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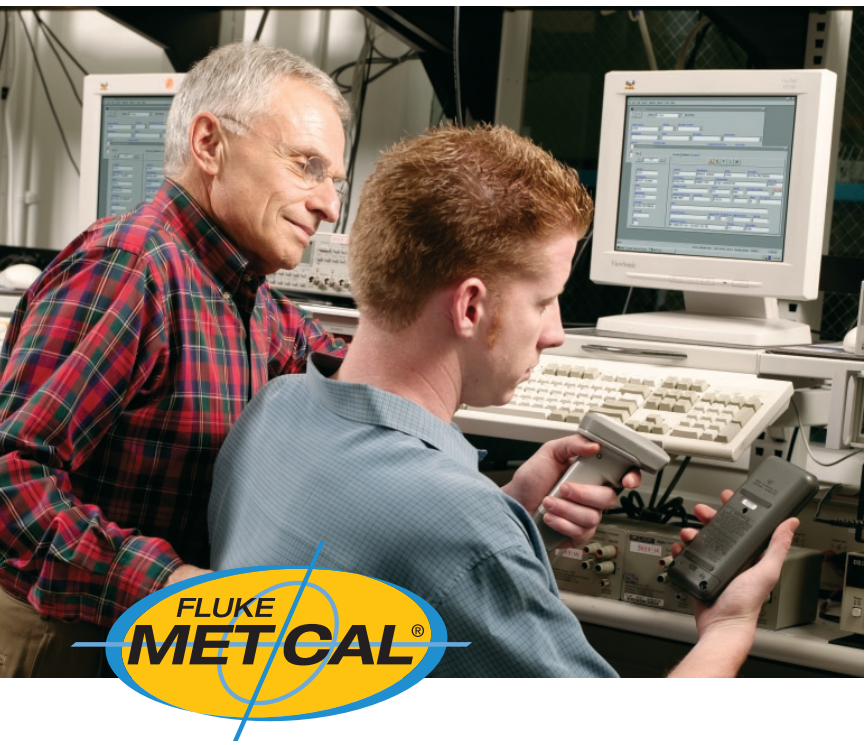
Using MET/CAL® Flexible Standards

Application Note



This application note is divided into three major sections

- Overview of the definition, purpose and implementation of Flexible Standards in MET/CAL software.
- Information needed to get MET/CAL software set up to run procedures that have been designed to use the Flexible Standards technique. New procedures provided by Fluke will use the Flexible Standards technique wherever it is appropriate, particularly in RF procedures where many different (but equivalent) instruments like counters and signal generators are in wide use.
- Detail on how the Flexible Standards technique is implemented. This information will be required if you choose to write your own procedures using Flexible Standards. Understanding of this section will require some knowledge of the MET/CAL procedure language and the use of sub-procedures.

What is the "Flexible Standards" technique?

Within a traditional MET/CAL procedure, each standard used to source or measure a tested parameter must be explicitly defined in the procedure file. This is generally done by including an appropriate Function Select Code (FSC) in the procedure at each test step requiring the standard. Most FSC's in MET/CAL software are instrument model specific. If you want to use a 5720A for a test step you use the 5720 FSC in your MET/CAL procedure. Likewise, for a 5520A, use a 5520 FSC, etc.

But suppose you have a procedure that is written to use a PM6680 counter, but your lab owns an HP5334A. You're now faced with two problems. First, the procedure will have to be modified to use the HP5334A. The second problem—which may be harder to overcome—is that MET/CAL software doesn't provide an FSC to control a HP5334A. This means that you are now responsible for both the metrology of the measurement and also for sending control strings to the HP5334A from within the procedure.

Even if there is an FSC for the standard you need to substitute into your procedure, you still have to edit the procedure file and replace the 6680 lines with the new replacement FSC. Your challenges in a nutshell...

- Is there someone around that knows how to edit a MET/CAL procedure?
- Can you find the time it takes to make the substitution?
- How will you manage the new procedure version?
- If there is no FSC for your standard, you must add control lines in your new procedure.

The "Flexible Standards" technique (FS) provides a solution to this problem.

Flexible Standards is a MET/CAL technique that allows the operator to interchange most reference instruments with another, specially configured instrument, of the same functional class without necessitating procedure modification.

When is the use of Flexible Standards appropriate?

FS is best suited to those categories of remotely controllable standards which include many different models with essentially the same functionality. These are the types of instruments that have similar functional capabilities but each model possibly has different range points, different specifications and, most probably, has different control commands. Instruments like signal generators, function generators and frequency counters are prime candidates and are supported with the introduction of Flexible Standards in MET/CAL software version 7.2.

Conceivably, any programmable standard can be configured in MET/CAL software as a "Flexible Standard." But the Flexible Standards technique is best applied to simpler instruments because of the amount of work required to create and test the necessary instrument control files.

Limitations of using Flexible Standards

Whenever you use Flexible Standards, you give up some capabilities of using regular FSC's.

- **No Editor based TUR checking**

  When using the MET/CAL editor to write or modify procedures, you will not get TUR calculations for those test steps that use Flexible Standards. The reason, of course, is because there is no way to know what instrument will be used on the final workstation when the procedure is executed.
- **Choosing an adequate standard**

  The standard that is actually used during the calibration process is determined by whoever configures the standards for the workstation. This moves the responsibility for choosing an instrument with sufficient performance to perform the calibration away from the procedure writer.
- **No state checking**

  When an FSC is designed, it is common practice to determine the correct sequence of commands needed to transition the instrument between states. This is a typical requirement where function changes require interim commands. Since control of the standard is left to the procedure writer, it is up to you to add any intermediate commands, resets or delays to switch states of your calibrator properly.

How does the Flexible Standards technique work?

The new MET/CAL Flexible Standards technique is implemented with the use of sub-procedures and a special initialization file (user_config_instr.ini). Interaction between the main calibration procedure and a FS instrument is directed through a sub-procedure that has been designed to control a specific class of standards. Parameter values are passed between the main procedure and the driver sub-procedure using Named Variables. The actual command strings needed to control the FS instrument are stored in the initialization file with a section dedicated to each specific standard model. The driver sub-procedure will look up the required control string from the initialization file and send it to the physical instrument as needed for the specific test.

How does MET/CAL know which model to choose?

In each MET/CAL workstation, instruments that need to be used as Flexible Standards will be configured just like all the other standards used in the system, but with one addition: the Alias name will contain the Flexible Standards Class Name. The MET/CAL procedure will contain the Alias name at each test step that requires the Flexible Standard instrument. MET/CAL's Run Time application will be able to associate the Alias name with an actual instrument model.

What is a Flexible Standards class?

The instruments used as flexible standards are grouped into like functionality or classes. A driver sub-procedure(s) is created for each class. MET/CAL 7.2 includes sub-procedure drivers for the following pre-defined flexible standards classes that you can use right away. For efficiency reasons, the included driver sub-procedures have been created as a pair of procedure files; more information is provided about that later.

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MET/CAL 7.2 Flexible Standard Classes

Name	Class type	Driver proc files
LFCTR	Low Frequency Counter	sub_driver_lfctr.txt sub_send_cmd_lfctr.txt
HFCTR	High Frequency Counter	sub_driver_hfctr.txt sub_send_cmd_hfctr.txt
UWCTR	Microwave Frequency Counter	sub_driver_uwctr.txt sub_send_cmd_uwctr.txt
DMM	Digital Multimeter	sub_driver_dmm.txt sub_send_cmd_dmm.txt
FGEN	Function Generator	sub_driver_fgen.txt sub_send_cmd_fgen.txt
LFSG	Low Frequency Signal Generator	sub_driver_lfsg.txt sub_send_cmd_lfsg.txt
HFSG	High Frequency Signal Generator	sub_driver_hfsg.txt sub_send_cmd_hfsg.txt
UWSG	Microwave Signal Generator	sub_get_options_uwsg.txt
LVLG	Level Generator	sub_driver_lvlg.txt sub_send_cmd_lvlg.txt
SWPG	Sweep Generator	sub_driver_swpg.txt sub_send_cmd_swpg.txt
LO	Local Oscillator	sub_driver_lo.txtsub_send_cmd_lo.txt

How do I prepare MET/CAL to use Flexible Standards?

Many of the newly developed MET/CAL procedures coming from Fluke use the new Flexible Standards technique. To use these new procedures, perform the following steps:

1. **Determine whether the instrument you want to use is supported.**
   Refer to Appendix A of this document for a list of instruments you can use with MET/CAL v7.2. If a Fluke provided procedure uses a model that is not listed, then a new FS initialization file is available. If the new file is not provided with the procedure, it will be made available for download on Fluke's web site.

2. **Add your instrument to MET/CAL as "User Configured."**
   In order for MET/CAL software to make the connection between the standards class name used in the procedure and the actual instrument you want to use, you must configure your workstation by adding your standard. This is done using the Run Time or Editor application.
   - Click on [Configure].
   - Select [Add].
   - Enter a name for this instrument that matches one of the model names provided in Appendix A, exactly.
   - Fill out the details including:
     - Asset Number
     - type of remote interface
     - If IEEE-488, provide address on the bus
     - Provide an "Alias" value corresponding to a class name appropriate for this flexible standard. See Appendix A.

Notes:
- Many instruments used as Flexible Standards can fulfill the requirements of more than one FS Class. When this is the case, you can use that instrument in both capacities by using the second Alias name to define the second FS Class.
- If your selected instrument is already configured (as "user configured") in your system, you may retain the Alias name already defined and use the second Alias name to configure it as a Flexible Standard.

3. **Additions to metcal.ini**
   In the [startup] section of the metcal.ini file, verify that the following line exists:
   ```
   rinfdir     = C:\metcal
   ```
   This line specifies where the flexible standards initialization file (user_config_instr.ini) is located. The actual directory may be different on your system, particularly if you are using a host with multiple workstations connected. The flexible standards initialization file should be placed where the main MET/CAL program files are located.

Details about Flexible Standards

If you only intend to use Flexible Standards in procedures supplied from Fluke, you do not need to delve into the implementation details presented in the following topics.

Typical usage

As an example of how the Flexible Standards technique is typically used, we will explore the LFCTR class. There are five main actions needed to use instruments in this class: Initialize, Reset, Measure, Setup and Read. Note that all of the driver sub-procedures exist in one procedure file. This is possible because each procedure file can have up to six Instrument names. If more than six actions are needed for a particular FS model, the required sub-procedures can be written in as many files as are required. The only important thing is that the procedure code for each action is contained in its own sub-procedure name.

For the LFCTR class, the relevant sub-procedure names are:
INSTRUMENT: Sub Initialize /LFCTR
INSTRUMENT: Sub Reset /LFCTR
INSTRUMENT: Sub Measure /LFCTR
INSTRUMENT: Sub Setup /LFCTR
INSTRUMENT: Sub Read /LFCTR

Initialize

The first action to be accomplished is Initialize. This action is primarily used to set named memory variables to an initial state in preparation for controlling the flexible standard and capturing a reading to be used in a subsequent test evaluation.

Your mainline procedure will call the appropriate sub-procedure to complete the initialization action:

```
CALL Sub Initialize /LFCTR
```

Below is the initialization section of the driver sub-procedure Sub Initialize /LFCTR.

Code Review for Sub Initialize /LFCTR

Line 2.002 MET/CAL will return the actual model name you have configured in your system with the alias LFCTR.

Lines 2.003–2.004 Store the section name in the initialization file for the configured LFCTR in memory variable LFCTR_ProgSecName then transfer that name to MEM2.

Line 2.005 Determine the control type of the configured LFCTR instrument by looking up the values(IEEE, IEEE2 or SCPI) in the initialization file. Store the value in memory variable LFCTR_FSC.

Lines 2.006 - 2.010 Get the names of terminals on the configured LFCTR instrument from the initialization file and store those values in named memory variables. This will allow the main procedure to display accurate connection messages to the user that match the actual instrument used.

Lines 2.011–2.027 Initialize named memory variables for each of the setup parameters required by the configured LFCTR to enable its operation.

Lines 2.028–2.035 Lookup the proper command to reset the configured LFCTR instrument from the initialization file.

```
# ========================== Initialize=================================
2.001 LABEL INITIALIZE
# Get and store device name.
2.002 MATH @LFCTR_DevName = INSTR("LFCTR")
# Get and store programming section name.
2.003 MATH MEM2 = RINFE(@LFCTR_DevName, "ProgSecName")
2.004 MATH @LFCTR_ProgSecName = MEM2
# Get and store FSC.
2.005 MATH @LFCTR_FSC = RINFE(@LFCTR_ProgSecName, "FSC")
# Get and store terminal names.
2.006 MATH @LFCTR_Ch1 = RINFE(@LFCTR_ProgSecName, "Ch1")
# Use RINF instead of RINFE because some counters have only one channel.
2.007 MATH @LFCTR_Ch2 = RINF(@LFCTR_ProgSecName, "Ch2")
2.008 MATH @LFCTR_RefIn = RINFE(@LFCTR_ProgSecName, "RefIn")
2.009 MATH @LFCTR_RefOut = RINFE(@LFCTR_ProgSecName, "RefOut")
2.010 MATH @LFCTR_ExtArm = RINFE(@LFCTR_ProgSecName, "ExtArm")
# Initialize parameters to the empty string (unset).
2.011 MATH @LFCTR_Func = ""
2.012 MATH @LFCTR_Ch1Attn = ""
2.013 MATH @LFCTR_Ch2Attn = ""
2.014 MATH @LFCTR_Ch1Cpl = ""
2.015 MATH @LFCTR_Ch2Cpl = ""
2.016 MATH @LFCTR_Ch1Slope = ""
2.017 MATH @LFCTR_Ch2Slope = ""
2.018 MATH @LFCTR_Ch1Lvl = ""
2.019 MATH @LFCTR_Ch2Lvl = ""
2.020 MATH @LFCTR_Ch1Hyst = ""
2.021 MATH @LFCTR_Ch2Hyst = ""
2.022 MATH @LFCTR_Ch1Imp = ""
```

```
2.023 MATH @LFCTR_Ch2Imp = “”
2.024 MATH @LFCTR_Ch1Lpf = “”
2.025 MATH @LFCTR_COM = “”
2.026 MATH @LFCTR_MeasTime = “”
2.027 MATH @LFCTR_ROSC = “”
# Get programming string for RESET FSC.
2.028 MATH ResetCmd = RINF(@LFCTR_ProgSecName, “ResetFSC”)
# If ResetFSC is defined, establish the RESET FSC.
2.029 IF NOT(EMPTY(ResetCmd))
2.030 IF ZCMPI(ResetCmd, “[SDC]”)
2.031 RESET [@LFCTR][SDC]
2.032 ELSE
2.033 RESET [@LFCTR][V ResetCmd]
2.034 ENDIF
2.035 ENDIF
# See if input termination other than EOI is specified.
2.036 MATH InputTerm = RINF(@LFCTR_ProgSecName, “TERM”)
# See CR or LF termination was specified...
2.037 IF ZCMPI(InputTerm, “CR”)
2.038 IEEE [@LFCTR][TERM CR]
2.039 ELSEIF ZCMPI(InputTerm, “LF”)
2.040 IEEE [@LFCTR][TERM LF]
2.041 ENDIF
2.042 END
```

Reset

To be sure that the configured LFCTR instrument is in a known reset state, your main procedure will call the reset driver sub-procedure:

```
CALL Sub Reset /LFCTR
```

Below is the reset section of the driver sub-procedure Sub Reset /LFCTR.

Code Review for Sub Reset / LFCTR

Lines 3.001-3.005 Store the complete reset command string in named memory variable LFCTR_Cmd, then call the Sub Send Command /LFCTR to send the reset command to the configured LFCTR instrument. Notice this is done by another sub-procedure Sub Send Command /LFCTR. The actual interaction with the LFCTR instrument has been broken out into its own sub-procedure to allow this code to be reused in multiple driver sub-procedures without duplicating these procedure steps.

Getting ready for a measurement

Now we have all of the named variables loaded with the setup strings needed to send a complete connection message to the operator in preparation for making a measurement.

Example Main Line procedure

```
3.007 DISP   Make the following connections:
3.007 DISP
3.007 DISP   [32] UUT (rear panel) to [V @LFCTR_DevName]
3.007 DISP   [32] REF FREQUENCY OUT -------> [V @LFCTR_RefIn]
3.007 DISP
3.007 DISP   [32] UUT (9640A-50) to [V @LFCTR_DevName]
3.007 DISP   [32] Leveling Head --------> [V @LFCTR_Ch1]
```

Now measurement parameters will be set in the main line procedure for the type of measurement action we want the configured LFCTR instrument to perform.

Example Main Line procedure

```
3.010 MATH @LFCTR_ROSC = “Ext”
3.011 MATH @LFCTR_MeasTime = “2s”
3.012 MATH @LFCTR_Func = “FreqCh1”
3.013 MATH @LFCTR_Ch1Imp = “LoZ”
```

```
# ============================Reset==================================
3.001 LABEL RESET
3.002 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, “Reset”)
3.003 CALL Sub Send Command /LFCTR
3.004 END
```

Measure
Your mainline procedure will call the appropriate sub-procedure to complete the measure action:
`CALL Sub Measure /LFCTR`

Below is the measure section of the driver sub-procedure Sub Measure /LFCTR

Code review for Sub Measure /LFCTR
Lines 4.002–4.139 This section examines the values of each setup variable and for non-empty strings, sends these setup values to the configured LFCTR instrument.

Lines 4.131–4.145 These lines command the configured LFCTR instrument to return a measurement reading. The "[I]" syntax causes the measurement value is returned to the main line procedure in the MEM variable.

```
# ============================ Setup or Measure ========================
4.001 LABEL SETUP
# ----- Function
4.002 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, @LFCTR_Func)
4.003 CALL Sub Send Command /LFCTR
# ----- Measurement Time
4.004 IF NOT(EMPTY(@LFCTR_MeasTime))
4.005 MATH Cmd = RINFE(@LFCTR_ProgSecName, "MeasTime")
# Convert to base units and insert in programming string.
4.006 MATH @LFCTR_Cmd = REPL("<val>", BASE(@LFCTR_MeasTime), Cmd)
4.007 CALL Sub Send Command /LFCTR
4.008 ENDIF
# ----- Reference Oscillator
4.009 IF NOT(EMPTY(@LFCTR_ROSC))
4.010 IF ZCMPI(@LFCTR_ROSC, "Int")
4.011 MATH RefOsc = "RefOscInt"
4.012 ELSE
4.013 MATH RefOsc = "RefOscExt"
4.014 ENDIF
4.015 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, RefOsc)
4.016 CALL Sub Send Command /LFCTR
4.017 ENDIF
# ----- Channel 1 Input Impedance
4.018 IF NOT(EMPTY(@LFCTR_Ch1Imp))
4.019 IF ZCMPI(@LFCTR_Ch1Imp, "LoZ")
4.020 MATH Imp = "Ch1Imp50_Ohm"
4.021 ELSE
4.022 MATH Imp = "Ch1Imp1_MOhm"
4.023 ENDIF
4.024 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Imp)
4.025 CALL Sub Send Command /LFCTR
4.026 ENDIF
# ----- Channel 1 Input Coupling
4.027 IF NOT(EMPTY(@LFCTR_Ch1Cpl))
4.028 IF ZCMPI(@LFCTR_Ch1Cpl, "AC")
4.029 MATH Cpl = "Ch1CplAC"
4.030 ELSE
4.031 MATH Cpl = "Ch1CplDC"
4.032 ENDIF
4.033 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Cpl)
4.034 CALL Sub Send Command /LFCTR
4.035 ENDIF
# ----- Channel 1 Input Attenuation
4.036 IF NOT(EMPTY(@LFCTR_Ch1Attn))
4.037 IF ZCMPI(@LFCTR_Ch1Attn, "x10")
4.038 MATH Attn = "Ch1Attn_x10"
4.039 ELSE
4.040 MATH Attn = "Ch1Attn_x1"
4.041 ENDIF
4.042 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Attn)
4.043 CALL Sub Send Command /LFCTR
4.044 ENDIF
```

```
# ----- Channel 1 Low-pass Filter
4.045 IF NOT(EMPTY(@LFCTR_Ch1Lpf))
4.046 IF ZCMPI(@LFCTR_Ch1Lpf, "On")
4.047 MATH Lpf = "Ch1LpfOn"
4.048 ELSE
4.049 MATH Lpf = "Ch1LpfOff"
4.050 ENDIF
4.051 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Lpf)
4.052 CALL Sub Send Command /LFCTR
4.053 ENDIF
# ----- Channel 1 Trigger Slope
4.054 IF NOT(EMPTY(@LFCTR_Ch1Slope))
4.055 IF ZCMPI(@LFCTR_Ch1Slope, "Pos")
4.056 MATH Slope = "Ch1SlopePos"
4.057 ELSE
4.058 MATH Slope = "Ch1SlopeNeg"
4.059 ENDIF
4.060 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Slope)
4.061 CALL Sub Send Command /LFCTR
4.062 ENDIF
# ----- Channel 1 Trigger Level
4.063 IF NOT(EMPTY(@LFCTR_Ch1Lvl))
4.064 MATH Cmd = RINFE(@LFCTR_ProgSecName, "Ch1TrigLevel")
4.065 MATH @LFCTR_Cmd = REPL("<val>", BASE(@LFCTR_Ch1Lvl), Cmd)
4.066 CALL Sub Send Command /LFCTR
4.067 ENDIF
# ----- Channel 1 Trigger Hysteresis
4.068 IF NOT(EMPTY(@LFCTR_Ch1Hyst))
4.069 MATH Cmd = RINFE(@LFCTR_ProgSecName, "Ch1TrigHyst")
4.070 MATH @LFCTR_Cmd = REPL("<val>", BASE(@LFCTR_Ch1Hyst), Cmd)
4.071 CALL Sub Send Command /LFCTR
4.072 ENDIF
# ----- Channel 2 Input Impedance
4.073 IF NOT(EMPTY(@LFCTR_Ch2Imp))
4.074 IF ZCMPI(@LFCTR_Ch2Imp, "LoZ")
4.075 MATH Imp = "Ch2Imp50_Ohm"
4.076 ELSE
4.077 MATH Imp = "Ch2Imp1_MOhm"
4.078 ENDIF
4.079 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Imp)
4.080 CALL Sub Send Command /LFCTR
4.081 ENDIF
# ----- Channel 2 Input Coupling
4.082 IF NOT(EMPTY(@LFCTR_Ch2Cpl))
4.083 IF ZCMPI(@LFCTR_Ch2Cpl, "AC")
4.084 MATH Cpl = "Ch2CplAC"
4.085 ELSE
4.086 MATH Cpl = "Ch2CplDC"
4.087 ENDIF
4.088 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Cpl)
4.089 CALL Sub Send Command /LFCTR
4.090 ENDIF
# ----- Channel 2 Input Attenuation
4.091 IF NOT(EMPTY(@LFCTR_Ch2Attn))
4.092 IF ZCMPI(@LFCTR_Ch2Attn, "x10")
4.093 MATH Attn = "Ch2Attn_x10"
4.094 ELSE
4.095 MATH Attn = "Ch2Attn_x1"
4.096 ENDIF
4.097 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Attn)
4.098 CALL Sub Send Command /LFCTR
```

```
4.099 ENDIF
# ----- Channel 2 Trigger Slope
4.100 IF NOT(EMPTY(@LFCTR_Ch2Slope))
4.101 IF ZCMPI(@LFCTR_Ch2Slope, "Pos")
4.102 MATH Slope = "Ch2SlopePos"
4.103 ELSE
4.104 MATH Slope = "Ch2SlopeNeg"
4.105 ENDIF
4.106 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Slope)
4.107 CALL Sub Send Command /LFCTR
4.108 ENDIF
# ----- Channel 2 Trigger Level
4.109 IF NOT(EMPTY(@LFCTR_Ch2Lvl))
4.110 MATH Cmd = RINFE(@LFCTR_ProgSecName, "Ch2TrigLevel")
4.111 MATH @LFCTR_Cmd = REPL("<val>", BASE(@LFCTR_Ch2Lvl), Cmd)
4.112 CALL Sub Send Command /LFCTR
4.113 ENDIF
# ----- Channel 2 Trigger Hysteresis
4.114 IF NOT(EMPTY(@LFCTR_Ch2Hyst))
4.115 MATH Cmd = RINFE(@LFCTR_ProgSecName, "Ch2TrigHyst")
4.116 MATH @LFCTR_Cmd = REPL("<val>", BASE(@LFCTR_Ch2Hyst), Cmd)
4.117 CALL Sub Send Command /LFCTR
4.118 ENDIF
# ----- Channel 2 COM (2 via 1)
4.119 IF NOT(EMPTY(@LFCTR_COM))
4.120 IF ZCMPI(@LFCTR_COM, "Off")
4.121 MATH Com = "Ch2ComOff"
4.122 ELSE
4.123 MATH Com = "Ch2ComOn"
4.124 ENDIF
4.125 MATH @LFCTR_Cmd = RINFE(@LFCTR_ProgSecName, Com)
4.126 CALL Sub Send Command /LFCTR
4.127 ENDIF
# Exit here if Setup.
4.128 IF PSUBI("Setup")
4.129 END
4.130 ENDIF
# Drop through for Measure.
# ========================== Read or Measure ============================
4.131 LABEL READ
# See if there is an initiate command.
4.132 MATH @LFCTR_Cmd = RINF(@LFCTR_ProgSecName, "Initiate")
# If there is an initiate command, send it.
4.133 IF NOT(EMPTY(@LFCTR_Cmd))
4.134 CALL Sub Send Command /LFCTR
4.135 ENDIF
# See if there is a fetch command.
4.136 MATH @LFCTR_Cmd = RINF(@LFCTR_ProgSecName, "Fetch")
# If there is no fetch command simply get the reading.
4.137 IF EMPTY(@LFCTR_Cmd)
4.138 IEEE [@LFCTR][I]
# Otherwise send the fetch command and get the reading.
4.139 ELSEIF ZCMPI(@LFCTR_FSC, "SCPI")
4.140 SCPI [@LFCTR][V @LFCTR_Cmd][I]
4.141 ELSEIF ZCMPI(@LFCTR_FSC, "IEEE2")
4.142 IEEE2 [@LFCTR][V @LFCTR_Cmd][I]
4.143 ELSE
4.144 IEEE [@LFCTR][V @LFCTR_Cmd][I]
4.145 ENDIF
4.146 END
```

Appendix A – Instruments supported as Flexible Standards in MET/CAL software version 7.2

Model	FS Class
Agilent 33220A	FGEN
Agilent 33250A	FGEN
Agilent 53131A	LFCTR
Agilent 53132A	LFCTR
Agilent 53181A	LFCTR HFCTR
Agilent E4400A	HFSG
Agilent E4400B	HFSG
Agilent E4420A	HFSG
Agilent E4420B	HFSG
Agilent E4421A	HFSG
Agilent E4421B	HFSG
Agilent E4422A	HFSG
Agilent E4422B	HFSG
Agilent E4423B	HFSG
Agilent E4424B	HFSG
Agilent E4425B	HFSG
Agilent E4426B	HFSG
Agilent E4430B	HFSG
Agilent E4431B	HFSG
Agilent E4432B	HFSG
Agilent E4433B	HFSG
Agilent E4434B	HFSG
Agilent E4435B	HFSG
Agilent E4436B	HFSG
Agilent E4437B	HFSG
Agilent E4438C	HFSG
Agilent E8247C	UWSC
Agilent E8257C	UWSC
Agilent E8257D	UWSC
Agilent E8267C	UWSC
Agilent E8267D	UWSC
Fluke 45	DMM
Fluke 80	FGEN
Fluke 81	FGEN
Fluke 271	FGEN
Fluke 281	FGEN
Fluke 282	FGEN

Model	FS Class
Fluke 6060A	HFSG
Fluke 6060A/AN	HFSG
Fluke 6060B	HFSG
Fluke 6061A	HFSG
Fluke 6062A	HFSG
Fluke 6080A	HFSG
Fluke 6082A	HFSG
Fluke 8840A	DMM
Fluke 8842A	DMM
Fluke 9640A	LFSG LVLG HFSG SWPG
Fluke PM 6690	LFCTR
HP 3325A	FGEN
HP 3325B	FGEN
HP 3335A	LVLG
HP 3336A	LVLG
HP 3336B	LVLG
HP 3336C	LVLG
HP 5334A	LFCTR
HP 5350A	UWCTR
HP 5350B	UWCTR
HP 5350M	UWCTR
HP 5351A	UWCTR
HP 5351B	UWCTR
HP 5351M	UWCTR
HP 5352A	UWCTR
HP 5352B	UWCTR
HP 5352M	UWCTR
HP 8340A	SWPG
HP 8340B	SWPG
HP 8341A	SWPG
HP 8341B	SWPG
HP 8642A	HFSG UWSG
HP 8642B	HFSG UWSG
HP 8643A	HFSG UWSG

Appendix A – Instruments supported as Flexible Standards in MET/CAL software version 7.2 continued

Model	FS Class
HP 8644A	HFSG UWSG
HP 8644B	HFSG UWSG
HP 8645A	HFSG UWSG
HP 8647A	HFSG UWSG
HP 8648A	HFSG UWSG
HP 8648B	HFSG UWSG
HP 8648C	HFSG UWSG
HP 8648D	HFSG UWSG
HP 8656A	HFSG UWSG
HP 8656B	HFSG UWSG
HP 8657A	HFSG UWSG
HP 8657B	HFSG UWSG
HP 8662A	HFSG UWSG
HP 8663A	HFSG UWSG
HP 8664A<	HFSG UWSG
HP 8665A	HFSG UWSG
HP 8665B	HFSG UWSG
HP 8671A	HFSG UWSG
HP 8671B	HFSG UWSG
HP 8672A	HFSG UWSG
HP 8672S	HFSG UWSG
HP 8673B	HFSG UWSG
HP 8673D	HFSG UWSG

Model	FS Class
HP 8673C	HFSG UWSG
HP 8673D	HFSG UWSG
HP 8673E	HFSG UWSG
HP 8673G	HFSG UWSG
HP 8673H	HFSG UWSG
HP 33120A	FGEN
HP 34401A	DMM
HP 83620A	HFSG UWSG SWPG
HP 83620B	HFSG UWSG SWPG
HP 83622A	HFSG UWSG SWPG
HP 83622B	HFSG UWSG SWPG
HP 83623A	HFSG UWSG SWPG
HP 83623B	HFSG UWSG SWPG
HP 83624A	HFSG UWSG SWPG
HP 83624B	HFSG UWSG SWPG
HP 83630A	HFSG UWSG SWPG
HP 83630B	HFSG UWSG SWPG
HP 83640A	HFSG UWSG SWPG
HP 83640B	HFSG UWSG SWPG

Appendix A – Instruments supported as Flexible Standards in MET/CAL software version 7.2 continued

Model	FS Class
HP 83642A	HFSG UWSG SWPG
HP 83650A	HFSG UWSG SWPG
HP 83650B	HFSG UWSG SWPG
HP 83711A	HFSG UWSG
HP 83711B	HFSG UWSG
HP 83712A	HFSG UWSG
HP 83712B	HFSG UWSG
HP 83731A	HFSG UWSG
HP 83731B	HFSG UWSG
HP 83732A	HFSG UWSG
HP 83732B	HFSG UWSG
HP 83751A	HFSG UWSG
HP 83751B	HFSG UWSG

Model	FS Class
HP 83752A	HFSG UWSG
HP 83752B	HFSG UWSG
Marconi 2023	HFSG
Marconi 2024	HFSG
Philips PM 6680	LFCTR
Philips PM 6681	LFCTR
Philips PM 6685	LFCTR
Rohde & Schwarz SMY02	HFSG
Rohde & Schwarz SMY03	HFSG
Rohde & Schwarz SMY43	HFSG
Tabor 8550	FGEN
Tabor 8551	FGEN
Wavetek 39A	FGEN
Wavetek 80	FGEN
Wavetek 81	FGEN
Wavetek 195	FGEN
Wavetek 900	LFCTR
Wavetek 901	LFCTR
Wavetek 905	LFCTR

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