Advanced (Delta) I_DDQ Measurement Instrument Supporting Various Test Applications

FEATURES

- Wide DUT Supply range: V_{DUT} = 0.5V to 7V
- Wide measurement range: I_{DDQ} = 0 – 30mA
- Typical measurement time: 100 µs
- High capacitive driving capability: up to 10µF
- High single sample resolution: 20nA$_{RMS}$
- 16-bits I_DDQ Value Read Out
- 3-Wire Serial Configuration/Read out Interface
- On-board data processing capabilities

APPLICATIONS

- ATE Probe Card Applications
- ATE Interface Board Applications
- Delta I_DDQ Measurements
- Pre & Post Stress Delta I_DDQ
- I_DDQ Pass/Fail Measurements
- I_DDQ Read Out Measurements
- I_DDQ Window Comparisons

DESCRIPTION

The QD-1011 is a full featured, advanced configurable quiescent supply current (I_DDQ) measurement instrument, supporting both probe and final test and designed for probe card and interface board applications. The instrument supports a wide range of I_DDQ test and measurements applications and provides digital measurement values as well as a pass/fail output signal. On-board memory and data processing capabilities allow implementing a wide range of basic and advanced current based test strategies.

The QD-1011 operates according to the Stabilised Voltage Drop principle and is designed to be inserted between the Automated Test Equipment (ATE) device power supply and the supply pin(s) of the Device Under Test (DUT). There is no need to remove the local on-pin decoupling capacitors. Its unique design ensures transparency to both the ATE and DUT, under all conditions. The unit can drive high capacitive loads (up to several µF).

The QD-1011 offers the capability to perform accurate and highly repeatable high speed (up to 10kHz) quiescent supply current measurements with nA resolution/repeatability.
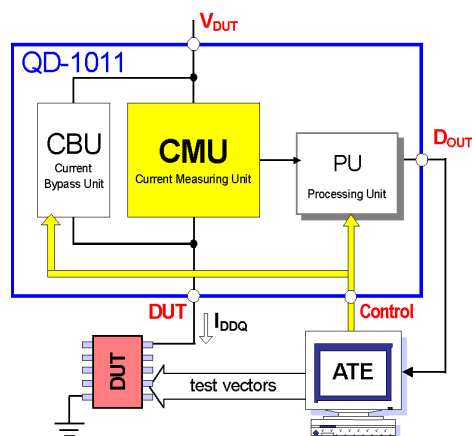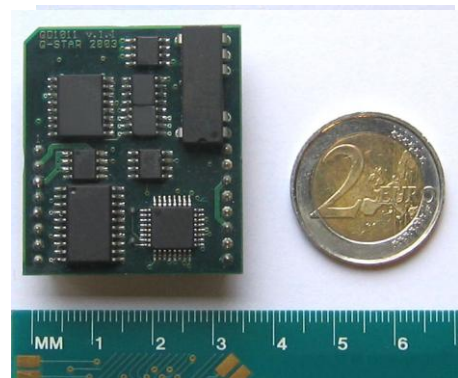

Figure 1. QD-1011 Application

The instrument has a wide measurement range (0-30mA). The serial output provides the Pass/Fail flag and/or the measured/processed I_DDQ values with a 16-bit resolution. The QD-1011 requires only a single positive supply, and allows a user programmable (0.5 to 7V) DUT supply level.

The QD-1011 has an on-board compensated bypass switch, which minimises charge transfers and is capable of transferring large transient currents. To assure DUT supply stability, the bypass switch is automatically activated when the measured current is out of the instrument's measurement range.

By default the QD-1011's Current Measurement Unit (CMU) is optimised to perform an I_DDQ measurement in 100µs for a 100nF to 10µF capacitive load. The processing and read out time is function of the application and takes typically 20µs. The default measurement range of the QD-1011 is set to 0-1mA with a single sample resolution of 50nA$_{RMS}$. Other possible fixed measurement ranges are 0-100µA, 0-10mA, 0-30mA with a single sample resolution of 20nA$_{RMS}$, 360nA$_{RMS}$ and 2.2µA$_{RMS}$. All these parameters can be customised for optimal performance in function of desired measurement speed/resolution and actual loading conditions.

Operating Modes

The QD-1011 has two main operating modes: **bypass mode** and **measurement mode**. During bypass, the instrument provides a low resistance path between ATE supply and DUT. During measurement, the actual measurement(s) take(s) place. The module can be programmed during bypass mode. The programming operation allows selecting the measurement approach and to set the pass/fail level(s). A simple programming protocol is used.

The normal measurement cycle consists of a settling period (typ. 100µs) followed by a capture, processing and read-out period (typ. 20µs). When in measurement mode the module is acting as DUT power supply. When during measurement mode the measured current is out of the instrument's measurement range, then the QD-1011 automatically switches back to bypass mode, meanwhile indicating a fail situation. Figures 1 and 2 show a general application diagram as well as a typical measurement cycle.
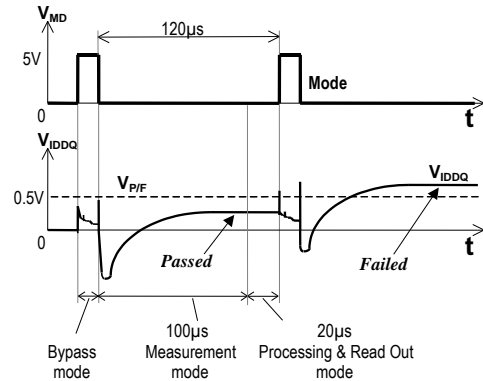

Figure 2. Typical Measurement Cycle

Typical Applications

The QD-1011 can be applied in various ways; some of them are listed below:

- The unit can be used as a pass/fail (P/F) instrument,
- The instrument can be used as a measurement device to determine the exact value of the measured current. The QD-1011 digitises the measured value with a 16-bit resolution. This value can be read out using the serial interface.
- The QD-1011 can be used as a delta-I_{DDQ} instrument, among the supported delta strategies are:
  - Vector-to-vector delta, providing a 16-bit delta value and/or P/F flag.
  - Vector-to-"reference vector" delta, providing a 16-bit delta value and/or P/F flag per vector referred to the measured value of the reference vector.
  - Vector-to-"external reference" (provided by the ATE and loaded in the module during configuring) delta, providing a 16-bits delta value and/or P/F flag per vector referred to the external reference. The reference value can be changed on a vector-to-vector basis.
  - Pre-to-post stress delta, providing a 16-bit delta value and/or P/F flag per vector referred to the pre stress measured value of the same vector

For all operating modes using a pass/fail flag, the pass/fail flag is generated either as a result of comparing the measurement result (measured value or calculated delta) with a single pass/fail reference value or a pass/fail reference window. The QD-1011 supports a modification of the pass/fail reference level or window on a vector-to-vector basis, as such it supports the use of current signatures.

ELECTRICAL SPECIFICATIONS

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS
V_{CC}	Positive Supply Voltage	+4.5	+5.0	+5.5	V
I_{DDQ}	Measurement Range	0.1	1	30	mA
V_{DUT}	DUT Supply Voltage	0.5	3 - 5	7	V
	Single Sample Resolution [1]	20	50	2200	nA_{RMS}
	Measurement Time	[2]	100	[3]	µs
C_L	Loading Capacitance	0.01	1	10	µF
V_{IDDQ}	V/I Conversion Ratio	0.5	5	50	mV/µA
I_{DDT}	Transient Current		30		A
R_{ON}	On Resistance		20		mΩ

(1) Configuration dependant, the values listed are for a C_L=0.5µF optimised unit.
(2) The QD-1011 can be used to perform static measurements
(3) The maximum measurement time is dependent on the number of samples taken. 114µs @ 1 sample, 150µs @ 4 samples, 290µs @ 16 samples.