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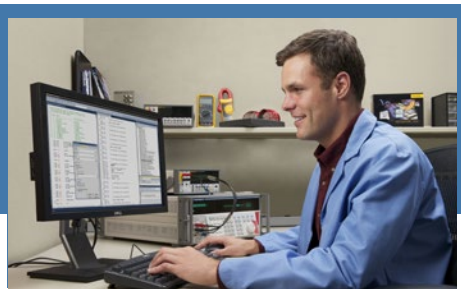
Calibration

Preserving Results Order While Optimizing Execution Sequence in MET/CAL® Procedures

Application Note

This application note describes the method used in Fluke Calibration MET/CAL Warranted Procedure code to optimize procedure execution. This allows the procedure author to maximize the benefits of using automation (primarily by minimizing connection changes), while retaining the correct results order.



In many written performance verification (PV) procedures, the written sequence of test steps matches the results order of a corresponding Data Sheet or Test Record. When automating the written PV with software, it is often desirable to maintain this same results order for consistency with the written procedure. However, the sequence of steps performed by the written PV often disregards efficiency by requiring the technician to change connections back and forth throughout the procedure. For example, Step #1 may require connection A, Step #2 changes the setup to Connection B, while Step #3 returns to Connection A. Often, there is no negative metrological impact when rearranging the execution sequence of PV steps. This allows the technician to re-arrange the sequence of tests so that all steps requiring a certain connection may be performed while that connection is in place, before changing to the next connection. Table 1 shows a digital multimeter example, while Table 2 shows a much larger example for a four-channel oscilloscope.

Different methods may be used in MET/CAL procedure code to optimize procedure execution. The most basic method is to just re-arrange the sequence of the steps in the procedure. Since MET/CAL executes the procedure in step number order, this will affect the execution sequence. However, MET/CAL also reports results in step number order, creating the side effect of the results being stored in the wrong order and not matching the written Data Sheet or Test Record.

A different method must be used for maintaining results order, while also optimizing the execution sequence for minimal connection changes. Since the results order is fixed by step number order, the test steps must remain in the correct sequence in MET/CAL procedure code. Execution order is then optimized by navigating through the procedure code, which can be accomplished in a variety of ways. Fluke MET/CAL warranted procedures navigate using a combination of the LABEL and JMPL (jump to label) Function Select Codes (FSCs), which is the method that this application note will focus on.

Results Order	Calibrator Connection to UUT	Execution Sequence	Calibrator Connection to UUT
DC VOLTAGE	NORMAL OUT	DC VOLTAGE	NORMAL OUT
DC CURRENT	AUX OUT	AC VOLTAGE	SAME
AC VOLTAGE	NORMAL OUT	FREQUENCY	SAME
AC CURRENT	AUX OUT	DC CURRENT	AUX OUT
RESISTANCE	4-WIRE OUT	AC CURRENT	SAME
FREQUENCY	NORMAL OUT	RESISTANCE	4-WIRE OUT

Table 1. Example Digital Multimeter Performance Verification

Following the example from Table 1, this is an example of how the MET/CAL procedure might look:

```
  1.001  LABEL          DC_VOLTAGE
# Steps required to perform DC Voltage tests.
  1.002  JMPL           AC_VOLTAGE

  1.003  LABEL          DC_CURRENT
# Steps required to perform DC Current tests.
  1.004  JMPL           AC_CURRENT

  1.005  LABEL          AC_VOLTAGE
# Steps required to perform AC Voltage tests.
  1.006  JMPL           FREQUENCY

  1.007  LABEL          AC_CURRENT
# Steps required to perform AC Current tests.
# Steps required to perform Resistance tests (no LABEL needed).
  1.008  JMPL           END

  1.009  LABEL          FREQUENCY
# Steps required to perform Frequency tests.
  1.010  JMPL           DC_CURRENT

  1.011  LABEL          END
  1.012  END
```

Each navigation waypoint is marked by an appropriately named **LABEL** FSC. As each section of the sequence is completed, the procedure will jump to the next waypoint, as specified by the procedure writer. Sample MET/CAL procedure code is provided above to accompany the example in Table 1.

Results Order	Calibrator Connection to UUT	Execution Sequence	Calibrator Connection to UUT
SELF TEST	N/A	SELF TEST	N/A
SIGNAL PATH COMPENSATION	N/A	SIGNAL PATH COMPENSATION	N/A
INPUT IMPEDANCE	N/A	RANDOM NOISE	N/A
INPUT IMPEDANCE	N/A	RANDOM NOISE	N/A
INPUT IMPEDANCE	N/A	RANDOM NOISE	N/A
INPUT IMPEDANCE	N/A	RANDOM NOISE	N/A
DC BALANCE	N/A	DC BALANCE	N/A
DC BALANCE	N/A	DC BALANCE	N/A
DC BALANCE	N/A	DC BALANCE	N/A
DC BALANCE	N/A	DC BALANCE	N/A
BANDWIDTH (50 OHM)	CHAN 1	SAMPLE RATE AND DELAY TIME ACC	CHAN 1
BANDWIDTH (1 MOHM)	CHAN 1	INPUT IMPEDANCE	CHAN 1
BANDWIDTH (50 OHM)	CHAN 2	DCV GAIN ACC (50 OHM)	CHAN 1
BANDWIDTH (1 MOHM)	CHAN 2	DCV GAIN ACC (1 MOHM)	CHAN 1
BANDWIDTH (50 OHM)	CHAN 3	DC OFFSET ACC	CHAN 1
BANDWIDTH (1 MOHM)	CHAN 3	BANDWIDTH (50 OHM)	CHAN 1
BANDWIDTH (50 OHM)	CHAN 4	BANDWIDTH (1 MOHM)	CHAN 1
BANDWIDTH (1 MOHM)	CHAN 4	DELTA TIME ACC	CHAN 1
DCV GAIN ACC (50 OHM)	CHAN 1	CROSSTALK TO RF CHANNEL	CHAN 1
DCV GAIN ACC (50 OHM)	CHAN 2	INPUT IMPEDANCE	CHAN 2
DCV GAIN ACC (50 OHM)	CHAN 3	DCV GAIN ACC (50 OHM)	CHAN 2
DCV GAIN ACC (50 OHM)	CHAN 4	DCV GAIN ACC (1 MOHM)	CHAN 2
DCV GAIN ACC (1 MOHM)	CHAN 1	DC OFFSET ACC	CHAN 2
DCV GAIN ACC (1 MOHM)	CHAN 2	BANDWIDTH (50 OHM)	CHAN 2
DCV GAIN ACC (1 MOHM)	CHAN 3	BANDWIDTH (1 MOHM)	CHAN 2
DCV GAIN ACC (1 MOHM)	CHAN 4	DELTA TIME ACC	CHAN 2
DC OFFSET ACC	CHAN 1	CROSSTALK TO RF CHANNEL	CHAN 2
DC OFFSET ACC	CHAN 2	INPUT IMPEDANCE	CHAN 3
DC OFFSET ACC	CHAN 3	DCV GAIN ACC (50 OHM)	CHAN 3
DC OFFSET ACC	CHAN 4	DCV GAIN ACC (1 MOHM)	CHAN 3
SAMPLE RATE AND DELAY TIME ACC	CHAN 1	DC OFFSET ACC	CHAN 3
RANDOM NOISE	CHAN 1	BANDWIDTH (50 OHM)	CHAN 3
RANDOM NOISE	CHAN 2	BANDWIDTH (1 MOHM)	CHAN 3
RANDOM NOISE	CHAN 3	DELTA TIME ACC	CHAN 3
RANDOM NOISE	CHAN 4	CROSSTALK TO RF CHANNEL	CHAN 3
DELTA TIME ACC	CHAN 1	INPUT IMPEDANCE	CHAN 4
DELTA TIME ACC	CHAN 2	DCV GAIN ACC (50 OHM)	CHAN 4
DELTA TIME ACC	CHAN 3	DCV GAIN ACC (1 MOHM)	CHAN 4
DELTA TIME ACC	CHAN 4	DC OFFSET ACC	CHAN 4
CROSSTALK TO RF CHANNEL	CHAN 1	BANDWIDTH (50 OHM)	CHAN 4
CROSSTALK TO RF CHANNEL	CHAN 2	BANDWIDTH (1 MOHM)	CHAN 4
CROSSTALK TO RF CHANNEL	CHAN 3	DELTA TIME ACC	CHAN 4
CROSSTALK TO RF CHANNEL	CHAN 4	CROSSTALK TO RF CHANNEL	CHAN 4

Table 2. Example 4-Channel Oscilloscope Performance Verification

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