



**Robert C. Byrd Green Bank Telescope
NRAO Green Bank**

Toney Minter

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GO Switching Signals Implementation

HTML version Available¹

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Abstract

This document describes how GO has implemented switching signal schemes. The switching signals can be set either by a single button - the GO switching signal keyword - or by setting each individual YGOR parameter. This document will be primarily concerned with the interaction of these two methods of setting the switching signals.

***N.B.** GO does not currently implement polarization switching. Polarization switching is included in this document to provide a rough outline of how it might be implemented in the future.*

¹<http://www.gb.nrao.edu/GBT/MC/doc/dataproc/gbtGOSwitchingSignals/gbtGOSwitchingSignals/gbtGOSwitchingSignals.html>

History

4th February 2002 Initial version.

7th March 2002 Add warning in abstract that GO does not currently have an implementation of polarization switching. Add the history section. Added switchDeltas and xferState to list of YGOR switching signal parameters. Changed the list of possible switch_mode values: added information on beam and polarization switching; added GO FITS keyword values; removed “Switching”, “Switching, No Cal.”, “Symmetric Switching”, “Sym. Switching, No Cal” and “Symmetric Total Power”; added “Freq Switch, 01”, “Freq Switch, 12”, “Freq Switch, 0102”, “Freq Switch, User Def.”, “Beam Switch”, “Beam Switch, User Def.”, “Pol. Switch”, “Pol. Switch, User Def.”, “Freq Switch, 01, No Cal”, “Freq Switch, 12, No Cal”, “Freq Switch, 0102, No Cal”, “Beam Switch, No Cal” and “Pol. Switch, No Cal”. Added information on GO’s setting values of additional YGOR switching signal parameters. GO not longer determines the switch_mode at startup but assumes that it is “User Defined”. Add information of what happens to GO’s switching scheme if YGOR managers are reset. Remove section on “Beam, Frequency and Polarization Switching.”

14th March 2002 Add section on position switching and when LASTON and LASTOFF are reset. Also add section on what keywords are changed when switch_mode is changed.

21st March 2002 Added the forgotten “Total Power With Cal, Spectral Processor” mode. Fixed errors with the cal_ctrl switch being omitted from the mode definitions.

1 Introduction

YGOR provides several parameters which together constitute the switching signals. These parameters are:

switching_signals_master The Switching Signals Master selects which back-end provides the switching signals to all of the back-ends.

cal.state Each element of the Cal State array specifies the state of the receiver calibration signal in the switching phase. The size of the array depends on the number of phases selected.

sig_ref.state Each element of the SigRef array specifies the state of the frequency/load/beam (sky signal or reference) in the switching phase. The size of the array depends on the number of phases selected.

blanking_time Each element of the Blanking array specifies the time in seconds at the beginning of each switch phase when data integration is inhibited. The size of the array depends on the number of phases selected.

number_of_phases The Number of Phases specifies how many phases are in the switching cycle. This parameter can have any integer value between 1 and 10.

switch_period The Switch Period specifies the time in seconds of a full switch cycle, *i.e.* switching once through the number of phases specified.

phase.start Each element of the Phase Start array specifies the beginning of this phase as a fraction of the total switch cycle. The first start time must be zero, they must increase monotonically, and the last phase start time must be less than one. The effective integration time for a phase in one switching cycle is the product of the Switch Period and the difference between that phase's and the next phase's start times minus the Blanking Time. The size of the array depends on the number of phases selected.

AdvanceTime In the DCR, two of the six switching signals may be advanced in time and sent to separate TTL output ports. These might be used to drive a high-inertia device, such as a secondary or tertiary mirror, to start it moving before the DCR switches phase integrators. The Advance Time specifies the time lead, in seconds between 0 and 0.5, of both of these signals.

AdvanceSig1 In the DCR, the Advance Sig1 parameter selects which of the six signals are advanced and connected to the first output port.

AdvanceSig2 In the DCR, the Advance Sig2 parameter selects which of the six signals are advanced and connected to the second output port.

switchDeltas In the LO1, the switchDeltas parameter is an array of length 0 to 4 which contains the frequency switching offset values in MHz. Frequency switching advances through the switchDeltas array every time that sig_ref.state changes. switchDeltas is mapped into three GO Keywords: num_fsw_offsets, ref_freq_1, and ref_freq_2.

xferState In the receivers, the xferState parameter controls whether or not beam switching is occurring. This parameter is mapped into the GO Keyword beam_ctrl.

calState In the receivers, the calState parameter controls whether or not the receiver "cal" listens to external switching signals or to its own internal settings. This parameter is mapped into the GO Keyword cal_ctrl.

Furthermore, a GO Keyword, switch_mode, is defined within GO. The purpose of the switch_mode GO Keyword is to be able to set a majority of the switching signals into a known, pre-defined state by setting only one GO Keyword value.

2 Definitions Of The Switching Modes

There are currently seven pre-defined states for the switch_mode GO Keyword. switch_mode also has four more user defined states and five modes which have not yet been implemented.

The states are²³:

Total Power; NONE; TPWCAL

number_of_phases = 2
 switchDeltas = [0.0]
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state
1	0.0	NoNoise	Sig
2	0.5	Noise	Sig

Total Power, No Cal; NONE; TWNOCAL

number_of_phases = 1
 switchDeltas = [0.0]
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state
1	0.0	NoNoise	Sig

Total Power, Spec. Proc.; NONE; TPWCALSP

number_of_phases = 2
 switchDeltas = [0.0]
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state
1	0.0	NoNoise	Sig
2	0.5	Noise	Ref

N.B. The "Total Power, Spec. Proc." is not yet implemented.

²For each item in the list the item's name has three values. These are the switch_mode GO button selection value, the expected GO FITS SWSTATE keyword value and the expected GO FITS SWITCHSIG value. Each value is separated by a semi-colon.

³Valid values other than the default of NONE are PSWITCHON, PSWITCHOFF, and PSWITCHOFFON for the following states: Total Power; and Total Power, No Cal.

Freq Switch, 01; FSWITCH; FSW01

number_of_phases = 4
 switchDeltas = [0.0, f_1] were f_1 denotes the 1st frequency offset.
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state	f_{offset}
1	0.00	NoNoise	Sig	0.
2	0.25	Noise	Sig	0.
3	0.50	NoNoise	Ref	f_1
4	0.75	Noise	Ref	f_1

Freq Switch, 12; FSWITCH; FSW12

number_of_phases = 4
 switchDeltas = [f_1 , f_2] were f_2 denotes the 2nd frequency offset.
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state	f_{offset}
1	0.00	NoNoise	Sig	f_1
2	0.25	Noise	Sig	f_1
3	0.50	NoNoise	Ref	f_2
4	0.75	Noise	Ref	f_2

Freq Switch, 0102; FSWITCH; FSW0102

number_of_phases = 8
 switchDeltas = [0, f_1 , 0, f_2]
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state	f_{offset}
1	0.000	NoNoise	Sig	0.
2	0.125	Noise	Sig	0.
3	0.250	NoNoise	Ref	f_1
4	0.375	Noise	Ref	f_1
5	0.500	NoNoise	Sig	0.
6	0.625	Noise	Sig	0.
7	0.750	NoNoise	Ref	f_2
8	0.875	Noise	Ref	f_2

Freq Switch, User Def.; FSWITCH; USERDEF

Any other combination of number_of_phases, phase_start, cal_state, sig_ref_state and cal_ctrl which were not defined above while switchDeltas \neq [0], beam_ctrl = "manual" and pol_ctrl = "manual".

Beam Switch; BSWITCH; BEAMSW

number_of_phases = 4
 switchDeltas = [0.0]
 beam_ctrl = "computer"
 cal_ctrl = "external"
 pol_ctrl = "manual"

phase	phase_start	cal_state	sig_ref_state	Beam Num.
1	0.00	NoNoise	Sig	1 or 3
2	0.25	Noise	Sig	1 or 3
3	0.50	NoNoise	Ref	2 or 4
4	0.75	Noise	Ref	2 or 4

Beam Switch, User Def.; BSWITCH; USERDEF

Any other combination of number_of_phases, phase_start, cal_state, sig_ref_state and cal_ctrl which were not defined above while switchDeltas = [0], beam_ctrl = "computer" and pol_ctrl = "manual".

Pol. Switch; PSWITCH; POLSW

number_of_phases = 4
 switchDeltas = [0.0]
 beam_ctrl = "manual"
 cal_ctrl = "external"
 pol_ctrl = "computer"

phase	phase_start	cal_state	sig_ref_state	Polarization
1	0.00	NoNoise	Sig	X or RCP
2	0.25	Noise	Sig	X or RCP
3	0.50	NoNoise	Ref	Y or LCP
4	0.75	Noise	Ref	Y or LCP

Pol. Switch, User Def.; PSWITCH; USERDEF

Any other combination of number_of_phases, phase_start, cal_state, sig_ref_state and cal_ctrl which were not defined above while switchDeltas = [0], beam_ctrl = "manual" and pol_ctrl = "computer".

User Defined; NONE; USERDEF

Any other combination of number_of_phases, phase_start, cal_state, sig_ref_state and cal_ctrl which were not defined above while switchDeltas = [0], beam_ctrl = "manual" and pol_ctrl = "manual".

Freq Switch, 01, No Cal.; FSWITCH; FSW01NOCAL

Not yet implemented.

Freq Switch, 12, No Cal.; FSWITCH; FSW12NOCAL

Not yet implemented.

Freq Switch, 0102, No Cal.; FSWITCH; FSW0102NOCAL

Not yet implemented.

Beam Switch, No Cal.; BSWITCH; BEAMSWNOCAL

Not yet implemented.

Pol. Switch, No Cal.; PSWITCH; POLSWNOCAL

Not yet implemented.

The switching_signals_master, blanking_time, switch_period, AdvanceTime, AdvanceSig1 and AdvanceSig2 parameters are set independently, *i.e.* they do not depend on the switch_mode GO Keyword.

3 Setting The Switching Signals In The Device Managers

GO sets the values of the `switching_signals_master`, `cal_state`, `sig_ref_state`, `blanking_time`, `number_of_phases`, `switch_period`, and `phase_start` YGOR parameters in the Scan Coordinator manager. The `AdvanceTime`, `AdvanceSig1`, and `AdvanceSig2` YGOR parameters only exist in the DCR manager and are set within the DCR manager by GO. The `switchDeltas` YGOR parameter only exists within the LO1 manager and is set within the LO1 manager by GO using the settings of the `switchDeltas`, `num_fsw_offsets`, `ref_freq_1` and `ref_freq_2` GO Keywords. The `xferState` YGOR parameters currently exists only in the 2 cm and 1 cm receivers and is set within the receiver managers using the GO Keyword `beam_ctrl`. The `calState` YGOR parameter currently exists only in the 2 cm and the 1 cm receivers and is set within the receiver managers using the GO Keyword `cal_ctrl`.

When a switching signal parameter is set in the Scan Coordinator manager, the value is passed down to each device which also uses these parameters. GO reads back the value from the device. This forms a requested value - actual value cycle between GO, the Scan Coordinator manager and the Device manager. This allows the observer to know what the switching signals are in each device for their observations.

N.B. *The request value - actual value cycle is not used to update the `switch_mode` GO Keyword. The `switch_mode` GO Keyword is intended to aid the observer in the overall setup of the GBT and is not guaranteed to reflect the actual state of the system. The `switch_mode` GO Keyword is used to derive the `SWSTATE` and `SWTCHSIG` GO FITS Keywords.*

When one of the “User Defined” modes of `switch_mode` is selected then the observer will be allowed to set all of the switching signal GO keywords. However, when `switch_mode` is selected to be one of the non-“User Defined” modes GO will disable the setting of most of the switching signal GO Keywords from the GO GUIs.

4 How The `switch_mode` GO Keyword Is Determined At Startup

When GO is started, GO will automatically assume that the `switch_mode` will be “User Defined”. This means that if GO needs to be restarted during an observation the observer will have to proceed through the initial setup sequence again.

5 GO and YGOR Switching Signals Interaction

CLEO allows the switching signal parameters to be set in the Scan Coordinator and the other devices. If CLEO is used to set the switching signals in a device other than the Scan Coordinator then the `switch_mode` GO Keyword will not match what is seen in the system.

If one of the YGOR managers is reset, rebooted, etc. then it is possible that the switching signals will change. This is especially true for the Scan Coordinator manager, the LO1 manager and the receiver managers. If this occurs it is likely that the `switch_mode` GO Keyword will not match what is seen in the system.

6 Position Switching

Position switching is “selected” when using one of the following GO procedures: `OffOn`, `OnOff` or `OffOnOff`. The On or Off positions can be contained in either a single scan or in separate scans. For a position switched observation in the same scan the GO FITS `SWSTATE` keyword will be `PSWITCHONOFF`. For a position switched scan with the off and the on in different scans the GO FITS `SWSTATE` keyword will be `PSWITCHOFF` and `PSWITCHON` respectively.

N.B. *It is possible to combine position switching with another type of switching such as beam or frequency switching. This modes are to be considered non-standard modes and are not strictly dealt with in the current GO*

*FITS file specification.*⁴ However, to attempt to preserve some information on what happened within the GO FITS file the SWSTATE FITS keyword will be set to PSWITCHONOFF, PSWITCHOFF or PSWITCHON while the SWCHSIG keyword will indicate which beam or frequency switching scheme was used.

6.1 LASTON and LASTOFF GO FITS Keyword Values

Two GO FITS keywords are defined as LASTON and LASTOFF. These will contain the last known scan numbers that are valid to use in combination with the current scan in data reduction.

There are cases when GO will not know what valid values for the LASTON and LASTOFF FITS Keywords should be. When this occurs GO will need to "reset" LASTON and LASTOFF to zero values. This occurs when:

1. Whenever GO is started. This means that if you need to stop GO and then restart it you will lose what these values were. GO does not have any "prior knowledge" of non-YGOR parameters built into it.
2. Whenever the Project ID is changed. You don't want to use someone else's data.
3. Whenever the observer's name is changed. Again you don't want to use someone else's data.
4. Whenever the scan number is changed by the operator. This can only be done in CLEO or if the Scan Coordinator manager is restarted. When the scan number is changed by the operator (or Scan Coordinator restart) GO can no longer guarantee that it knows what is going on.
5. Whenever the back-end selected is changed. You don't want to use DCR off's for the Spectrometer. This means that anytime the Scan Coordinator manager is restarted during an observation we might lose the LASTON and LASTOFF information - depending on what actually happens as far as the events that GO receives from the Scan Coordinator.
6. Whenever the observing mode is changed. You don't want to mix spectral line and pulsar observations for example.
7. Whenever the receiver is changed.
8. Whenever the frequency of the observation is changed. If you decide to go from using f_1 to f_2 then decide to go back to f_1 without doing a scan then it's "sorry Charlie". GO doesn't have a history of parameter values for the last scan.
9. Whenever any switches or filters are changed in the IF system. This will constitute a new observing setup and new ons and offs will be assumed to be needed.
10. Whenever a different procedure is used. If you change from OffOn to OnOff you are OK but if you go from OffOn to OffOnOff you probably want to reset things.
11. Whenever the source name is changed.
12. Whenever the scan length changes. Comparing a 30 second off with a 5 minute scan is not the right thing to do in all cases.
13. Whenever the switching signals are changed. We don't necessarily want to compare total power without cal and total power with cal.
14. Whenever the switching signals master is changed.
15. Whenever the bandwidth in the back-end is changed.

⁴<http://www.gb.nrao.edu/GBT/MC/doc/dataproc/gbtGOFits/gbtGOFits/gbtGOFits.html>

7 Keywords Automatically Set By switch_mode Selection

Whenever the value of the GO switch_mode keyword is changed, GO automatically changes the values of several keywords. The keywords that are changed and the values to which they are set are listed in §2. *However, it should be noted that the switchDeltas, beam_ctrl cal_ctrl and pol_ctrl keywords currently are not changed when the switch_mode is changed.*