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

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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. *Note: all of the options except the HM-151/IC-7000 map function keys to the CD4094 outputs. However, for any given radio, only certain combinations are defined. Thus, the radio modes defined in the assembly notes may be used with other radios with the appropriate resistors installed.*

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).

Note: builders who choose to build the complete assembly or build from scratch will have to populate the P1 programming connector, or a 10-pin dual row header wired to match the SiLabs USB programmer (P1 is listed as DNP in the parts list). For those who use the small form-factor connector, you will also need to construct a programming adapter cable (as described in the SiLabs Programming Guide*, see below for a link).*

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
1	R40	RES, VAR, TOP, 1K, SMD	3313J-2-102E	Bourns
1	R40 (alt)	RES, VAR, TOP, 2K, SMD	3313J-2-202E	Bourns

Assembly notes

1) ICOM (generic): INST. R8 & R37, Do Not Inst. (DNI) R9, R13, R34, R35, R36, Ro1, Ro2, Ro3, & R10

   ICOM HM-151 (IC-7000): INST R34 Ro1, Ro2, Ro3, and R10. DNI R8 R9, R12, R13, R24, R34, R35, R36, & R37

   Kenwood (TM731 and similar):
   RES VALUES AS FOLLOWS:

R8 = 0	R34 = 0	Ro2 = 6.8K
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	Ro1 = 6.8K
R12 = 22K	R37 = 54.9K	R8 = 137K	R9 = 357K

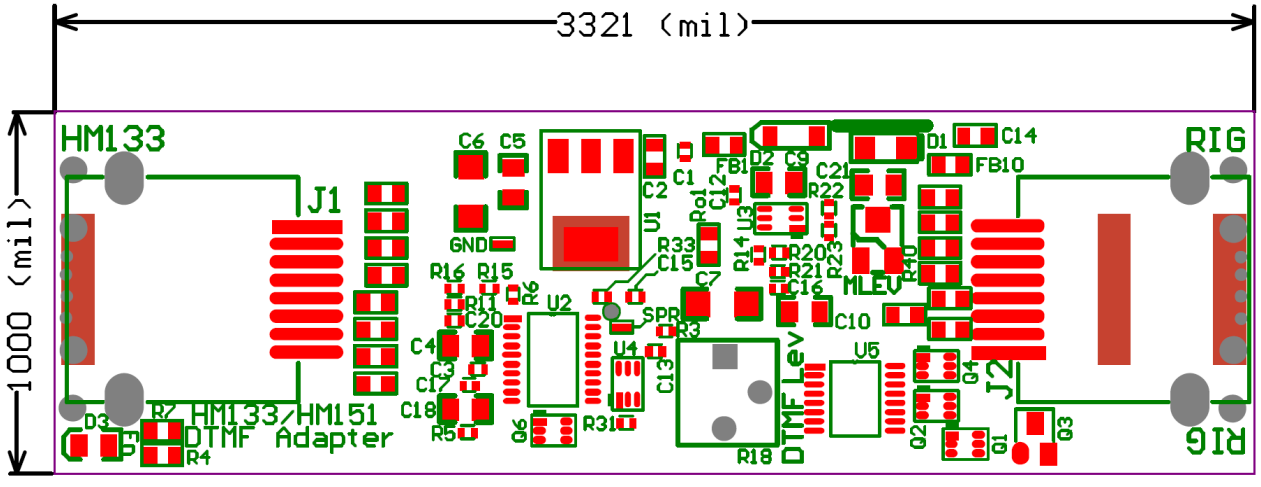
   DNP: R13, R34

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.

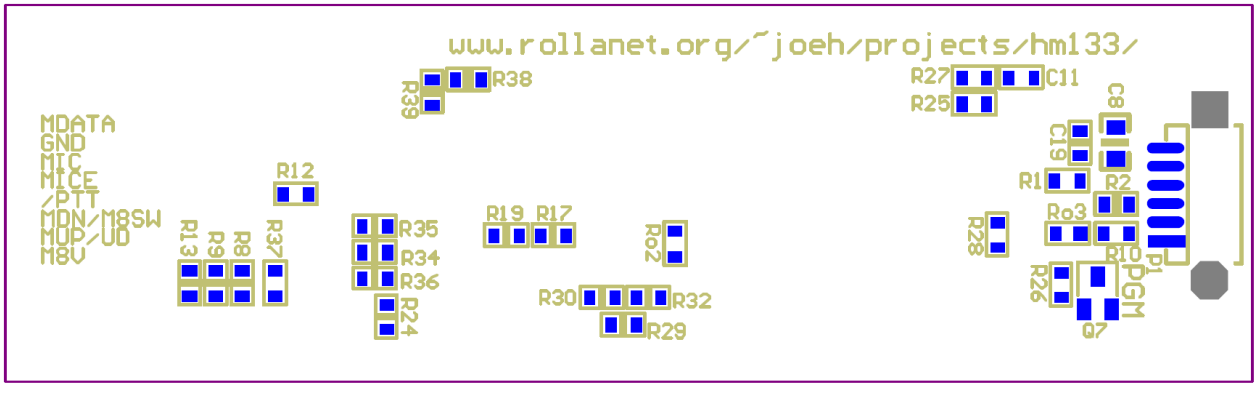
3) Ro1 & Ro2 (6.8K/OPEN) and Ro3/R10 (1K/OPEN) ARE SOFTARE OPTION STRAPS.
   1 = RES INST, 0 = OPEN (default)

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)



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

   ICOM HM-151 (IC-7000): INST R34, Ro1, Ro2, Ro3, R10
       DNI R0 R9, R12, R13, R24, R34, R35, R36, & R37

   Kenwood (TM731 and similar):
       RES VALUES AS FOLLOWS:
          R0 = 0          R34 = 0        Ro2 = 6.0K
          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    Ro1 = 6.8K
          R12 = 22K       R37 = 54.9K     R8 = 137K     R9 = 357K
          DNP: R13, R34

2) INST. R7 FOR D4 - PWR LED, or INST R4 FOR D4 - Fn LED.
    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 (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     1     0    TBD
          1     1     1    HM-151 feedthru mode (for IC-7000, et.al.)
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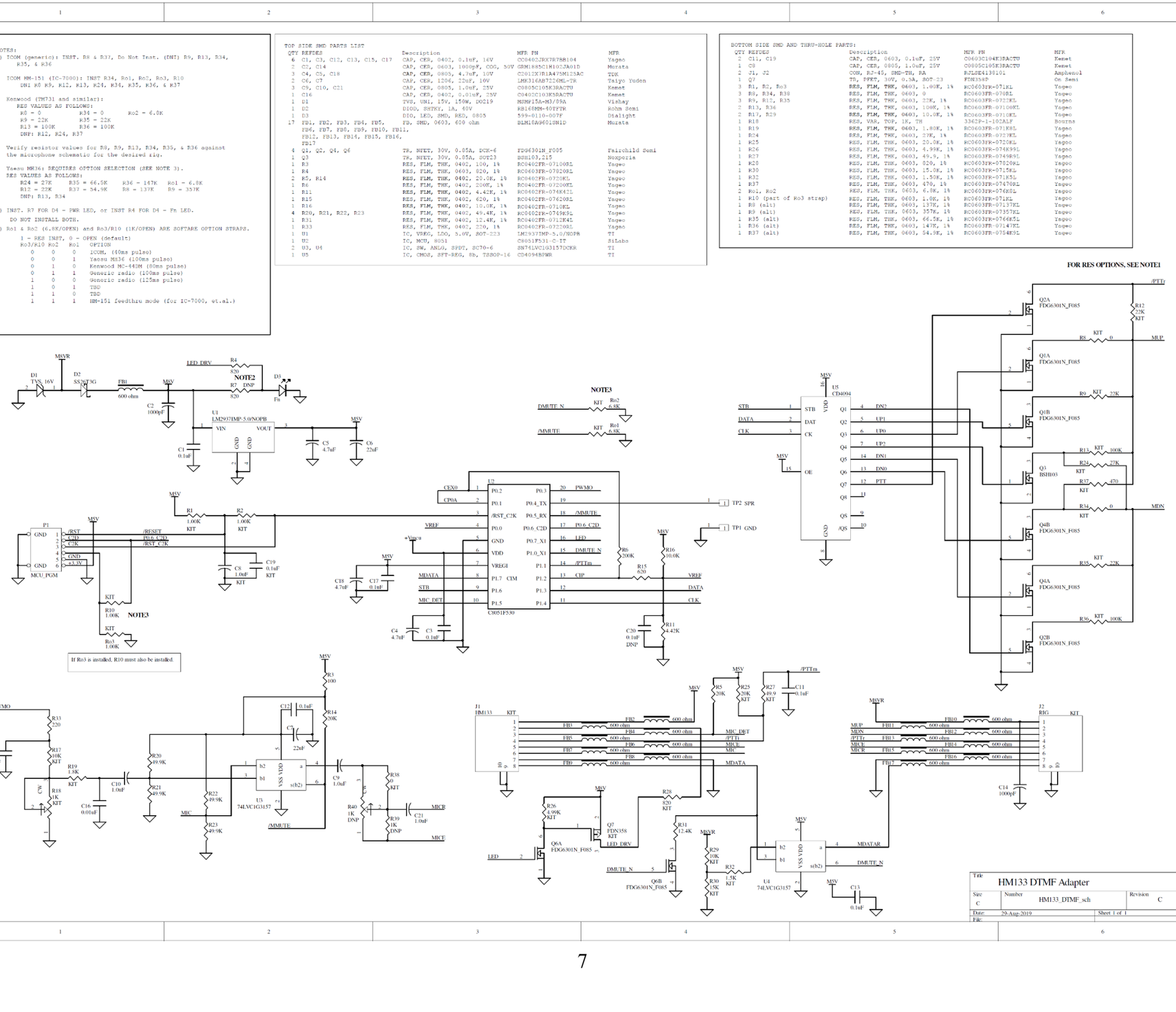
TOP SIDE SMD PARTS LIST

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, C0G, 50V	GRM188C1H102JA01D	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	RB160MM-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, 0.05A, DCK-6	FDG6301N_F085	Fairchild Semi
1	Q3	TR, NFET, 30V, 0.05A, 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

BOTTOM SIDE SMD AND THRU-HOLE PARTS:

QTY	REFDES	Description	MFR PN	MFR
2	C11, C19	CAP, CER, 0603, 0.1uF, 25V	C0603C104K3RACTU	Kemet
1	C8	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
2	Ro1, Ro2	RES, FLM, THK, 0603, 6.8K, 1%	RC0603FR-076K8L	Yageo
1	R10 (part of Ro3 strap)	RES, FLM, THK, 0603, 1.0K, 1%	RC0603FR-071KL	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



Programming the MCU

For complete instructions on programming the SiLabs MCU for this project, see the "SiLabs Programming Guide" at this link:
http://www.rollanet.org/~joeh/projects/Orion/silabspgm.pdf

For the latest object code, go to this link:
http://www.rollanet.org/~joeh/projects/hm133/hm133hex.zip

The location of the source code for this project is located at this link:
http://www.rollanet.org/~joeh/projects/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 the resulting key data is interpreted by the microphone processor, so 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 off whenever a non-tone keypress is detected. It also pulses off for each automatic up/down signal pulse. DTMF keys follow the standard "123A" layout and the lower 16 keys on the microphone comprise these digits (the HM-133 has nomenclature that corresponds to the DTMF keys, while the HM-151 does not have DTMF nomenclature – the 0-9 keys are labeled consistently with the DTMF usage). In addition, the "F-2" key ("MW" on the HM-151) sends a 1 KHz tone while it is pressed.

When DTMF signals are being sent, the status 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. For the HM-133, 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) and the status LED turns off. Once the DTMF key is released, the tone stops while PTT and mic-mute persists for about 1.6 seconds, then the PTT drops, and the mute is released, and the status LED illuminates. 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. While some radios accommodate this feature, having the adapter perform this function provides for consistent operation between different radios. 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, including UP or DOWN, 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 since the outputs that would normally drive these conditions are not connected (the resistors are DNP).

For HM-151 microphones, or HM-133 microphones that have the wired-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, press the PTT then key in digits in order to send the tones to the transmitter. Regardless of the differences in button marking, the HM-151 buttons send the same data as the HM-133 buttons, except for DTMF-S and FUNC which don't exist on the HM-151 (the "F-1" and F-2" buttons in the same position behave differently). It is the position of a button on the microphone 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. However, R34 must be installed as this is the "microphone present" signal for the IC-7000. In this mode, only tone (DTMF and 1 KHz) and LED brightness functions are supported.

In order to produce DTMF tones the operator must press the F-2 key on the HM-151 (*Note, this is NOT the F-2 key on the front panel of the IC-7000*) to toggle the adapter between data feed-through mode (status LED = off) and DTMF mode (status LED = on). In DTMF mode, the MDATA switch disables the sending of key-data to the IC-7000 so that the DTMF keys are not otherwise interpreted by the IC-7000. Because the adapter switches the data path so quickly, the IC-7000 won't recognize that the F-2 key has been pressed. The result of this is that the F-2 key function is essentially re-assigned to control the DTMF status of the microphone, and the radio function for this key will be ignored.

With the adapter in the DTMF mode (the status LED will be illuminated), 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.

Note: It is possible that the IC-7000 will decode a single random command key if the interface is plugged into the radio while it is powered on. While the interface takes steps to mitigate this possibility, it still exists (less than 10% of the plug-in cycles have been observed to result in this effect).

Failsafe

In all modes, 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.

Radio Adapter Cables

To complete the assembly, an adapter cable must be constructed. Generally, each radio manufacturer will need a separate cable (most radios from the same MFR and vintage share compatible pinouts, but please verify your pinout before connecting to any given radio).

For short adapter cables, one can make use of off-the-shelf Ethernet cables (those with stranded wire are preferred) to simplify the process. Simply choose a cable end and cut the cable 4”-6” from the connector. Strip the outer covering approximately 3/8” and connect the appropriate wires to a connector which mates with the desired radio (a couple of radios are listed below, but the user should verify their cable against the microphone connector in their radio’s manual).

It is arguably better to choose the pairing of the conductors in CAT5 cable and crimp an RJ-45 to make use of that pairing. For those who have an RJ-45 crimp tool, this is a good solution to pursue (again, stranded CAT5 is recommended). The following tables illustrate a couple of possible pairing scenarios.

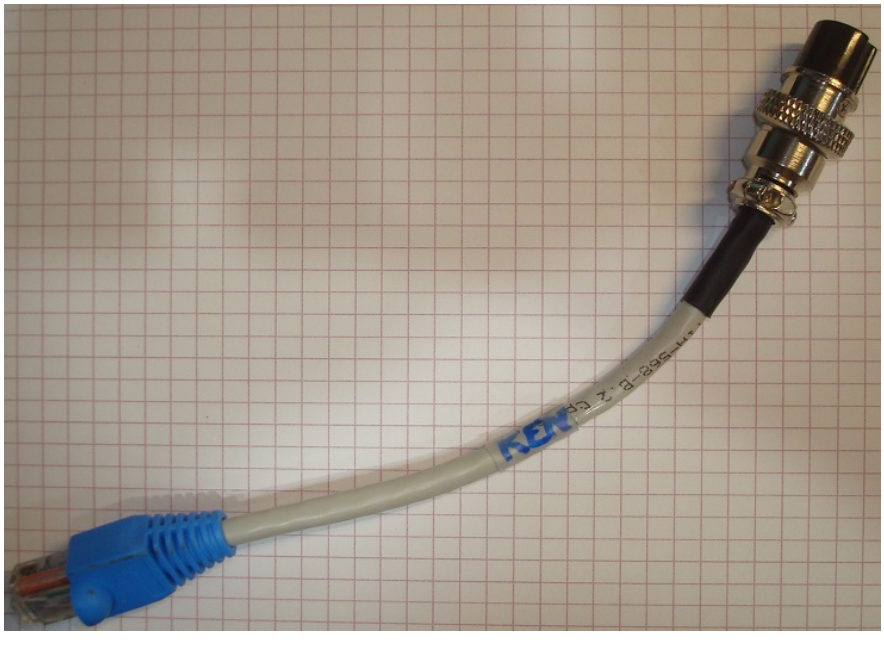
Radio: ICOM IC-901 (RJ-45 to 8-pin DIN)

Signal name	J1 pin#	Pair with (pin#)	Rig Connector pin
M8V	1	7 (GND)	2
UP/DN	2	4 (PTT)	3
N/A	3	8 (n/c)	
PTT	4	3 (DOWN)	5
MICE	5	6 (MIC)	7
MIC	6	5 (MICE)	1
GND	7	1 (M8V)	6
MDATA	8	3 (n/c)	

Radio: ICOM IC-7000 (RJ-45 to RJ-45, 1:1 pin connections)

Signal name	J1 pin#	Pair with (pin#)
M8V	1	7 (GND)
UP/DN	2	4
MIC-PRESENT	3	8 (MDATA)
PTT	4	2
MICE	5	6 (MIC)
MIC	6	5 (MICE)
GND	7	1 (M8V)
MDATA	8	3 (MIC-PRESENT)

Most older radios utilize the 8-pin DIN style for the microphone connector. These are available from many sources. Make sure that you acquire the correct connector to mate with your radio and check the pinout against the radio operating manual.



Example of a radio interface cable for a Kenwood TM-731A.

Radio Requirements

The DTMF Adapter has a few requirements of the target radio. The radio must accept microphone level audio directly from an electret element. A source of power is needed for the adapter: 8Vdc at 50mA, nominal. 6.5Vdc minimum, 9Vdc maximum. The PTT input must be GND for transmit, open for receive.