Best Practices for Modern Transmitter Remote Control

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Abstract

IP based transmitter remote control is providing busy broadcast engineers with much needed relief in the form of better data, more granular alarm notifications and armchair access to multiple transmitter sites. Environmental monitoring and flowchart based automatic control functions increase up-time and protect equipment from extremes, while distributed I/O provides cost savings by eliminating long multi-conductor wiring runs. This presentation will present best practices for specifying, installing and configuring a remote control system. Special attention will be paid to efficiently upgrading legacy systems to IP. Simplified automatic testing of backup equipment will also be demonstrated through the use of active flowcharts.

Introduction

Modern remote control systems are different from their predecessors in two major ways: a powerful embedded processor and IP connectivity.

We will discuss the reasons for switching to IP and the advantages of fast embedded processors, followed by best practices for installation, operation, and automation of a modern remote control system.

A discussion of Active Flowcharts as a means to simple, maintainable facility automation will conclude the presentation.

Reasons for Switching to IP

One of the obvious drivers to prompt upgrading to an IP based remote control is the increasing difficulty in obtaining legacy data channels between studio and transmitter.

Copper pairs that were common at one time might cost $125.00/month, a 10-fold increase. Even where available, finding qualified telco support is much more difficult.

FM subcarriers, once common for transmitter to studio links are now inadequate because of limited bandwidth or unavailable because of higher priority use for the subcarrier spectrum.

P channels in the 450MHz band were once a common solution, but they are scarce.

Dialup modems might provide the bandwidth, but most users find the reliability less than ideal.

Affordable Distributed I/O

By placing IP-based I/O units near specific pieces of equipment, users can use short parallel interface runs or in some cases a direct serial connection to the equipment, avoiding long multi-conductor signal cables. Each I/O unit connects to the LAN via CAT 5, as does the remote control unit.

Better Access

Switching to IP for remote control also means better operator access to your site. In the past, connection was generally point-to-point. Now, users can connect directly to the site via IP from many different types of devices. The studio or TOC might be connected using a PC while the engineer at home might be using the web page to see what's happening at his sites. On the road, a smartphone provides instant notification for alarms and full access to site controls via a mobile web app.

Even the remote control unit at the transmitter can provide access to all other sites in the system via site-to-site control. No longer does the engineer have to make sure he has a laptop charged up before heading to the site.

Other Uses for IP at Remote Sites

Before, if a dry pair was used for remote control, that's all it was good for. With IP at the transmitter site, a wide range of benefits become available. Many transmitters have in depth monitoring that may not be brought out on the remote control but can be observed via a web page. Audio processors can frequently be adjusted over IP. Web cameras can be used for better security. When the cost of the IP connection is shared with all of the other benefits, it becomes clear that IP is a bargain.

Advantages of New Technology

In addition to IP connectivity, modern remote control systems with fast embedded processors offer a world of advantages.

Scalability

As requirements change, it’s nice to know that more channels are available without having to replace the entire system. A good system today can connect to hundreds of sites, each with hundreds of channels of data and control.

Data Quality

The hot new embedded processors allow us to build systems that update each of 256 channels four times every second. That's a new piece of data every millisecond. If a reading is corrupted in transmission, there will be three more readings for that channel in the same second.

Alarms

Alarms can be emailed or texted directly from the remote control. A separate distribution list for each type of alarm allows the notification to go to the proper person or group. Later, this paper will show how alarm rollups can help show the root cause of the alarm.

Environmental Monitoring

Modern environmental monitoring goes well beyond hanging a temperature probe on a remote control channel. We'll show how the new tech allows major improvements in performance and reliability.

Automatic Functions without Code

Before, if you wanted to create an automatic function, you either had to resort to learning a macro programming language or grapple with PLC style logic ladder diagrams. Automatic operation of broadcast plants involves sequential logic which is best represented by flow charts instead of Boolean expressions or basic style code.

Logging

Modern systems allow the user to generate reports after the fact. This is useful because you may wish to drill down into greater detail than you can see with a conventional FCC style log.

Best Practices

For the remainder of this presentation, we'll cover each of these topics in more detail, with a focus on getting the most out of a modern remote control system.

IP Availability

Most sites today have conventional options to get service from a local Internet Service Provider, including DSL and cable. This is often the best option, as it is well understood, reasonably priced and generally very reliable.

Where these choices are not available, there are still lots of viable options. Usually the first place to look is the program link. Often, a small amount of bandwidth can be used to provide very good performance for remote control (see figure 1).

Just to show how efficient IP remote control can be, fig. 1 shows that over 3200 channels can update once per second over a 64 Kbps IP channel. For typical systems, even less bandwidth is very practical.

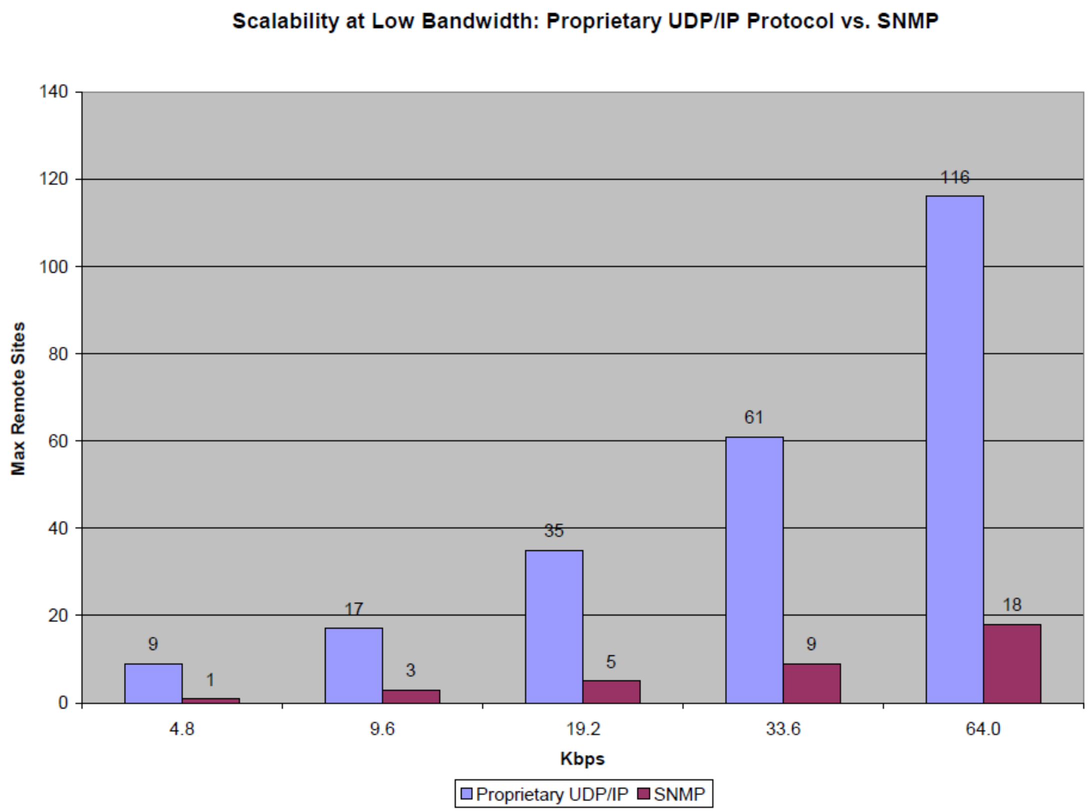

Figure 1. Embedded System Scalability.

Figure 1 shows the data for systems using fulltime connection between the Autopilot computer and the ARC Plus units. Recently, in response to the demands of users having many systems to their NOC another layer of efficiency has been added in order to further reduce the network traffic and speed up reporting. We recommend the use of the Warp Engine feature for users with hundreds, or thousands of connected units. See **Figure 2** below.

Total Bytes/Second for Polling Rate of 1 Second						
		Number of Channel Values per site				
		1	4	8	16	32
Number of Sites	1	130	154	186	250	378
	10	1300	1540	1860	2500	3780
	20	2600	3080	3720	5000	7560
	30	3900	4620	5580	7500	11340
	40	5200	6160	7440	10000	15120
	50	6500	7700	9300	12500	18900
	60	7800	9240	11160	15000	22680
	70	9100	10780	13020	17500	26460
	80	10400	12320	14880	20000	30240
	90	11700	13860	16740	22500	34020
	100	13000	15400	18600	25000	37800

Figure 2 Embedded System Scalability with Warp Engine enabled

Studio to transmitter links are now frequently bidirectional and with TDM or other means to divide the capacity appropriately, it is easy and affordable to get a narrow IP channel to the site.

RF methods such as Wi-Fi, WiMax or other unlicensed technology can often be used if the site is not too far away. Stations using a 950 STL may be able diplex the existing antennas to use a 900MHz data channel. Lanlink is one example of a product that exploits this method.

Cellular IP connections are also available, but with a caveat. In order to connect to the site from a computer or smartphone, you will need to know the IP address. Most cellular IP connections assume browsing or email type applications that originate the connection from the cellular end. They use a temporary IP address which may only live a short time.

The solution is to pay for a fixed IP address from the cellular provider. Both Verizon and AT&T offer a fixed IP for a one-time charge of about $500.00, plus the nominal monthly fee.

Satellite links are acceptable for remote control, although the system must be configured for the inherent delays. If you are considering satellite, make certain this option is available on the system you choose.

Finally, a serial link may be used with the addition of a learning serial-to-Ethernet bridge. The serial-to-Ethernet bridge extends a LAN to a remote location over a serial link, at speeds as low as 4800 baud. Unlike a serial-to-Ethernet converter, which locally transforms serial data into TCP/IP and requires an existing IP path, a serial-to-Ethernet bridge connects two LANs and operates on a serial link such as one provided by a digital STL or dedicated telco link. To optimize throughput, the bridge "learns" the location of each MAC address, and transports only that network traffic which is destined to the other side of the bridge. The Burk SL-1 Serial LAN Extender is an example.

Installation

For broadcasters who haven't adapted to the new tech, installing a new remote control can seem daunting. IT issues, system configuration, alarm setup, and automatic functions all need to be handled, but if done in an organized manner it doesn't have to be complicated.

IT Considerations

For starters, organize all of the IT data that you will need. You probably already keep a spreadsheet or database of all your IT assignments at the studio. Just do the same thing at the transmitter and it will save a lot of time.

You will also probably have to reconfigure some addresses that are on a different subnet by default, so make sure you have a crossover cable available.

Provide a redundant path for your IP connection if possible. The best plan is a second IP connection connected via a dual-WAN router. This gives you all of the IP advantages even if the primary connection goes down. If this isn't feasible, consider a dial-up speech unit.

Remember when you plan redundancy that if the backup arrives in the same pipe as the primary, you are still subject to back-hoe fade.

Distributed I/O can be installed at different sites and connected to a single remote control, but remember that if the IP link between the remote control and the I/O goes down, you don't have control of those items. It is best to have a separate remote control at each site if the budget allows.

Studio Monitoring

This presentation is focused on transmitter control, but many broadcasters are operating with studios that are unattended at least part of the time. Be sure to consider this when you plan your remote control system. It could save you from a lengthy outage.

Upgrading Legacy Systems

If you are upgrading from any of the legacy systems for which an adapter exists, the installation will be much simpler.

For these systems, you leave the existing wiring interfaces in place. The adapters have the appropriate plugs to connect to your existing interfaces, so all you do is remove the old remote control and plug in the adapter. Both the adapter and the new remote control then plug into the LAN.

For some of the adapters, software is included which copies the channel information from the old to the new system. All that is left is set up of any new features and of course meter calibration.

Planning New Installations

For new installations, plan everything before you begin. A spreadsheet is easier to change than a terminal strip. Some systems have a grid style setup that makes it easy to assign all the details ahead of time (see fig. 3). You may be able to download the program before you even receive the equipment so that you can take your time getting everything the way you want it.

	Label	Alarm Delay (hh:mm:ss)	Rearm Delay (hh:mm:ss)	Enabl e Alarm	Low Critical Limit	Low Warning Limit	High Warning Limit	High Critical Limit	Warning Priority	Critical Priority
1	TX-A FWD	00:00:00	00:01:00	☑	450	475	510	525	100	100
2	TX-A RFL	00:00:00	00:01:00	☐	No Limit	No Limit	40	50	100	100
3	TX-A PAV	00:00:00	00:01:00	☐	30	33	40	45	100	100
4	TX-A PAI	00:00:00	00:01:00	☐	No Limit	12	20	23	100	100

Figure 3. AutoLoad grid for meter alarm settings.

Verify all of your input and output connections. Mistakes are easy to make, especially if you find yourself working late at night. If you are using distributed I/O such as the Plus-X series, you can verify your connections to each unit by using the built-in web page.

Make sure all analog inputs will remain within range yet large enough to read accurately. A 12-bit A/D means that a full-scale reading will be precise to 1 part in 4096 or 0.024 percent. The precision will drop inversely proportional to the percent of full scale, so the minimum voltage to have 0.5 percent precision with 5volts full scale is 5 / 2^12 / .005 or about 250 mV.

Status inputs need to be verified, as there are many different ways to produce a status and for the remote control system to make certain you are connecting these signals properly.

Attention to these two details will eliminate a large share of potential installation problems.

Serial Transmitter Connections

Many transmitters now have a serial or IP output with SNMP, HTTP or a proprietary protocol. It may be possible to bring your transmitter into the remote control with nothing more than a CAT 5 cable, eliminating all parallel wiring. Of course, you'll still have peripheral equipment to wire, but this relieves a large part of the task.

Often, the transmitter will contain many more pieces of information that you want to observe on a routine basis. Too much data is like tying yellow ribbons around all of the oak trees, obscuring the important bits that really interest you. Best practice here is to bring only the significant data into the remote control and use the web browser to connect directly to the transmitter when you want a lot of details.

Operation

A properly installed remote control is just the start. Customizing the system to match your needs and style is just as important. After all, it's why you invested in a modern control system.

Custom Views

One of the easiest ways to get operators to buy into a new system is to give them screens that make sense to them. Custom views allow you to position each piece of the screen the way you like. Instead of rows of identical boxes, use controls that are more familiar or more like the real world counterpart (see figure 4). Group each piece of gear together.

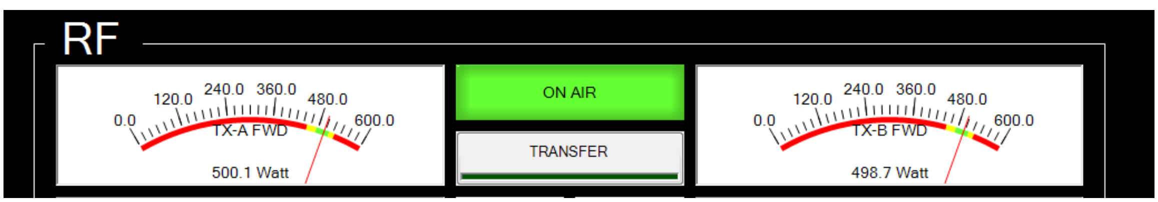

Figure 4 Custom Views allow sensible arrangements of controls.

It's easy to lay out a custom view. You simply drag the objects onto the screen and select the control, meter or status to work with that object.

Virtual Channels

One way to get the most out of your data is to present it in a way that means something to the user. For instance, looking at the stack temperature of your transmitter is a good idea, and looking at the ambient temperature is also good. But one really interesting data point is the difference between the two. This is easy with virtual channels. Simply define a new channel as virtual and enter the expression: M2 - M1 (where M2 is the stack temperature meter channel and M2 is ambient). Figure 5 shows how you might display this on a custom view. You can use the virtual channel as any other channel, setting an alarm, for instance, if the differential is out of bounds.

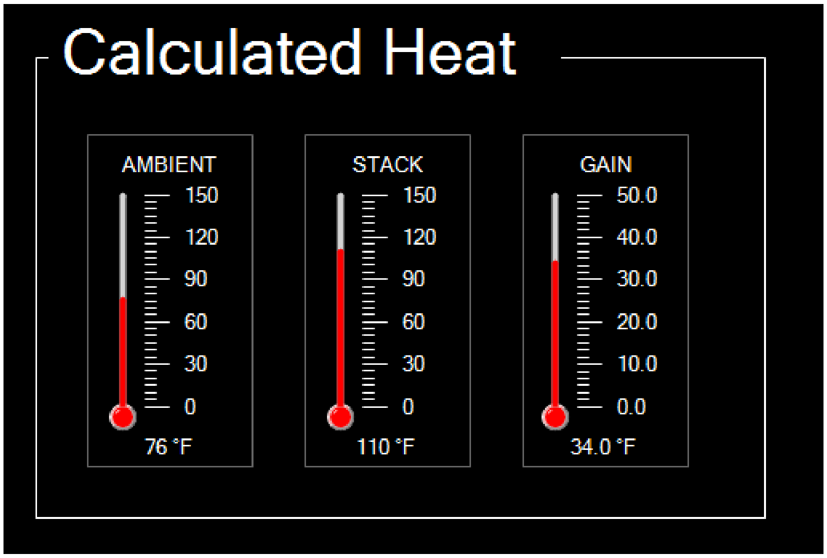

Figure 5. Using a virtual channel to determine heat gain.

Another application for virtual channels is day/night values that are too different to display well on a single meter. Create a virtual channel for night and for the expression simply put the day channel (M1 for instance). Now, change the parameters on the new meter channel so that the night reading is at about 80% of full scale. You can set separate alarm values on the night channel as well.

To calculate running efficiency, Assign a virtual channel and enter the formula M1 / M2 / M3 where the real meters are Output Power, Final Voltage and Final Current respectively. Again, you can alarm this so that if the efficiency is suddenly different you can react.

Where there are multiple ways of measuring a parameter, a useful way to be alerted to a metering failure is to use virtual channels to compare two readings and create alarm if the difference is larger than you would expect.

Virtual channels in conjunction with custom views makes for some very smart displays.

Using a Smartphone Effectively

Making effective use of your smart phone is one of the best ways you can increase your efficiency. A mobile web page is a very fast way to get a complete picture of your system (see figure 6). Channel groups can be set up to display related information without having to scroll through all the channels. Commands are protected from fat thumbs with a confirm button.

Figure 6. Mobile webpage and email template for iPhone or Droid

The smartphone is also useful for responding to alerts. Create templates for different types of alarms and let the system fill in all of the pertinent information. When an event triggers the alarm, the use gets not only the alarm, but important conditions that were observed at the same time.

From here the user can go to the web page to take corrective action. To make this easier for engineers with many stations, the user can add a hyperlink to the email to jump right to the site that is in alarm.

Web page

A web page has become standard fare for modern remote control systems. This one is optimized for tablets, but also works on a PC (see figure 7).

Figure 7. Tablet optimized remote control web page

Environmental Monitoring

It used to be that environmental monitoring was no more than a thermometer at the transmitter that may or may not be connected to the remote control. Not since vacuum tubes have we had so many individual heat producers in our racks. It’s becoming important to respond quickly to a failed air conditioner. It’s also important to track the temperature in various locations over time.

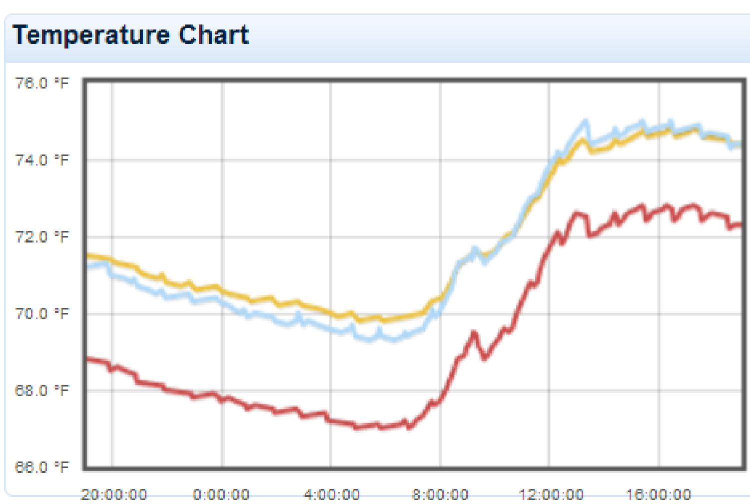

Figure 8. Temperature as read at three locations over time.

There are systems today that can integrate with the remote control while providing independent logging optimized for environmental parameters (see figure 8). These systems can also guard against leaks, smoke, and intrusion.

Logging

With the responsibility clearly on the broadcaster to stay in compliance, a good log is your best friend. In the event that the FCC observes a violation, you want to be able to demonstrate through your logs that it was an isolated event.

Best practice today for transmitter logging is to capture as much data as often as practical and store it on disk. For compliance purposes, it is a good idea to print out skeleton logs that contain only critical parameters. You'll still have the full data available, should you have an event that you want more information about. The full data doesn't need to be kept as long as the skeleton logs, but it really isn't much of a hardship to store on DVD or even in the cloud.

Alarms

Many people go overboard with alarms initially, then soon try to figure out how to keep from being bothered by them. The general rule is to set alarms only where you think you will actually take action. This is especially true for things like line voltage where you really can't do much about it anyway. Yes, set an alarm if you lose power but don't set an alarm that the power is three percent above normal.

As the scalability of a broadcast facility management system increases, so does the need for more intelligent alarm reporting. Alarm aggregation generates alarms on actionable conditions, not the conditions that obviously occur as the result of a primary failure. Modern systems have aggregation or alarm rollup to make the root cause standout. Figure 9 illustrates this for a main AC failure.

Alarm Aggregation: Main AC Failure	
Out of tolerance conditions	**Alarms reported**
MAIN AC OFF	MAIN AC OFF
XMTR OFF AIR	XMTR OFF AIR
SUPPLY VOLTAGE LOW	
LINE VOLTAGE LOW	
LINE VOLTAGE OFF	
XMTR POWER LOW	
HVAC OFF	
STL SIGNAL LOW	
SILENCE SENSOR ALARM	
EXCITER POWER LOW	
EXCITER OFF	

Figure 9. Alarm aggregation suppresses obvious resultant alarms.

Automatic Functions

Some engineers are intimidated by the process of building automatic functions for their transmitter plant. We promised to show you and easier way, and here it is (see figure 10):

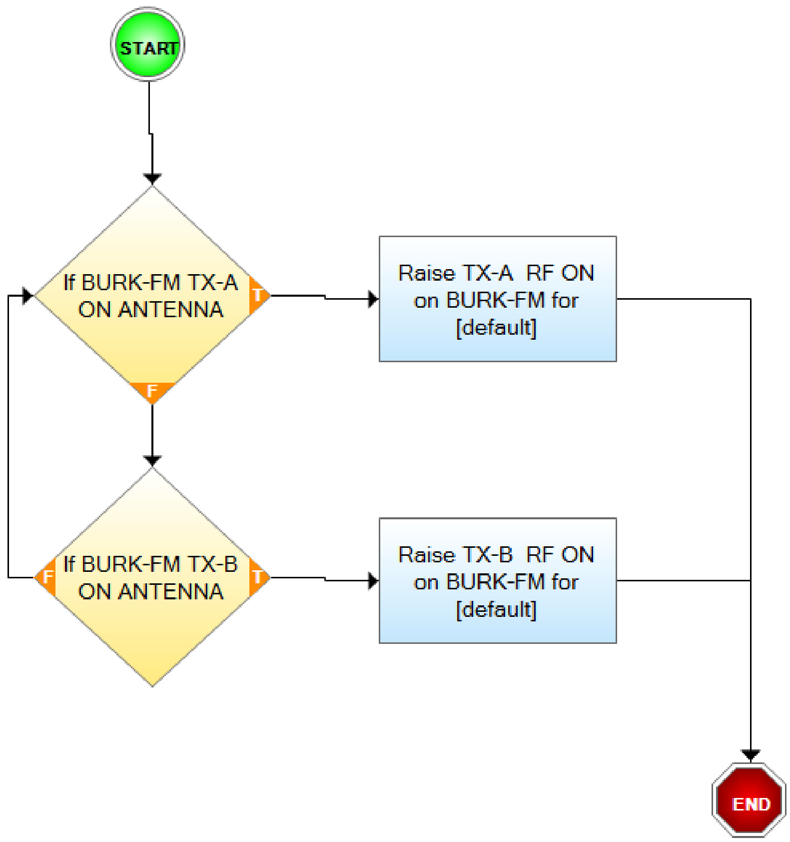

Figure 10. Jet Active Flowchart

This flowchart would be started by either an off air event or a sign-on event. It looks to see which transmitter is on the antenna, then starts it. If the switch is between transmitters, it will wait until one or the other is indicated.

Active flowcharts are drawn with a Visio-like tool that allows you to insert diamonds for conditions and rectangles for actions. Drop-downs give you all of the choices you can make for each object.

The flowcharts are saved right in the remote control and execute directly from the drawing you made.

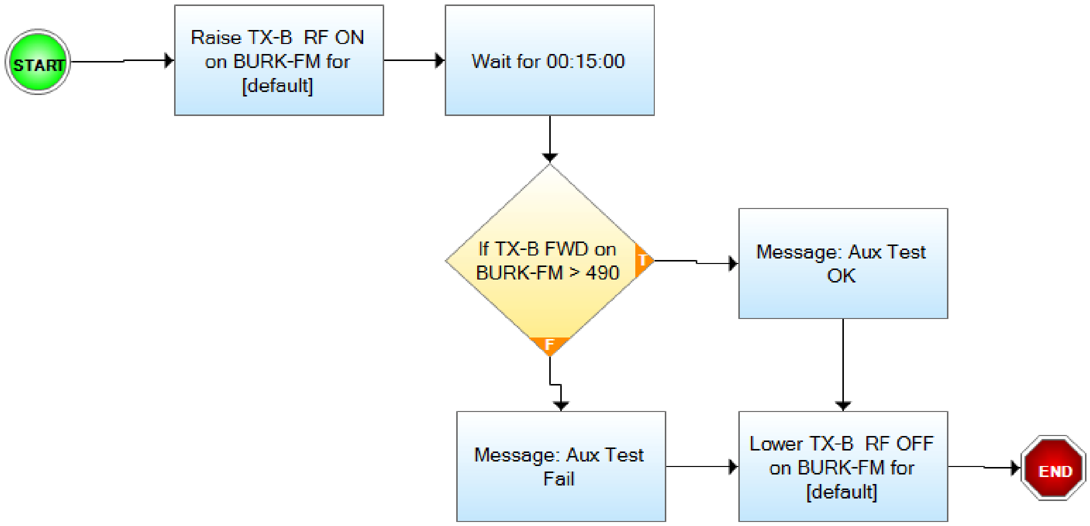

Figure 11. Weekly Backup Test Routine

We will end with the backup test routine mentioned earlier (see Figure 11). This is a bit simplified from what you might actually do, but you should get the idea from this. First we start the aux transmitter into the dummy load. This could be a raise command as shown or it could start a macro that includes other steps like turning on the cooling for the load. Next we just let it run for 15 minutes, then check the output power. If it is sufficient, we send a successful message, else we send a failed message. Note that we could also email a report which would include all of the relevant parameters.

This Active Flowchart would be initiated by a calendar in the schedule function. Perhaps it would run every Wednesday at 3:00AM.

Conclusion

This presentation has shown some reasons for embracing IP remote control and new technology, and given best practices to maximize the value of the investment. The best way to get up to speed is to download demo programs and manuals from the manufacturers and start configuring your own system. You'll be surprised how fast it will come together.