The Morse->USB keyboard uses Morse code and custom pro-signs to produce standard keyboard keys and key sequences that are not easily produced with standard Morse code. At its core, standard Morse code (per ITU standards and American variations) is implemented much as it is in radio applications. A notable exception is the pro-sign /BT (this document uses "/" to prefix pro-signs) which is generally interpreted as an "=" symbol. Here, /BT is the "Enter" or "CR" key. To support the "=" symbol, /EQ (∗−−∗−) was selected.

This guide is written to support the PCB version of the device. However, if a builder follows the general circuit presented in the schematic and uses the software as provided, this guide should apply equally well to hand-assembled versions.

This device consists of a TI microcontroller that has software which configures it to act as a USB-HID (Human Interface Device) keyboard. No PC configuration is required, it is a plug-n-play device. A set of Morse keyer paddles are required with a 1/8" stereo connector (straight key input is not supported at this time). The paddles may be iambic (Iambic "A" or "B" mode based on a jumper-option) or straight. A set of 100-ohm headphones or earbuds are needed to hear the side-tone output (an 8-ohm speaker may be used, but the amplitude will be somewhat limited). Side-tone frequency and Morse speed are adjustable using pots connected to the interface board. Weight is adjusted using the side-tone pot with a specific jumper grounded on the interface board.

A second side-tone (the status output) is used to output status messages in Morse code. This tone is set to a frequency of 800 Hz.

Ensure that the slide switch near the USB connection is set to "device" and connect the USB connector labeled "DEVICE" to one of the available USB ports on the PC. When first powered on Morse code "V3x" (SW version 3, with "x" indicating the iambic mode "A" or "B") is issued and the paddles/keypad are "locked". The device will respond to keyer paddle inputs but will not send any keycodes to the PC. Unlocking requires the issuance of the /LOK pro-sign. This pro-sign responds with "KL" when locking, and "OK" when unlocking. The following pro-signs issue a response on the status tone output:

Pro-sign	Description	Status response (Morse code)
/LOK	Paddle lock	"KL" when locked, "OK" when unlocked
/IFT	Shift key	"S" (also releases shift-lock), "N" if used to release shift-lock
/SL	Shift-lock	"SL" for shift lock, "NS" when shift-lock released
/CL	CAPS-lock toggle	"CL"
/ALT	ALT key	"A" or "N" if released
/CTL	CTRL key	"C" or "N" if released
/WIN	WIN (GUI) key	"W" or "N" if released
/WL	WIN-Lock	"L" (Windows security lock)
/VER	Paddle reverse	"SWP" is paddles reversed, "NRM" if normal
/WRD	Word delete (next)	"D"
/WRM	Word backspace (prev)	"B"
/KP	ALT-Keypad select	"KLTx" where "x" is "0" or "1". The keypad analogy of keyboard "shift"
/CTZ	CTRL-Z shortcut	"CZ" Only valid if PF4 strap is grounded
/STR	Store STW to EEPROM	"STR" – Stores speed, tone, and weight to EEPROM

(table continued)

Pro-sign	Description	Status response (Morse code)
/SKS	Straight-key toggle	"SKS" if straight key, "PDL" if paddle – Toggles between straight-key and paddle mode
/WWW	Read Morse Speed	Responds with Morse Code speed folowed by "WPM" on the status output tone

Pro-signs generally apply to the next "printable" key unless noted as "sticky" or "lock" (WIN-L is simply a shortcut of the security lock feature of Windows; the WIN key does not remain active after it is executed). Once a "printable" character is entered, the non-sticky modifiers are cleared.

The following jumper-options are available. The jumper number is printed next to the jumper pads on the PCB silkscreen, and the GPIO port is also indicated:

Jumper#	GPIO	Description
J1-10	PA7	Speed/Tone/Weight lock. Open allows speed, tone, and weight to be adjusted. GND = adjustments locked, EEPROM holds settings. If EEPROM is invalid (not programmed), this jumper is treated as OPEN.
J2-6	PB7	Iambic mode. GND = "A", Open = "B". This jumper is only recognized at power-on, or when unlocking the paddles with the /LOK pro-sign.
J4-4	PC4	Default paddle swap. Open = normal (tip = DIT), GND = reverse (tip = DAH)
J4-5	PC5	Factory Defaults. Open = normal, GND = reset stored EEPROM to factory settings
J4-7	PC7	TLC device clock select. Open = TLC14, GND = TLC04
J4-8	PD6	Weight adjust pot enable. Open = Tone, GND = weight
J4-9	PD7	Keypad assign enable. Open = keypad programming disabled, GND = enabled
J4-10	PF4	GND = Enable CTRL-Z pro-sign shortcut, Open = shortcut disabled
J3-6	PD3	GND = Force unlock on power-on, Open = lock on power-on (/LOK required to unlock)
J3-5	PD2	GND = Straight key on power-up, Open = iambic.

The Morse character parameters can be locked to prevent inadvertent changes (the status Morse output is fixed). To lock the settings, first establish the desired speed, weight, and tone (in that order) using the weight adjust jumper (J4-8) as needed. When the settings are as desired, ground STW lock (J1-10), issue the /LOK command to lock the paddles, then issue /STR to store the values to EEPROM. Cycle power to the Morse->USB keyboard (or reset) to complete the process. While J1-10 is in place, the Speed/Tone/Weight adjustments are disabled. To re-enable, remove J1-10 and cycle power (or reset).

P1 connects to a 4x4 keypad and/or a special, 4-button board designed to install on a Bencher paddle (other paddles are likely to support a similar installation method). This allows for up to 20 user-defined key-buttons to be used in conjunction with the Morse paddles. The pinout is defined as follows:

Descr.	Pin	Pin	Descr.
ROW0	1	2	COL0
ROW1	3	4	COL1
ROW2	5	6	COL2
ROW3	7	8	COL3
ROW4	9	10	LED1 (ALT KEYPAD)
(SHLK) LED4	11	12	LED2 (WIN)
(CAPLK) LED5	13	14	LED3 (ALT)
(CTRL) LED6	15	16	+5V

P1 Keypad connector pin-out.

ROW0 is reserved for the 4-button board, while ROWS1-4 are provided for a 4x4 keypad (such as Jameco part# 169245, www.jameco.com). A crimp-style DSUB-25 connector pair may be used to pass these signals through a chassis bulkhead. Make sure to bias the 16 position cable towards pin 1 on each connector.

The keypad assignment mode allows the operator to set the "meaning" of each key in the keypad. These settings are stored to EEPROM and recalled on power up. To enter the keypad assignment mode, issue the /KP command (as needed) to select the desired keypad ("0" or "1") then ground the Keypad Assign enable jumper (J4-9, PD7) and then lock the paddles with the /LOK command pro-sign. "PE" (kp 0) or "PI" (kp 1) will be issued to the status message channel and the system is ready for input. If no Morse characters are pending (none are when entering the assignment mode), the operator may press any keypad key and a message describing the keycode will be sent. The keypad response messages are as listed below:

Key character	MSG	Meaning
Any printable character:	<chr>	The associated character (printable)
Delete chr	DEL	Delete Key
/CR	ASP	Cmd to toggle auto-space mode
/IFT	SFT	Shift key
/CL	CL	Caps Lock
/PGU	PGU	Page Up
/PGD	PGD	Page Down
/ALT	ALT	ALT key
/CTL	CTL	CTRL key
/WL	WNL	WIN-L (lock computer)
/WIN	WIN	WIN key
/F1	F1	F1 key
/F2	F2	F2 key
/F3	F3	F3 key
/F4	F4	F4 key
/F5	F5	F5 key
/F6	F6	F6 key

Key character	MSG	Meaning
/F7	F7	F7 key
/F8	F8	F8 key
/F9	F9	F9 key
/FE1	F10	F10 key
/FE2	F11	F11 key
/FE3	F12	F12 key
/UAR	ARU	Up arrow key
/DAR	ARD	Down arrow key
/LAR	ARL	Left arrow key
/RAR	ARR	Right arrow key
Backspace chr	BKS	Backspace key
/TAB	TAB	TAB key
/CR	CR	Toggle auto-space mode
/ESC	ESC	ESC key
/LOK	LOK	Paddle lock command
/VER	REV	Paddle swap command (/VER)
/WRD	WDL	Word delete shortcut command
/WRM	WBS	Word backspace shortcut command
/SL	SLK	Shift lock command
/KP	KSP	Keypad swap command
/CZ	CTZ	CTRL-Z shortcut command
/STR	STR	Store Speed-Tone-Weight to EEPROM command
/SKS	SKS or PDL	Straight-key mode toggle
/WWW	ddWPM	Read current (dd) WPM setting

To change a keypad assignment, enter the character that will be assigned to the key. Then, press the desired key. The system will respond with "S" followed by the character that was just assigned. This process continues until all of the assignments are complete.

When finished, remove the jumper (or flip the switch) to disable the key assignment mode, then issue the /LOK command. The system will issue "PGM" followed by "OK". After this sequence is complete. Once an assignment is made, any further changes will be saved when the assignment mode is terminated. The only way to abort a session is to turn off (or reset) the device. The following table describes the factory default for each of the two keypad definitions:

Keypad 0				
	COL0	COL1	COL2	COL3
ROW0	CTRL	BACKSP	SHIFT	SHIFTLK
ROW1	'/'	Up-Arrow	'-'	PgUP
ROW2	Left-Arrow	'='	Right-Arrow	Keypad-Swap
ROW3	/SKS	Down-Arrow	'.'	PgDN
ROW4	Paddle-LK	/VER	Word-BKSP	Word-DEL
Keypad 1				
ROW0	CTRL	BACKSP	SHIFT	SHIFTLK
ROW1	'/'	Up-Arrow	'-'	PgUP
ROW2	Left-Arrow	'='	Right-Arrow	Keypad-Swap
ROW3	CTRL	ALT	DEL	WIN
ROW4	Paddle-LK	/VER	Word-BKSP	Word-DEL

Table 1 illustrates the supported Morse and modified-Morse characters and their resulting keyboard action. The "Notes" columns describe the character/pro-sign, while the "CHAR" column depicts the keypress that results.

To program the user defined pro-sign ($*-*-$), enter the keypad assignment mode as described above. Enter the desired Morse sequence to be programmed, then enter the user pro-sign "/AA". The system should respond with "U" followed by the Morse character that was assigned. *Note: The user defined pro-sign "/AA" cannot be assigned to a keypad button. Also, this feature only assigns Morse characters that are currently defined in the system.* If there is an error in entering the Morse character to assign, simply re-enter. If there is an error sending the "/AA" pro-sign, then the entire sequence must be re-sent. Activating the Factory Defaults jumper clears the user pro-sign selection.

Notes	* = dit, - = dah	CHAR	* = dit, - = dah	CHAR	Notes	* = dit, - = dah
/SPACE	* * — —	<space>	— — — — —	0	/CR (auto space)	— * — * * — *
	— * — * — —	!	* — — — —	1	/IFT (shitf)	* * * * — * —
	* — * * — *	"	* * — — —	2	/SL (shift lock)	* * * * — * *
/NUM	— * * * — — —	#	* * * — —	3	/CL (capslk)	— * — * * — * *
	* * * — — * * —	$	* * * * —	4	/PGU	* — — * — — * * * —
/PER	* — — * * * — *	%	* * * * *	5	/PGD	* — — * — — * — * *
	* — * * *	&	— * * * *	6	/ALT	* — * — * * —
	* — — — — *	'	— — * * *	7	/CTL	— * — * — * — * *
	— * — — *	(	— — — * *	8	/WL (WIN-L)	* — — * — * *
	— * — — * —	)	— — — — *	9	/WIN	* — — * * — *
/STA (/SK)	* * * — * —	*	* —	A	/UAR (up arrow)	* * — * — * — *
	* — * — * — *	+	— * * *	B	/DAR	— * * * — * — *
	— — * * — —	,	— * — *	C	/LAR	* — * * * — * — *
	— * * * * —	-	— * *	D	/RAR	* — * * — * — *
	* — * — * —	.	*	E	/TAB	— * — — * * *
	— * * — *	/	* * — *	F		
	— — — * * *	:	— — *	G	/BT (Enter)	— * * * —
	— * — * — *	;	* * * *	H	/ESC	* * * * — * — *
	* — * * — * * * *	<	* *	I	/LOK paddles	* — * * — — — — * —
/EQ	* — — * —	=	* — — —	J	/VER	* * * — * * — *
	— — * — * * * *	>	— * —	K	/WRD del (fwd)	* — — * — * — * *
	* * — — * *	?	* — * *	L	/WRM backsp	* — — * — * — —
	* — — * — *	@	— —	M	DEL	* * * * * * —
	— * — — * — *	[	— *	N	DEL	* * * * * * * —
	— * * — * —	\	— — —	O	DEL	* * * * * * * * —
	— * — — * — —	]	* — — *	P	/F1	* * — * * — — — —
/CA	— * — * * —	^	— — * —	Q	/F2	* * — * * * — — —
	* * — — * —	_	* — *	R	/F3	* * — * * * * — —
	* — — — — * *	`	* * *	S	/F4	* * — * * * * * —
	— * — — * *	{	—	T	/F5	* * — * * * * * *
/PI	* — — * * *	|	* * —	U	/F6	* * — * — * * * *
	— * — — * * —	}	* * * —	V	/F7	* * — * — — * * *
/TIL (~)	— * * * — * *	~	* — —	W	/F8	* * — * — — — * *
			— * * —	X	/F9	* * — * — — — — *
/WWW	* — — * — — * — —		— * —	Y	/FE1 (F10)	* * — * * * — — — —
/SKS	* * * — * — * * *		— — * *	Z	/FE2 (F11)	* * — * * * * — — —
/aa (user defined)	* — * —	<pgmd>			/FE3 (F12)	* * — * * * * * — —
/STR	* * * — * — *				BKSPC	* * * * * *
/KP (alt kp)	— * — * — — *				BKSPC	* * * * * * *
/CTZ (ctrl-z)	— * — * — — * *				BKSPC	* * * * * * * *

Table 1. Morse character set for the Morse Keyboard.

Note: While some Morse characters result in the corresponding character to be sent to the PC, the modifier keys help determine what character is sent. For example, "Shift" followed by "4" will cause a "$" to be processed by the PC. "Shift" followed by "." sends ">". However, Morse characters that are "shifted" on a normal keyboard will be sent as-is. For example, "Shift" followed by "?" sends "?" to the PC.

The keyer paddles connect via a 1/8" stereo jack (labeled "J1"). Tip = DIT paddle, Ring = DAH paddle, Shield = GND (straight-key is not supported).

100-ohm Headphones/earbuds connect to the headphone jack (labeled "J3" – an 8-ohm speaker may be used, but the amplitude will be somewhat limited). Tip & Ring = audio, Shield = GND.
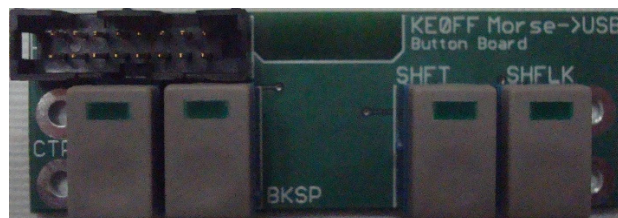

Figure 1. Morse->USB Keyboard assembly

Figure 2. Mini-Keypad assembly. The LED indicators (from left to right) are:
CTRL, ALT Keypad, CAP-Lock, and Shift-Lock.
The button actions are labeled per the factory Default key assignments.

For recent Windows operating systems (WIN7+), multiple keyboards may be connected to a single PC without any observable consequences (assuming there are not persons competing to enter data on separate keyboards – *Note: the behavior of Windows OS versions prior to 7 is unknown*). Thus, an existing keyboard may remain connected when installing the Morse keyboard on systems using these operating system versions.