

# Technical Information

TI 04L51B01-05EN

Applying Yokogawa Recorders and Controllers to Heat Treatment Applications in the Aerospace and the Automotive Industry

**SMARTDAC+™**



**DXAdvanced™**



**UTAdvanced™**



The contents of this Technical Information are subject to change without notice.

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# 1. Scope

- (1) This document describes how the DXAdvanced, the SMARTDAC+ and the UTAdvanced can fulfill the requirements from AMS2750G and CQI-9.
- (2) This document refers to the above regulations. The copyright of each regulation belongs to its owner. If the quoted passage is different from the original documentation, the original documents prevail at all times.

# 2. What are DXAdvanced, SMARTDAC+ and UTAdvanced?

## 2-1 DXAdvanced: DX1000 & DX2000

- (1) DXAdvanced is a paperless recorder; maximum number of directly connected universal measurement inputs is 48.

## 2-2 SMARTDAC+: GX10, GX20, GP10, GP20 & GM

- (1) The GX10, GX20, GP10 and GP20 are paperless recorders with multi-touch display; maximum number of directly connected universal measurement inputs is 100.
- (2) The Data Acquisition System GM is a data logger that excels in versatility and expandability; maximum number of directly connected universal measurement inputs is 100.

## 2-3 DAQStandard for DXAdvanced

- (1) DAQStandard is PC based software used for hardware configuration (Online- and Offline-), and historical data analysis and playback.
- (2) Users can modify and/or upload and download configuration settings of the DXAdvanced.

## 2-4 Webserver and Hardware Configurator for SMARTDAC+

- (1) The Webserver consist of a realtime monitor function and an on-line configurator.
- (2) The Hardware Configurator is PC based software used for off-line hardware configuration.

## 2-5 Data Viewer software

- (1) Users can playback the measurement data using the historical viewer in both trend-graph and digital format. Log information (Alarm log, operation log, ...) can be displayed as well. All necessary information can be printed out using standard printers. Data conversion to major spreadsheet formats is also supported.

## 2-6 UTAdvanced: UT52A, UT55A & UP55A

- (1) The UTAdvanced is a digital indicating PID controller with ladder sequence control; UT55A and UP55A have 1/4 DIN external structure and UT52A has 1/8 DIN external structure. Also UP55A is embedded with program pattern control.

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## **3. Detail Description of DXAdvanced/SMARTDAC+ and UTAdvanced – Operation Securities**

### **3-1 Briefing**

- (1) AMS2750G requires that access to systems that are used to create, modify, maintain, or retrieve electronic records must be limited to authorized individuals.
- (2) Additionally, authority checks are required to assure that authorized individuals accessing the systems are able to perform only tasks for which they have the appropriate level of access and for which they have been properly trained.
- (3) DXAdvanced and SMARTDAC+ have a) Log-in security and b) key-lock function as standard.
- (4) UTAdvanced has key-lock function and password control for configuration parameters as standard.

### **3-2 Log-in Security – DXAdvanced and SMARTDAC+**

- (1) Both can be configured to utilize a combination of user name, and password to limit system access to authorized users. Each user name must be unique. Permissions can be further defined to provide a variety of access levels ranging from view-only access to full administrative and remote communication and configuration rights. DXAdvanced allows the configuration of a maximum of five (5) administrators and up to thirty (30) users. SMARTDAC+ allows the configuration of a maximum of fifty (50) administrators and users in total. Individual users cannot modify their own access levels.
- (2) Limiting system access to authorized users and controlling individual levels of access provides effective security for the use of the instrument.

### **3-3 Access Security – DXAdvanced, SMARTDAC+ and UTAdvanced**

- (1) DXAdvanced and SMARTDAC+ GX/GP series have a physical locking system on its front door, which prevents unauthorized access to the external media and to the power switch.
- (2) UTAdvanced has locking functionality for front button and password control for configuration parameters. Both functions prevent unauthorized access and misoperation.

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## 4. Detail Description of DXAdvanced/SMARTDAC+ – Data Security

### 4-1 Briefing

- (1) AMS2750G and CQI-9 require that records are protected so that they can be retrieved readily and accurately throughout any required retention period. This requirement applies not only to records at their time of creation but also to archived electronic records for the duration of their storage period.

### 4-2 Data file Management

- (1) DXAdvanced/SMARTDAC+ data files are stored in a proprietary encrypted binary format and as such cannot be modified by ordinary means once they have been created.
- (2) Acquired data, such as temperature values, are also stored in a proprietary binary format and cannot be changed once they have been stored. DXAdvanced/SMARTDAC+ maintains records of all alarms, alarm acknowledgements, error messages in the same binary files. These files cannot be changed by users or administrators. When the user directly accesses binary data and edits it, the file becomes unavailable. An error message will appear the next time anyone attempts to access the data notifying the user that the file is damaged and cannot be viewed.
- (3) DAQStandard and Viewer display and print data in human readable form. The files can be easily copied for backups, archiving, inspection, and review.
- (4) Neither the DXAdvanced/SMARTDAC+ nor the DAQStandard and Viewer software allow a user to overwrite records, nor do they automatically overwrite records.

### 4-3 Data Security – Data redundancy using the FTP function

- (1) An FTP client mode function allows records created by the DXAdvanced/SMARTDAC+ to be automatically sent to a secure FTP server directory for long-term or short-term storage. The DXAdvanced/SMARTDAC+ has the capability of automatically sending a preconfigured username and password combination, if required, for file upload access to the FTP directory. The SMARTDAC+ can also send the files by using SSL encryption.
- (2) Access levels at the FTP server directory can be further controlled through good local network security policy.
- (3) Data files are stored sequentially to the DXAdvanced/SMARTDAC+ external archive media and then to the FTP server when this function is used. The data record is always archived even if the network connection to the server is lost. If the connection fails, data will be automatically transferred via FTP as soon as the connection is restored. These records can then be maintained under a company's general electronic records archiving policy.

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## 5. Detail Description of DXAdvanced/SMARTDAC+ – Batch Header Function

### 5-1 Briefing

- (1) AMS2750 requires that lots (batches) and sub-lots (sub-batches) of identical parts are to be identified to preclude their mixing and to ensure lot integrity.

### 5-2 Batch header function of DXAdvanced/SMARTDAC+

- (1) DXAdvanced/SMARTDAC+ has a Batch header function as standard. Customers can input a batch name and a lot number for each batch record. The batch name together with the lot number can be used as the file name of the data file.
- (2) DXAdvanced/SMARTDAC+ can be operated in either a Batch or Continuous mode for data collection.
- (3) For both cases above, batch header information is compiled together with the measurement data.
- (4) The Viewer software shows batch header information together with the measurement record.

## 6. Description Table

### 6-1 AMS2750G

Please note that this table is referring to AMS2750 revision G, which was originally established by SAE International. If there are any incompatibilities, the original document always prevails.

AMS2750G Requirements		Comments	
		DXAdvanced/SMARTDAC+	UTAdvanced
Test Instruments, Controlling, Monitoring or Recording Instruments			
6-1-1	3.1.4.8 Sensor Calibration	DXAdvanced has up to 15-segment linearizer for each measurement input channel as a configuration option (/CC1). The approximation method is used for linearization. SMARTDAC+ has up to 11-segment linearizer function for each input channel as standard. Either biasing or approximation method is used for linearization. In addition, SMARTDAC+ has the option (/AH) which allows for T/C offsets to be entered with each set point.	UTAdvanced has up to 10-segment linearizer besides bias function for control input channel as standard. Either biasing or approximation method is used for linearization.
	Interpolation of correction factors between two known calibration points is permitted using the linear method.		
6-1-2	3.2.3.1, 3.2.3.2 Minimum Readability	Yokogawa's DXAdvanced/SMARTDAC+ have a readability resolution of 0.1 °F or 0.1 °C.	Yokogawa's UTAdvanced has a readability resolution of 0.1 °F or 0.1 °C.
	All control, recording, and Over-Temperature Instruments shall be digital. Digital recording instruments shall produce permanent records with a minimum readability of 0.1°F or 0.1°C.		
6-1-3	3.2.3.3 Sensor Signals	Yokogawa's DXAdvanced/SMARTDAC+ accept all T/C sensor inputs except for type M and C as listed in Table 2. All signals are digitally processed. Please refer to GS for measurement accuracy.	Yokogawa's UTAdvanced accepts all T/C sensor inputs except for type M and C as listed in Table 2. All signals are digitally processed. Please refer to GS for measurement accuracy.
	Instruments shall receive an unmodified signal from sensors excepts for analog to digital and digital to analog conversions, or a digitally processed, error-checked equivalent representation of a direct measured value.		
6-1-4	3.2.6.1.1 Offsets	DXAdvanced has up to 15-segment linearizer for each measurement input channel as a configuration option (/CC1). The approximation method is used for linearization. SMARTDAC+ has up to 11-segment linearizer function for each input channel as standard. Either biasing or approximation method is used for linearization. In addition, SMARTDAC+ has the option (/AH) which allows for T/C offsets to be entered with each set point.	UTAdvanced has up to 10-segment linearizer besides bias function for control input channel as standard. Either biasing or approximation method is used for linearization.
	If instrument correction and/or modification offsets are used, a documented procedure shall exist describing when and how to make instrument correction and/or modification offsets.		
Instrument Calibration			



6-1-5	3.2.1.3 Calibration Accuracy	Yokogawa's DXAdvanced/SMARTDAC+ will meet or exceed the calibration requirement in Table 7. Please refer to the tables on page 8.	Yokogawa's UTAdvanced will meet or exceed the calibration requirement in Table 7. Please refer to the table on page 8.
	Instruments shall be calibrated in accordance with Table 7 and shall be traceable to NIST or other internationally recognized standards organization. Field Test Instrument: $\pm 1$ °F ( $\pm 0.6$ °C) or $\pm 0.1\%$ of reading, whichever is greater Controlling, Monitoring, or Recording Instrument (Digital instrument) : $\pm 2$ °F ( $\pm 1.1$ °C) or 0.2% of reading whichever is greater		

SMARTDAC+ measurement accuracy after adjustment using calibration correction function



Input type		Measurement range in Fahrenheit	Measurement range in Celsius	Typical value (Incl. RJC error)
TC	R	932 to 3,200 °F	500 to 1,760 °C	±1 °F(±0.6 °C) or ±0.06% of reading, whichever is greater
	S	932 to 3,200 °F	500 to 1,760 °C	
	K	32 to 2,498 °F	0 to 1,370 °C	±0.5 °F(±0.3 °C) or ±0.03% of reading, whichever is greater
	N	32 to 2,372 °F	0 to 1,300 °C	
	J	32 to 2,012 °F	0 to 1,100 °C	
	K-H	32 to 932 °F	0 to 500 °C	
	T	32 to 752 °F	0 to 400 °C	

Note: - Under general operating condition mentioned in User's Manuals;  
 - This table is applicable to GX90XA-10-U2 only;  
 - A/D integration time: 16.67 ms or more;  
 - Typical value does not include the error of measuring instruments which is used to gather actual errors.

#### DXAdvanced measurement accuracy after adjustment using calibration correction function

Input type		Measurement range in Fahrenheit	Measurement range in Celsius	Typical value (Incl. RJC error)
TC	R	932 to 3,200 °F	500 to 1,760 °C	±1 °F(±0.6 °C) or ±0.1% of reading, whichever is greater
	S	932 to 3,200 °F	500 to 1,760 °C	
	K	32 to 2,498 °F	0 to 1,370 °C	
	N	932 to 2,372 °F	500 to 1,300 °C	
	J	32 to 2,012 °F	0 to 1,100 °C	
	T	32 to 752 °F	0 to 400 °C	

Note: - Under general operating condition mentioned in User's Manuals;  
 - A/D integration time: 16.67 ms or more;  
 - Typical value does not include the error of measuring instruments which is used to gather actual errors.

#### UTAdvanced measurement accuracy after adjustment both zero and full point of the measurement range.

Input type		Measurement range in Fahrenheit	Measurement range in Celsius	Typical value (Incl. RJC error)
TC	K	32 to 2,498 °F	0 to 1,370 °C	±2 °F(±1.1 °C) or ±0.2 % of reading, whichever is greater
	J	32 to 2,192 °F	0 to 1,200 °C	
	T	32 to 752 °F	0 to 400 °C	
	S	32 to 3,092 °F	0 to 1,700 °C	
	R	32 to 3,092 °F	0 to 1,700 °C	
	N	32 to 2,372 °F	0 to 1,300 °C	

Note: - The accuracy is that in the standard operating conditions: 23±2°C, 55±10 %RH, and power frequency at 50/60 Hz.  
 - Zero and full point of measurement range can be adjust using 10-segment linearizer and bias function.  
 - Typical value does not include the error of measuring instruments which is used to gather actual errors.

**Table 1. Measurement Accuracy of SMARTDAC+, DXAdvanced, and UTAdvanced**

AMS2750G Requirements		Comments	
		DXAdvanced/SMARTDAC+	UTAdvanced
Electronic Data Recording			
6-1-6	3.2.4.2. a Electronic Records – Operation	Acquired data is stored in a proprietary binary format and cannot be changed once the data have been stored. Should a user attempt to change any data by directly accessing the binary data, the file will become unusable. An error message will appear the next time anyone attempts to access the data notifying the user that the data has been changed and the file cannot be viewed.	Not applicable
	The system creates records that cannot be altered without detection.		
6-1-7	3.2.4.2. b Electronic Records – Playback	Yokogawa's DXAdvanced/SMARTDAC+ allow for playback in trend-graph format. The viewer software displays and prints data in human readable form using a PC. Such files can be easily copied for backups, archiving, inspection and review.	Not applicable
	The system provides software and playback utilities as a means of examining and/or compiling the data but shall not allow the user any means for altering the source data.		
6-1-8	3.2.4.2 c Electronic Records – Data Output	Yokogawa's DXAdvanced/SMARTDAC+ allow for record generation in both human readable form and electronic form for inspection, review, and copying.	Not applicable
	The system provides the ability to generate accurate and complete copies of records in both human readable and electronic form suitable for inspection, review, and duplication.		
6-1-9	3.2.4.2. d Electronic Records – Signature	Yokogawa's advanced security function option (/AS1 for DXAdvanced and /AS for SMARTDAC+) allows the user to utilize viewer software to review sign off on the data electronically. Additionally, users can physically print out the record and sign physically.	Not applicable
	The system is capable of providing evidence the record was reviewed by recording an electronic review, or a method of printing the record for a physical marking verifying review.		
6-1-10	3.2.4.2. e & f Electronic Records - Record Retention	Yokogawa's DXAdvanced supports up to 32GB of external CF card memory. SMARTDAC+ supports up to 32GB of SD card memory.	Not applicable
	The system supports protection, retention, and retrieval of accurate records throughout the record retention period. And the system ensures that the hardware and/or software shall operate throughout the retention period as specified in section 3.7.		
6-1-11	3.2.4.2. g Electronic Records – Data Access	Yokogawa's DXAdvanced/SMARTDAC+ can prevent illegal data access by unauthorized users with log-in authentication and/or software-key lock protection.	Not applicable
	The system provides methods of protection, such as a password, to limit system access to only individuals whose authorization is documented.		

## 6-2 CQI-9

The table below quotes “CQI-9 Special Process: Heat Treat System Assessment, Edition 4 Study Guide” by the Automotive Industry Action Group (AIAG). In case of discrepancies, the original document always takes precedence.

CQI-9 Requirements		Comments	
		DXAdvanced/SMARTDAC+	UTAdvanced
Controlling, Monitoring, and Recording Instrument			
6-2-1	3.2.1 General Instrumentation Requirements	The SMARTDAC+ calibration certificate provides a traceability diagram of the system from product testing to national standards, and a list of the calibration equipment used therein.	The UTAdvanced calibration certificate provides a traceability diagram of the system from product testing to national standards, and a list of the calibration equipment used therein.
	3.2.1.1 All instrumentation calibrations shall be traceable to the National Institute of Standards and Technology(NIST) or national or international standard.		
	3.2.1.3 Calibration frequencies and accuracies are specified in the Instrumentation Table 3.2.1. Field Test Instrument: $\pm 0.6^{\circ}\text{C}(\pm 1.0^{\circ}\text{F})$ or $\pm 0.1\%$ of reading whichever is greater. Control Monitoring or Recording Instruments: $\pm 2.0^{\circ}\text{C}(\pm 4.0^{\circ}\text{F})$	DXAdvanced/SMARTDAC+ satisfies the calibration requirements in table 3.2.1. See table 1 on page 8. SMARTDAC+ also has control functions, and enables control, monitoring, and recording in a single unit.	UTAdvanced satisfies the calibration requirements in table 3.2.1. See table 1 on page 8.
	3.2.1.4 The temperature for each control zone shall be recorded by a recording instruments. 3.2.1.4.1 Recorder shall be operating during the entire time that product is in the furnace and print intervals/sample rates shall not exceed 5 minutes for analog recorders and 2 minutes for digital recorders. Process record shall be legible.	The shortest DXAdvanced recording interval is 25 msec. The shortest SMARTDAC+ recording interval is 100 msec.	Not applicable
6-2-2	3.2.2 Readability and Resolution	Yokogawa's DXAdvanced/SMARTDAC+ have a readability resolution of $0.1^{\circ}\text{C}$ or $0.1^{\circ}\text{F}$ .	Yokogawa's UTAdvanced has a readability resolution of $0.1^{\circ}\text{C}$ or $0.1^{\circ}\text{F}$ .
	3.2.2.1 Test instruments shall be digital and have a minimum readability of $1.0^{\circ}\text{C}$ or $1.0^{\circ}\text{F}$ .		
	3.2.2.2 At least one controlling, monitoring, or recording instrument for each furnace or even zone shall have a minimum readability of $1.0^{\circ}\text{C}$ or $1^{\circ}\text{F}$ for digital instruments or $2.0^{\circ}\text{C}$ or $4.0^{\circ}\text{F}$ for analog recorders.	Yokogawa's DXAdvanced/SMARTDAC+ have a readability resolution of $0.1^{\circ}\text{C}$ or $0.1^{\circ}\text{F}$ .	Yokogawa's UTAdvanced has a readability resolution of $0.1^{\circ}\text{C}$ or $0.1^{\circ}\text{F}$ .
6-2-3	3.2.3 Offsets	DXAdvanced has up to 15-segment linearizer for each measurement input channel as a configuration option (/CC1).The approximation method is used for linearization. SMARTDAC+ has up to 11-segment linearizer function for each input channel as standard. Either biasing or approximation method is used for linearization. In addition, SMARTDAC+ has the option (/AH) which allows for T/C offsets to be entered with each set point.	UTAdvanced comes standard with a bias function for the control input channels and up to 10 segments of linearizer bias or linearizer approximation input correction.
	3.2.3 Although the use of offsets is generally discouraged, they are allowed to (specifically) correct for calibration errors, SAT errors and to center a TUS result. When offsets are used a documented procedure shall exist which at a minimum describes each of the following: - When the use of offset is permitted - How manual and electronic offsets are performed - How the basis (calibration, SAT or TUS) for the offset is documented - How offset is accounted for when performing calibrations - How offset is considered when performing an SAT - How to reintroduce any intentional offsets - Who has the authority to approve the use of offsets - How the approval is documented		

6-2-4	3.2.4 Calibration	The calibration procedure is clearly documented in the DXAdvanced/SMARTDAC+ user's manual.	Not applicable
	3.2.4 Calibration of control, monitoring, and recording instruments shall be performed to the manufacturer's instructions.		
6-2-5	3.2.6 Electronic Records	By using the advanced security function (the DXAdvanced /AS1 option and the SMARTDAC+ /AS option), changes to parameters and the changing of users are saved in the data. Data is saved in a proprietary binary format, and saved data cannot be altered.	Not applicable
	3.2.6 When using a control, recording, monitoring or data acquisition system that creates electronic records the system shall create write-once, read-only electronic records that cannot be altered without detection.		
6-2-6	3.4.2 Continuous and Semi-continuous Furnaces	With DXAdvanced, you can connect up to 48 thermocouples. With SMARTDAC+, you can connect up to 100 thermocouples to the main unit. With an expansion, you can connect up to 450 thermocouples.	Not applicable
	3.4.2.2 Number and Location of TUS Thermocouples		
	3.4.2.2.1 Volumetric Method: Shall be used with continuous pusher furnaces. See Table 3.4.1 for number of TUS thermocouples. See Figure 3.4.1 for the location of the TUS thermocouples.	With DXAdvanced, you can connect up to 48 thermocouples. With SMARTDAC+, you can connect up to 100 thermocouples to the main unit. With an expansion, you can connect up to 450 thermocouples.	Not applicable
	3.4.2.2.2 Plane Method: Shall be used for continuous furnaces where the product is continuously moving through the furnace, e.g., belt furnaces. See Table 3.4.2 for number of thermocouples. Refer to table 3.4.2 for the location of the US thermocouples.		
6-2-7	3.4.2.3 TUS Data Collection	The shortest DXAdvanced recording interval is 25 msec. The shortest SMARTDAC+ recording interval is 100 msec.	Not applicable
	3.4.2.3.2 Data collection shall begin when the TUS test thermocouples are loaded into the furnace. All data collected shall be included in the TUS reporting. All temperature data generated by the TUS test thermocouples shall be recorded automatically at least every thirty seconds. The process record for furnace zone temperature shall be compared to the TUS data to ensure compliance to TUS requirements. Manual data collection is not allowed.		
6-2-8	3.4.3 Batch/ Chamber Furnaces	The shortest DXAdvanced recording interval is 25 msec. The shortest SMARTDAC+ recording interval is 100 msec.	Not applicable
	3.4.3.4 TUS Data Collection : Data Collection shall begin when the TUS thermocouples are loaded into the furnace. All temperature data generated by the TUS thermocouples and recorded on the process record for furnace zone temperature shall be recorded automatically at a frequency of at least one set of readings every two minutes for the duration of the survey.		
	3.4.3.4.1 When the furnace temperature control achieves set point temperature, displaying a normal control cycling around set point, and the TUS test thermocouples have stabilized, then the TUS data collection shall continue for an additional thirty minutes minimum.	The data length is clearly documented in the DXAdvanced/SMARTDAC+ user's manual.	Not applicable

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## 7. AMS2750G and CQI-9 Compliance Statement

### 1) Controlling, Monitoring, or Recording Instrument

Yokogawa recorders and controllers covered for “Controlling, Monitoring or Recording Instruments” in AMS2750G and CQI-9 are as follows:

- SMARTDAC+ GX/GP Series Paperless Recorders and GM Series Data Acquisition System with 11-segment linearizer function;
- Daqstation DXAdvanced Series Paperless Recorders with 15-segment linearizer function;
- UTAdvanced Series Digital Indicating Controllers with 10-segment linearizer function.

These products meet the accuracy requirements of AMS2750G table 7 and CQI-9 table 3.2.1 for “Controlling, Monitoring, or Recording Instrument” and are compliant to “Electronic Records” in AMS2750G clause 3.2.4.

### 2) Field Test Instrument

Yokogawa recorders covered for “Field Test Instruments” in AMS2750G and CQI-9 are as follows:

- SMARTDAC+ GX/GP Series Paperless Recorders and GM Series Data Acquisition System with 11-segment linearizer function;
- Daqstation DXAdvanced Series Paperless Recorders with 15-segment linearizer function.

These products meet the accuracy requirements of AMS2750G table 7 and CQI-9 table 3.2.1 for “Field Test Instrument” and are compliant to “Electronic Records” in AMS2750G clause 3.2.4.

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