ProtoThrottle

Realistic Control Stand Throttle

MANUAL

Ver. 3, 4/18

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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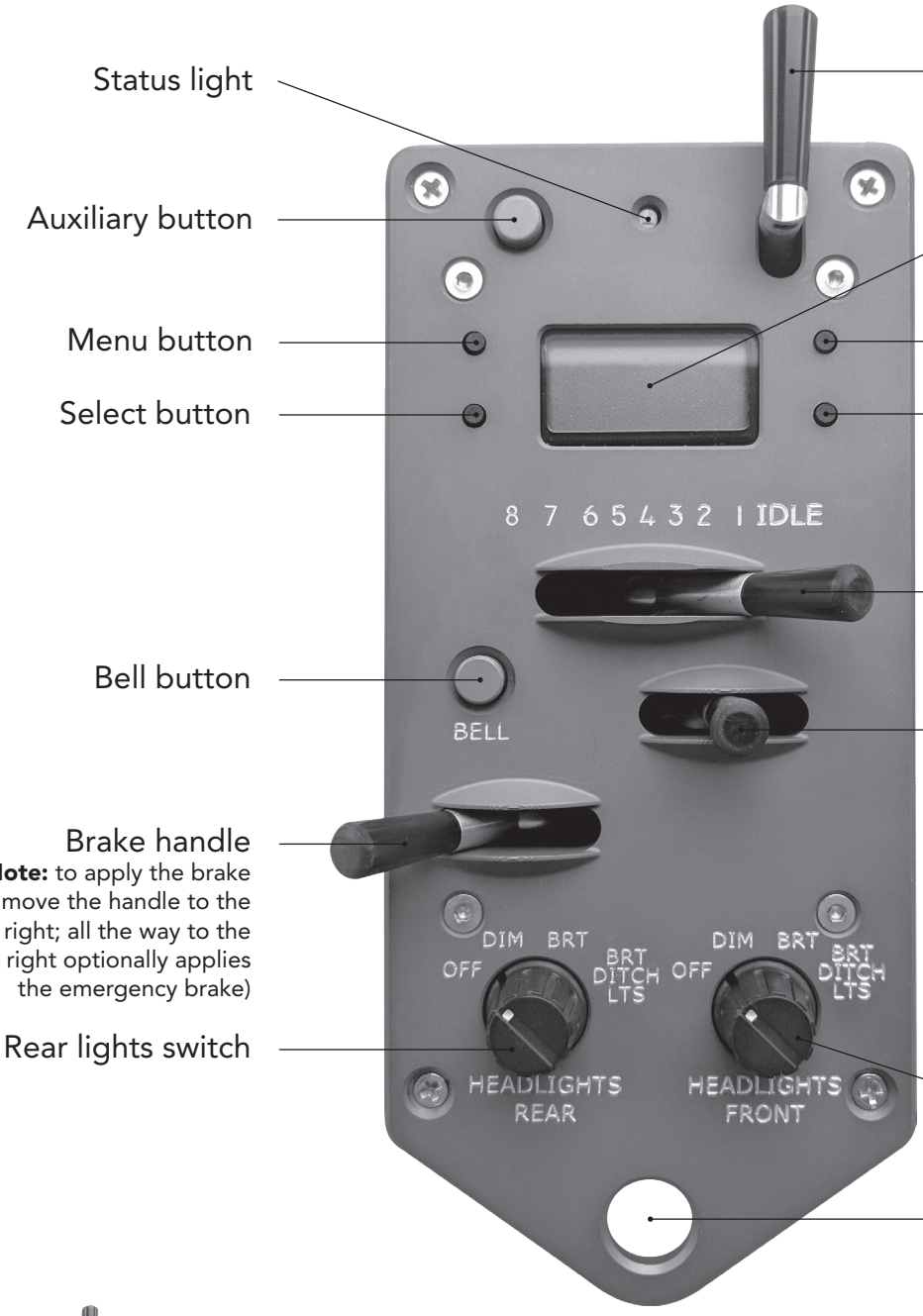
ProtoThrottle Controls & Battery Install



Status light

Auxiliary button

Menu button

Select button

Bell button

Brake handle
(**Note:** to apply the brake move the handle to the right; all the way to the right optionally applies the emergency brake)

Rear lights switch

Horn handle

LCD screen

Up button

Down button

Throttle handle

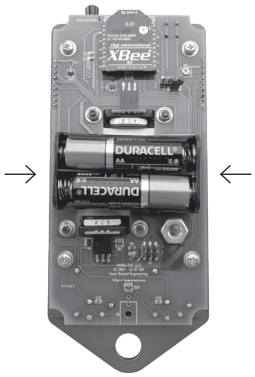
Reverser handle
(**Note:** centered position allows no directional movement; to the right is forward; to the left is reverse. You can remember the prototypical directions by referencing the lights below. e.g.: "front" is forward, "rear" is reverse. The directions can be reversed for consists, see page 18 under Reverser Swap.)

Front lights switch

Lanyard attachment

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. Battery life averages 72-84 hours when active.

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). All of the current decoders on the market will work with the ProtoThrottle because it uses standard DCC commands and functions. The ProtoThrottle is not a DCC system and will not replace the system you use.

The ProtoThrottle currently supports the following DCC command stations:
- NCE
- ESU Cab Control
- Lenz
- DigiKeijs DR5000

Support for additional systems is in development.
Check the Iowa Scaled Engineering website periodically for updates – 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 16.)

3. If using multiple ProtoThrottles, set each throttle to a unique ID. (See page 16.)

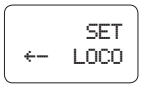
2

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

Set deceleration momentum high or maximum depending on your decoders braking function. 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.

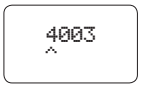
3

Input the locomotive number into the ProtoThrottle:



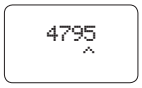
1. Click the Menu button 4 times

2. Click the Select button once

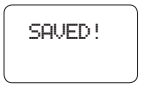


3. Use the Up and Down buttons to change numbers

4. Use the Menu button to move cursor right



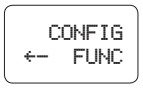
5. After number is input, click Select button to save



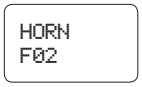
NOTE: the ProtoThrottle function settings are set to standard DCC function numbers by default. If you need to change any function number, the steps are explained below:

4

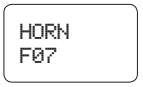
To set the horn, bell, and brake function numbers:



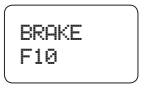
1. Click the Menu button 6 times



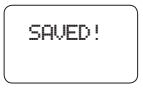
2. Click the Select button once



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

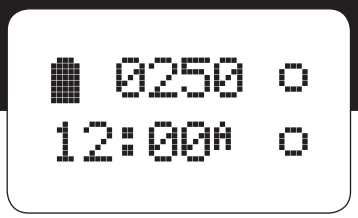
5

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.

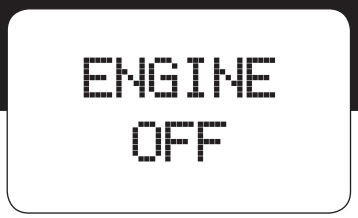
In addition, our website has detailed operational scenarios developed by professional locomotive engineer, Tim Garland. If you are not familiar with prototype operation from a engineer's perspective, Tim's scenarios will give you insight on how to operate more realistically using the ProtoThrottle.

Main Screen



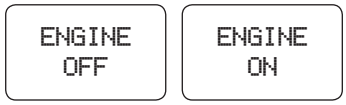
ELEMENT	DESCRIPTION
0250	Locomotive Address. Extended (also known as long or 4-digit) addresses are displayed directly (e.g. 0250 0000 9999). Primary (also known as short or 2-digit) addresses are displayed with an 's' prefix (e.g. s003 s000 s127). After the locomotive address is set it will display constant. In certain situations it may be replaced by an alert message: EMRG Emergency stop is active! 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/MRB-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
	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

Engine Menu



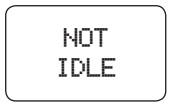
DESCRIPTION

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 decoders), configure ENG ON to that function number and set ENG STOP to off. 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 Tsunami 2), 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 appropriate functions are pulsed.

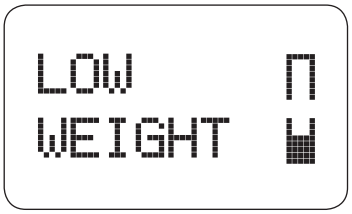
If the throttle is not in idle when attempting to turn off the prime mover, a warning will be displayed and the ENG STOP function will not be sent. Move the throttle back to idle to continue.

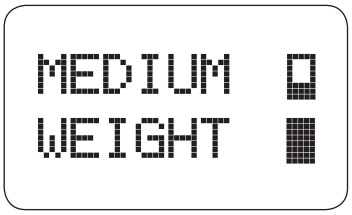


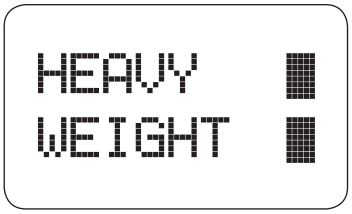
Example #1, F8 for ESU Loksound:
ENG ON = F08
ENG STOP = F--

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

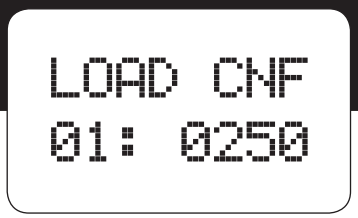
Return to Main Screen

LCD Screen

Increase tonnage value

Decrease tonnage value

Load Configuration Menu



ELEMENT	DESCRIPTION
01	Configuration Number. Up to 15 distinct configurations (locomotive address, function mappings, throttle notch settings) can be stored in the ProtoThrottle and recalled quickly using this menu.
0250	Locomotive Address. This is the locomotive address associated with the selected configuration number.

Advance to Set Locomotive Menu

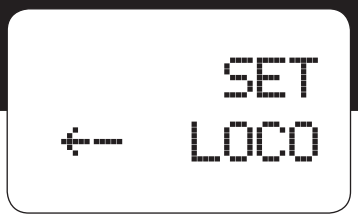
Load selected configuration and return to Main Screen. (*Any future changes to the locomotive address, function mappings, or throttle notch settings will be stored in this configuration.*)

LCD Screen

Increase configuration number

Decrease configuration number

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. Increasing the first digit above 9 selects primary (also known as short or 2-digit) addresses, indicated by an 's' prefix in the first digit.

Decrease selected digit. To select extended (also known as long or 4-digit) addresses, press the Down button when the first digit displays an 's' and is selected by the Digit

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 turn 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.

ELEMENT	DESCRIPTION
F00	Function Number. Available range from function 0 to function 28.
---	Function Setting. --- Ignored, 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
UP BTN	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) 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; used in the Dim setting F.DIM #2 Front dim headlight function #2; used 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; used in the Dim setting R.DIM #2 Rear dim headlight function #2; used 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

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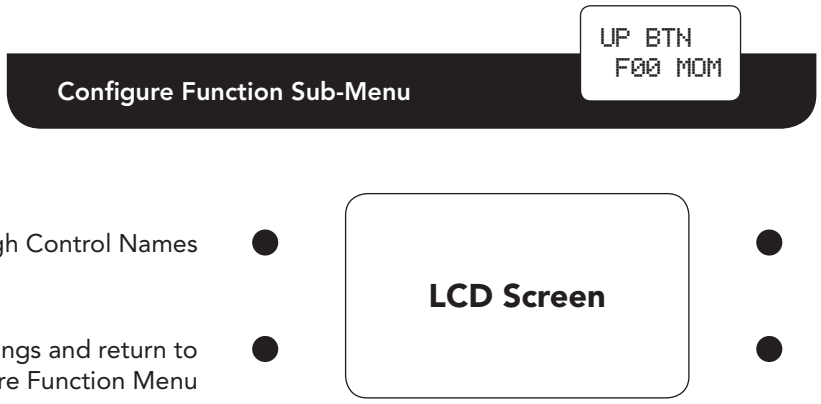
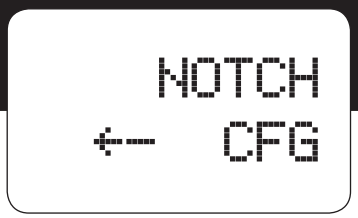
MOM | Momentary / Latching Function. Only appears for the Up and Down button assignments.

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



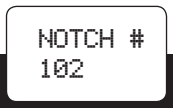
Advance to Threshold Calibration Menu

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

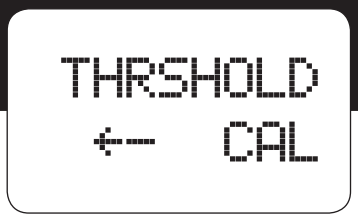
Save notch settings and return to Notch Configuration Menu

LCD Screen

Increase Speed Step

Decrease Speed Step

Threshold Calibration Menu



Advance to Communication Configuration ●

Enter Threshold Calibration Sub-Menu ●

LCD Screen

● None

● None

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
○	Control Status. Shows the on/off status of the selected control. ○ 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 ●

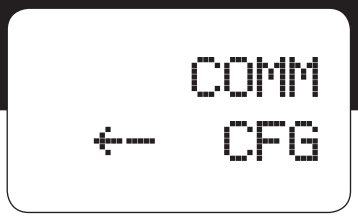
Save threshold settings and return to Threshold Calibration Menu ●

LCD Screen

● Set new calibration value

● None

Communication Configuration Menu



Advance to Preferences Menu

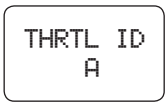
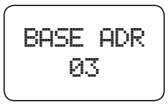
Enter Communication Configuration Sub-Menu

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 Names

Save address settings and return to Communication Configuration Menu

LCD Screen

Increase Address

Decrease Address

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 is locked and should not normally need to be changed by the user.
TX HLDOF 0.15s	**Transmit Holdoff.** Minimum time between wireless transmissions to the ProtoThrottle receiver. This setting is locked and should not normally need to be changed by the user.
VAR BRK ON	**Variable Brake.** When set to ON, the brake function will be pulsed at a duty cycle corresponding to the brake handle position, simulating varying amounts of braking force. 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 based on the brake calibration setting (see the Threshold Calibration Menu).
BRK PWM 1.0s	**Brake Pulse Timing.** This sets the rate at which pulse commands are sent during braking. A smaller value results in smoother braking but can result in a less responsive system due to the higher rate at which commands are being sent.

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Preferences Sub-Menu

ELEMENT	DESCRIPTION
BRK ESTP ON	**E-Stop on Brake Handle.** When set to ON, the brake handle can set emergency stop for the selected locomotive when moved past the Brake High threshold. When set to OFF, the brake handle will not cause an emergency stop to be set.
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.
REV SWAP OFF	**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.
REV LOCK ON	**Reverse 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 direction regardless of the throttle setting.

Cycle through preference settings

Save preference settings and return to Preferences Menu

LCD Screen

Increase value or turn on setting

Decrease value or turn off setting

Diagnostics Menu

Return to Main Menu ●

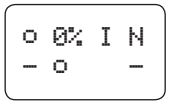
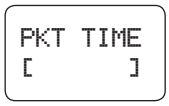
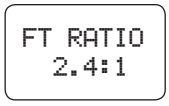
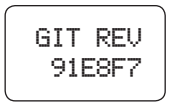
Enter Diagnostics Sub-Menu ●

LCD Screen

● None

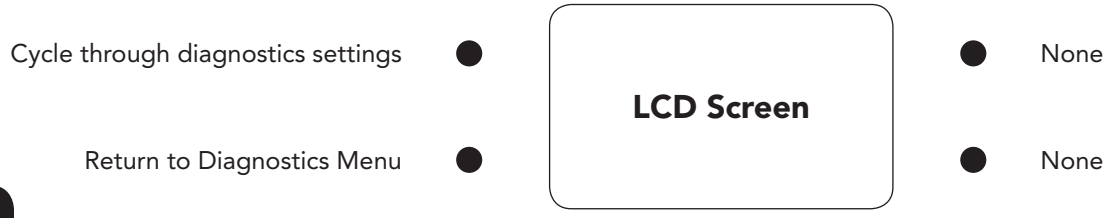
● None

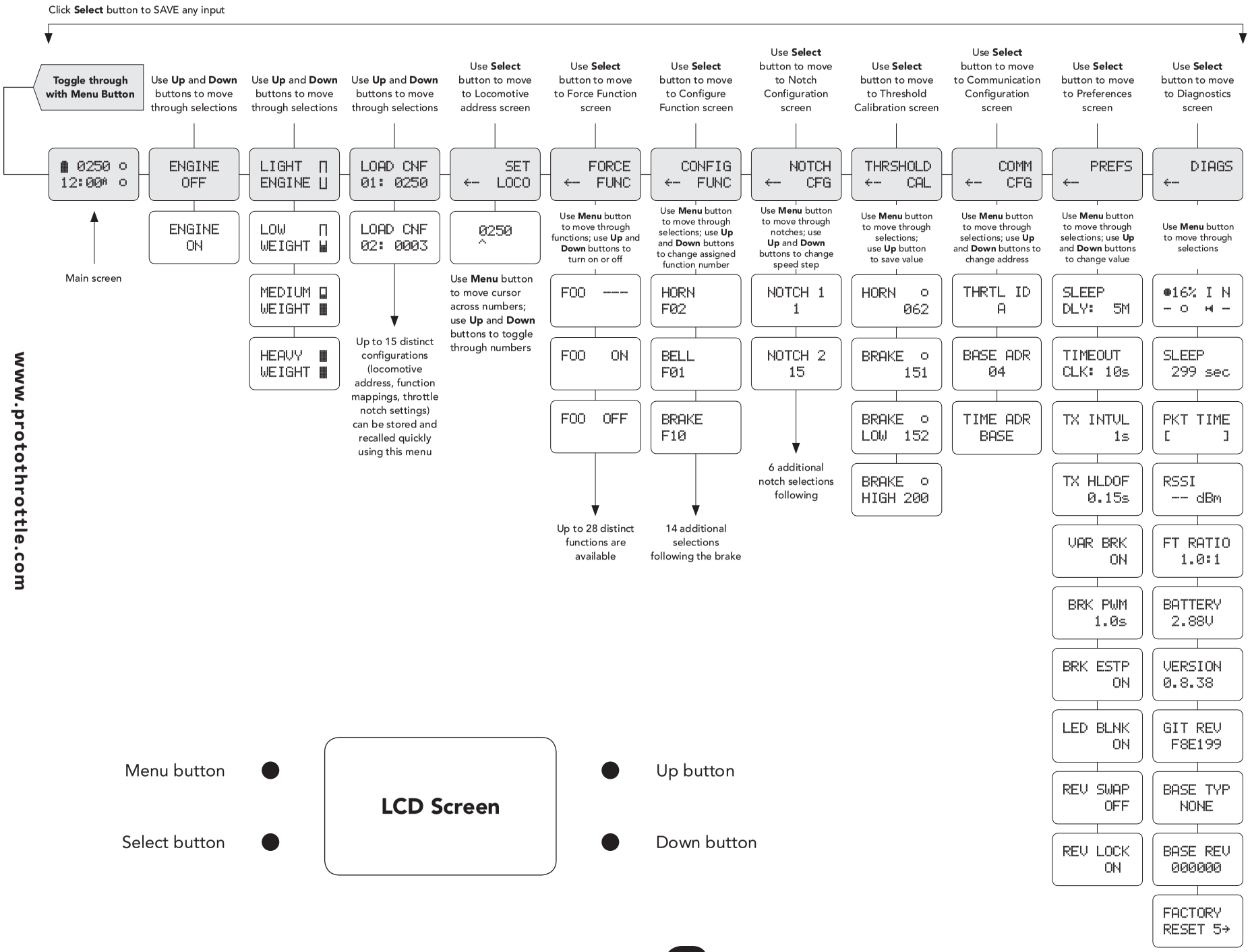
Diagnostics Sub-Menu

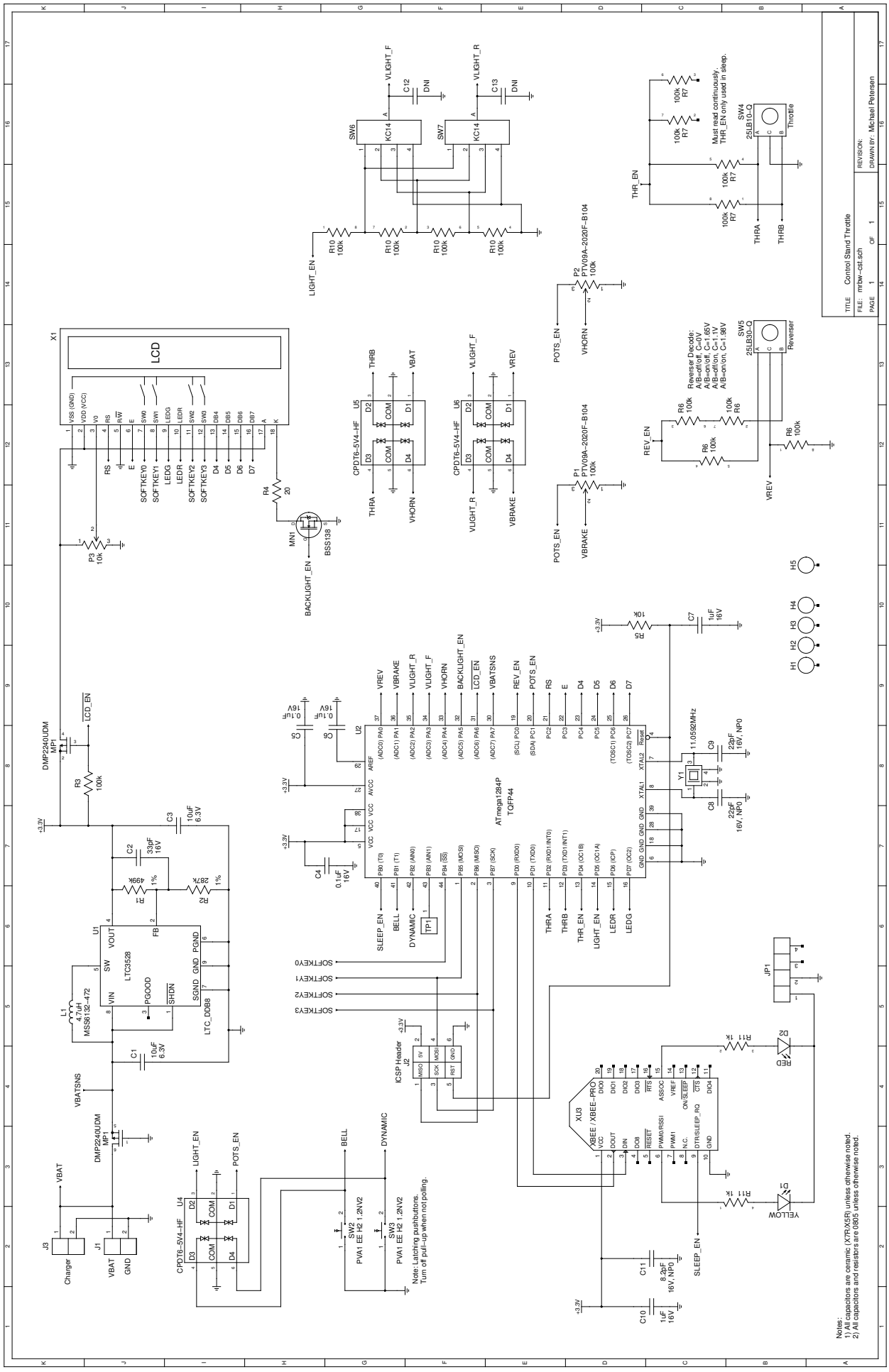
ELEMENT	DESCRIPTION
	**Controls Display.** Shows the current status of the ProtoThrottle controls and buttons.
	**Sleep Timeout.** Shows the number of seconds until the throttle goes to sleep.
	**Packet Timeout.** Timer reset by each packet received from the ProtoThrottle receiver. Communication is considered lost when the bar reaches zero.
	**Received Signal Strength Indicator.** Reports the strength of the wireless connection to the throttle.
	**Fast Time Ratio.** Reports the fast time ratio from the last update received.
	**Battery Voltage**
	**ProtoThrottle Firmware Version**
	**ProtoThrottle Firmware Short Git Hash**

Continued on next page

ELEMENT	DESCRIPTION
BASE TYP CAB BUS	**Base Type.** The type of ProtoThrottle receiver to which the ProtoThrottle is connected.
BASE REV B187EC	**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!**




Click **Select** button to SAVE any input
Toggle through with Menu Button
Use **Up** and **Down** buttons to move through selections
Use **Up** and **Down** buttons to move through selections
Use **Up** and **Down** buttons to move through selections
Use **Select** button to move to Locomotive address screen
Use **Select** button to move to Force Function screen
Use **Select** button to move to Configure Function screen
Use **Select** button to move to Notch Configuration screen
Use **Select** button to move to Threshold Calibration screen
Use **Select** button to move to Communication Configuration screen
Use **Select** button to move to Preferences screen
Use **Select** button to move to Diagnostics screen
0250
12:00A
ENGINE OFF
ENGINE ON
LIGHT
ENGINE
LOW WEIGHT
MEDIUM WEIGHT
HEAVY WEIGHT
LOAD CNF
01: 0250
LOAD CNF
02: 0003
SET
LOCO
0250
FORCE
FUNC
FOO ---
FOO ON
FOO OFF
CONFIG
FUNC
HORN F02
BELL F01
BRAKE F10
NOTCH
CFG
NOTCH 1
1
NOTCH 2
15
THRSHOLD
CAL
HORN 062
BRAKE 151
BRAKE LOW 152
BRAKE HIGH 200
COMM
CFG
THRTL ID A
BASE ADR 04
TIME ADR BASE
PREFS
SLEEP DLY: 5M
TIMEOUT CLK: 10s
TX INTVL 1s
TX HLDOF 0.15s
VAR BRK ON
BRK PWM 1.0s
BRK ESTP ON
LED BLNK ON
REV SWAP OFF
REV LOCK ON
DIAGS
16% I N
SLEEP 299 sec
PKT TIME
RSSI -- dBm
FT RATIO 1.0:1
BATTERY 2.88V
VERSION 0.8.38
GIT REV F8E199
BASE TYP NONE
BASE REV 000000
FACTORY RESET 5
Main screen
Use **Menu** button to move cursor across numbers; use **Up** and **Down** buttons to toggle through numbers
Up to 15 distinct configurations (locomotive address, function mappings, throttle notch settings) can be stored and recalled quickly using this menu
Use **Menu** button to move through functions; use **Up** and **Down** buttons to turn on or off
Up to 28 distinct functions are available
Use **Menu** button to move through selections; use **Up** and **Down** buttons to change assigned function number
14 additional selections following the brake
Use **Menu** button to move through notches; use **Up** and **Down** buttons to change speed step
6 additional notch selections following
Use **Menu** button to move through selections; use **Up** button to save value
Use **Menu** button to move through selections; use **Up** and **Down** buttons to change address
Use **Menu** button to move through selections; use **Up** and **Down** buttons to change value
Use **Menu** button to move through selections
Menu button
Select button
LCD Screen
Up button
Down button


LCD
ATmega1284P
TQFP44
XBEE / XBEE-PRO
LTC3528
ICSP Header
Charger
VBAT
GND
Control Stand Throttle
mftw-cst.sch
Michael Petersen
Throttle
Reverser
Notes:
1) All capacitors are ceramic (X7R/X5R) unless otherwise noted.
2) All capacitors and resistors are 0805 unless otherwise noted.

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.

For questions or comments, contact Scott Thornton at 515-232-0328 or email: **scott@designgrid.com**

For technical support, email: **support@iascaled.com**

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

www.iascaled.com

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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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