Brake lever, when brake is activated BRK OFF Brake lever, when in the full left position AUX Aux button ENG ON Prime mover ON/start function (see Engine menu for details) ENG STOP Prime mover stop function (see Engine menu for details) THR UNLK Function which, when active due to another control, allows the throttle to send speed commands when the reverser is in centered position. (e.g. Loksound Drive Hold) REV SWAP Function which, when active due to another control, flips the direction of the reverser F.HEAD Front headlight; active in the Bright and Ditch Lights settings F.DITCH Front ditch lights; active in the Ditch Lights setting F.DIM #1 Front dim headlight function #1; active in the Dim setting F.DIM #2 Front dim headlight function #2; active in the Dim setting R.HEAD Rear headlight; active in the Bright and Ditch Lights settings R.DITCH Rear ditch lights; active in the Ditch Lights setting R.DIM #1 Rear dim headlight function #1; active in the Dim setting R.DIM #2 Rear dim headlight function #2; active in the Dim setting UP BTN Main screen Up button DOWN BTN Main screen Down button
F00	Function Number. The function to be activated when the associated ProtoThrottle button is pressed or control is moved. Available settings are none (F--) and functions 0 (F00) to 28 (F28).

Continued on next page

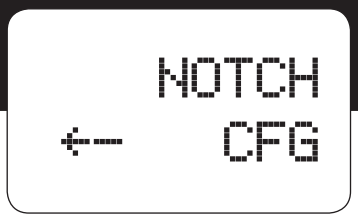
Continued from previous page

MOM | Momentary / Latching Function. Only appears for the Up and Down button assignments.

MOM Momentary – the function is only active while the button is pressed
LAT Latching – the function toggles on and off with each press of the button



Notch Configuration Menu



Advance to Options Menu

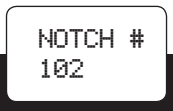
Enter Notch Configuration Sub-Menu

LCD Screen

None

None

Notch Configuration Sub-Menu



ELEMENT	DESCRIPTION
#	Notch Number.
102	Speed Step. The speed step to send when the throttle is in the selected Notch Number. Range from 1 to 126 (128 speed step mode only). Idle is always speed step zero.

Cycle through Notch Numbers

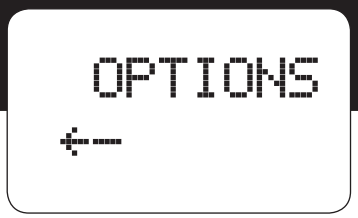
Save notch settings and return to Notch Configuration Menu

LCD Screen

Increase Speed Step

Decrease Speed Step

Options Menu



Advance to Threshold Calibration Menu ●

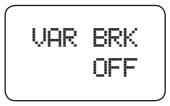
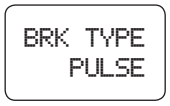
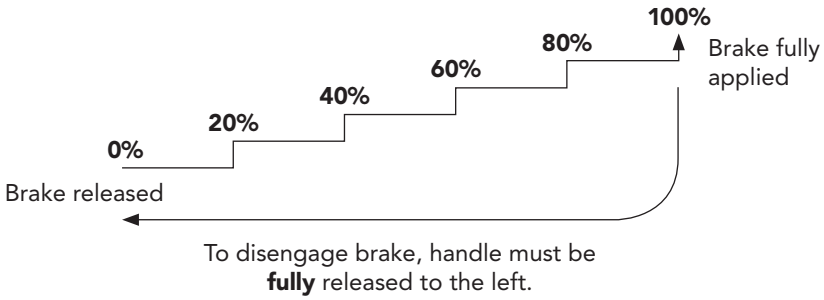
Enter Options Sub-Menu ●

LCD Screen

● None

● None

Options Sub-Menu

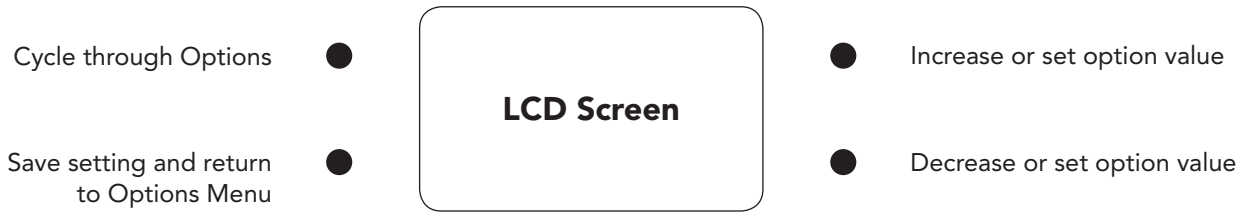
ELEMENT	DESCRIPTION
	**Variable Brake.** When set to ON, the brake effect will be proportional to the brake handle position. It is recommended to disable the emergency brake when variable braking is enabled. When set to OFF, the brake will be a simple on/off function.
 **NOTE:** Only displayed if variable brake is **ON**	Brake type: ● PULSE braking ○ STEP braking (works with TCS WOWSound function) **Pulse braking.** The brake function will be pulsed at a duty cycle corresponding to the brake handle position, simulating varying amounts of braking force. **Step braking.** This feature is for use with TCS WOWSound decoders only. As the brake handle is moved to the right, a greater percentage of the brake is applied.  **NOTE:** the only way to disengage the brake is to fully release the brake handle completely to the left. Also, the emergency brake feature must be disabled for step braking to work correctly.

Continued on next page

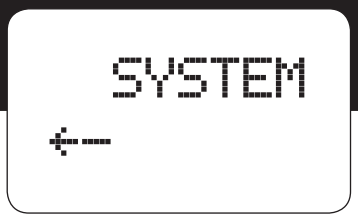
Continued from previous page

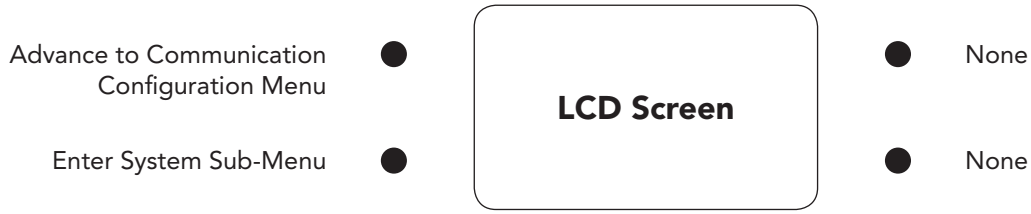
Options Sub-Menu

ELEMENT	DESCRIPTION
 **NOTE:** Only displayed if variable brake is **ON** and brake type is **PULSE**	**Brake Pulse Rate** This sets the rate (0.2 - 1.0 second) at which brake commands are sent during pulse braking. A smaller value results in smoother braking but can result in a less responsive DCC system due to more commands being sent on the throttle bus.
	**E-Stop on Brake Handle.** When set to ON, the brake handle can set emergency stop for the selected locomotive when moved completely to the right. When set to OFF, the brake handle will not cause an emergency stop to be set.
	**Reverser Swap.** When set to ON, the reverser directions are swapped. This can be used to correct for a locomotive whose direction is set incorrectly or when changing the leading end of a back-to-back consist. When set to OFF, the reverser directions are normal.



System Menu

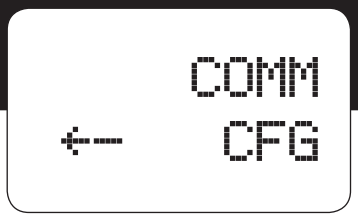




Options Sub-Menu

ELEMENT	DESCRIPTION
MENU LCK OFF	When set to ON, only the following menus are available: ENGINE, TONNAGE, LOAD CNF, SET LOCO, FORCE FUNC, and SYSTEM.
ADV FUNC OFF	When set to ON, advanced functions in the throttle are enabled. These include the Threshold Calibration menu and the Transmit Interval and Transmit Holdoff settings in the Preferences menu.
BAT OKAY 2.2V	**Battery OK Voltage.** The voltage above which the batteries are considered good.
BAT WARN 2.0V	**Battery Warning Voltage.** The batteries are low when the voltage is between the OK and Warning levels.
BAT CRIT 1.8V	**The batteries need to be replaced** when the voltage is between the Warning and Critical levels. **NOTE:** When the voltage falls below the Critical level, LOW BATTERY will be displayed and operation of the throttle will not be possible.

Communication Configuration Menu



Advance to Preferences Menu

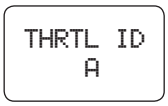
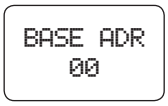
Enter Communication Configuration Sub-Menu

LCD Screen

None

None

Communication Configuration Sub-Menu

ELEMENT	DESCRIPTION
	**Throttle ID.** Set each throttle to a unique ID using letters A-Z
	**Base Address.** Set to the address of the ProtoThrottle receiver – see reciever instructions.
	**Time Source Address.** Selects the fast time source. Set to "BASE" to display time information received from the command station by the ProtoThrottle receiver. To use an Iowa Scaled Engineering Wireless Fast Clock Master, set to the Node Address of the clock (0x01 to 0xFE). Set to "ALL" to display any time information received by the ProtoThrottle. The "ALL" setting works well with a single receiver in a private setting, but may result in erratic time display when multiple ProtoThrottle receivers are in close proximity (e.g. a public train show).

Cycle through Address/ID Names

Save Address/ID settings and return to Communication Configuration Menu

LCD Screen

Increase

Decrease

Preferences Menu

Advance to Diagnostics Menu

Enter Preferences Sub-Menu

LCD Screen

None

None

Preferences Sub-Menu

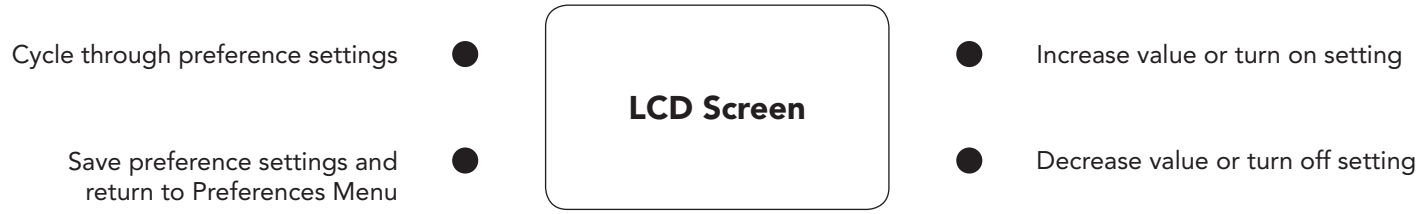
ELEMENT	DESCRIPTION
SLEEP DLY: 5M	**Sleep Delay.** Time until the throttle automatically enters low power mode. The throttle handle must be in idle, the reverser handle in centered position, and no buttons or controls actuated for this time. Range from 1 to 99 minutes.
TIMEOUT CLK: 10s	**Clock Timeout.** Maximum time between fast clock time packets. If no time information is received in this interval, the clock display will show dashes to indicate it has lost communication with the fast clock master. Range from 1 to 25 seconds.
TX INTVL 1s	**Transmit Interval.** Time between periodic wireless transmissions to the ProtoThrottle receiver. This setting can only be changed if Advanced Functions are ON in the SYSTEM menu.
TX HLDOF 0.15s	**Transmit Holdoff.** Minimum time between wireless transmissions to the ProtoThrottle receiver. This setting can only be changed if Advanced Functions are ON in the SYSTEM menu.
LED BLNK ON	**LED Blink.** When set to ON, the LED on the ProtoThrottle will blink green when communication with a ProtoThrottle receiver is active. When set to OFF, the LED will remain off when communication is active. The LED will always blink red when no communication link has been established.

Continued on next page

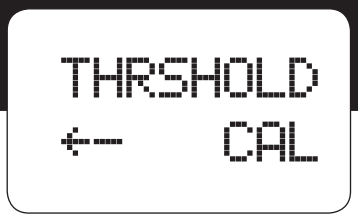
Continued from previous page

Preferences Sub-Menu

ELEMENT	DESCRIPTION
REV LOCK ON	**Reverser Lock.** When set to ON, the reverser can only change the locomotive direction when then throttle is in idle, just like the prototype (in fact, on the prototype, the reverser handle is locked and cannot be moved). If the reverser is moved when the throttle is not in idle, the direction will remain the same and the Main Screen will display REV!. When set to OFF, the reverser is allowed to change the locomotive direction regardless of the throttle setting.



Threshold Calibration Menu



Advance to Communication Configuration ●

Enter Threshold Calibration Sub-Menu ●

LCD Screen

● None

● None

NOTE: These settings are factory calibrated and do not, under most circumstances, need to be changed. Modify them at your own risk!

NOTE: Only displayed if Advanced Functions are **ON** in the **SYSTEM** menu

Threshold Calibration Sub-Menu

ELEMENT	DESCRIPTION
NAME	Control Name. The name of the ProtoThrottle control to be calibrated. Hold the control in the desired location and press the Up button to set the new calibration value. HORN Threshold for the horn function activation BRAKE Threshold for the brake function activation BRAKE LOW Left brake handle stop BRAKE HIGH Right brake handle stop; also threshold for emergency stop
o	Control Status. Shows the on/off status of the selected control. o OFF ● ON
240	Internal ADC value for the selected control. Can normally be ignored, unless you're developing code for the ProtoThrottle or are just a nerd.

Cycle through Control Names ●

Save threshold settings and return to Threshold Calibration Menu ●

LCD Screen

● Set new calibration value

● None

Diagnostics Menu

Return to Main Menu ●

Enter Diagnostics Sub-Menu ●

LCD Screen

● None

● None

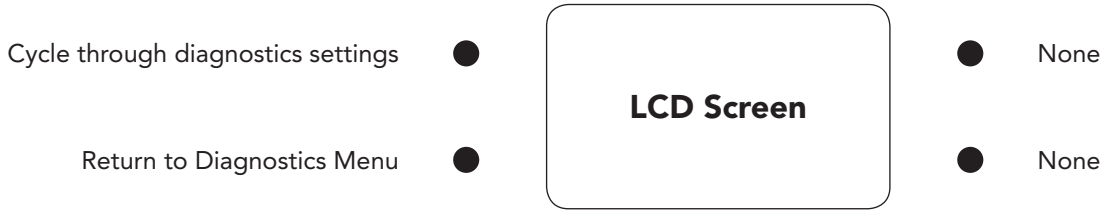
Diagnostics Sub-Menu

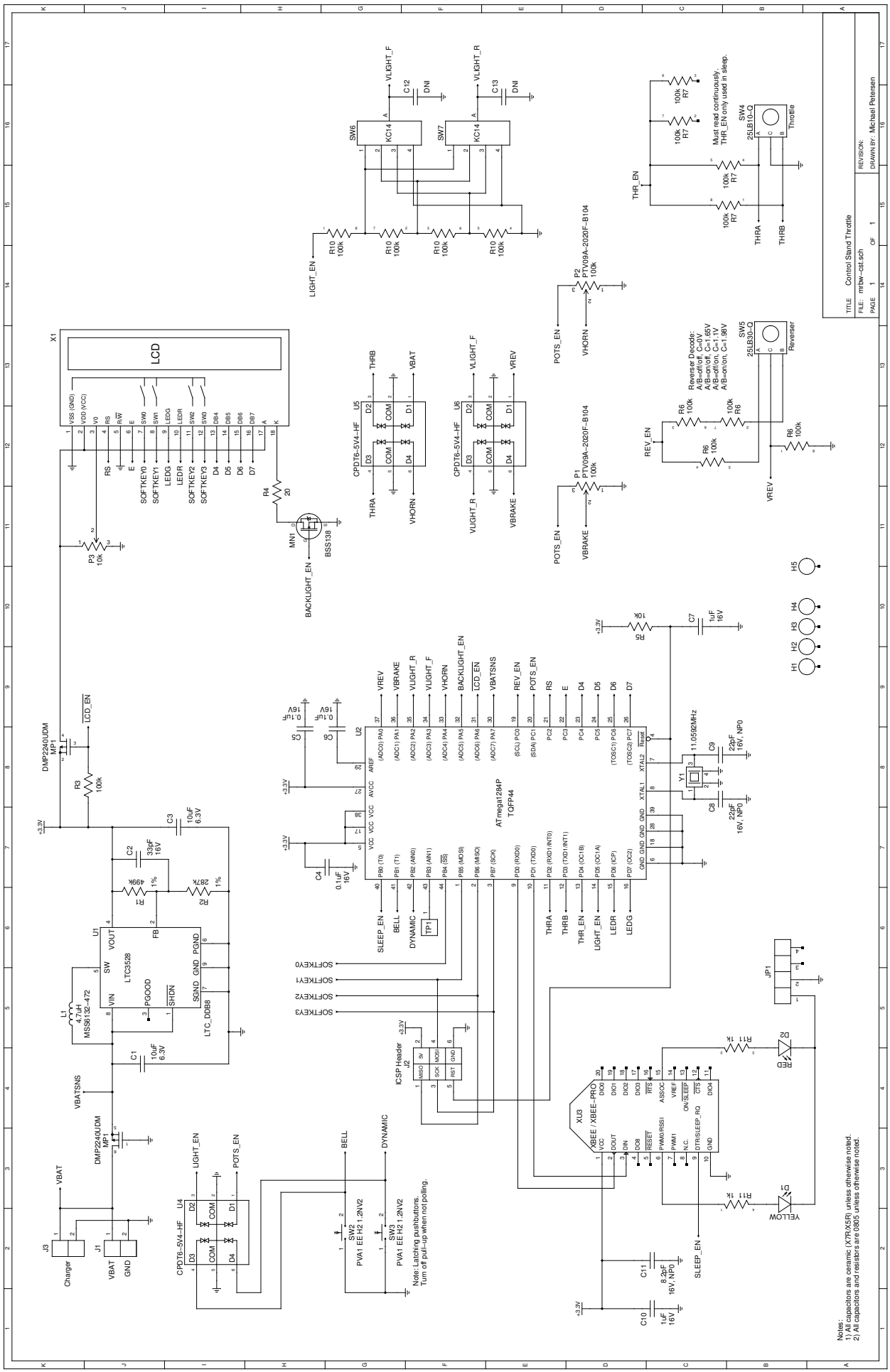
ELEMENT	DESCRIPTION
o 0% I N – o –	**Controls Display.** Shows the current status of the ProtoThrottle controls and buttons. Pressing the up/down buttons will toggle through the current DCC function status.
SLEEP 300 sec	**Sleep Timeout.** Shows the number of seconds until the throttle goes to sleep.
PKT TIME [▮▮▮▮▮▮▮]	**Packet Timeout.** Timer reset by each packet received from the ProtoThrottle receiver. Communication is considered lost when the bar reaches zero.
RSSI -43dBm	**Received Signal Strength Indicator.** Reports the strength of the wireless connection to the throttle.
FT RATIO 2.4:1	**Fast Time Ratio.** Reports the fast time ratio from the last update received.
BATTERY 2.30V	**Battery Voltage**
VERSION 1.1.0	**ProtoThrottle Firmware Version**
GIT REV 000000	**ProtoThrottle Firmware Short Git Hash**

Continued on next page

Diagnostics Sub-Menu

ELEMENT	DESCRIPTION
BASE TYP CAB BUS	**Base Type.** The type of ProtoThrottle receiver to which the ProtoThrottle is connected.
BASE REV 000000	**Base Unit Short Git Hash**
FACTORY RESET 5→	**Factory Reset.** Press the Down button 5 times to reset the ProtoThrottle to factory settings. **WARNING: This will erase all configuration settings, except those in the Threshold Calibration menu, so use with caution!**




TITLE: Control Stand Throttle
FILE: mrbw-cst.sch
PAGE 1 OF 1
REVISION:
DRAWN BY: Michael Petersen
Notes:
1) All capacitors are ceramic (X7R/X5R) unless otherwise noted.
2) All capacitors and resistors are 0805 unless otherwise noted.
Note: Latching pushbuttons.
Turn off pull-up when not polling.
Must read continuously.
THR_EN only used in sleep.
Reverser Decode:
A/B=off/off, C=0V
A/B=on/off, C=1.65V
A/B=off/on, C=1.1V
A/B=on/on, C=1.98V
LCD
ATmega1284P
TQFP44
XBEE / XBEE-PRO
LTC3528
LTC_DB88
ICSP Header
11.0592MHz
Throttle
Reverser
Charger
VBAT
GND
BELL
DYNAMIC
SLEEP_EN
LIGHT_EN
THR_EN
REV_EN
POTS_EN
BACKLIGHT_EN
VLIGHT_F
VLIGHT_R
VHORN
VBRAKE
VREV
THRA
THRB
LEDR
LEDG
SOFTKEY0
SOFTKEY1
SOFTKEY2
SOFTKEY3
RED
YELLOW

Open Design
Iowa Scaled Engineering is committed to creating open designs that users are free to build, modify, adapt, improve, and share with others.

Hardware
The design of the ProtoThrottle hardware is open source hardware, and is made available under the terms of the Creative Commons Attribution-Share Alike v3.0 license, a copy of which is available from:
http://creativecommons.org/licenses/by-sa/3.0/

Design files can be found on the Iowa Scaled Engineering's Github site:
https://github.com/IowaScaledEngineering/mrbw-cst

Firmware
The official Iowa Scaled Engineering firmware for the ProtoThrottle is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version. A copy of the GNU GPL can be found at:
http://www.gnu.org/licenses/gpl.html

New firmware can be flashed into the ProtoThrottle through J2.
The six pins are a standard AVR 6-pin ISCP programmer connection.

We encourage you to join the ProtoThrottle group forum:
https://groups.io/g/ProtoThrottle
The forum will help with general and technical questions regarding the ProtoThrottle.

Visit the Iowa Scaled Engineering website to learn more about our full line of model railroad electronics.

www.iascaled.com
support@iascaled.com

Manual 1.1 (updated version)

ProtoThrottle
Model: MRBW-CST
HW Version: 1.2

Iowa Scaled Engineering, LLC
22750 County Road 37
Elbert, CO 80106
support@iascaled.com

Contains FCC ID: OUR-XBEEPRO
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modification to the device could void the user's authority to operate the equipment.

Contains Model XBee-PRO Radio, IC: 4214A-XBEEPRO
This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:
(1) This device may not cause interference; and
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux RSS exempts de licence d'Industrie Canada. L'opération est soumise aux deux conditions suivantes:
(1) Cet appareil ne doit pas causer d'interférences; et
(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

Changes or modification to the device could void the user's authority to operate the equipment.
Des changements ou des modifications à l'appareil pourraient annuler l'autorité de l'utilisateur à utiliser l'équipement.

Notes

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