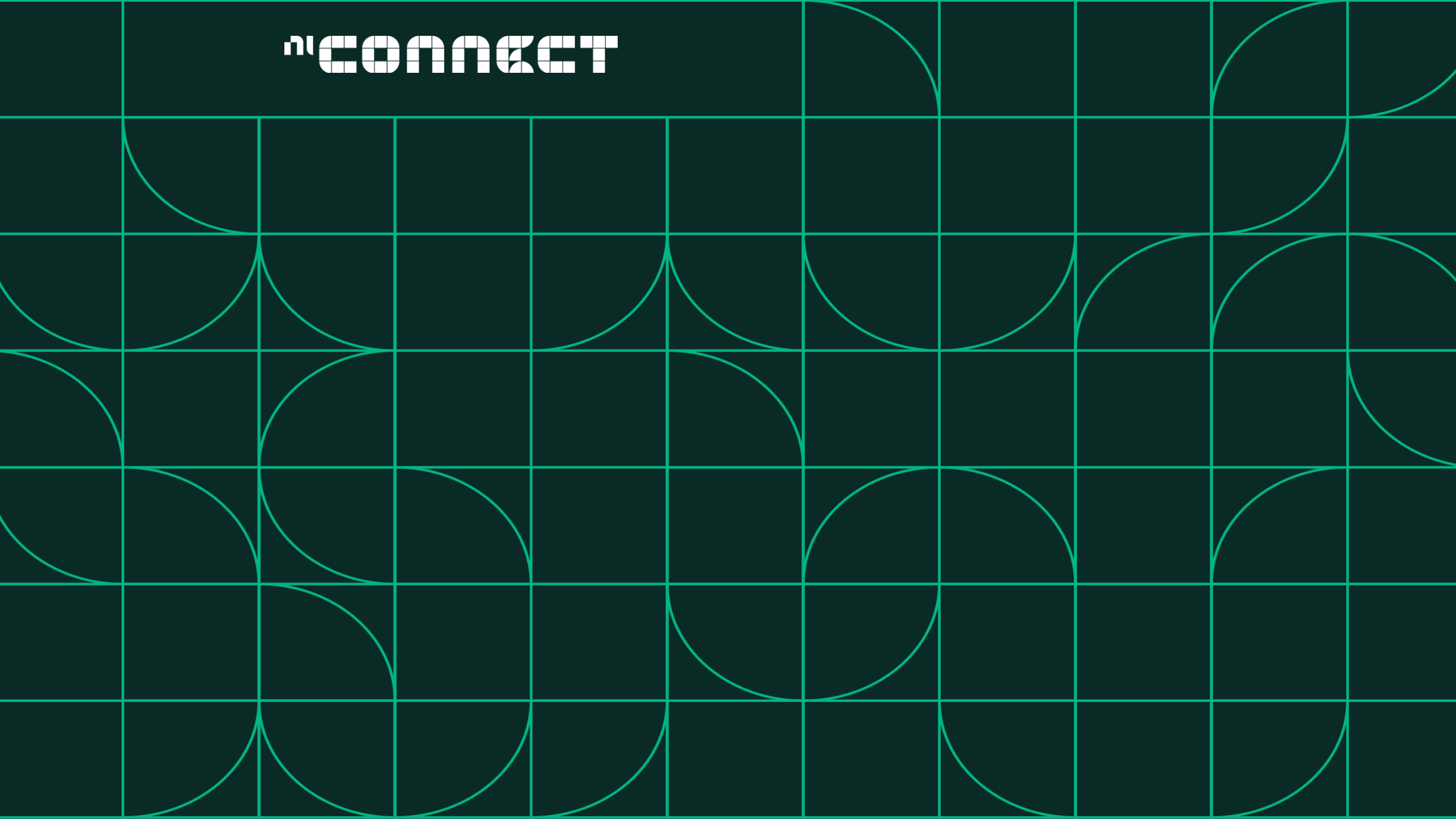


י"ח **connect**



Sweep Like a Pro

11:15 – 12:00

May 25, 2022

Shauna Rae



Chief Product Owner, TestStand

Sweep Like a Pro

11:15 – 12:00

May 25, 2022

Juan Carlos Contreras



**Semiconductor and Electronics Test
Software Domain Lead**

Agenda

Why Sweep

Inputting Sweep Parameters

Nesting sweeps

Sweep Strategies

Test Vector Table

Conditions-Parameters and the
Captured Values - Measurements

Exporting Results

Why Sweep

Let's consider an example to get us on the same page





Why Sweep

Seeking Understanding

Exploring and Probing

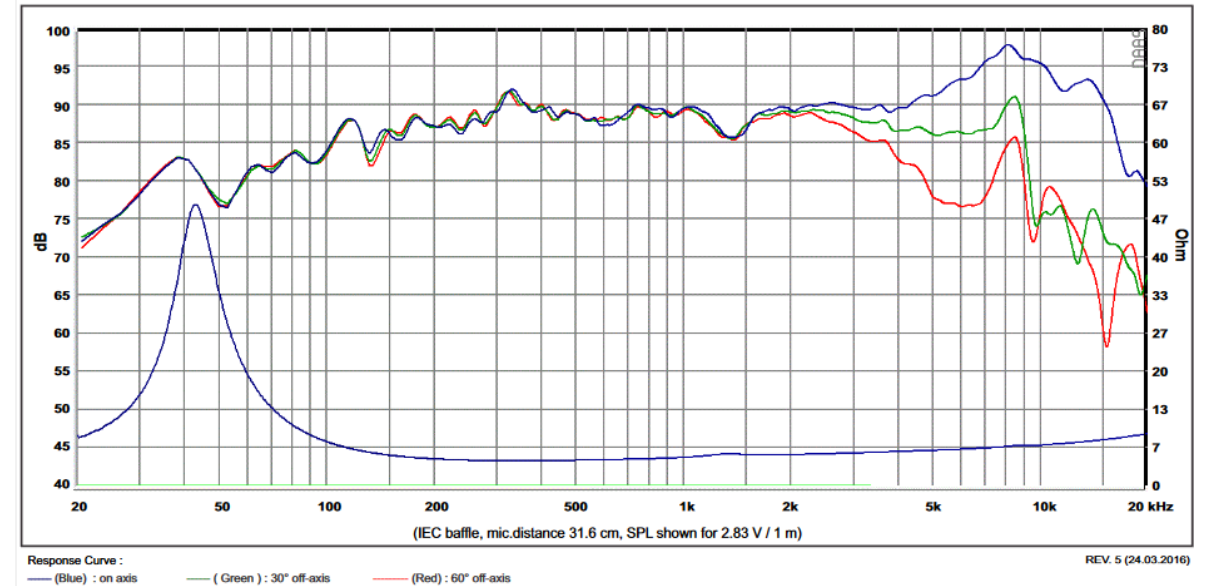
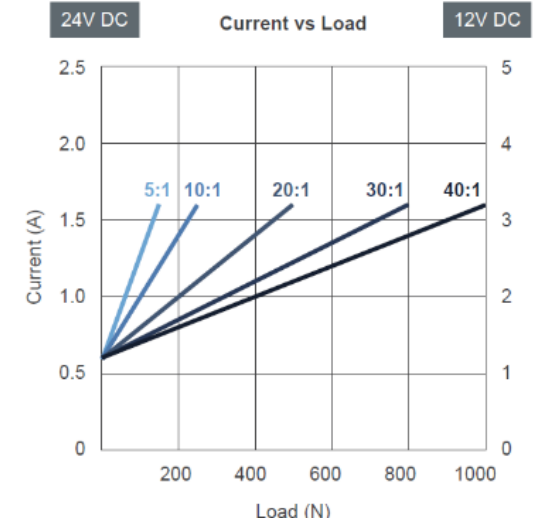
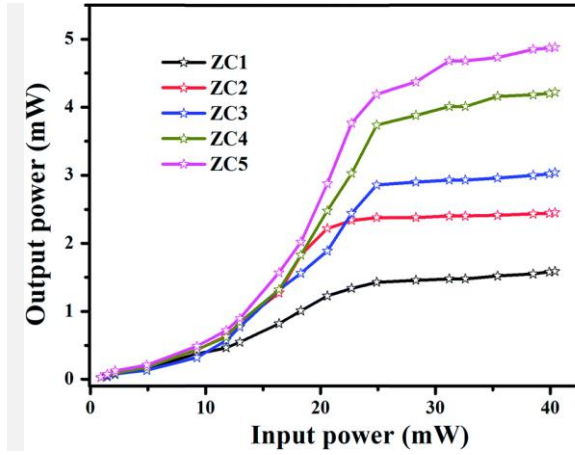
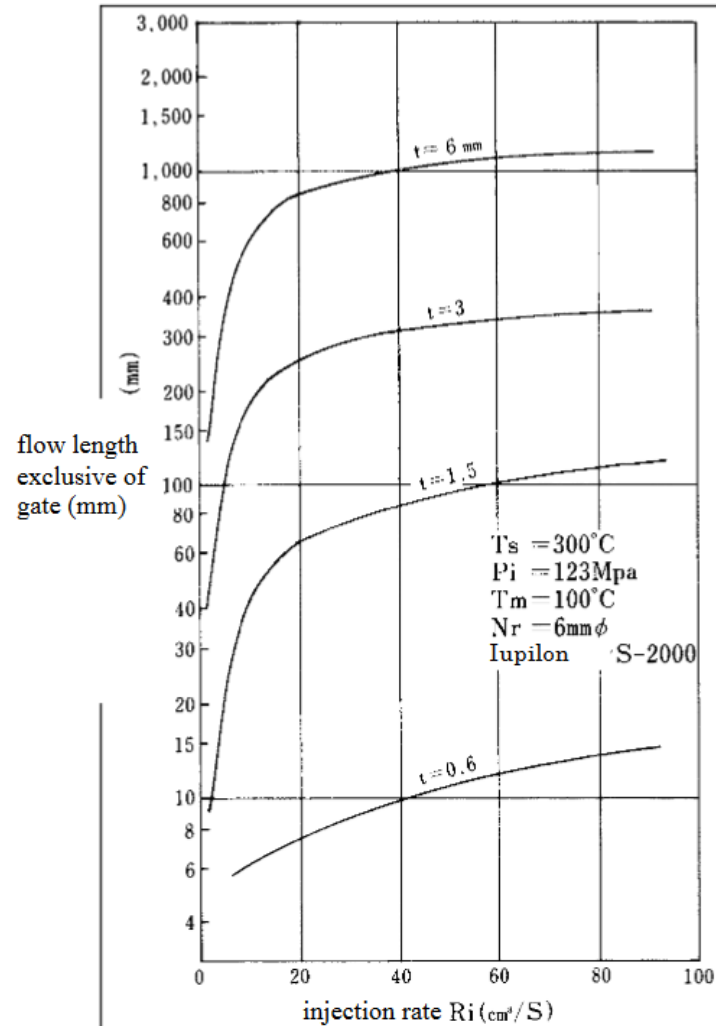
No matter the device under test, you need to look at **how it works** under a **variety of conditions**.

Some of those conditions need to **change continuously**, say the base current of a transistor.

Other conditions need to be **set and held** while you change other parameters. Like, the temperature of a chamber or the position of a robotic arm.

When you seek to validate a design, we want to **support you** as you **probe deeper** by sweeping parameters and **collecting** associated **measurements**.

Examples in Every Industry





Case Study

The 2N2222a transistor

Let's explore the 2N2222a transistor, a part that most of you may have encountered in school.

In order to validate the design of the part and provide characterization details, engineers needed to detail how it worked under a variety of conditions by nesting sweeps, use different sweeping strategies, fine tuning the set of values to explore, taking measurements, and plotting those results.

Example in TestStand: ..\Examples\Interfacing with Hardware\Transistor Characterization using Sweep Loop Step

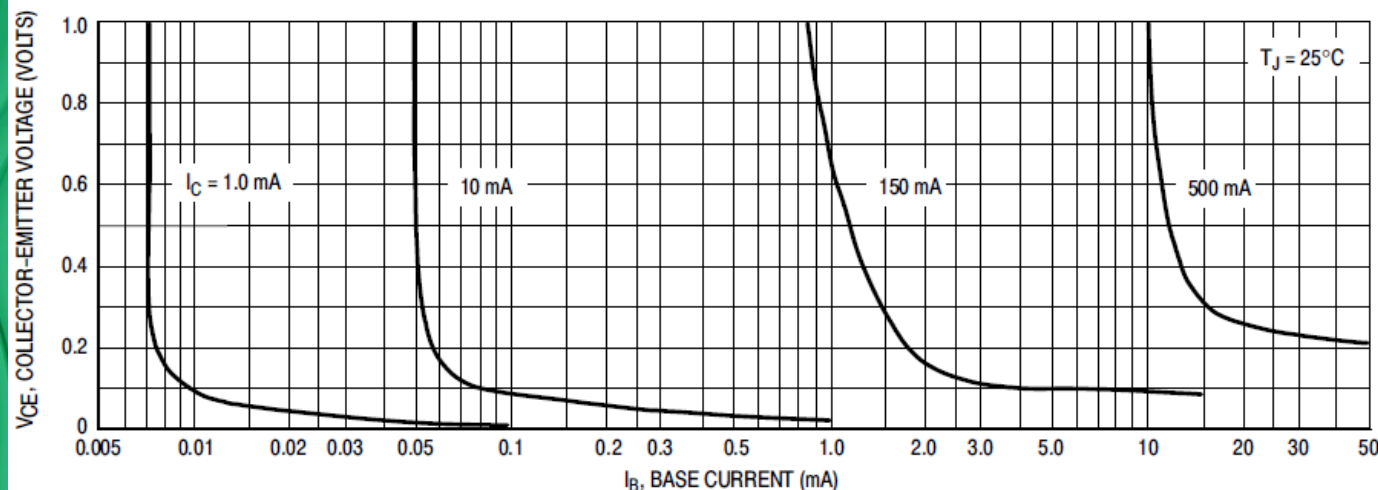


Figure 4. Collector Saturation Region

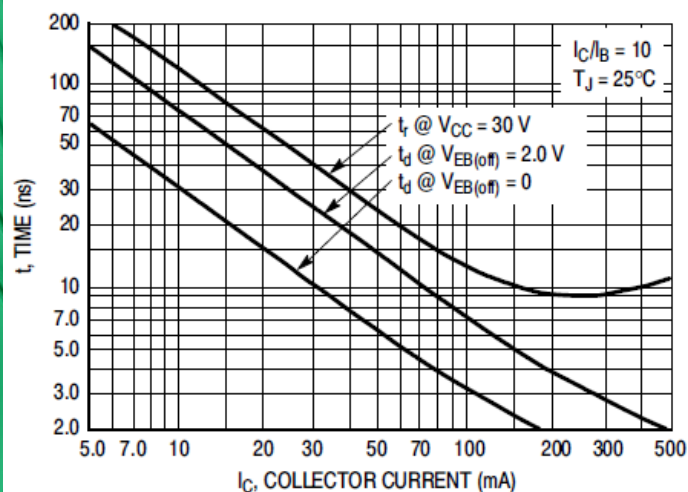


Figure 5. Turn-On Time

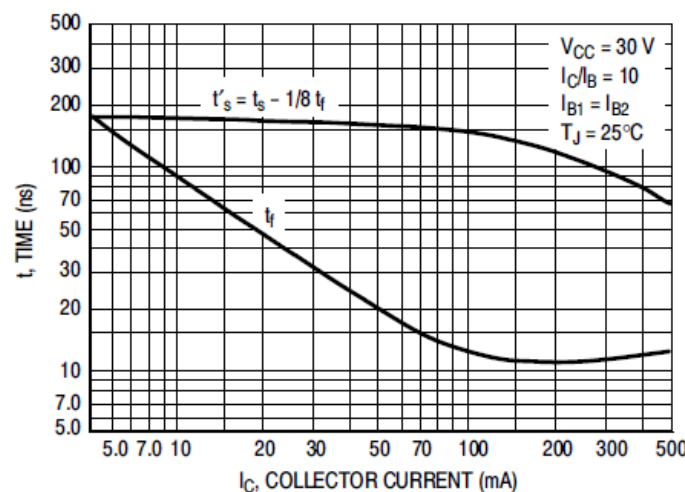
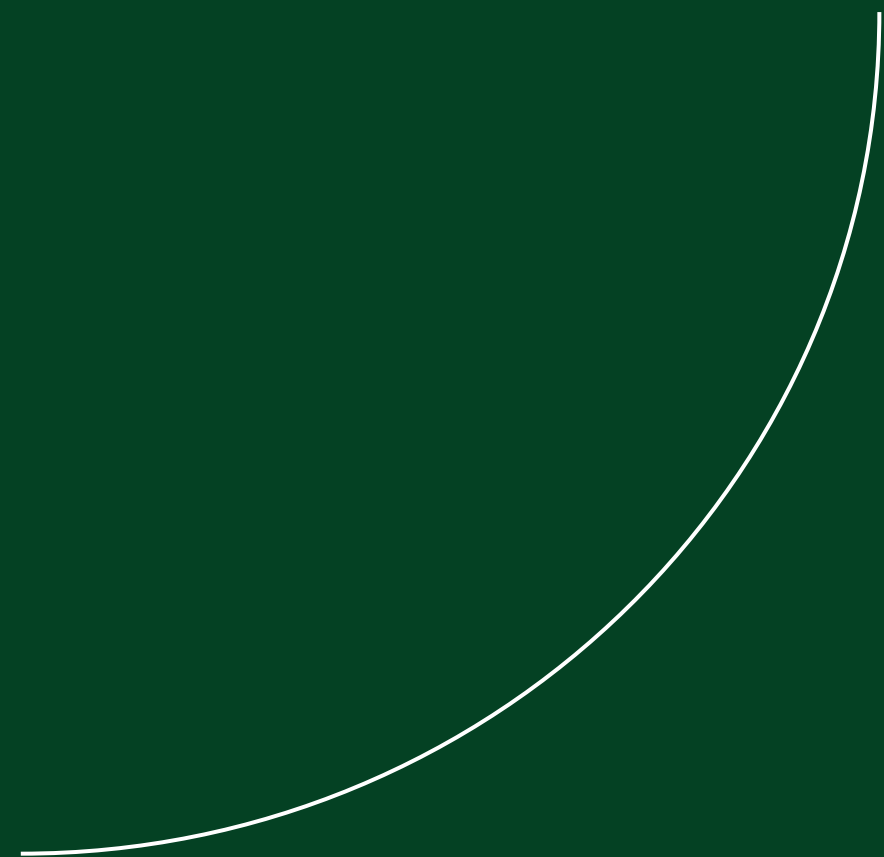


Figure 6. Turn-Off Time

Sweep Parameters

Importing and Automatic Variables



NI TestStand (64-bit) - Sequence Editor [Edit]

File Edit View Execute Debug Configure Source Control Tools Window Help

Sequence File 3 x TransistorCharacterization.seq QuiescentCurrent.seq

Steps: MainSequence

STEP	DESCRIPTION	SETTINGS
+ Setup (0)		
- Main (0)		
<Insert Steps Here>		
+ Cleanup (0)		

Step Settings

There are no steps selected.

Variables

NAME	VALUE
Locals ('MainSequence')	
ResultList	
<Right click to insert Local>	
Parameters ('MainSequence')	
<Right click to insert Parameter>	
FileGlobals ('Sequence File 3')	
<Right click to insert File Global>	

User: administrator Environment: <Global> Model: SequentialModel.seq No Steps Selected Number of Steps: 0

Input Sweep Parameters

Creating Parameters

Multiple ways to add and manage

Can represent both stimulus and response

Manually enter parameter names

New variables are created automatically

Import parameters from CSV

Automatic variable names update as you update them in the sweep loop step

Use instrument attributes from InstrumentStudio sessions

Nesting Sweeps

Support for Nested and Parallel Sweeps

Explore the spectrum

Understand the IV Curves of 2n2222a

Explore an array of temperatures

Need to explore V_{CE} across a range of values

- V_{CE} is set with **two** parameters
 - V_{CC} and V_E

Also need to change I_C

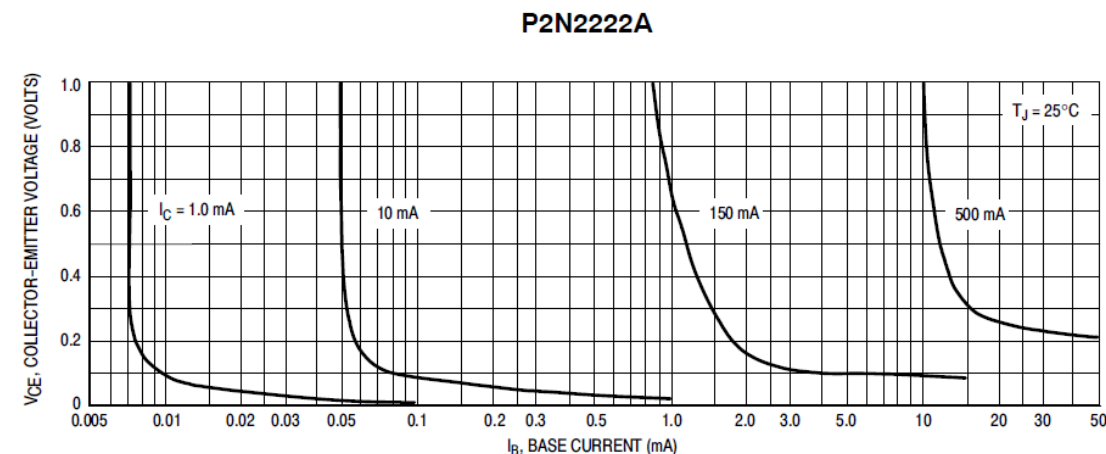


Figure 4. Collector Saturation Region

```
for (each Temp)
  Set Temp
  for (range of  $V_{CE}$ )
    Set  $V_{CC}$ 
    Set  $V_E$ 
    for (each  $I_C$ )
      Set  $I_C$ 
    end
  end
end
```

Step Settings for Sweep Transistor - Voltage and Current

Sweep Parameters						
TEST VECTORS: 228 TOTAL						
		PARAMETER NAME	TYPE		PARAMETER VALUE/SESSION	[COUNT], {RANGE}
<input checked="" type="checkbox"/>	0	Temp	123 ▼	<input type="checkbox"/>	Locals.Temp	[3] {-55 - 125}
<input checked="" type="checkbox"/>	1	Vcc	123 ▼	<input type="checkbox"/>	Locals.Vcc	[2] {5 - 15}
<input checked="" type="checkbox"/>	1	Ve	123 ▼	<input type="checkbox"/>	Locals.Ve	[2] {4 - 5}
<input checked="" type="checkbox"/>	2	Ic	123 ▼	<input type="checkbox"/>	Locals.Ic	[38] {0.1 - 501.1958979517}

Loop
nesting
level

Use to control
order and
nesting

Hover over
controls for tips

Vcc and Ve
increment
together

Inner loop

Step Settings for Sweep Transistor - Voltage and Current

Sweep Parameters									
Input Output Loop Information Properties									
TEST VECTORS: 228 TOTAL									
		PARAMETER NAME	TYPE		PARAMETER VALUE/SESSION	[COUNT], {RANGE}			
<input checked="" type="checkbox"/>	0	Temp				[125]			
<input checked="" type="checkbox"/>	1	Vcc	123 ▼		Locals.Vcc	[2] {5 - 15}	⚙	✓	
<input checked="" type="checkbox"/>	1	Ve	123 ▼		Locals.Ve	[2] {4 - 5}	⚙	✓	
<input checked="" type="checkbox"/>	2	Ic	123 ▼		Locals.Ic	[38] {0.1 - 501.1958979517}	⚙	✓	

Must move to bottom of nesting set, then move right

NI TestStand (64-bit) - Sequence Editor [Edit]

File Edit View Execute Debug Configure Source Control Tools Window Help

TransistorCharacterization.seq* LDO Sweep in Python.seq [Read Only]

Steps: MainSequence

STEP	DESCRIPTION	SETTINGS
	transistor, whereas, other parameters are used to measure current values...	
	Sweep Transist... 7 Sweep Parameter(s)	
	fx Calculate Vce Locals.Vce = Locals.V...	
	.N Measure Ic Action, NationalInstru...	
	.N Measure Ie Action, NationalInstru...	
	fx Calculate D... Locals.CurrentGain = L...	

Variables

NAME	VALUE
Locals ('MainSequence')	
ResultList	
SeqFileDirectory
CSVOutputStream	Nothing

Step Settings for Sweep Transistor - Voltage and Current

Sweep Parameters Input Output Loop Information Properties

TEST VECTORS: <Cannot Evaluate>

	PARAMETER NAME	TYPE	PARAMETER VALUE/SESSION	[COUNT], {RANGE}	PARAMETER:	VALUES:
<input checked="" type="checkbox"/>	0 Vcc	123 ▼	Locals.Vcc	[2] {5 - 15} Parameters	Strategy	Start, Stop, Step
<input checked="" type="checkbox"/>	0 Ve	123 ▼	Locals.Ve	[2] {4 - 5} Parameters	Mode	Static
<input checked="" type="checkbox"/>	0 Vce	123 ▼	Locals.Vce	Capture Value	Distribution	Geometric Progression
<input checked="" type="checkbox"/>	0 Ic	123 ▼	Locals.Ic	[38] {0.1 - 501.19589}	Numeric Format	<Default>
<input checked="" type="checkbox"/>	0 measured_Ic	123 ▼	Locals.measured_Ic	Capture Value	Start	0.1
<input checked="" type="checkbox"/>	0 measured_Ie	123 ▼	Locals.measured_Ie	Capture Value	Stop	510
<input checked="" type="checkbox"/>	0 CurrentGain	123 ▼	Locals.CurrentGain	Capture Value	Step	1.258926
					Count	38

User: administrator Environment: <Global> Model: SequentialModel.seq 1 Step Selected [4] Number of Steps: 16

Nesting Sweeps

Control and group

Multi-level nesting

Each step supports a top nesting level

Use multiple sweep steps in a sequence

Use nesting inside sweep step

One or more parameters at each nesting level

Sweep Strategies

Explore a variety of pre-defined sweep strategies



NI TestStand (64-bit) - Sequence Editor [Edit]

File Edit View Execute Debug Configure Source Control Tools Window Help

TransistorCharacterization.seq* x LDO Sweep in Python.seq

Steps: MainSequence

STEP	DESCRIPTION	SETTINGS
	This sweep loop step sweeps on various Voltage and Current parameters. Some of the parameters are used to set voltage or current values in the transistor, whereas, other parameters are used to measure current values...	
	Sweep Transist... 7 Sweep Parameter(s)	
	Calculate Vce Locals.Vce = Locals.V...	
	Measure Ic Action, NationalInstru...	
	Measure Ie Action, NationalInstru...	
	Calculate D... Locals.CurrentGain = L...	
	Write Recor... Locals.CSVOutputStre...	
	End	
	End	

Variables

NAME	VALUE
Locals ('MainSequence')	
ResultList	
SeqFileDirectory	""
CSVOutputStream	Nothing
123 Temperature	0
123 measured_Temperature	0
123 Vcc	0
123 Ve	0
123 Vce	0

Step Settings for Sweep Transistor - Voltage and Current

Sweep Parameters Input Output Loop Information Properties

TEST VECTORS: 76

	PARAMETER NAME	TYPE	PARAMETER VALUE/SESSION	[COUNT], [RANGE]	PARAMETER:	VALUE!
<input checked="" type="checkbox"/>	0 Vcc	123	Locals.Vcc	[2] {5 - 15}	Strategy	5
<input checked="" type="checkbox"/>	0 Ve	123	Locals.Ve	[2] {5 - 6}	Mode	Static
<input checked="" type="checkbox"/>	0 Vce	123	Locals.Vce	Capture Value	Distribution	Linear
<input checked="" type="checkbox"/>	1 Ic	123	Locals.Ic	[38] {0.1 - 501.1958979}	Numeric Format	<Default>
<input checked="" type="checkbox"/>	1 measured_Ic	123	Locals.measured_Ic	Capture Value	Start	5
<input checked="" type="checkbox"/>	1 measured_Ie	123	Locals.measured_Ie	Capture Value	Stop	15
<input checked="" type="checkbox"/>	1 CurrentGain	123	Locals.CurrentGain	Capture Value	Step	10
					Count	2

User: administrator Environment: <Global> Model: SequentialModel.seq 1 Step Selected [4] Number of Steps: 16

Sweep Strategies

Step how you want

Fine tuned control

Standard strategies

- Start, Stop, Step
- Start, Stop, Count
- Linear and Log Progression

Array

Edit as static array

Stream

- Load custom strategies

Capture Values

- Use to view measurements or variables in Test Vector Table and output data

NI TestStand (64-bit) - Sequence Editor [Edit]

File Edit View Execute Debug Configure Source Control Tools Window Help

TransistorCharacterization.seq* x LDO Sweep in Python.seq

Steps: MainSequence

STEP	DESCRIPTION	SETTINGS
	This sweep loop step sweeps on various Voltage and Current parameters. Some of the parameters are used to set voltage or current values in the transistor, whereas, other parameters are used to measure current values...	
	Sweep Transist... 7 Sweep Parameter(s)	
	fx Calculate Vce Locals.Vce = Locals.V...	
	.N Measure Ic Action, National Instru...	
	.N Measure Ie Action, National Instru...	
	fx Calculate D... Locals.CurrentGain = L...	
	Write Recor... Locals.CSVOutputStre...	
	End	
	End	

Variables

NAME	VALUE
ResultList	
SeqFileDirectory
CSVOutputStream	Nothing
123 Temperature	0
123 MinVcc	5
123 StepSize	10
123 MaxVcc	15
123 measured_Temperature	0
123 Vcc	0

Step Settings for Sweep Transistor - Voltage and Current

Sweep Parameters Input Output Loop Information Properties

TEST VECTORS: 76

	PARAMETER NAME	TYPE	PARAMETER VALUE/SESSION	[COUNT], {RANGE}	PARAMETER:	Vcc	VALUES:
<input checked="" type="checkbox"/>	0 Vcc	123	Locals.Vcc	[2] {5 - 15}	Strategy	Start, Stop, Step	5
<input checked="" type="checkbox"/>	0 Ve	123	Locals.Ve	[2] {4 - 5}	Mode	Static	15
<input checked="" type="checkbox"/>	0 Vce	123	Locals.Vce	Capture Value	Distribution	Linear	
<input checked="" type="checkbox"/>	1 Ic	123	Locals.Ic	[38] {0.1 - 501.1958979}	Numeric Format	<Default>	
<input checked="" type="checkbox"/>	1 measured_Ic	123	Locals.measured_Ic	Capture Value	Start	5	
<input checked="" type="checkbox"/>	1 measured_Ie	123	Locals.measured_Ie	Capture Value	Stop	15	
<input checked="" type="checkbox"/>	1 CurrentGain	123	Locals.CurrentGain	Capture Value	Step	10	
					Count	2	

User: administrator Environment: <Global> Model: SequentialModel.seq 1 Step Selected [4] Number of Steps: 16

Sweep Strategies

Static and Dynamic

When to use what and why

Static mode

- Used for values that will not change
- Allows the most control
 - Edit static arrays
 - Enable and disable test vectors and values

Dynamic mode

- Uses TestStand Expressions
- Variables can determine values
- Can change at run time

Table Views

Know what you are sweeping **and** the results



Table Views

Test Vectors and Value Summary

Preview the sweep space

Value Table

- Review all conditions

Test Vector Table

- Filter
- Enable and disable rows (static mode only)

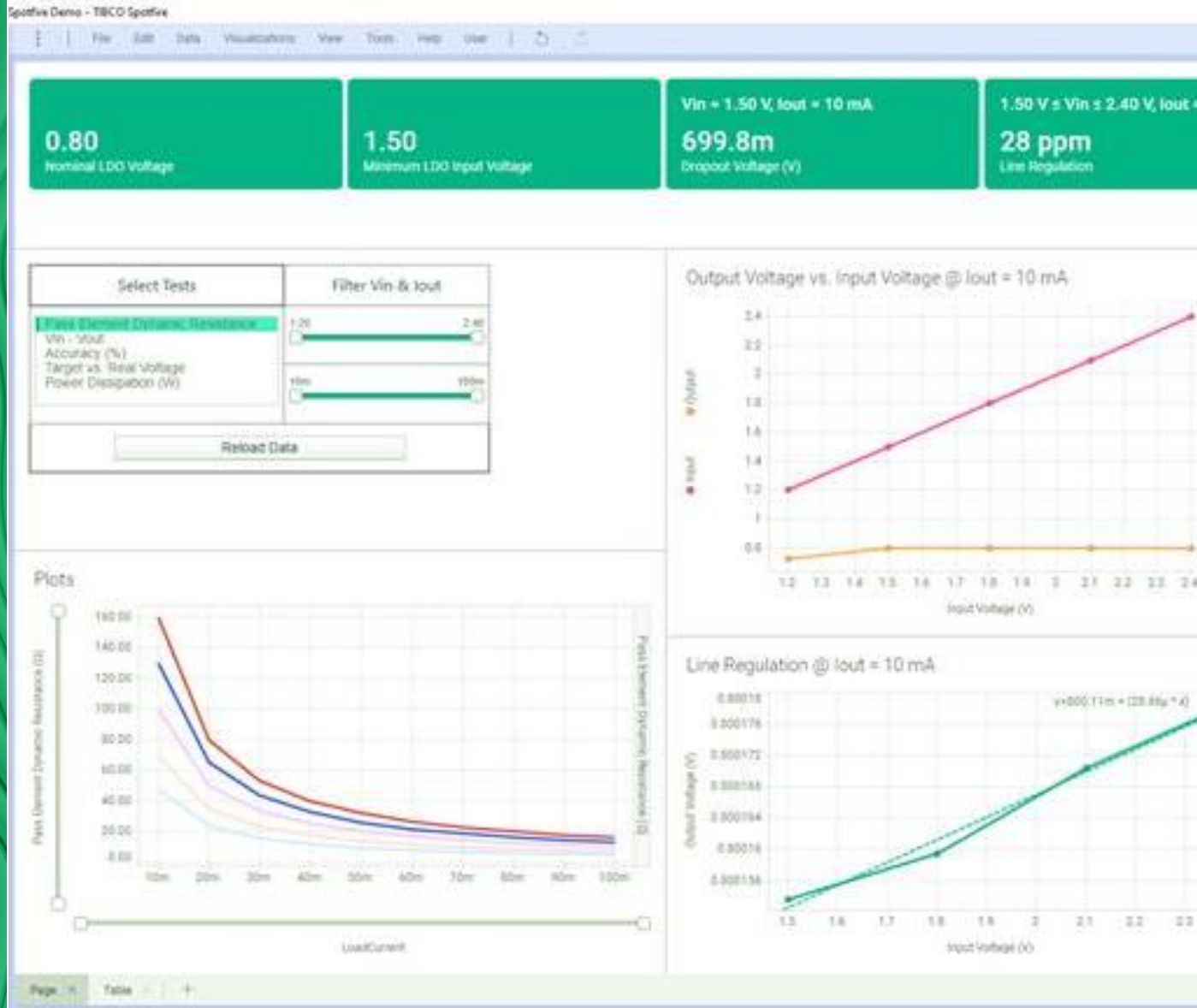
Save to disk

- Before execution
 - To rerun exact same tests
- After execution
 - Archive data, open in 3rd party tools

Exporting Results

Know what you are sweeping **and** the results





Exporting Results

Export your data

Digging deeper

Export to CSV

- Stream to disk or database
- Save from Test Vector Table

Use as Input Parameters

Stream

Further analyze the characteristics in external tools

Recap and Questions

Summary and your turn

Recap and Questions

Powerful Sweep Capabilities

Nesting and grouping of parameters

Input manually and automatically create variables

Import from CSV

Many sweep strategies and customizations

Table View to preview data and refine test coverage

Export input and output values together



Join the User Research Panel

We want to hear from you!

You can help inform decisions about the NI products you use by taking part in user research activities such as surveys, interviews, and usability tests.

If you are interested, follow the link below or scan the QR code with your mobile device to join the User Research Panel.

<https://survey.sogosurvey.com/r/o2CVhf>



Scan QR Code to participate