Sample Specification

PowerFlex 70 Enhanced Control

GENERAL

REFERENCES

Designed to meet the following specifications:

- NFPA 70 - US National Electrical Code
- NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- NEMA 250 - Enclosures for Electrical Equipment
- UL 508C - Underwriter's Laboratory
- CAN/CSA-C22 No. 14-M91. - Canadian Standards Association.
- IEC 146 - International Electrical Code.

REGULATORY REQUIREMENTS

Conforms to the following requirements:

- NFPA 70
- IEC 146
- C-UL marking to provide an approved listing for Canadian users.
- UL listing
  Manufacturer will furnish the product as listed and classified by Underwriter's Laboratories as suitable for the purpose specified and indicated.
- NSF certification and marking (NEMA 4X / IP66 stand alone ratings only).
- SEMI F47 certification
- EN Standard/CE marked for the following directives (excluding 600V ratings):

  Low Voltage Directive (73/23/EEC)
  EN50178 Electronic Equipment for use in power installations
  EMC Directive (89/336/EEC)
  EN61800-3 Adjustable Speed electrical power drive systems Part 3.

  Drive has an internal EMC filter capable of meeting the Second Environment levels for the EMC directive without the need for additional components. First environment classification is achievable with the addition of an external filter.

- C-Tick EMC Standards for Australia / New Zealand

QUALIFICATIONS

MANUFACTURER:

Allen-Bradley entered the AC Variable speed drive market in 1980. Rockwell Automation / Allen-Bradley Standard Drives Business continues to specialize in the design and manufacturing of PWM Adjustable Frequency Drives.

SUPPORT:

Rockwell Automation maintains factory trained and authorized service facilities within 100 miles of the project and has a demonstrated record of service for at least the previous three years. Rockwell Automation employs full-time support personnel.

CERTIFICATION:

All Allen-Bradley drive manufacturing locations are certified to the ISO-9001 Series of Quality Standards as well as the ISO-14001 Environmental Standards. This insures all quality and corrective action procedures are documented and implemented with a goal of Total Customer Satisfaction.

PRODUCT

RATINGS

VOLTAGE CLASSES:

Available in the following three voltage classes and is self-adjustable within each class:

200VAC – 10% to 240 VAC +10%, three phase

380VAC – 10% to 480 VAC +10%, three phase

500VAC – 13.6% to 600 VAC +10%, three phase.

Displacement power factor is between 1.0 and 0.95, lagging, over the entire speed range. The efficiency is a minimum of 97% at full load and speed.

ENVIRONMENT:

Storage ambient temperature range: -40º C to 70º C (-40º to 158ºF).
Operating ambient temperature range without derating:

IP00, Open Type	0º C to 50º C (0º to 122º F)
IP20, Type 1	0º C to 50º C (0º to 122º F)
Flange Mount (IP66/NEMA 4X/12 backside)	0º C to 50º C (0º to 122º F)
IP66, Type 4X/12 (indoor use)	0º C to 40º C (0º to 104º F)

The relative humidity range is 5% to 95% non-condensing.
Operating elevation: up to 1000 Meters (3,300ft) without derating.
Shock: 15G peak for 11ms duration
Vibration: 0.152 mm (0.006 inches) displacement, 1G peak

Drives can be Zero-Stacked (mounted next to other drives with zero clearance between them).

REFLECTED WAVE

A software algorithm to limit the reflected wave due to long cable lengths to a maximum of 2.25 times the bus voltage or 1600V, whichever is less, up to cable lengths of 600 ft (183m). Hardware designs also limit peak voltages on the motor.

DESIGN

HARDWARE:

Employs the following power components

- Diode or fully gated bridge on the input.
- DC bus inductor on ratings 7.5HP (5.5kW) or greater.
- Switching logic power supply operating from the DC bus.
- MOV protection - phase to phase and phase to ground with jumpers to remove the phase to ground unit when applicable.
- Common Mode Capacitors on all units above 2 HP, 480V with jumpers for removal when used on ungrounded systems
- Gold plated plug-in connections on printed circuit boards.
- Microprocessor based inverter logic isolated from power circuits.
- Nominal IGBT rise time of 200ns or longer.
- Inverter section has no commutation capacitors.
- The Main Control Board is the same for all ratings to optimize spare parts stocking and exchange.
- Common control connection for all ratings.
- Device Peripheral Interface (DPI) for connection to common options.
- Status LED for drive condition, viewable through the cover.
- Status LEDs for communications status, including embedded DPI status, adapter health and communications network status, viewable through the cover.

CONTROL LOGIC:

Programmable or self-adjusting for the following:

- Operating the drive with motor disconnected.
- Controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit and fault annunciation.
- Advanced thermal manager to provide full protection of the power devices by reducing PWM frequency, and output speed.
- Adjustable PWM carrier frequency within a range of 2-12 kHz.
- Selectable V/ Hz, Sensorless Vector, and Vector Control with Force Technology
- Suitable for use on both Normal Duty and Heavy Duty loads.
  - Normal Duty ratings are:
    - Rated Current continuously
    - 110% Overload capability for up to 1 minute
    - 150% Overload capability for up to 3 seconds
  - Heavy Duty ratings are:
    - Rated Current continuously
    - 150% Overload capability for up to 1 minute
    - 200% Overload capability for up to 3 seconds
- Multiple programmable stop modes including - Ramp, Coast, DC-Brake, and Ramp-to-Hold.
- Multiple acceleration and deceleration rates.
- All adjustments to be made with the door closed.
- Protection for loss of an input phase
- Adjustable output frequency up to 500Hz.

POWER CONDITIONING:

Designed to operate on an AC supply, which may contain line notching, and up to 10% harmonic distortion. An input isolation transformer is not required for protection from normal line transients. If line conditions dictate the use of a transformer, the required K factor is 4.0 or less.

OPERATOR INTERFACE:

Display is a 7 line by 21 character backlit LCD display with graphics capability. It is used to display drive operating conditions, fault / alarm indications and programming information with full text support in multiple languages, including but not limited to English, German, French, Italian, Spanish, Portuguese and Dutch.

The monitoring mode provides the following information on the display all at the same time (doesn't require jumping between screens)

1. A status line indicating direction, status, fault / alarm conditions and Auto / Manual mode.
2. Three additional lines that may be programmed for at least 20 different quantities with custom text and scaling capability. This section is also configurable as a "screen saver" with programmable timeout. When time expires, the LCD display automatically reverts to this display.

The Human Interface Module is available in three package styles:

- An IP20 / Type 1 used on the IP20 / Type 1 drive , or as a handheld terminal by connecting via a separate cable, or used in a bezel kit mounted to a cabinet / panel. In all cases this package style is removable (slides out) without the use of a tool.
- An IP66 / UL Type 4X-12 remote mounted version for cabinet / panel mounting that is connected via cable.
- An IP66 / UL Type 4X-12 local drive mounted version used for stand alone for IP66 / UL Type 4X-12 drives.
- An IP54 / UL Type 12 local drive mounted version used for stand alone for IP54 / UL Type 12 drives.

The Human Interface Module is available in 2 control versions. Both versions include programming keys, numeric keys for direct data entry, and an ALT (alternate function) key used for quick access to common tasks. These ALT functions include S.M.A.R.T. Start for fast and easy commissioning, View selection, Auto Manual operation, HIM removal under power, and device selection for programming:

1. Full Numeric with control buttons:
   This version includes the following drive operating keys (Start, Stop, Direction, Jog and Speed Control).
2. Full Numeric without control buttons (programmer only):
   This version does not include drive operating keys so that personnel cannot locally command motion from the Human Interface

ANALOG INPUTS

(1) differentially isolated 0 to 10V / 4 to 20mA input , ≥ 10 bit, ≥ 10V common mode voltage range
(1) differentially isolated bipolar -10 to +10V or 4-20 mA input, ≥ 10 bit plus sign, ≥ 160 V common mode voltage range.

All functions are programmable for a variety of uses including frequency command, process loop inputs and others. Inputs are also programmable for scaling (including invert), offset, signal loss detect and square root.

ANALOG OUTPUT

A single ended output capable of either 0 – 10 Vdc or 4 – 20mA is available as standard, and programmable for a wide variety of process parameters including output frequency, output current, output power and others. Programming is available to select either absolute or signed values of these parameters, in addition to offset and gain adjustments for matching signal requirements such as 2 – 10V DC.

REFERENCE SIGNALS:

Capable of the following speed reference signals:

- Digital MOP
- Jog
- HIM (Program/Control panel)
- Analog Input signals
- Preset Speeds (7)
- 16 bit network reference
- 32 bit network reference
- Encoder (pulse) signal

Analog input references are independently scaleable, both from the analog input side and from the speed reference side. A bi-polar analog signal (-10V to + 10V) may also be used to control direction.

Includes over speed protection in the event that the output frequency exceeds the maximum reference by a specified amount.

All reference signals may have a trim signal applied to them for finer resolution and accuracy. Trim source and amount is programmable.

LOSS OF REFERENCE:

Capable of sensing the following reference loss conditions;

- 2-10V DC signals below 2 volts
- 4-20ma signals below 4 ma

- In the event of loss of an analog input reference signal, the following actions are programmable:

  Fault the drive
  Alarm and maintain last reference
  Alarm and go to preset speed
  Alarm and go to minimum speed
  Alarm and go to maximum speed
  Alarm and maintain last output frequency

Signal loss detection is available regardless of the function of the analog input.

DIGITAL INPUTS:

Six inputs are provided and are configurable as 24Vdc sink or source. 115VAC control interface is available and fit under the cover of the drive. All inputs are individually programmable for functions from a list of 29 or more, that include Start (3-wire control), Run (2-wire control), Stop, External fault, Speed select, Jog, Process PI functions, and others. The state of these inputs can also be communicated over a network, whether the drive is using them for control functions or not. One of the digital inputs supports a dedicated enable input, which is configured by the removal of a jumper. All other digital inputs do not require jumpers or switches for digital input configuration.

Inputs draw 11.2 mA minimum each @ 24 VDC and require 19.2 V minimum for “ON” state and a maximum of 3.2 V for “OFF” state

DIGITAL OUTPUTS:

Two Form C (1 N.O - 1 N.C) output relays are provided. Contact output ratings are 250V AC/ 220V DC, 50VA and 60W (resistive), 25VA and 25W (inductive). Both relays are programmable for at least 26 different conditions including Fault, Alarm, At Speed, Drive Ready, PI Excess Error and others. Each output has on-delay and off-delay timers relative to the function assigned to the input. The inputs can also be controlled over network communications if they are not assigned to drive related functions.

SAFETY INPUT:

One Safe – Off interface option is provided. This interface, when used along with the dedicated enable digital input, is TUV certified to EN954-1, category 3. Drives less than 500V carry the TUV Functional Safety mark. 500 – 600V drives are supported by a TUV test certificate.

ENCODER FEEDBACK:

One incremental encoder interface option is provided. This option is selectable to receive either 5V or 12V from an encoder with a maximum of 250kHz. The encoder interface also has the ability to power the encoder. Minimum high state voltage is 3.5Vdc (5V mode) and 7.0Vdc (12V mode). Maximum low state voltage is 1Vdc (for both 5V and 12V modes).

FEATURES

ACCELERATION/DECELERATION:

Accel/Decel settings provide separate adjustments to allow either setting to be adjusted from 0.0 seconds to 3600.0 seconds. A second set of remotely selectable Accel/Decel settings are accessible through digital inputs. Programming capability allows the user to produce acc/dec profiles with linear or "S-Curve" characteristics that provide changing accel/decel rates. S-Curve profiles are adjustable.

AUTO ECONOMIZER:

This feature automatically reduces the output voltage when the drive is operating at a stable speed and partial load. The voltage is reduced to minimize flux current in a lightly loaded motor thus reducing kW usage. If the load increases, the drive will automatically return to normal operation.

AUTO / MANUAL MODE:

The Human Interface Module has the ability to switch between Auto (remote signals) and Manual (local control form the HIM buttons) for both speed reference and start control. Auto / Manual transfer of either speed reference, start control, or both, are programmable. The feature is compatible with both two wire and three wire digital input run / start assignments.

The user has the choice of preloading the HIM with the current “auto” frequency reference before transferring control to allow for smooth transitions.

AUTO RESTART:

Provides up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault, shorted output faults and other internal microprocessor faults. The time between restarts is adjustable from 0.5 seconds to 30.0 seconds.

BRAKING OPTIONS:

Dynamic Braking

A standard built in 7th IGBT for use as a dynamic braking chopper. This IGBT can provide at least 100% braking torque on a continuous basis. Drives up to 30 HP, 480V also have an optional drive mounted dynamic braking resistor for low duty cycle braking applications and interactive software to protect the resistor from abuse. If the resistor's duty cycle or power rating is exceeded, the drive software manages the operation of the 7th IGBT to bring the loading below the resistor's maximum level.

If applications require additional braking, the 7th IGBT is capable of driving an externally mounted resistor that can provide 100% duty cycle.

Flux Braking

An algorithm to provide additional braking power by eliminating additional regenerative energy as flux in the motor. This can be used during all decelerations including stopping.

Fast Braking

An algorithm to provide maximum braking power (during a stop command only) without the use of a DB resistor by maximizing slip in the motor.

BUS REGULATION:

DC Bus regulation is available to reduce the possibility of overvoltage trips due to regenerative conditions. The reaction to a bus voltage increase is programmable as follows.

Disabled:	faults on Overvoltage Fault
Adjust Frequency :	adjusts the output frequency to maintain bus voltage at a predetermined regulation level.
Dynamic Brake:	dissipates the excess energy on the bus through the internal DB chopper and connected resistor.
Both – DB 1st	begins by actuating the dynamic brake. If more response is needed, it will then adjust the output frequency.
Both – FRQ 1st	begins by adjusting the output frequency. If more response is needed, the it will then actuate the dynamic brake

Alternating between two of the above modes during operation is accomplished through digital input functions.

COMMUNICATIONS

DPI™ Peripheral INTERFACE

Provides an interface for up to 4 independent peripherals to be connected to the drive at one time. This protocol operates between 125K and 500k baud and allows for connection to other networks via third party suppliers. Connection and identification of DPI port addresses requires no user adjustments.

COMMUNICATIONS INTERFACE:

Capability for 1 internally mounted and 2 additional externally mounted communications interface cards. Internal cards use drive power and can operate at higher speeds. Externally mounted cards are separately powered and connected to the drive via a cable. The following is available as internal solutions:

DeviceNet
EtherNet IP
ControlNet Coax
ControlNet Fiber
Remote I/O

CONTROL MODE:

Programming provides the ability to select either V/ Hz, Sensorless Vector, or Vector Control with Force Technology. The sensorless vector and vector control modes use motor nameplate data plus motor operating data such as stator resistance, nominal flux current and flux up time to tune the motor / drive for optimum torque performance. The volts per hertz mode can be programmed for constant torque, fan/pump curve, or full custom patterns.

CURRENT LIMIT:

Programmable current limit up to 150% of drive rated amps. Current limit is active for all drive states; accelerating, constant speed and decelerating. Both the source of the current limit value and the gain for responsiveness adjustment are programmable. Employs PI regulation with an adjustable gain for smooth transition in and out of current limit.

DRIVE OVERLOAD PROTECTION:

Provides overload protection that automatically adjusts PWM frequency, Current Limit, or both (programmable) in an attempt to provide tripless operation. Two different levels of accumulated overload can be signaled as alarm conditions, allowing the user to adjust a process to eliminate an overload trip. A parameter is available to directly read the level of accumulated overload.

DROOP CONTROL

This function reduces output frequency in response to load, allowing other drives to share the load. Function is adjustable in amount of RPM difference at full load.

FAULT MEMORY:

The last four fault codes with respective times are stored in the fault buffer. In addition, information about the drive's condition at the time of the last fault such as operating frequency, output current, dc bus voltage and 27 other status conditions are stored at the time of fault. Information is maintained in the event of a power loss. A power up marker is also provided at each power up time to aid in analyzing fault data.

FLUX UP:

This function prefluxes the motor for quicker starts in high cycle applications. The flux-up time can be manually adjusted or automatically calculated based on entered motor nameplate data.

FLYING START:

Capable of determining the speed and direction of a spinning motor and matching the frequency and voltage, with or without the use of encoder feedback.

INERTIA RIDE THROUGH:

Responds to a loss of AC input power by adjusting the output frequency to create a regenerative situation in the motor allowing the drive to retain control of the motor during a power outage. Performance is based on the amount of system inertia and the length of the outage.

LOAD LOSS DETECTION:

Capable of detecting when the load has been reduced to a specified amount, which is adjustable. An alarm will occur when this condition is present, and a fault will occur when the condition exists for a specified amount of time, which is also adjustable. The detection is based on a torque measurement algorithm and not simply just total output current.

MEMORY STORAGE:

Stores all settings in NVS (non-volatile storage) memory, which is retained while the drive is powered or unpowered. Three User Set locations are offered and can be chosen instantaneously (while the drive is stopped) through a single network command or by actuating the digital inputs when programmed for this function. The user sets can also be independently named.

MOTOR OVERLOAD PROTECTION:

Provides UL listed Class 10 motor overload protection to comply with N.E.C. Article 430. Overload protection is speed sensitive and adjustable. To accommodate a variety of motors with different speed range capabilities, the frequency at which the overload begins to derate is programmable.

PROCESS PID CONTROL:

The internal process PID regulator has proportional, integral, and derivative gain adjustments as well as error inversion, integrator preload, and anti-windup functions. Protection is provided for a loss of feedback or reference signal. A signal can also be provided to indicate that excess error exists.

RIDE THROUGH:

Control logic is capable of "riding through" a power outage of at least 0.5 seconds in duration. The inverter section is shut off after an 18% drop in bus voltage to conserve power for the drive logic.

SKIP FREQUENCIES:

Three adjustable setpoints that lock out continuous operation at frequencies that may produce mechanical resonance are provided. The setpoints have a bandwidth adjustable from 0Hz to 60Hz.

SLEEP / WAKE MODE:

Capability to use an analog input as a Start – Stop command. A signal below the sleep level acts as a Stop Command and a signal above the wake level acts as a Start Command. Sleep / Wake time and level are fully programmable and can be inverted.

SPEED REGULATION:

Performs as follows in the Vector Control mode:

- Open Loop: 120:1 operating range. 0.1% of base speed across 120:1 speed range
- Closed Loop: 1000:1 operating range. 0.001% of base speed across 120:1 speed range.

START AT POWER UP:

A user programmable restart function is provided to automatically restart the equipment after restoration of power after an outage. A run or start input is required for this function.

START UP ROUTINES:

Start Up Routines allow the user to commission the drive more quickly and accurately. Two type of routines exist:
S.M.A.R.T. Start
Assisted Start Up

S.M.A.R.T. Start is accessible by using the "ALT" function key on the LCD HIM. This simple 2-keystroke access brings up a list of parameters needed to program the eight most commonly adjusted drive functions. They include Start, Stop, Minimum Speed, Maximum Speed, Acceleration Time, Deceleration Time, Reference source (speed command) and Electronic Overload setting for the motor. No knowledge of parameter organization or access is required. S.M.A.R.T. Start can commission the drive in just a few minutes.

Assisted Start Up routine to aid the user in commissioning the drive asking simple Yes/No or "Enter Data" questions. The user is guided through the Start Up to reduce the amount of time necessary to get the drive "up and running". The following are included in startup:

- Input Voltage Ratings
- Motor Data
- Motor Tests & Auto-tuning
- Speed/Torque Control & Direction Limits
- Speed Reference
- Start & Stop Modes
- Ramp setup
- Digital and analog I/O

Auto-Tune is also available independently to aid in setup of the Sensorless Vector and Vector Control algorithms. Both a static (motor does not rotate) and a dynamic (motor rotates) routine are available. If tuning is not desirable, the drive can be instructed to calculate the values for tuning directly based on entered motor data.

TEST POINTS:

Two electronic test point parameters are available to examine data within the drive memory that is not available through other parameters.

TORQUE REGULATION:

Performs as follows in the Vector Control mode:

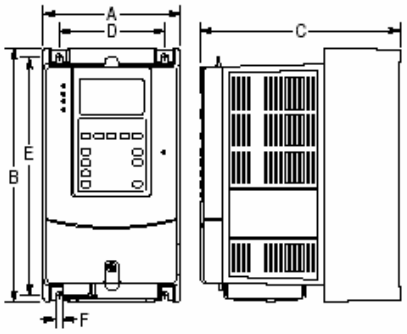
- Open Loop: + / - 10% of full torque
- Closed Loop: + / - 5% of full torque

DIMENSIONS:

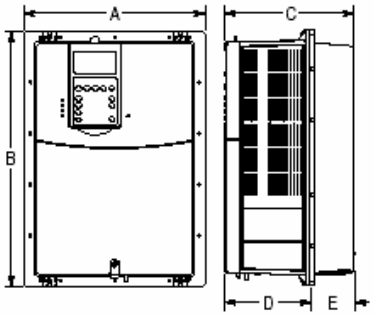
Rating/Frame Size Cross-Reference

Output Power		Frame Size								
		200-240V			400-480V			500-600V		
kW ND (HD)	HP ND (HD)	Without Internal Filter	With Internal Filter	IP66, NEMA Type 4X/12	Without Internal Filter	With Internal Filter	IP66, NEMA Type 4X/12	Without Internal Filter	With Internal Filter	IP66, NEMA Type 4X/12
0.37 (0.25)	0.5 (0.33)	A	B	B	A	B	B	A	–	B
0.75 (0.55)	1.0 (0.75)	A	B	B	A	B	B	A	–	B
1.5 (1.1)	2.0 (1.5)	B	B	B	A	B	B	A	–	B
2.2 (1.5)	3.0 (2.0)	B	B	B	B	B	B	B	–	B
4.0 (3.0)	5.0 (3.0)	–	C	D	B	B	B	B	–	B
5.5 (4.0)	7.5 (5.0)	–	D	D	–	C	D	C	–	D
7.5 (5.5)	10 (7.5)	–	D	D	–	C	D	C	–	D
11 (7.5)	15 (10)	–	D	D	–	D	D	D	–	D
15 (11)	20 (15)	–	E	E	–	D	D	D	–	D
18.5 (15)	25 (20)	–	E	E	–	D	D	D	–	D
22 (18.5)	30 (25)	–	–	–	–	D	D	D	–	D
30 (22)	40 (30)	–	–	–	–	E	E	–	E	E
37 (30)	50 (40)	–	–	–	–	E	E	–	E	E

IP20/66, NEMA Type 1/4X/12



Flange Mount



Dimensions are in millimeters and (inches).

Frame	A	B	C	D	E	F	Drive Weight ⓘ *kg (lbs.)*
IP20, NEMA Type 1							
A	122.4 (4.82)	225.7 (8.89)	179.8 (7.08)	94.2 (3.71)	211.6 (8.33)	5.8 (0.23)	2.71 (6.0)
B	171.7 (6.76)	234.6 (9.24)	179.8 (7.08)	122.7 (4.83)	220.2 (8.67)	5.8 (0.23)	3.60 (7.9)
C	185.0 (7.28)	300.0 (11.81)	179.8 (7.08)	137.6 (5.42)	285.6 (11.25)	5.8 (0.23)	6.89 (15.2)
D	219.9 (8.66)	350.0 (13.78)	179.8 (7.08)	169.0 (6.65)	335.6 (13.21)	5.8 (0.23)	9.25 (20.4)
E	280.3 (11.04)	555.8 (21.88)	207.1 (8.15)	200.0 (7.87)	491.0 (19.33)	6.9 (0.27)	18.60 (41.0)
IP66, NEMA Type 4X/12							
B	171.7 (6.76)	239.8 (9.44)	203.3 (8.00)	122.7 (4.83)	220.2 (8.67)	5.8 (0.23)	3.61 (8.0)
D	219.9 (8.66)	350.0 (13.78)	210.7 (8.29)	169.0 (6.65)	335.6 (13.21)	5.8 (0.23)	9.13 (20.1)
E	280.3 (11.04)	555.8 (21.88)	219.8 (8.65)	200.0 (7.87)	491.0 (19.33)	6.9 (0.27)	18.60 (41.0)
Flange Mount							
A	156.0 (6.14)	225.8 (8.89)	178.6 (7.03)	123.0 (4.84)	55.6 (2.19)	–	2.71 (6.0)
B	205.2 (8.08)	234.6 (9.24)	178.6 (7.03)	123.0 (4.84)	55.6 (2.19)	–	3.60 (7.9)
C	219.0 (8.62)	300.0 (11.81)	178.6 (7.03)	123.0 (4.84)	55.6 (2.19)	–	6.89 (15.2)
D	248.4 (9.78)	350.0 (13.78)	178.6 (7.03)	123.0 (4.84)	55.6 (2.19)	–	9.25 (19.8)
E	280.3 (11.04)	555.8 (21.88)	207.1 (8.15)	117.2 (4.61)	89.9 (3.54)	–	18.60 (41.0)