Getting Started with Commercial Radios

or

Commercial Radios 101

or

Everything You Wanted to Know About Commercial Radios

(but were afraid to ask)

Part 1

by Robert B. Whitaker, KI5PG © 2022   ki5pg@arrl.net

Have you ever been curious about using commercial radios on the amateur bands? Have you seen some commercial radios at a very reasonable price but you hesitated because you did not know if they could be used or not? This article is intended to provide even a novice with enough information to confidently start using commercial radios. We will start with basic information and then add some tips to help increase your proficiency. We will use Motorola mobile commercial radios in general but the tips offered

here can be adapted and used with a wide range of commercial radios. In Part Two we will focus more specifically on the Motorola MCS2000 mobile radio as the example but the tips given will be transferrable to other Motorola and other commercially manufactured radios.

There is a large amount of commercial two way radios in the market these days. Much of the available radios are obsolete for commercial use, *but they still have value and useful life for use by amateurs.* You'll never see an advertisement for these radios in QST Magazine. I'll show you how to separate the useful radios from the radios with value only as boat anchors. Years ago I began building repeaters with GE crystal controlled radios like the Mastr II and the Executive II. I liked these radios because I could understand their operation and they were easy to modify. But I never ventured into the newer synthesized commercial radios because I never knew much about them. Finally, a few years ago, I had an opportunity to learn about the Motorola CDM series radios when a ham acquaintance gave me a pair of radios to build a repeater and copy of the programming software or CPS. From that point I saw the value of working with the newer synthesized Motorola radios. The repeater we built with the two Motorola CDM-1550 UHF radios is still in service today. It provides excellent service to our local ham community.

My next experience with Motorola mobile radios was with the MCS2000. I found some very reasonably priced UHF Motorola MCS2000 radios offered on eBay and I wondered if they could be used on the ham band and modified for repeater service. I'll walk you through the steps I followed to crack the secrets of the MCS2000. I've also worked with Motorola MaxTrac radios in their various models.

Knowledge is Empowering

If you're unfamiliar with a particular radio start out by doing your research. Not only is this website (Repeater-Builder.com) probably the best source for information about repeater building, it's also an excellent source for information on specific commercial radios and other related equipment that can be used my amateurs. If a radio or piece of equipment can be used by amateurs to make a repeater, there's a good chance you'll find at least some information about it here. But with some 17 GB of manuals, operating guides, and other helpful information stored here you'll probably be overwhelmed (like me) and somewhat lost as to where to begin. First take a while to read over the main index page. Scroll down to The Concept of This Site and The Modification and Information Index. From here you can begin to drill down into the particular area of your desired research.   You will see that this website has a whole section dedicated specifically to the MCS2000 radio:

http://www.repeater-builder.com/motorola/mcs2000/mcs2000-index.html

There you can learn all sorts of helpful information from the manufacturer. Gobble up all that information. You might also try a general internet search if you have a less well known model radio, but chances are this website will have some information on the most commonly available commercial radios these days.

Where do I find the Radios?

You can find radios in many ways. You might find some in government surplus auctions. Maybe you can check with a local business or utility companies that operates a fleet of vehicles that use two way radios. Of course, you're very likely to find some radios offered at hamfests and swap meets. The best source I've found for Motorola and other mostly obsolete commercial radios these days is eBay. But be careful when you

shop on eBay. You do need to know exactly what you're looking for because many eBay sellers are not knowledgeable about what they're selling. They're often just liquidators that acquired a lot of old junk and they're trying to sell them for anything they can get for them. I've seen a lot of mis-identified radios offered on eBay. Know exactly what you're looking for and know exactly what you're looking at when you search for a radio.

How do I know if I have the right radio?

You can't judge a book by the cover. Neither can you identify a (Motorola) radio by just looking at it from a distance. You have to dig down further to know exactly what model radio you're looking at. Motorola radios have two primary identifiers: ID numbers and Model numbers. These are coded numbers and letters found on the data plate of each radio which provide specific information about that particular radio. Actually, the ID number is more useful to you than the model number because the ID number includes more specific details about the radio including the frequency range, the number of channels, and the power output. There are a number of internet sources with charts for deciphering the ID numbers and Model numbers. Usually the radio operating guides will have a chart that helps you identify your exact radio. The chart attached to the end of this article identifies the various models of MCS2000 radios. A quick and convenient source for model numbers and basic accessory connections for the MCS2000 radios can also be found here:

http://k9omw.com/mcs2000.html
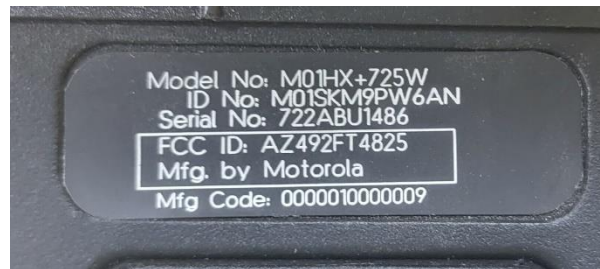
But Will It Work on the Ham Bands?

Commercial radios are designed (obviously enough) to work on the commercial radio bands. But that doesn't necessarily exclude them from working on the adjacent ham 2-meter band or the adjacent 440 MHz ham UHF band. In the case of the MCS2000 radio we can use it on the ham VHF and 440 UHF ham band but we first need to perform some modifications to the software to actually extend the programming range. At the top of the MCS2000 Index page there is an important modification article written by Jacob Nagel, AD0JA, found here:

http://www.repeater-builder.com/motorola/mcs2000/mcs2000-hex-edits/mcs2000-hex-edits.html

It's not that hard to hex edit the CPS using the free hex editing program cited in the article. Be brave, Grasshopper. Good things await those who are willing to learn.

Other commercial radios may have different ways to program for use on the ham bands. You just need to figure out what techniques have been developed for each model radio. Again, usually the information you will find on this website will give you information on how the radio can be programmed for use on amateur frequencies.

Locating Programming Software

Commercial radios are not designed like ham radios. They are not designed to be frequency agile and easily programmed by the consumer. Most modern commercial radios require programming software (or CPS for consumer programming software to set frequencies and modes of operation. Without it, you're dead in the water. For many years Motorola fiercely guarded their programming software. That made utilizing their radio by amateurs pretty difficult unless you had access to the software. However, in recent years more Motorola programming software has become "liberated" to the point that much of it can be found on the

internet. I've heard different stories as to why this has happened. My best speculation is that Motorola simply decided not to expend time and money to defend programming software for radios that became obsolete in the commercial field.

If you find a radio that you're interested in listed here on the Repeater-Builder.com website, you'll usually also find a reference to the programming software. You need to be very specific though. For instance: Motorola made a number of variants of their popular MaxTrac mobile radio. The radios look very similar to one another. But each variant usually requires its own CPS. It can get confusing.

After a long search I found a large resource for Motorola and other manufacturer programming software on the internet. Run a Google search for "Zapto Motorola Radio Software." The first return should lead to a treasure trove of programming software and information for Motorola and other radios.
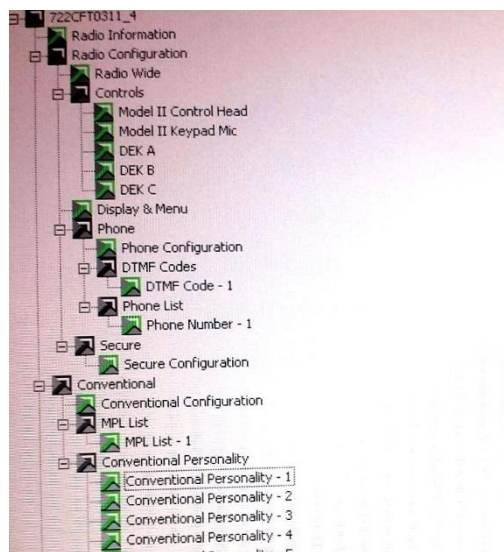
The programming software you need for the MCS2000 mobile radio is: MCS2000 CPS R02.02.00. On the website alluded to above I found the software in in a zipped file entitled: "mcs2000 cps vr02.02.00 & tuner vr02.01.00.zip." The file size is 45.10 MB. Unzip and install the software on your computer. Virtually every commercial radio programming software I've found runs on Microsoft DOS or Microsoft Windows. Most of what you'll find for programmable radios was made for PCs running Windows XP or earlier. My good friend, WT0B, tells me that every CPS he has worked with will run just fine on everything from Windows XP all the way up to Windows 11. If you have any problem just check and be sure to operate the program under the Windows compatibility mode.

Programming Cable

Along with the programming software you'll also need the programming cable to connect the radio to your computer. If you really want a challenge you can try to fashion your own cable but if you run into connection problems you can't tell if the problem is with the cable or the software or the computer or the radio.   Make it easy on yourself and buy a programming cable from a dealer you have confidence in. Again, eBay is a good source for locating programming cables. Be careful about selecting the right cable to go with the right radio. Many cables are radio specific. The listing should clearly tell you which cables will work with which radios.   I never buy programming cables from Chinese vendors. That's just my choice. I also avoid shopping for the cheapest cable I can find. I personally recommend programming cables sold by KJ6ZWL, doing business as BlueMax49ers. He's a ham and he stands behind all his products. You might pay a few bucks more but you'll know you're getting a cable that works.

Here's one more word of advice. The Motorola guides will show diagrams and reference a "RIB." This was a small box that went between the computer and the radio.   It was basically a level converter from the RS-232 serial port to the TTL level programming port of the radio.   Don't bother trying to find a RIB these days. Newer and less expensive USB programming cables are available which translate from the USB port serial directly to TTL. You do need to make sure that you correctly set the USB Com port number on your computer to match what the programming software is expecting.

Programming

The scope of this article does not allow sufficient time and space to give instructions on operating the programming software. There are some programming guides for some Motorola software. Some of that is outdated or relates to earlier programs. The best advice I can give you is to simply jump in and try it out. Be sure to make an archive copy of the initial code plug first because you're bound to make mistakes. At least the help tab on the MCS2000 program provides some helpful information. Other CPS programs provide very little or no help. After a while you'll begin to make sense of things. Maybe you'll be lucky enough to find some YouTube videos to help. Here's a hint: Much of the Motorola CPS is similar to DMR radio programming. So if you can learn to program a DMR radio, you're well on your way to learning how to program the MCS2000 and other Motorola radios. Practice may not make perfect, but it certainly helps.

Radio Information Sheet

Each model radio you work with will have its own quirks and secrets. Likely each model radio will also have its own CPS and its own programming cable. While you are building a knowledge base for each radio take the time to write down important notes about each radio. This is especially important if you work with multiple radios at the same time. I designed an information sheet to go with each radio I work with. Believe me, it helps when you pick up a radio that you haven't work with for a few weeks. And while you're at it, label each programming cable for the radio the cable works with. I have at least half a dozen programming cables all my amateur radios and another three of four cables for the commercial radios that I work with. Having a quick reference information sheet for each has helped my fading short term memory a great deal.

Build Notes

Just as important as a radio information sheet for commercial radios is another longer and more detailed document which has information about a radio which (especially in a repeater system) which you're working on. In the case of a repeater system build notes will include things like technical settings including transmitter power and receiver sensitivity. It might include things like the combination of a lock for a repeater sight and the phone number of persons that can allow access to the repeater. Build notes should include a comprehensive description of the radio or repeater system in case a new person has to take over the maintenance or perform repair to the system. It might include things like operating agreements in case you have an agreement with a hospital or a county government to allow you to operate a repeater on their tower. Not only do you need to know who to call in case of an operating problem, the entity that is allowing you to operate your repeater on their sire needs to know who to call in case of an emergency. These situations can be very sensitive when there is a breakdown in communication lines.

Well, this is the basic information that you need to know to get started working with commercial programmable radios. This is enough to steer you in the right direction and get you going. Most programmable commercial radios made in the last 20 years will have these attributes in common. In the rest of this article I'll share tips that might help you specifically with the Motorola MCS2000 radio. But again, the tips offered here may be helpful to you with other commercial radios.
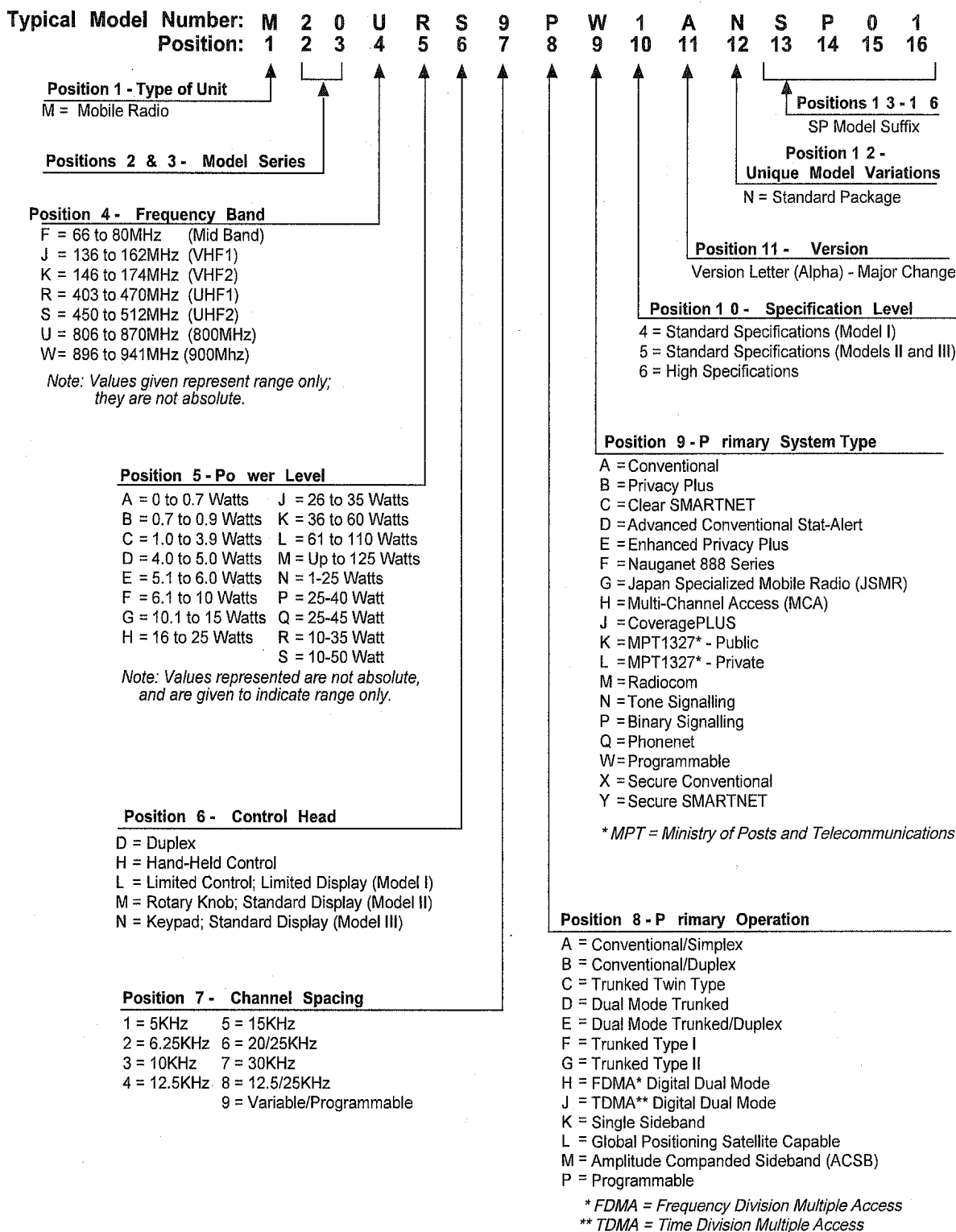
Good luck and happy hunting in your venture into commercial radios.

In Part Two of this article I will share tips specifically for the MCS2000 radio but you will see that these ideas will be transferrable to many other model radios.

Model Numbering, Charts, and Specifications

Motorola MCS2000

Mobile Radio Model Numbering System

Typical Model Number:	M	2	0	U	R	S	9	P	W	1	A	N	S	P	0	1
Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Position 1 - Type of Unit
M = Mobile Radio

Positions 2 & 3 - Model Series

Position 4 - Frequency Band
F = 66 to 80MHz (Mid Band)
J = 136 to 162MHz (VHF1)
K = 146 to 174MHz (VHF2)
R = 403 to 470MHz (UHF1)
S = 450 to 512MHz (UHF2)
U = 806 to 870MHz (800MHz)
W = 896 to 941MHz (900Mhz)

Note: Values given represent range only;
they are not absolute.

Position 5 - Power Level
A = 0 to 0.7 Watts   J = 26 to 35 Watts
B = 0.7 to 0.9 Watts   K = 36 to 60 Watts
C = 1.0 to 3.9 Watts   L = 61 to 110 Watts
D = 4.0 to 5.0 Watts   M = Up to 125 Watts
E = 5.1 to 6.0 Watts   N = 1-25 Watts
F = 6.1 to 10 Watts   P = 25-40 Watt
G = 10.1 to 15 Watts   Q = 25-45 Watt
H = 16 to 25 Watts   R = 10-35 Watt
                        S = 10-50 Watt

Note: Values represented are not absolute,
and are given to indicate range only.

Position 6 - Control Head
D = Duplex
H = Hand-Held Control
L = Limited Control; Limited Display (Model I)
M = Rotary Knob; Standard Display (Model II)
N = Keypad; Standard Display (Model III)

Position 7 - Channel Spacing
1 = 5KHz   5 = 15KHz
2 = 6.25KHz   6 = 20/25KHz
3 = 10KHz   7 = 30KHz
4 = 12.5KHz   8 = 12.5/25KHz
              9 = Variable/Programmable

Positions 13 - 16
SP Model Suffix

Position 12 -
Unique Model Variations
N = Standard Package

Position 11 - Version
Version Letter (Alpha) - Major Change

Position 10 - Specification Level
4 = Standard Specifications (Model I)
5 = Standard Specifications (Models II and III)
6 = High Specifications

Position 9 - Primary System Type
A = Conventional
B = Privacy Plus
C = Clear SMARTNET
D = Advanced Conventional Stat-Alert
E = Enhanced Privacy Plus
F = Nauganet 888 Series
G = Japan Specialized Mobile Radio (JSMR)
H = Multi-Channel Access (MCA)
J = CoveragePLUS
K = MPT1327* - Public
L = MPT1327* - Private
M = Radiocom
N = Tone Signalling
P = Binary Signalling
Q = Phonenet
W = Programmable
X = Secure Conventional
Y = Secure SMARTNET

MPT = Ministry of Posts and Telecommunications

Position 8 - Primary Operation
A = Conventional/Simplex
B = Conventional/Duplex
C = Trunked Twin Type
D = Dual Mode Trunked
E = Dual Mode Trunked/Duplex
F = Trunked Type I
G = Trunked Type II
H = FDMA* Digital Dual Mode
J = TDMA** Digital Dual Mode
K = Single Sideband
L = Global Positioning Satellite Capable
M = Amplitude Companded Sideband (ACSB)
P = Programmable

FDMA = Frequency Division Multiple Access
**TDMA = Time Division Multiple Access*

RADIO INFORMATION SHEET

Model Number: _____ Date: _____

Combination Number: _____

Serial Number: _____

CPS/RSS Version: _____

Where cps/rss found: _____

Type of programming cable used: _____

Frequency Range: _____

How to program out of range: _____

_____

Current frequencies programmed: _____

_____

Accessory pins programmed: _____

_____

More information is found at: _____

_____

Comments: _____

_____

_____

_____

_____

_____