joeh-*at*-ke0ff-*dot*-org

HM-133 DTMF Adapter Manual – **!! DRAFT !!**

By Joseph Haas, KEØFF
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This manual provides details for the assembly and operation of the HM-133 DTMF Adapter module. The assembly directions are divided into two parts, full assembly from a blank PCB, and partial kit assembly. The operation section is aimed at the software produced as of the date of this manual. Since it is likely that the source code for the device will be offered on an open-source venue, the operation section in this manual may not apply to the software deployed on the hardware in question.

Assembly Options

The DTMF adapter has several options which are determined by the configuration of resistors installed (or not) at various locations (all on the bottom side). Determine the options desired prior to assembling the bottom side components.

UP/DOWN Options

Using the assembly notes, determine the desired UP/DOWN configuration desired: ICOM (up/down only), ICOM IC-7000, Kenwood (up/down, and 4 function buttons), or Yaesu (up/down, and 4 function buttons). Install the resistor options per these choices when the bottom side assembly is reached.

Microphone Emulation Option (Ro1 – Ro3)

The type of microphone to be emulated requires that the Ro resistors be selected and installed. Again, the assembly notes detail the selection matrix.

MIC Level Option

There are two resistor locations that can be used to reduce the microphone signal level which is provided to the radio. For ICOM radios, R38 can generally be installed with a 0Ω resistor, and R39 omitted. For other radios, the choice of resistors for these two locations can be more difficult to determine.

To reduce the level one can either provide a series resistance to increase the effective source impedance of the microphone (which will reduce its level), provide a shunt resistance (with R38 = 0Ω) which will form a voltage divider with the microphone source impedance (thus reducing the level), or install R38 and R39 to form a resistive divider. It is difficult to provide a deterministic and analytical

approach to allow the user to choose the best resistor values. Each of the previously described approaches will have advantages and drawbacks.

From an ease-of-implementation standpoint, the best approach is to use a potentiometer with a medium value pot (2KΩ, for example) that is temporarily installed at R38 and R39. The user can then adjust the pot for the best modulation level for a given radio. Once an adjustment is determined, the values for R38 and R39 can be measured directly on the PCB, and the nearest standard values installed upon removal of the pot. This allows the level to be quickly adjusted, and tests performed to confirm that the level and frequency response of the microphone are acceptable. *Note: All other assembly operations must be complete and the MCU programmed before testing the MIC level option.*

Assembly, the Full Monty

Those skilled in SMD soldering (0402 or larger) should not have any difficult assembling the PCB for this project. It is recommended to start with the top side and attach the IC and diodes first, followed by the 2-pad chip parts, with J1 and J2 installed last. J1 and J2 will then act as supports when assembling the bottom layer parts.

Refer to the parts-placement diagrams to locate the components on the PCB. Solder using an appropriate, temperature-controlled iron. No-clean solder and flux is easy to obtain and leaves an inert and easy to remove residue (The Kester 245 flux is recommended).

Assembly, (Partial) Kit

The partial kit option provides a PCB with all top SMD parts soldered and the MCU programmed. The kit-builder should attach J1 and J2 first, followed by the remaining parts on the top and bottom (P1 is not needed unless custom software programming is desired).

Refer to the assembly diagrams (below) for parts-placement. Solder using an appropriate, temperature-controlled iron. No-clean solder and flux is easy to obtain and leaves an inert and easy to remove residue (The Kester 245 flux is recommended).

Assembly Data

TOP SIDE SMD PARTS LIST

QTY	REFDES	Description	MFR_PN	MFR
6	C1, C3, C12, C13, C15, C17	CAP, CER, 0402, 0.1uF, 16V	CC0402JRX7R7BB104	Yageo
2	C2, C14	CAP, CER, 0603, 1000pF, COG, 50V	GRM1885C1H102JA01D	Murata
3	C4, C5, C18	CAP, CER, 0805, 4.7uF, 10V	C2012X7R1A475M125AC	TDK
2	C6, C7	CAP, CER, 1206, 22uF, 10V	LMK316AB7226ML-TR	Taiyo Yuden
3	C9, C10, C21	CAP, CER, 0805, 1.0uF, 25V	C0805C105K3RACTU	Kemet
1	C16	CAP, CER, 0402, 0.01uF, 25V	C0402C103K5RACTU	Kemet
1	D1	TVS, UNI, 15V, 150W, DO219	MSMP15A-M3/89A	Vishay
1	D2	DIOD, SHTKY, 1A, 40V	RB168MM-40TFTR	Rohm Semi
1	D3	DIO, LED, SMD, RED, 0805	599-0110-007F	Dialight
17	FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8, FB9, FB10, FB11, FB12, FB13, FB14, FB15, FB16, FB17	FB, SMD, 0603, 600 ohm	BLM18AG601SN1D	Murata
4	Q1, Q2, Q4, Q6	TR, NFET, 30V, 0.85A, DCK-6	FDG6301N_F085	Fairchild Semi
1	Q3	TR, NFET, 30V, 0.85A, SOT23	BSH103,215	Nexperia
1	R3	RES, FLM, THK, 0402, 100, 1%	RC0402FR-07100RL	Yageo
1	R4	RES, FLM, THK, 0603, 820, 1%	RC0603FR-07820RL	Yageo
2	R5, R14	RES, FLM, THK, 0402, 20.0K, 1%	RC0402FR-0720KL	Yageo
1	R6	RES, FLM, THK, 0402, 200K, 1%	RC0402FR-07200KL	Yageo
1	R11	RES, FLM, THK, 0402, 4.42K, 1%	RC0402FR-074K42L	Yageo
1	R15	RES, FLM, THK, 0402, 620, 1%	RC0402FR-07620RL	Yageo
1	R16	RES, FLM, THK, 0402, 10.0K, 1%	RC0402FR-0710KL	Yageo
4	R20, R21, R22, R23	RES, FLM, THK, 0402, 49.4K, 1%	RC0402FR-0749K9L	Yageo
1	R31	RES, FLM, THK, 0402, 12.4K, 1%	RC0402FR-0712K4L	Yageo
1	R33	RES, FLM, THK, 0402, 220, 1%	RC0402FR-07220RL	Yageo
1	U1	IC, VREG, LDO, 5.0V, SOT-223	LM2937IMP-5.0/NOPB	TI
1	U2	IC, MCU, 8051	C8051F531-C-IT	SiLabs
2	U3, U4	IC, SW, ANLG, SPDT, SC70-6	SN74LVC1G3157DCKR	TI
1	U5	IC, CMOS, SFT-REG, 8b, TSSOP-16	CD4094BPWR	TI

KIT PARTS
BOTTOM SIDE SMD AND THRU-HOLE PARTS:

QTY	REFDES	Description	MFR_PN	MFR
1	C8	CAP, CER, 0805, 1.0uF, 25V	C0805C105K3RACTU	Kemet
2	C11, C19	CAP, CER, 0603, 0.1uF, 25V	C0603C104K3RACTU	Kemet
1	C21	CAP, CER, 0805, 1.0uF, 25V	C0805C105K3RACTU	Kemet
2	J1, J2	CON, RJ-45, SMD-TH, RA	RJLSE4138101	Amphenol
1	Q7	TR, PFET, 30V, 0.5A, SOT-23	FDN358P	On Semi
3	R1, R2, Ro3	RES, FLM, THK, 0603, 1.00K, 1%	RC0603FR-071KL	Yageo
3	R8, R34, R38	RES, FLM, THK, 0603, 0	RC0603FR-070RL	Yageo
3	R9, R12, R35	RES, FLM, THK, 0603, 22K, 1%	RC0603FR-0722KL	Yageo
2	R13, R36	RES, FLM, THK, 0603, 100K, 1%	RC0603FR-07100KL	Yageo
2	R17, R29	RES, FLM, THK, 0603, 10.0K, 1%	RC0603FR-0710KL	Yageo
1	R18	RES, VAR, TOP, 1K, TH	3362P-1-102ALF	Bourns
1	R19	RES, FLM, THK, 0603, 1.80K, 1%	RC0603FR-071K8L	Yageo
1	R24	RES, FLM, THK, 0603, 27K, 1%	RC0603FR-0727KL	Yageo
1	R25	RES, FLM, THK, 0603, 20.0K, 1%	RC0603FR-0720KL	Yageo
1	R26	RES, FLM, THK, 0603, 4.99K, 1%	RC0603FR-074K99L	Yageo
1	R27	RES, FLM, THK, 0603, 49.9, 1%	RC0603FR-0749R9L	Yageo
1	R28	RES, FLM, THK, 0603, 820, 1%	RC0603FR-07820RL	Yageo
1	R30	RES, FLM, THK, 0603, 15.0K, 1%	RC0603FR-0715KL	Yageo
1	R32	RES, FLM, THK, 0603, 1.50K, 1%	RC0603FR-071K5L	Yageo
1	R37	RES, FLM, THK, 0603, 470, 1%	RC0603FR-07470RL	Yageo
1	R38	RES, FLM, THK, 0603, 0, 1%	RC0603FR-070RL	Yageo
2	Ro1, Ro2	RES, FLM, THK, 0603, 6.8K, 1%	RC0603FR-076K8L	Yageo
1	R10 (part of Ro3 strap)	RES, FLM, THK, 0603, 2.2K, 1%	RC0603FR-072K2L	Yageo
1	R8 (alt)	RES, FLM, THK, 0603, 137K, 1%	RC0603FR-07137KL	Yageo
1	R9 (alt)	RES, FLM, THK, 0603, 357K, 1%	RC0603FR-07357KL	Yageo
1	R35 (alt)	RES, FLM, THK, 0603, 66.5K, 1%	RC0603FR-0766K5L	Yageo
1	R36 (alt)	RES, FLM, THK, 0603, 147K, 1%	RC0603FR-07147KL	Yageo
1	R37 (alt)	RES, FLM, THK, 0603, 54.9K, 1%	RC0603FR-0754K9L	Yageo

DO NOT POPULATE (DNP) PARTS (not provided in KIT):

QTY	REFDES	Description	MFR_PN	MFR
1	C20	CAP, CER, 0402, 0.1uF, 16V	CC0402JRX7R7BB104	Yageo
1	P1	CON, 6POS, 1.25MM, SMD	53261-0671	Molex
1	R7	RES, FLM, THK, 0603, 820, 1%	RC0603FR-07820RL	Yageo
1	R39	RES, FLM, THK, 0603, 1K, 1%	RC0603FR-071KL	Yageo

Assembly notes

1) ICOM (generic): INST. R8 & R37, Do Not Inst. (DNI) R9, R13, R34, R35, & R36

   ICOM HM-151 (IC-7000): INST R34, DNI R8 R9, R12, R13, R24, R34, R35, R36, & R37

   Kenwood (TM731 and similar):
   RES VALUES AS FOLLOWS:
   R8 = 0 R34 = 0
   R9 = 22K R35 = 22K
   R13 = 100K R36 = 100K
   DNP: R12, R24, R37

   Verify resistor values for R8, R9, R13, R34, R35, & R36 against the microphone schematic for the desired rig.

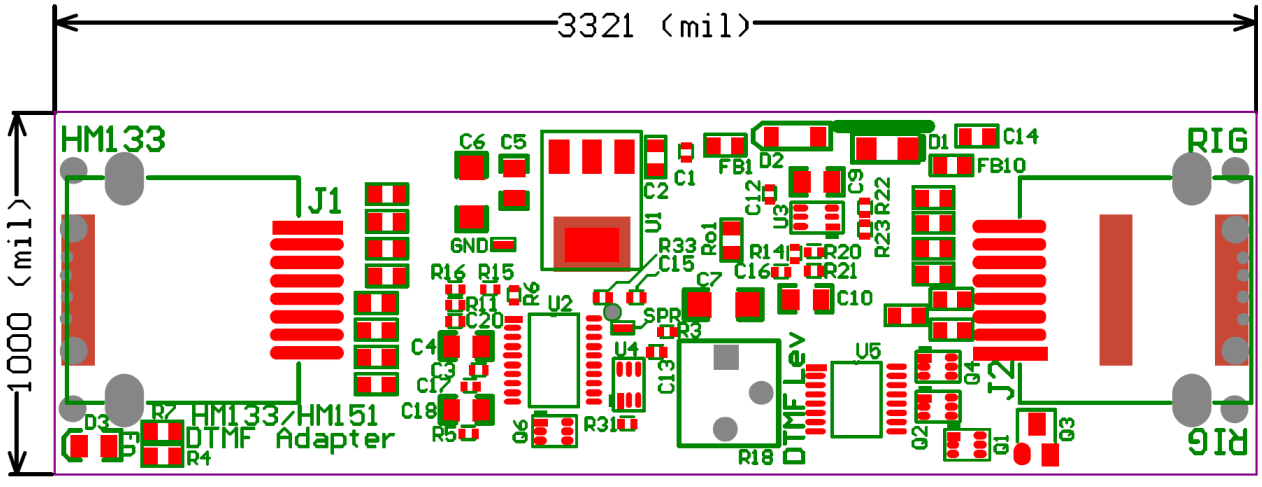
   Yaesu MH36: REQUIRES OPTION SELECTION (SEE NOTE 3).
   RES VALUES AS FOLLOWS:
   R24 = 27K R35 = 66.5K R36 = 147K
   R12 = 22K R37 = 54.9K R8 = 137K R9 = 357K
   DNP: R13, R34

2) ON-BOARD LED SELECTION: INST. R7 FOR D4 = PWR LED, or INST R4 FOR D4 = STATUS LED (R4 IS DEFAULT). DO NOT INSTALL BOTH.

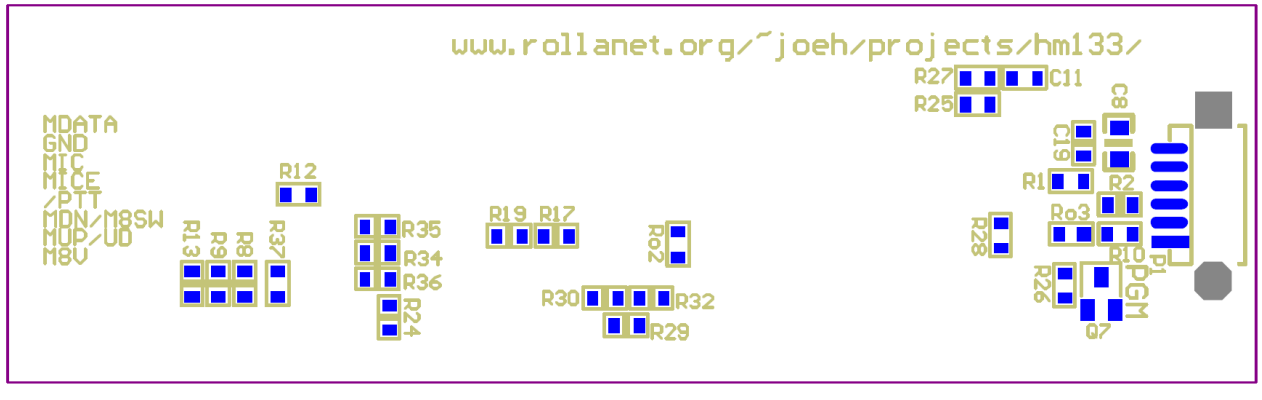
3) Ro1 & Ro2 (6.8K/OPEN) and Ro3/R10 (1K/OPEN) ARE SOFTARE OPTION STRAPS.
   1 = RES INST, 0 = OPEN (default)

Ro3/R10	Ro2	Ro1	OPTION
0	0	0	ICOM (40ms pulse)
0	0	1	Yaesu MH36 microphone (100ms pulse)
0	1	0	Kenwood MC-44DM (80ms pulse)
0	1	1	Generic radio (100ms pulse)
1	0	0	Generic radio (125ms pulse)
1	0	1	TBD
1	0	1	TBD
1	1	1	HM-151 feedthru mode (for IC-7000, et.al.)

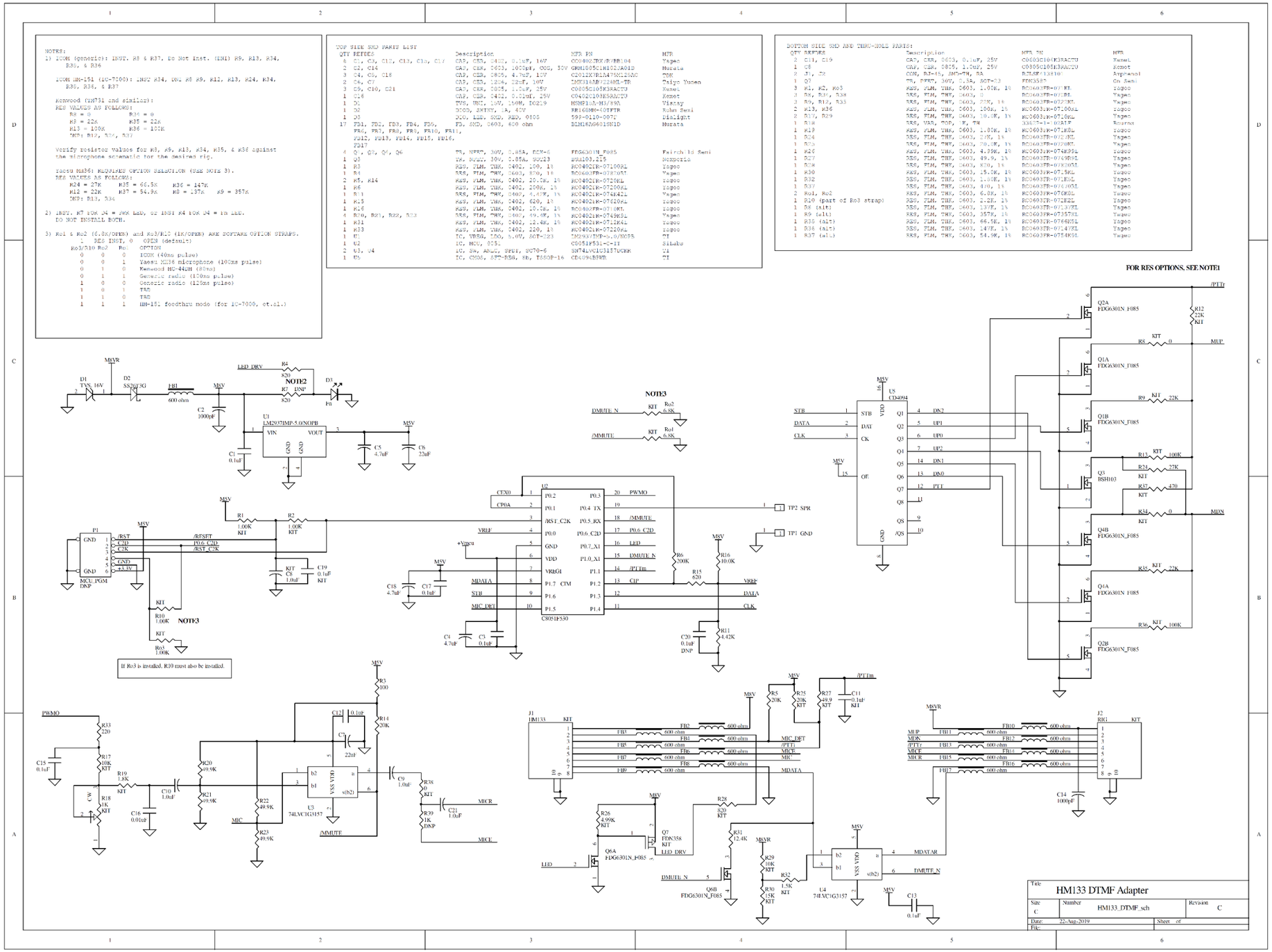
Parts Placement (top)



Parts Placement (bottom)



Note: rollanet.org is no longer in use.


NOTES:
1) IC6M (generic): INST. R8 & R37, Do Not Inst. (DNI) R9, R13, R34, R36, & R36
IC6M HM-151 (IC-7000): INST R34, DNI R8 R9, R12, R13, R24, R34, R36, R36, & R37
Kenwood (TH731 and similar):
RES VALUES AS FOLLOWS:
R8 = 0 R36 = 0
R9 = 22k R35 = 22k
R13 = 100k R36 = 150k
DNP: R12, R24, R37
Verify resistor values for R8, R9, R13, R34, R35, & R36 against the microphone schematic for the radios rig.
Yaesu MH36: REQUIRES OPTION SELECTION (SEE NOTE 3).
RES VALUES AS FOLLOWS:
R24 = 27K R35 = 66.5K R36 = 147K
R12 = 22K R37 = 54.9K R8 = 137K R9 = 357K
DNP: R13, R36
2) INST. R7 FOR D4 = 9MX LED, or INST R4 FOR D4 = 4M LED.
DO NOT INSTALL BOTH.
3) Ro1 & Ro2 (6.8K/OPEN) and Ro3/R10 (1K/OPEN) ARE SOFTWARE OPTION STRAPS.
1 RES INST, 0 OPEN (default)
Ro3/R10 Ro2 Ro1 OPTION
0 0 0 ICOM (40ms pulse)
0 0 1 Yaesu MH36 microphone (100ms pulse)
0 1 0 Kenwood HC-44DM (80ms)
0 1 1 Generic radio (120ms pulse)
1 0 0 Generic radio (150ms pulse)
1 0 1 TBD
1 1 0 TBD
1 1 1 HM-151 feedthru mode (for IC-7000, et.al.)
TOP SIDE SMD PARTS LIST
QTY REFDES Description MFR PN MFR
6 C1, C4, C12, C13, C16, C17 CAP, CER, 0402, 0.1uF, 16V C0402C7BX7R7BB104 Vagen
2 C2, C14 CAP, CER, 0603, 1000pF, C0G, 50V GRM1885C1H102JA01D Murata
3 C3, C5, C18 CAP, CER, 0805, 4.7uF, 10V C2012X7R1A475M125AC TDK
2 C6, C7 CAP, CER, 1206, 22uF, 10V TMK316ABJ226ML-TR Taiyo Yuden
2 C9, C10, C21 CAP, CER, 0805, 1.0uF, 25V C0805C105K3RACTU Kemet
1 C15 CAP, CER, 0402, 0.01UF, 25V C0402C103K5RACTU Kemet
1 D1 TVS, UNI, 16V, 150W, DO219 MSMP16A-M3/89A Vishay
1 D2 DIOD, SKTKY, 1A, 40V RB160M-40TFTR Rohm Semi
1 D3 DIOD, LED, RED, RED, 0805 598-8110-007F Dialight
17 FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8, FB9, FB10, FB11, FB12, FB13, FB14, FB15, FB16, FB17 FB, SMD, 0603, 600 ohm BLM18AG601SN1D Murata
4 Q, Q2, Q4, Q6 TR, NFET, 30V, 0.85A, SOT-6 FDG6301N_F085 Fairchild Semi
1 Q3 TR, NFET, 30V, 0.68A, SOT23 BSH103,215 Nexperia
1 R3 RES, FLM, THK, 0402, 100, 1% RC0402FR-07100RL Yageo
1 R4 RES, FLM, THK, 0603, 820, 1% RC0603FR-07820R Vagen
2 R5, R14 RES, FLM, THK, 0402, 20.0K, 1% RC0402FR-0720KL Yageo
1 R6 RES, FLM, THK, 0402, 200K, 1% RC0402FR-07200KL Yageo
1 R7 RES, FLM, THK, 0402, 4.87K, 1% RC0402FR-074K42L Yageo
1 R15 RES, FLM, THK, 0402, 620, 1% RC0402FR-07620RL Yageo
1 R16 RES, FLM, THK, 0402, 10.0K, 1% RC0402FR-0710KL Yageo
4 R20, R21, R22, R23 RES, FLM, THK, 0402, 49.9K, 1% RC0402FR-0749K9L Yageo
1 R24 RES, FLM, THK, 0402, 12.4K, 1% RC0402FR-0712K4L Yageo
1 R33 RES, FLM, THK, 0402, 220, 1% RC0402FR-07220RL Yageo
1 U1 IC, VREG, 250, 5.0V, SOT-223 LM2937IMP-5.0/NOPB TI
1 U2 IC, MCU, 8051 C8051F531-C-IT Silabs
2 U3, U4 IC, SW, ANAC, SPST, SC70-6 SN74LVC1G3157DCKR TI
1 U5 IC, CMOS, SPI-BUS, 8b, TSSOP-16 CD4094BPWR TI
BOTTOM SIDE SMD AND THRU-HOLE PARTS:
QTY REFDES Description MFR PN MFR
2 C11, C19 CAP, CER, 0603, 0.10uF, 25V C0603C106K3RACTU Kemet
1 C8 CAP, CER, 0805, 1.0uF, 25V C0805C105K3RACTU Kemet
2 J1, J2 CON, RA-45, SMT-TH, RA RJLSF4418101 Amphenol
1 Q7 TR, PFET, 30V, 0.5A, SOT-23 FDN358P On Semi
3 R1, R2, R43 RES, FLM, THK, 0603, 1.00K, 1% RC0603FR-071KL Yageo
2 R8, R36, R38 RES, FLM, THK, 0603, 0 RC0603FR-070RL Yageo
3 R9, R12, R35 RES, FLM, THK, 0603, 22K, 1% RC0603FR-0722KL Yageo
2 R13, R36 RES, FLM, THK, 0603, 100K, 1% RC0603FR-07100KL Yageo
2 R37, R29 RES, FLM, THK, 0603, 10.0K, 1% RC0603FR-0710KL Yageo
1 R38 RES, VAR, TOP, T, TH 3386T-1-103ALF Bourns
1 R18 RES, FLM, THK, 0603, 1.05K, 1% RC0603FR-071K05L Yageo
1 R24 RES, FLM, THK, 0603, 27K, 1% RC0603FR-0727KL Yageo
1 R25 RES, FLM, THK, 0603, 20.0K, 1% RC0603FR-0720KL Yageo
1 R26 RES, FLM, THK, 0603, 4.99K, 1% RC0603FR-074K99L Yageo
1 R27 RES, FLM, THK, 0603, 49.9, 1% RC0603FR-0749R9L Yageo
1 R28 RES, FLM, THK, 0603, 820, 1% RC0603FR-07820RL Yageo
1 R30 RES, FLM, THK, 0603, 15.0K, 1% RC0603FR-0715KL Yageo
1 R32 RES, FLM, THK, 0603, 1.00K, 1% RC0603FR-071K0L Yageo
1 R37 RES, FLM, THK, 0603, 470, 1% RC0603FR-07470RL Yageo
2 Ro1, Ro2 RES, FLM, THK, 0603, 6.8K, 1% RC0603FR-076K8L Yageo
1 R10 (part of Ro3 strap) RES, FLM, THK, 0603, 2.2K, 1% RC0603FR-072K2L Yageo
1 R8 (alt) RES, FLM, THK, 0603, 137K, 1% RC0603FR-07137KL Yageo
1 R9 (alt) RES, FLM, THK, 0603, 357K, 1% RC0603FR-07357KL Yageo
1 R36 (alt) RES, FLM, THK, 0603, 66.5K, 1% RC0603FR-0766K5L Yageo
1 R36 (alt) RES, FLM, THK, 0603, 147K, 1% RC0603FR-07147KL Yageo
1 R37 (alt) RES, FLM, THK, 0603, 54.9K, 1% RC0603FR-0754K9L Yageo
NOTE2
NOTE3
If Ro3 is installed, R10 must also be installed.
FOR RES OPTIONS, SEE NOTE1
Title: HM133 DTMF Adapter
Size: C
Number: HM133_DTMF_sch
Revision: C
Date: 22-Aug-2019
Sheet of
File:

Programming the MCU

For complete instructions on programming the SiLabs MCU for this project, see the "SiLabs Programming Guide" at this link:
https://ke0ff.github.io/Orion/silabspgm.pdf

For the latest object code, go to this link:
https://ke0ff.github.io/hm133/hm133hex.zip

The location of the source code for this project is located at this link:
https://ke0ff.github.io/hm133/hm133source.html

Operation, DTMF Emulation modes (all except IC-7000)

These modes do not connect the MDATA signal to the radio and thus the only key functions are those defined by the application software. For HM-133 microphones that have not had the PTT modification performed, the "DTMF-S" button places the microphone in DTMF mode. "FUNC" is not used, but it is interpreted by the microphone processor, so it shouldn't be used. If it is inadvertently pressed, and any other key but "FUNC" follows, the DTMF adapter will simply ignore the sequence. "FUNC" toggles, so pressing it twice returns the microphone to normal without sending any data to the adapter.

The status LED pulses whenever a keypress is detected. It also pulses for each up/down signal pulse. When DTMF signals are being sent, the LED is off for as long as the microphone is muted. The status LED can be set to dim or bright, to match changing ambient lighting conditions. Pressing the "*" will dim the LED, while pressing "#" will set the LED to bright. DTMF-S must be off for this sequence to be recognized. When first powered, the intensity is set to bright.

With DTMF-S enabled (signified by the green LED above the "A" key illuminating), pressing any DTMF key will set PTT and send a DTMF tone (which mutes the microphone audio). Once the key is released, the tone stops while PTT and mute persists for about 1.6 seconds, then the PTT drops, and the mute is released. If another DTMF key is pressed before PTT drops, another tone is generated, and the process repeats.

The UP and DOWN buttons activate the UP/DOWN signals as defined by the resistor options. Each press toggles the appropriate signal once. If the button is

held for more than 2 seconds, the system will continuously pulse the appropriate signal at the rate defined in the configuration notes. If DTMF-S is off, and one or two numeric digits are entered, resulting in a number from 0 to 99, that number of pulses are sent at the configured pulse rate (a value of "0" will send one pulse, all other values send at face value). Entering any non-numeric digit clears the value to 0 (so the value is only good for one operation).

The "function" buttons present on the MC-44 and MH-36 microphones are implemented as described in the following table:

Microphone key nomenclature vs. Rig function:

	{HM-151:	*SPCH/LOCK*	*TUNER/CALL*	*XFC*	*V/M}*
Rig/mic	HM-133:	VFO/LOCK	MR/CALL	BAND/OPT	F-1
MC-44		Call	VFO	MR	PF
MH-36		ACC	D/MR	P1	P2

For the ICOM modes, these buttons have no effect.

For HM-151 microphones, or HM-133 microphones that have the PTT modification performed, the DTMF behavior is somewhat different. For these cases, 1) the HM-151 does not have a DTMF-S button, and 2) the HM-133 should leave DTMF-S off (although, it will work the same as any other HM-133 if DTMF-S is on). For the wired-PTT microphones, one must press the PTT, then key in digits in order to send the tones to the transmitter. Other than the differences in marking, the HM-151 buttons behave the same as the HM-133 buttons, with the exception of DTMF-S and FUNC. Simply note that the name of the button does not determine the data pattern sent to the adapter, but rather it is its position that determines the data pattern. Since the adapter has no way to directly identify which microphone is connected, it simply interprets the key codes it receives.

Operation, IC-7000

The IC-7000 Mode does not support any function keys, nor does it support up/down pulsing. In this mode, only DTMF and LED brightness functions are supported. In order to produce DTMF tones without sending key-data to the IC-7000, the operator must press the F-2 key to toggle the adapter between data feed-through mode (status LED = off) and DTMF mode (status LED = on).

With the adapter in the DTMF mode, simply press the PTT, and then enter the desired digits. When finished, press F-2 again to return to feed-through mode to

allow the microphone keys to control the radio. The IC-7000 should be configured such that F-2 has no function is selected.

Failsafe

The adapter can detect when an HM-133 or HM-151 is connected. Thus, when the microphone is disconnected, the adapter de-activates the PTT and then performs a software reset. It will do nothing more until it detects that a microphone has been plugged in.